CHALMERS
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Accelerating Sustainability through Business Models & Digital Solutions

Exploring how to impact a sustainable transition within the Swedish food system

Master Thesis within Management and Economics of Innovation

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SUMMARY
The critical importance of sustainability has recently been highly discussed within society and by actors such as the UN. In addition to the current climate crisis, recent years have been further characterized by several external shocks such as the COVID-19 pandemic, global conflicts, and associated supply chain implications. These external shocks have impacted the economic environment, and hence the ongoing inflation. Furthermore, the food industry is the third largest industry in Sweden, and therefore the industry is central to achieve a sustainable Swedish society. However, due to critical external shocks, the industry is currently in an urgent state. Hence, it is highly important to explore how a sustainable transition within the industry can be accelerated. Moreover, key industrial trends are digitalization and increased focus on plant-based products. To accelerate the transition, the research study aims to explore the potential impact of traceability and sustainable business models.

The research study followed an abductive approach by iteratively combining previous research and the empirical environment. The research design was developed based on the Double Diamond principle, hence the research study was divided into two subsequential phases; research study 1 and research study 2. The data collection consisted of qualitative interviews and collection of secondary data. The findings were analyzed through a thematic analysis and from the perspective of previous research, as well as further discussed.

Five key factors were identified as critical for actors to consider achieving a sustainable industry. The concept of a Dynamic Market Fit was further developed to highlight the importance of simultaneously adopting to and influencing customer demand. Moreover, the research study concludes that there is an identified unlocked potential for sustainable business models, that could positively support the transition. Similarly, a great potential with traceability was further identified, as well as the associated potential positive impact on sustainable business models. Despite the great potential with traceability, the technology is considerably in an emerging phase, characterized by several explorative actors. Finally, the research study concludes that individual and collaborative actions are required from all actors within the industry to accelerate a sustainable transition.

Keywords: Sustainable transition, food industry, sustainable business models, traceability, sustainable strategies, digital solutions.

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The research study will conclude our master's degree within Management and Economics of Innovation at Chalmers University of Technology, after a bachelor's degree within Industrial Engineering and Management. We would therefore like to express our gratefulness and gratitude towards our friends and family for all support, knowledgeable experiences, and happy memories during these years at Chalmers University of Technology.

Ellen Antonsson Torin
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Ella Wallinder
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1. Introduction

Awareness regarding sustainability has massively increased during recent years and is currently a highly critical factor to consider for society (Coppla & Blohmke, 2019; Steinmann, 2023). The Intergovernmental panel on climate change (IPCC) (2023) further stress today's critical climate situation and the importance of required actions. For instance, unsustainable lifestyles have historically accelerated, resulting in a negative impact on the environment e.g., increased fluctuations in weather (IPCC, 2023). The Sustainable Development Goals (SDG) created by the United Nations (UN) were initiated to establish a global agenda for how to e.g., tackle climate change (UN, 2023). The SDG are based on the description of sustainability considering economic, environmental, and societal factors (UN, 2023). To achieve these goals, the food industry has a central role in the transition to a sustainable society (Barth et al., 2021; Röös et al., 2023). The Swedish Board of Agriculture (2022) highlights the correlated and uncorrelated challenges related to a sustainable agriculture. Correlated challenges include for instance sufficient food production and greenhouse emissions, whereas uncorrelated challenges rather include external changes (The Swedish Board of Agriculture, 2022). The ongoing climate crisis, COVID-19 pandemic, emergent conflicts, energy crisis, and global inflation exemplify external challenges in today's society (UN, 2022). With regards to the food industry, some of these external factors have resulted in changed consumer behaviour towards a focus on e.g., high value/price ratio, which further have resulted in e.g., switching of brands (Bazzoni et al., 2022; The Swedish Food Federation, 2023a). Additionally, the demand for sustainable products have decreased, potentially indicating that these products are sensitive to changes in the economic environment (Johansson, 2023).

With the aim of managing today's critical situation, several global organisations, countries, companies, and individuals have initiated actions to positively impact a sustainable transition (IPCC, 2023). Agriculturally related actions include factors such as production efficiency, ecosystem benefits, and food security. Consequentially, the aims are to e.g., reduce residual waste and restore biodiversity (IPCC, 2023). However, further actions are required globally to achieve a sustainable transition (IPCC, 2023). Moreover, positive tipping points have been identified as a potential source to accelerate the transition, and when achieved, they could have a fundamental impact on the system (The Food and Land Use Coalition, 2021). However, despite their great potential, they are yet to be explored (The Food and Land Use Coalition, 2021). Additionally, the importance of maintaining a holistic business perspective by considering all

impacted stakeholders is highlighted as well as the potentially associated increased costs (The Swedish Agency for Economic and Regional Growth, 2023).

The food sector represents the third largest industry in Sweden (The Swedish Food Federation, 2023b), and is therefore considered highly central for the transition. Moreover, the Swedish industry is considerably at the forefront due to sustainable actions by actors, however, additional actions are critical (The Swedish Board of Agriculture, 2022). Furthermore, the increased focus on value/price ratio has negatively impacted the profitability for Swedish producers within the industry (The Swedish Food Federation, 2023a).

For companies to address today's critical challenges and to sense and seize potential opportunities, business model innovations are central (Gennari, 2022). The Swedish Agency for Economic and Regional Growth (2023) stresses that business models are impacted by the agricultural digitalization and are central for establishing competitive advantages. Similarly, PiiA (2020) highlights the importance of new business models to fully utilize the potential with digitalization. Despite the potential with business model innovation, Aagaard et al. (2021) address the lack of research on the relationship between sustainable transitions and business models.

1.1 Industry Background

Johansson and Gidlund (2021) describe the food value chain through four segments; primary production, food processing, retail, and restaurant and other facilities which provide food in e.g., hospitals or schools. However, the research study is mainly focused on primary production, food processing, and retail, as presented in Figure 1. The number of actors within each value chain segment is radically decreasing from primary producers to retailers (The Swedish Board of Agriculture, 2022). Within primary production, small companies dominate the business population and contribute to the majority of turnover and employment (Johansson, 2023). These characteristics can further be applied for the companies within the food processing segment, however to a slightly lower ratio. While the retail segment also includes many small business actors, large companies contribute to the majority of turnover and employment (Johansson, 2023).

Figure 1

A delimited illustration of the food value chain

Note. A simplified and delimited description of the various activities in the food value chain based on the research study's focus area.

To achieve a sustainable transition in the food industry, value chain actors are key enablers (Röös et al., 2023). However, the industry is fragmented due to diverse actor characteristics (PiiA, 2020). Moreover, a high business risk level is associated with primary production regarding e.g., weather uncertainties and difficulty in adjusting after fluctuating demand due to long product lead times (European Commission, 2023). Low margins within primary production further limit the possibilities for reinvestments, increasing the dependencies from public funding (PiiA, 2020). Additionally, Sweden has significantly lower levels of financial governmental support in research and development in comparison with other Nordic countries (The Swedish Agency for Economic and Regional Growth, 2023). To grow the Swedish industry, increased export is essential and the high, national knowledge regarding sustainable, ethical, and secure production methods are stressed as potential competitive advantages (PiiA, 2020).

The shift towards plant-based products have been identified as a key trend within the Swedish food industry (Malmer, 2021; Axel Johnson, 2023). The sales in plant-based products advanced during the Covid-19 pandemic (European Institute of Technology and Innovation (EIT) Food, n.d.; Axel Johnson, 2023), potentially explained by increased time spent on cooking and increased willingness to try new products (Axel Johnson, 2023). However, the trend stagnated in 2022 due to increased price sensitivity among consumers, caused by the economic environment (Axel Johnson, 2023). Additionally, the economic environment and turbulent times could potentially have negatively affected consumers' openness, who tends to switch to more traditional food and away from plant-based alternatives. However, improved scalability and intensified competition are driving plant-based products to reach critical adoption levels of value/price, which is necessary to compete with traditional alternatives (Axel Johnson, 2023).

Furthermore, the food industry is impacted by increased digitalization (The Swedish Agency for Economic and Regional Growth, 2023; Malmer, 2021; Axel Johnson, 2023). For instance, the utilization of connectivity is expected to increase, resulting in potentially increased efficiency within food production (The

Swedish Agency for Economic and Regional Growth, 2023). The potential with digitalization within the industry could positively impact profitability and value creation through reduced costs and increased transparency (PiiA, 2020).

1.2 Empirical Setting

The research study was initiated as a part of the research consortia Food Innovation for sustainable system transitions (FINEST), coordinated by Research Institute of Sweden (RISE). The purpose of FINEST is to support the transition towards an environmentally, economically, and socially sustainable food sector (RISE, 2023). FINEST consists of both academic and industrial partners and supports individual actors by identifying and addressing potential collaboration areas to manage challenging issues (RISE, 2023). Moreover, the research study was further conducted in collaboration with Lantmännen and ICA Sweden. Lantmännen and ICA Sweden are two of these industry partners, and based on their various value chain positions, as well as great interest within this area, these partners are the industrial stakeholders in the research study.

Lantmännen is a cooperative company within agriculture owned by 19 000 primary producers, with the purpose of creating a long-term, economically profitable, and sustainable agriculture (Lantmännen, 2023). Their core activities lie within the first two steps of Figure 1, primary production, and food processors (Lantmännen, 2023). ICA Sweden is a food retailer with around 1300 stores in Sweden (ICA Real Estate, 2023), and 53% of the Swedish market share in 2022 (The Swedish Grocery Trade Association, 2022). The organization consists of locally independent retailers and a central unit of ICA Sweden, resulting in a combination of strong local consumer knowledge and economics of scale due to the central group's supporting functions (The ICA Group, 2021).

1.3 Aim

The research study aims to explore how a sustainable transition can be achieved within the Swedish food industry, and how sustainable business models and traceability can support a sustainable transition. The intention is to maintain both a short-term perspective and a long-term perspective. The short-term perspective is central to manage the current urgent situation, and the long-term perspective is central to explore how to create and capture new business values.

The intention is that the research study will contribute with increased understanding of the current state of art in the Swedish food industry, identified unlocked business potential, as well as prioritized areas to guide actors in their contribution to a sustainable transition. The research study further aims to inspire actors to engage in the complex yet critical sustainable transition of the Swedish food industry.

1.4 Purpose and Research Questions

The food industry is considerably in a critical phase, hence actors within the value chain have several aspects to consider to successfully manage the current situation. The purpose of the research study was to understand which factors are critical to consider accelerating a sustainable transition of the food industry. Based on these identified factors, the purpose was to discover and explore a potential key area that could leverage the identified factors. Due to largely available information and great interest, the research study was divided into two phases to enable a deep exploration of the two studied areas. The two phases are referred to as research study 1 and research study 2.

The aim with research study 1 was to answer research question 1. Based on research question 1, research question 2 was further developed when traceability was identified as a key enabler to accelerate the transition to a sustainable food industry.

Research Question 1:

What are key factors to consider supporting a sustainable transition within the Swedish food industry?

Research Question 2:

How can traceability leverage value creation for actors?

1.5 Delimitations

The research study was delimited geographically to the Swedish food industry to be able to perform an in-debt analysis and to propose implications based on the current industry characteristics. The food value chain was delimited to focus on plant-based products since this is a high-priority area for all stakeholders. The research study refers to plant-based substitutes and plant-based alternatives. Plant-based substitutes are referred to as plant-based proteins processed to have similar characteristics as meet, while plant-based alternatives are referred to as plant-based raw products such as lentils, beans, and peas. However, inspiration was drawn from studying foreign, and adjacent food value chains to identify opportunities.

The research study maintained a holistic perspective on the delimited value chain, covering all segments in Figure 1. However, an increased focus will be on the research study's stakeholders and their position in the value chain.

2. Method

The aim of this section was to describe the research design, data collection, and associated data analysis. A critical analysis of the research design as well as ethical considerations were further performed.

2.1 Research Design

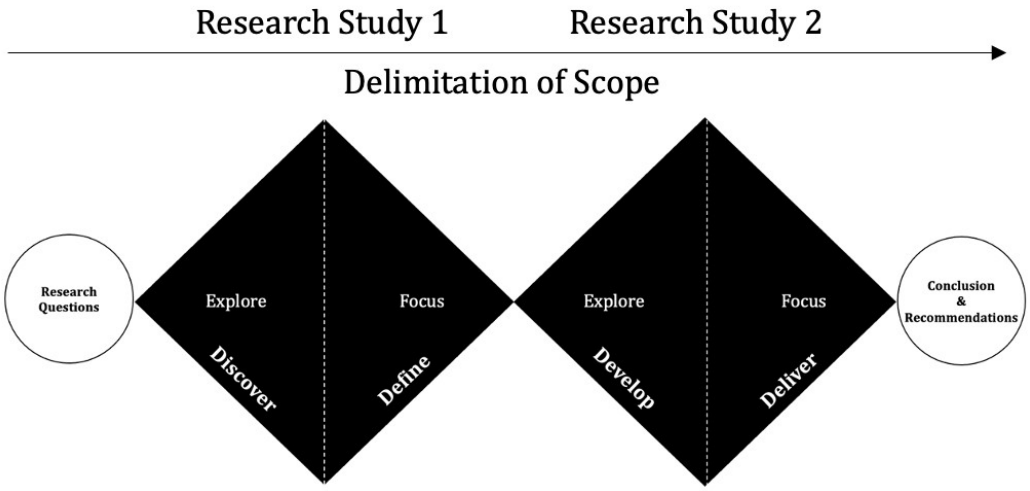
The research study followed a qualitative approach and an abductive method (Bell et al., 2019). The intention was that the research questions would benefit from this approach due to their exploratory nature, the ability to use various analysis levels, and the iterative research strategy between previous research and the empirical setting (Bell et al., 2019). Systematic combining is the concept of the bidimensional research strategy and is beneficial for agile research studies as well as when incrementally developing theoretical concepts (Dubois & Gadde, 2002).

Moreover, the research study consisted of two phases, research study 1 and research study 2. The design process of the research study was based on the Double Diamond principle, developed by Design Council (2019). The intention was to enable two explorative phases to answer the research questions sequentially. Design Council (2019) describes the double diamond based on four phases; discover, define, develop, and deliver, which are represented in Figure 2. The discovery phase enables an explorative approach and increases the understanding of the area to investigate. Based on these insights, a research scope can be delimited in the define phase (Design Council, 2019). In the research study, the discovery phase was represented by the data collection in research study 1, with the aim to answer RQ1. Based on these insights, traceability was identified in the define phase as a key enabler for a sustainable transition, consequentially, RQ2 was redefined to delimit the scope.

Thereafter the develop phase allows for an additional explorative approach to identify potential solutions to the more deeply defined scope (Design Council, 2019). This was represented by the data collection in research study 2. The aim was to answer RQ2, which was performed in the deliver phase. By including two phases to explore and two phases to focus, the aim was that this would result in a more deeply investigated research study.

Figure 2

An illustrative presentation of the developed Double Diamond method that was used as research design



Note. A description of the Double Diamond method that was used during the research study. The various steps are based on the Double Diamond Principle developed by Design Council (2019). However, the figure is illustrated specifically for the research study.

Research study 1 and research study 2 followed similar research approaches. Both research studies had an explorative approach, and the data collection consisted of a combination of qualitative interviews and collection of secondary data. The main differences between research study 1 and research study 2 were the studied area, the key search words during the collection of secondary data, and the focus of the interviewees.

Moreover, an external validation was made for the findings, analysis, and discussion of research study 1 and research study 2. The external validation was performed through a presentation to industry and research actors, as well a critical study and discussion of the provided information. The aim was to increase the validity of research study 1 and research study 2.

2.2 Data Collection in Research Study 1

The data collection in research study 1 consisted of both qualitative interviews and collection of secondary data, described in detail in the following section. The findings of the data collection resulted in a developed framework of five key factors to consider to successfully support the transition to a sustainable food industry.

2.2.1 Qualitative Interviews in Research Study 1

Qualitative interviews were used as a key data collection method. Qualitative interviews with industry experts and knowledgeable stakeholder representatives were performed through individual interviews and focus group interviews. In total, 13 individual interviews were conducted, as well as 2 focus group interviews. The aim with the focus groups was to enable discussions and to combine various perspectives of the subject. All interviews followed a semi-structured approach. A semi-structured interview enables the interviewer to ask pre-prepared questions, combined with spontaneous follow-up questions (Bell et al., 2019). The used interview guide is attached in Appendix A. However, the interview guides were iterated throughout the research study due to increased developed knowledge and updated scope. The aim of using this approach was to enable and identify interesting areas while ensuring that the interviews provided relevant and sufficient data for the research scope. A purposive sample approach was used mainly through a snowball sampling method and the sample size was dependent on identified interviewees, depth of interviews, and data saturation (Bell et al., 2019). The intention was that all interviews would be performed face-to-face, however, due to efficiency and practicalities, digital interviews through Microsoft Teams and telephone, were used as well. Bell et al. (2019) highlight several benefits of recording and transcribing of interviews e.g., natural flow during the interviews. Therefore, all interviewees were asked for permission to record the interviews. The recording was mainly performed through Microsoft Teams, however, in some cases an additionally recording on the interviewers' phones was performed as well to avoid technical issues. The interviewees were approximately between 30 minutes to 60 minutes. All interviewees from research study 1 are summarized in Tables 1, 2, and 3 below. Moreover, both interviewers participated in all interviews, and the responsibility of being the main interviewer was shared equally. Furthermore, to increase validity, reliability, and transparency, all interviews were transcribed and summarized, and thereafter shared with the interviewee to ensure data consistency. However, the transcriptions of focus group two and three were only shared upon request due to time constraints and a mutual agreement.

Table 1

Summary of all individual interviews that were held during research study 1

Company	Role
ICA Group	Chief Strategy Officer
ICA Group	Co-lead ICAx
ICA Group	Head of Sustainability Strategy & Development
ICA Group	Senior Sustainability Manager
Lantmännen	Director Digital Business Development
Lantmännen	Group Strategy Director
Lantmännen	Project Manager Agriculture
Lantmännen	Strategy & Digital Business Development
Lantmännen	Sustainability Project Manager
RISE	Postdoctoral Researcher
RISE	Research & Business Leader within Food and Agriculture
RISE	Research & Business Leader within Food and Agriculture
RISE	Scientist Food Functionality

Note. This table presents the individual interviewees that participated in the data collection for research study 1. The interviewees are represented by their company and associated title.

Table 2

Summary of all interviewees in focus group 1 that was held during research study 1

Company	Role
ICA Sweden	Innovation Manager
ICA Sweden	Scale-up Manager

Note. This table presents all interviewees that participated in focus group 1 by presenting their company and associated role. The interview was held during the data collection for research study 1.

Table 3

Summary of all interviewees in focus group 2 that was held during research study 1

Company	Role
Chalmers University of Technology	Professor in Innovation Management
ICA Sweden	Innovation Manager
Jönköping University	Senior Lecture (PhD) in Management
Lantmännen	Innovation Manager

Note. This table presents all interviewees that participated in focus group 2 by presenting their company and associated role. The interview was held during the data collection for research study 1.

2.2.2 Collection of Secondary Data in Research Study 1

Collection of secondary data was used as a key data collection method during the research study. To enable the initial explorative phase of the Double Diamond principle, and to be open-minded for various data, the literature review was based on the perspective of Bell et al. (2019) regarding a narrative review. Bell et al. (2019) highlight several benefits of utilizing existing resources, for instance, time efficiency and quality insurance. The main source bases were online databases, and to ensure validity, reliable databases e.g., Chalmers Online Library and Google Scholar were used. However, additional sources e.g., corporate, or organisational webpages, published articles or reports, and books were used as well to ensure a sufficient data collection.

Searching keywords followed an explorative nature (Bell et al., 2019), and relevant keywords such as *business models, sustainability,* and *food industry* was used.

2.3 Data Collection in Research Study 2

The data collection in research study 2 consisted of both qualitative interviews and the collection of secondary data. Details about the interview method, the interviewees, and the method for the collection of secondary data are described in the following section.

2.3.1 Qualitative Interviews in Research Study 2

Research study 2 followed a similar interview approach as in research study 1, which is further described in 2.2.1. The qualitative interviewees included 13 individual interviews, and one focus group interview. These interviewees are concluded in Tables 4, and 5. Moreover, the interview guide for research study 2 is attached in Appendix B.

Table 4

Summary of all individual interviews that were held during research study 2

Company	Role
Agronod	Manager for Innovation & Collaboration
Foodchain by Blockchain	Chief Executive Officer & Founder
ICA Sweden	Data Governance Manager
ICA Sweden	Sustainability and Quality Manager Food & Nearfood
ICA Sweden	Retailer
Lantmännen	Director Digital Business Development
Lantmännen	Strategic Communication
Lantmännen	Business Developer
Primary Producer	Farmer in Crop Cultivation & Animal Production
Primary Producer	Farmer in Crop Cultivation & Animal Production
Primary Producer	Farmer in Crop Cultivation
Primary Producer	Farmer in Crop Cultivation
Sweden Food Arena	Director of Operations

Note. This table presents the individual interviewees that participated in the data collection for research study 2. The interviewees are represented by their company and associated title.

Table 5

Summary of all interviewees in focus group 3 that was held during research study 2

Company	Role
Chalmers University of Technology	Professor in Innovation Management
ICA Sweden	Innovation Manager
Jönköping University	Senior Lecture (PhD) in Management
Lantmännen	Innovation Manager

Note. This table presents the interviewees that participated in focus group 3 by presenting their company and associated role. The interview was held during the data collection for research study 2.

2.3.2 Collection of Secondary Data in Research Study 2

Research study 2 followed a similar approach regarding collection of secondary data as in research study 1. The approach is further explained in 2.2.2. However, key search words in research study 2 were *digitalization, traceability,* and *sustainability.*

Moreover, the collection of secondary data resulted in the identification of two empirical examples of traceability regarding *IBM Food Trust* and TE-Food. These examples are further explained in 5.1.2.

2.4 Analysis of Qualitative Data

The collected interview data was mainly analysed by following the concept of thematic analysis, enabling an analysis that focused on identifying concluding themes (Bell et al., 2019). The thematic analysis was of an explorative nature with the aim of identifying recurring or specifically important perspectives from the interview transcriptions. These perspectives were noted as various individual labels and thereafter clustered into themes.

The analysed interview data was further combined with other secondary sources e.g., scientific articles, to extend and deepen the analysis. The combination of interviews and secondary data enabled an increased understanding for the studied areas, consideration of various perspectives, and validation of information. The collection of secondary sources and held interviewees were iterative. However, despite that the combined data collection was iterated, there could be a potential bias due to the initial thematic analysis of the interviews.

2.5 Critical Analysis of the Research Design

The explorative approach of the Double Diamond method could possibly result in time constraints for the research study in general due to difficulties in reaching data saturation. The potential time constraint is especially related to research study 1 due to the wide scope, explorative nature, and focus on increasing knowledge within the research study in general.

Moreover, it is critical to highlight the potential lack of being collectively exhaustive in the developed framework of five key factors to consider accelerating a sustainable transition. The main constraints are due to the limitation of selective sources, interviews, and perspectives.

2.6 Ethical Considerations

To ensure a transparent and ethical methodology there were additional aspects that were considered. Firstly, all interviewees are anonymous to avoid potential harm (Bell et al., 2019). However, if permission was allowed, some information e.g., the interviewees' corporate role, was included to increase the understanding of the collected data. This information is summarized in the Tables 1, 2, 3, 4, and 5 above. Bell et al. (2019) further state important factors in interview preparations e.g., formulation of questions, and topic relevance. Therefore, a preliminary interview template was created before each interview phase, and then shared

with the university supervisor to ensure the relevance, and language of questions to e.g., avoiding leading questions. Furthermore, information about the aim of the research study was communicated in advance, as well as the interview questions if requested, to enable full transparency.

3. Previous Research on Sustainable Transitions

The aim of describing previous research was to develop an understanding for the dynamics between industry actors, how innovations are diffused, and sustainable business models. These concepts were divided into the following main sub-titles; Sociotechnical Transitions; and Sustainable Business Models. However, the impact from digitalization was systematically considered.

3.1 Sociotechnical Transitions

Transitions towards a sustainable sociotechnical system are described as major changes in an existing system that ensure a sustainable future without radical changing today's living conditions (Markard et al., 2020). Moreover, diffusions of innovations are central to potentially leverage sustainability transitions within a sociotechnical system (Markard et al., 2020).

3.1.1 Sociotechnical Systems

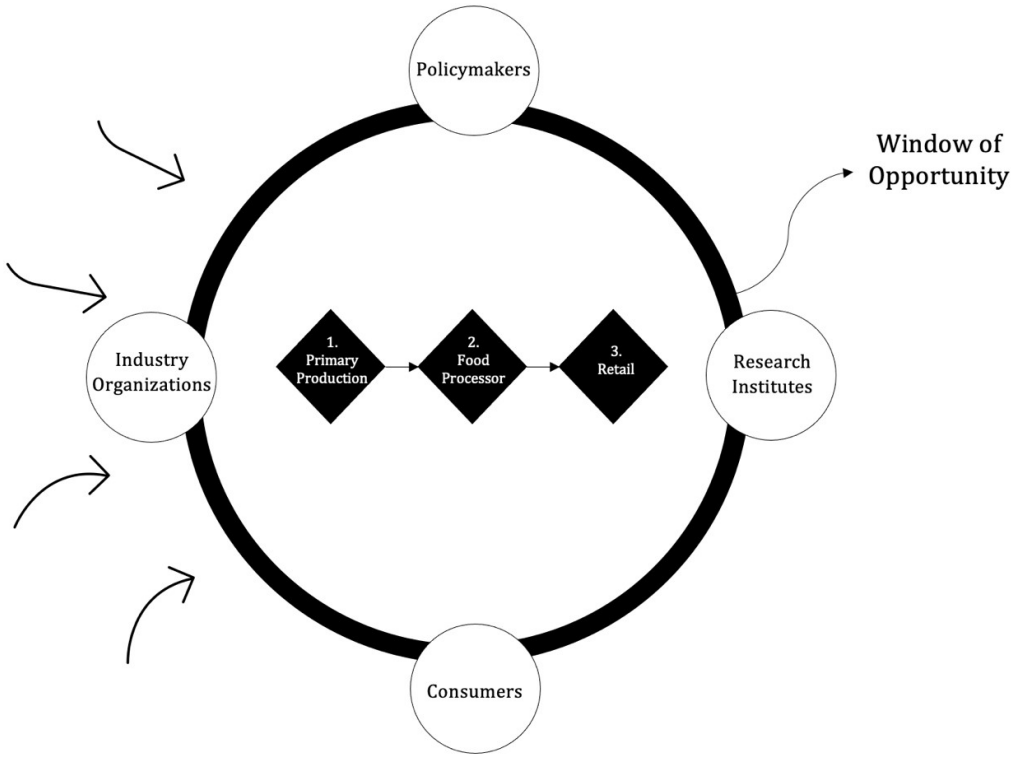
The sociotechnical system takes a holistic approach on innovation to describe how societal groups and technology can co-evolve to accelerate sociotechnical transitions, i.e., large changes in societal functions (Geels, 2004). Innovation can be defined as something new and commercially useful (Korres, 2012; Granstrand & Holgersson, 2020). The concepts of innovation can have various characteristics depending on the context (Korres, 2012). An incremental innovation is an improvement of an existing product (Veryzer, 1998), while a radical innovation is an innovation that radically impact actors' business models, value chains, and industry characteristics (O'Connor, 2008).

The sociotechnical system is characterised by various sociotechnical regimes, e.g., consumers, standards, and regulations, that impact the nature of the sociotechnical system (Geels, 2002). The sociotechnical system further considers several actors who influence a transition, e.g., industry actors, public authorities, consumers, research institutes, and other societal groups, (Geels, 2004), further referred to as innovation system actors. Further, Geels (2004) describes how niche innovations that differ radically from the existing system can emerge when the existing system is destabilized, which creates "windows of opportunity" (p.914) for radical innovations. The cause of the destabilization can differ, but is exemplified by changed societal values, consumer preferences, and climate change (Geels, 2004). The destabilization of a sociotechnical system is graphically illustrated in Figure 3. However, the destabilization is gradually established rather

than directly changed (Geels, 2002). Furthermore, the acceleration of the system transformation differs depending on the local context, since political forces, industry actors and social norms are country specific (Geels et al., 2017). Tödtling and Trippl (2005) further strengthen the importance of local context, arguing that strategies and policies must be adapted to country specific needs.

Figure 3

An illustration of a potential destabilization of a sociotechnical system



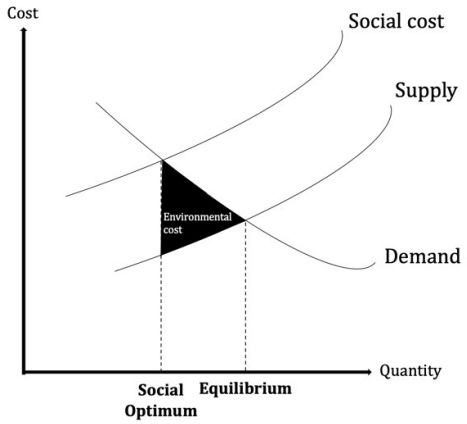
Note. Figure 3 illustrates a potential destabilization of a sociotechnical system, based on the description of Geels (2002) and Geels (2004). However, the figure is developed especially for the research study and the related empirical setting, hence the value chain actors correspond to the value chain actors in Figure 1.

The notion of potential impact from social constructions is further highlighted by Tödtling and Trippl (2005) as central for the development of innovations. Social constructions can be further exemplified through individual or collaborative strategic actions by companies that can impact the system (Geels, 2004). The social constructions are described as ""soft" institutions" (p.1205), in contrast to ""hard" institutions" (p.1205) which include e.g., political regulations (Tödtling & Trippl, 2005). Innovation systems are impacted by various institutions, and it is central to stress that national innovation systems are impacted by multi-level institutions from e.g., a European Union (EU)-level (Tödtling & Trippl, 2005).

The collective nature of sustainability could result in low adoption incentives of sustainable actions, due to non-sufficient comparably added value, which increases the importance of policymakers and their regulations to support a sustainable transition (Geels, 2011). Political tools can be used by governments to incorporate the social costs of unsustainable ways of production to coordinate and steer economic activities (Granstrand, 2018). Granstrand (2018) describes policies in relation to externalities, defined as the indirect benefits or costs that are not reflected in the price of a product or service, and that affect a third party. Negative externalities can be exemplified through pollution, where the equilibrium quantity of the supply curve exceeds the social optimum quantity, resulting in an environmental cost of pollution if negative externalities are not considered (Granstrand, 2018). In contrast, positive externalities, e.g., ecosystem services (Natali & Giacomo, 2020), result in lower equilibrium quantity than the social optimum (Granstrand, 2018). Hence, policymakers can manage externalities through steering economic incentives to reach a social optimum (Granstrand, 2018). Figure 4 graphically describes the phenomenon of negative externalities.

Figure 4

A graphic illustration of the impact of negative externalities on the environment



Note. This figure describes the impact from negative externalities and is based on Figure 15.1 (p.365) by Granstrand (2018). However, this figure was created especially for the research study. The environmental cost can be exemplified through pollution, where the social optimum is lower than the quantity achieved when negative externalities are not considered.

3.1.2 Diffusion of Innovation as a Part of Sociotechnical Transitions

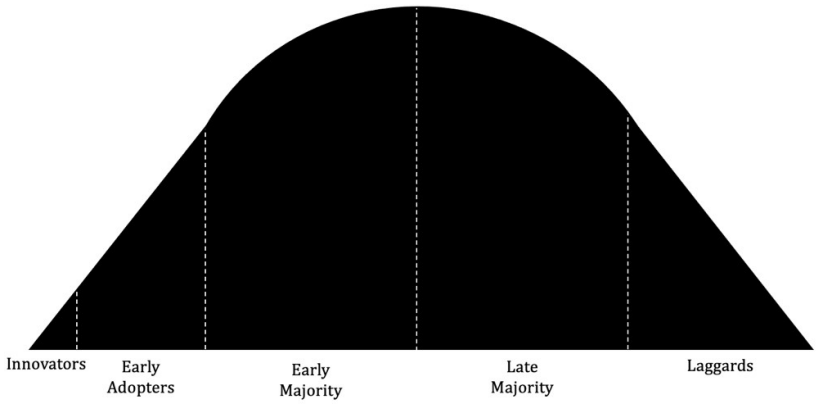
The development of an innovation can be described through a s-shaped curve, graphically illustrating the improved performance of a product over time due to various innovation activities (Granstrand, 2018). Initially, the innovation

activities are product-focused, and the innovations' industry is characterized by a high number of actors, competition, and uncertainty (Andersson & Jacobsson, 2000). Eventually, a product standard is established. As a result, uncertainty is reduced and innovation activities are focused on production efficiency, hopefully positively impacting demand (Andersson & Jacobsson, 2000).

The diffusion of innovation can on the demand side be described through the curve *"Technology Adoption Life cycle"* (Moore, 2014, p.15). The curve is graphically illustrated in Figure 5. Moore (2014) separates the adopters of innovation into five categories; *Innovators; Early Adopters; Early Majority; Late Majority*; and *Laggards*. The categories' characteristics vary regarding willingness to change and required incentives for adopting (Moore, 2014). The willingness to change depends on the level of risk-taking and expected value from the innovation. The level of risk-taking decrease from innovators to laggards, while the expected innovation value increase (Moore, 2014). For instance, the value of a technical innovation can be evaluated by the innovations' price/performance ratio (Andersson & Jacobsson, 2000). Moreover, the incentives for adoption range from high interest in the innovation to social acceptance' expectations (Moore, 2014). Innovators are characterized by having a high interest in the innovation, while laggards are driven by the concern to not meet social requirements (Moore, 2014).

Figure 5

A generalisation of various adopters of innovations



Note. A graphical presentation of the various adopter categories of innovations described by Moore (2014). The figure is based on the "TECHNOLOGICAL ADOPTION LIFE CYCLE" by Moore (p. 15, 2014), however, Moore (2014) illustrates the figure as a normal distribution curve. Despite various curves, Figure 5 similarly presents the distribution of adopters.

A successful innovation requires a diffusion through various adoption categories, hence corporate diffusion strategies are necessary (Moore, 2014). The most

critical diffusion phase is the transition from *Early Adopters* to *Early Majority* due to their contrasting characteristics, and the resulting non-sufficient innovation recommendation by *Early Adopters* that *Early Majority* require (Moore, 2014). Knowledge about the various adoption categories is critical to successfully overcome this phase. The knowledge can then be applied through market strategies to attract a specific sub-category of the *Early Majority* by satisfying their specific requirements, potentially resulting in market leadership of the sub-category (Moore, 2014). Hence, the market leadership will potentially result in increased adoption among the *Early Majority*, and consequentially the critical phase is managed (Moore, 2014).

3.1.3 The Impact of Digital Technologies on Sociotechnical Transitions

Industrial transitions can emerge due to the implementation of digital technologies (Thomson, 2022; Ardito et al., 2021). However, there is a perceived adoption barrier in generating digitalization related revenues due to the required assets and the associated implementation (Björkdahl, 2020). Consequently, there are several corporate areas to consider in addition to implementation of digital technologies, and therefore a successful digitalization requires strategic prioritization (Björkdahl, 2020). Consumer perceptions and related demand is highly influenced by a digitalization, which further stress the importance of adopting corporate strategies (Vial, 2019). Further, dynamic capabilities can be described as the ability to successfully adopt the business and its assets to an industrial transition and is further impacting the long-term corporate competitiveness (Teece, 2009).

3.2 Sustainable Business Models

Business models are a tool to describe how companies create, appropriate and deliver value for their customers (Teece, 2010), while business model innovation refers to "the search of new logics of the firm and new ways to create and capture value for its stakeholders" (Casadesus-Masanell & Zhu, 2013, p.464). The business model is described as a model of the company's strategy, which should be implemented throughout the processes and structures of the organization (Osterwalder & Pigneur, 2010). Osterwalder and Pigneur's (2010) widely adapted framework, the *Business Model Canvas*, includes e.g., the economic viability, unique value offering, and customers. During the last decades, attention on sustainable business models (SBM) has increased, as well as their importance to contribute to improved social welfare and reduced impact on climate change (Mignon & Bankel, 2022). SBM expands the perspective of business models by adding the sustainability perspective regarding value, and a broader perspective on stakeholders and timeframe (Mignon & Bankel, 2022).

3.2.1 The Triple-Layered Business Model Canvas

Joyce and Paquin's (2016) well-known *Triple-layered business model canvas* (TLBMC) is a tool to develop SBM, describing how companies create various forms of values: economic, environmental, and social. The TLBMC adds to Osterwalder and Pigneur's economic-oriented concept of a business model, by including all aspects of sustainability, resulting in a holistic view (Joyce & Paquin, 2016). The environmental factor originates from the research on life cycle assessments, the environmental impact of a product or service throughout its entire lifecycle. Multiple indicators can be used to track environmental impacts, such as CO2 emissions, water use, and health of the ecosystem. The main objective of the environmental dimension is to guide organizations on how to generate environmental positive impact (Joyce & Paquin, 2016). The social factor is based on companies' social impact, with the objective to widen the perspective of how organizations can maximize their gain and instead balance it with the interest of their stakeholders. The stakeholders commonly include the organization's customers, shareholders, employees, suppliers, and interest groups (Joyce & Paquin, 2016). However, the stakeholder group is context depending, hence a wide and flexible factor. The social factor guides organizations on how to create social benefits for their stakeholders and society (Joyce & Paquin, 2016).

3.2.2 The Impact of SBM on Sustainable Transitions

Rapidly changing business environments impacts companies' competitive advantage and increases the importance of agile business models (Teece, 2009). Aagaard et al. (2021) highlight how SBM can accelerate sustainable transitions. Business models can be viewed as a system-level concept, allowing insights beyond a single organization, and taking the meso- and macro-level influences into consideration. The concept allows for BMI opportunities e.g., new customer offerings and stakeholder interactions, which can generate impacts beyond the organization. Consequentially business models can positively affect the external environment and hence contribute to a sustainable transition (Aagaard et al., 2021). Further, Osterwalder and Pigneur (2010) stress the importance of analysing the outside environment to understand the conditions in which a business model is created and adapt it to external factors. Understanding the surroundings by mapping industry forces, market forces, macro-economic forces, and key trends, supports business model strategies and is critical due to the high levels of market uncertainty related to external factors such as rapid development of technological innovations (Osterwalder & Pigneur 2010). If the business model succeeds with meeting the external demand of value creation, a "product-market fit" (p. 22) is potentially achieved (Olsen, 2015).

3.2.3 Balancing Profitability and Sustainability

The need to integrate sustainability to achieve business success is highlighted by Haessler (2020). However, profitability is a key concern for businesses that at times experience trade-offs between profit and sustainability. While sustainability is linked to long-term value creation, short-term profit maximization is sometimes prioritized when profit and sustainability is conflicting (Haessler, 2020). However, recent trends indicate that societal sustainability should be prioritized over corporate profitability (Grant, 2022). Additionally, Grant (2022) stresses several benefits of widening the value creation perspective through e.g., securing the environmental impact and improving brand perception.

3.2.4 The Impact of Digital Technologies on SBM

Digital technologies are transforming how businesses create and appropriate value (Katsamakas, 2022; Correani et al., 2020), for instance, through access to continuous data or the creation of products that better align with customer needs (Correani et al., 2020). A rapid increase in digital technologies and the consequential existing data collection have enabled businesses to create and adopt processes for value-creation (Correni, 2020; Vial, 2019), and hence business model innovation. Digital technologies could enable new value propositions and redefine networks as it enables actors to have closer coordination and collaboration (Vial, 2019). Moreover, data can be used to seize market opportunities and provide closer customer proximity which improves firms' ability to adapt to changes in the environment (Vial, 2019). Additionally, firms should seek to build SBM to leverage the impact from a digital transformation strategy and to ensure long-term competitiveness by considering the TLBMC (Katsamakas, 2022).

Grant (2022) further stresses the difficulty in balancing the focus on cost and differentiation when developing a competitive advantage yet indicating that it is crucial to manage both factors in todays' society. Empirical findings present that digitalization can be an enabler to enhance values created by both cost and differentiation, for instance, through reduced production cycles resulting in enhanced production efficiency and an agile response to market demand (Thomson, 2022).

3.3 Synthesis of Previous Research

Previous research discussed in chapter 3, stress several important concepts regarding sustainable transitions e.g., product-market fit, *The s-curve*, and *Technology Adoption Life cycle*. However, it was identified that these concepts mainly focus on products, hence potentially missing some perspectives of e.g., new values created through digital solutions.

Additionally, it was further identified that the *s-curve* and *Technology Adoption Life cycle* mainly focus on technological innovations, hence potentially missing the perspectives of non-technological innovations. Moreover, by mainly focusing on products and technological innovations, the created values from novel business offerings could be limited. Therefore, by applying the concepts mentioned in chapter 3 to novel business offerings, the intention is to widen the perspective and application area of the concepts.

4. Research Study 1

The following section summarizes findings and developed key factors to consider to successfully support a transition to a sustainable food industry based on the data collection in research study 1. This framework is presented in Figure 6. The literature and interview findings of the data collection are further presented, as well as an analysis and discussion. Moreover, the developed concept of Dynamic Market Fit was applied to the key five factors. Furthermore, identified implications for innovation system actors regarding the proposed framework are concluded in Table 6. Finally, the identified five key factors were analyzed to identify a key enabler for a sustainable transition, resulting in traceability as a suggested key accelerator.

4.1 Findings from Research Study 1

Research study 1 was executed to establish a holistic view of a sustainable transition within the Swedish food industry, by identifying critical factors to consider for innovation system actors. The holistic perspective was established by iteratively combining literature findings with interview findings. The factors resulted in a developed framework, that is introduced in Figure 6, and further described in section 4.1.2, 4.1.3, 4.1.4, 4.1.5, and 4.1.6. These factors were the foundation for the delimitation of the scope for research study 2.

4.1.1 Proposing a Framework to Support a Sustainable Transition within the Swedish Food Industry

Several factors were identified as critical to support the transition to a sustainable food industry. Figure 6 summarizes the identified key areas based on the contextual setting of the Swedish Food Industry. The areas are mainly based on articles and reports from World Economic Forum (2020) in collaboration with McKinsey & Company, EIT Food (2021), Good Food Finance Network (2021), and qualitative interviews. The areas are described and exemplified with additional qualitative sources.

Figure 6

Five developed key factors to consider to successfully support a transition to a sustainable food industry

1. Research & Innovation	2. Value Generation	3. Innovation System	4. Value Chain Collaboration	5. Valid Communication
Research is fundamental for identifying value potential, while innovation is central to capture value based on identified opportunities. There is a need for sustainable solutions to drive the transition, and such solutions should be transferred and implemented by industry actors.	Value generation aims to include all aspects of sustainability by leveraging SBM. Hence, identification of new opportunities through value creating, value capturing, or value enhancing activities could be enhanced.	An innovation system include actors at macro, meso, and micro levels e.g., policymakers, industry actors, research institutions, and consumers. Actors at various levels can impact the industry through e.g., bottom-up initiatives, or top-down regulations. Hence, a transition can be accelerated.	Collaboration between actors in the value chain is critical to collectively drive a sustainable transition. Central benefits are knowledge sharing, mitigation of risks, and exploration of new business models.	Scienced based data is essential to create valid product communication through enhanced transparency, which could impact purchasing choices. Moreover, to have an effective impact it is of importance to leverage associated business values.

Note. This table presents five key factors to consider to successfully support a transition to a sustainable food industry and is developed based on the data collection of research study 1. The table presents the identified key areas together with a description of the connection to the food industry.

4.1.2 Research & Innovation

Based on the findings, research was identified as fundamental for identifying value potential, while innovation is central to capture value based on identified opportunities. Moreover, there was an identified need for sustainable solutions to drive the transition, and such solutions should be transferred and implemented by industry actors.

Literature Findings

Research is fundamental for identifying value potential, while innovation is central to capture value based on identified opportunities (EIT Food, 2021; Malmer, 2021). The food industry is characterized by both incremental and radical innovations (EIT Food, 2021). For instance, an incremental innovation is the N-sensor optimizing the usage of nitrogen (Yara, 2023a). The optimization is performed through a nitrogen measurement by sensors placed on the roof of the tractor, which is then communicated to the fertiliser spreader (Yara, 2023b). An example of a radical innovation is the new plant-based protein, mycoprotein, that enables a protein with several application areas while having significant climate benefits (MyCorena, 2023). Additionally, the rapid development of digital technologies such as Internet of Things (IoT) and blockchain are stressed as predicted key innovations for a sustainable transition (Abbate et al., 2023). The IoT technology includes connected devices such as sensors that gather and communicate data with other devices, resulting in enabled accurate data collection (World Economic Forum, 2019). The blockchain technology uses ledgers to store decentralized and immutable data with required accessibility rights, resulting in high data safety and quality (World Economic Forum, 2019).

To exemplify, IoT and blockchain enable collection and sharing of data, resulting in e.g., secured food quality and increased product transparency (Abbate et al., 2023).

However, the Swedish innovation intensity within the food industry is considerably low compared to the national average (Wikström, 2020). Additionally, there is a need for new sustainable solutions, e.g., regarding improved biodiversity, to achieve the transition and therefore it is essential to overcome the identified innovation gap (Lantmännen, 2019). Moreover, the intensity of research that is being transferred and implemented by industry actors needs to be increased (Malmer, 2021). Investments are fundamental to increase the intensity of research and innovation, however, incentives are central enablers to achieve this (Rydberg et al., 2019). Lack of sufficient incentives are especially identified within primary production, where large investments require financial capital, risk management, and are associated with an uncertainty regarding return on investment (The Swedish Environmental Protection Agency, 2022).

While innovations are required on the supply side, a change in consumer demand is further critical to secure sustainable consumptions (Johansson, 2023). The Food and Land Use Coalition (2021) stresses the difficulty in achieving product-market fit, due to potentially required changed consumer behaviours. This is exemplified through the consumption of plant-based products, especially alternatives, partly due to a gap in consumers' associated cooking knowledge (The Food and Land Use Coalition, 2021).

Interview Findings

There is an alignment with the literature findings regarding an existing innovation gap. One perception is that the industry mainly is characterised by incremental rather than radical innovations, and it is further stated that there is a potential to leverage disruptive innovations by questioning the status quo of the existing industry. Moreover, shifting consumer demand towards e.g., exploring new culinary experiences, can be considered as radical due to potentially changed behaviours e.g., new taste experiences, culinary knowledge, and an open mindset. However, it could be a possibility to size the opportunities with existing plant-based products e.g., lentils. Furthermore, the corporate focus has been identified to mainly focus on substitutes, rather than alternatives. The potential driver for plant-based substitutes could be explained through corporate profitability. However, the associated comparably high price of plant-based substitutes is problematized from a social sustainability perspective regarding affordability.

Moreover, an implementation gap is further highlighted through the potential of increasing the utilization of existing technology that e.g., increase the production

efficiency, and reduce the climate impact. Additionally, an imbalance regarding the level of digitalization between various value chain actors is stressed, as well as the importance of change management to increase the implementation and to achieve the transition. Moreover, the primary production's perceived high focus on operational activities could potentially explain the implementation gap due to potential lack of strategical focus.

An investment barrier regarding the associated risk with primary production is further highlighted, yet adding the perspective of climate change and weather uncertainties which further increases the risk level. Additionally, the complexity of public investments from various levels is highlighted as a vital yet problematic factor, resulting in limitations of investments. Finally, a majority of the interviewees highlight the importance of profitability for all actors in the value chain to enable a sustainable transition.

4.1.3 Value Generation

The findings identified that value generation aims to include all aspects of sustainability by leveraging SBM. Hence, identification of new opportunities through value creating, value capturing, or value enhancing activities could be enhanced.

Literature Findings

It is essential for actors to establish a holistic perspective of the triple bottom line, and to achieve the transition, business model innovation can be a supportive utilizer (World Economic Forum, 2020). Business models are continuously impacted by changed industry characteristics and external shocks, which further stress the importance of corporate business model adjustability to secure appropriability (Hacklin et al., 2018). SBM is a growing and relatively unknown field within the industry (Barth et al., 2021), however, several initiatives have been identified.

An example of a SBM is Industrial symbios, where actor's residual become valuable resources for other actors, resulting in some environmental and economic benefits (Dalväg & Jansson, 2022). Industrial symbios can be exemplified in the municipality of Sotenäs, Sweden where several actors are collaborating within the fish industry (Dalväg & Jansson, 2022). Another example of a SBM is Regenerative agriculture, which is a farming method that has positive impacts of the surrounding ecosystem at the core of its output while producing food (Ellen Macarthur Foundation, 2023). Regenerative agriculture could be implemented through various solutions, e.g., diversified farming where different plants create a positive symbiosis (Ellen Macarthur Foundation, 2023). Additionally, there is a potential for ecosystem services monetization i.e., when an

activity, which has a positive environmental impact, is receiving an economical transaction (Forest Trends et al., 2008). This can be exemplified through agricultural carbon storage which financially benefits primary producers that use carbon storage methods (Svensk Kolinlagring, 2023).

Interview Findings

Several SBM within the industry, which are comparable with the examples mentioned above, are highlighted. Moreover, the example of the retail company *True Price*, where prices include the cost of externalities, is highlighted as an SBM. Finally, another example is ICA's *The Anatomical Business* that increases the utilization of an animal through purchasing the whole animal and then distributing various parts to different suppliers. Additionally, the value maximization of products is exemplified through discounts, prolonging life, or charity actions. Moreover, climate transformation and required corporate adjustments are highly important. However, the importance of required profitability is a critical requisite for sustainable actions.

Waste is exemplified as an example of collaborative value creation, and the perceived shared positive mentality is stressed as a possible enabler. Moreover, it is further highlighted that niched products mainly are associated with small companies while large companies focus on utilizing their high capacity. Finally, a high potential is identified in communicating product associated added values by exemplifying several factors such as restoration of biodiversity, and health benefits.

4.1.4 Innovation System

In the research study, the innovation system includes actors at macro, meso, and micro levels e.g., policymakers, industry actors, research institutions, and consumers. The findings indicated that actors at various levels can impact other actors through e.g., bottom-up initiatives, or top-down regulations. Hence, a transition can be accelerated.

Literature Findings

Collaboration, knowledge sharing, and a shared strategy among industry actors are arguably important to achieve a sociotechnical transition (Johansson, 2023). Further, an alignment of sustainable strategies from actors at a macro, meso, and micro level is necessary (World Economic Forum, 2020). Worldwide macro-level initiatives can impact and guide national regulations, for instance the UN's *Policy Action Agenda* that aims to achieve a sustainable agriculture (UN Climate Change Conference UK 2021, 2023). Macro-level initiatives can further be identified at an EU-level through, for instance, the EU Green Deal strategy (The European Council, 2022). The EU Green Deal strategy aims to reach the goal of "achieving climate

neutrality by 2050" that was established by the Paris Agreement (The European Council, 2022). The EU Green Deal strategy includes various focus areas related to the food industry, such as the *Farm-to-fork* and *EU Biodiversity Strategy for 2030* (The European Council, 2022). The *Farm-to-fork* strategy aims to support the food system in the transition to a climate neutral future, and the *EU Biodiversity Strategy for 2030* aims to restore biodiversity (The European Council, 2022). As a response to new strategies, EU policies such as the *Common agricultural policy* is being updated which further impacts national food systems within the EU (European Commission, 2023). On a national level, Swedish regulations, such as the national food strategy, impacts all actors within the innovation system (Löfven & Bucht, 2017). However, due to the recent external shocks, e.g., climate change, the Covid-19 pandemic, and geopolitical uncertainties, the Swedish government are currently revising the national food strategy with the intention of achieving a robust and resilient food system (The Government Council, 2023). Concludingly, there are several policymaker strategies that could be critical for the transition. Financial strategies could impact accountable actors through either benefiting positive externalities through e.g., subventions (The Swedish Environmental Protection Agency, 2022; Röös et al., 2020; UN Climate Change Conference UK, 2021), or negatively influencing negative externalities through e.g., taxes (Röös et al., 2020; Hans, 2021; The Swedish Environmental Protection Agency, 2022).

Additionally, a gap was identified between the existing and required consumer demand to ensure a sufficient sustainable consumption behaviour (Johansson, 2023; Walsh, 2021). Hence, it is argued that a shift in demand is required as well as additional dynamic capabilities (Collier et al., 2023), from industry actors to meet and influence changed consumer demand. Moreover, demand recommendations e.g., a standard for the communication of sustainability, could further be used as policymaker' strategies to simplify conscious choices, which potentially could enhance consumer impact due to increased knowledge (World Economic Forum, 2020).

Interview Findings

The Swedish food system's impact from an EU-level is further aligned with the interviewees. Moreover, a national strategy is essential to aim towards a shared goal. Additionally, the importance of long-term strategies and dedicated investments are essential to stimulate long-term innovation projects, hence potentially resulting in an established momentum for sustainability. There is a potential impact from financial regulations managing externalities, which stress the importance of an industrial sustainability standard to aim towards a shared goal. Additionally, the previous implementation of the national food strategy is perceived to have a positive impact on the possibility for investments. Finally, a majority of the interviewees agree with the importance of increasing the Swedish

supply capacity, due to recent external factors that visualized the dependency on foreign supply chains.

Several sources such as validated public media e.g., the report *Livestock Long Shadow* by the UN and the movie *Inconvenient Truth* scripted by an American former vice president, have historically resulted in increased focus on sustainability within the innovation system. Further, the impact from individual enthusiasts is stressed as a driver for the historically sustainable transition. Moreover, the potential impact from public authorities can be considered as an enabler to stimulate new consumer habits, food preferences, hence potentially increasing the adoption of plant-based products. For instance, through increasing the utilization of plant-based products in schools.

4.1.5 Value Chain Collaboration

Based on the findings, collaboration between actors in the value chain is critical to collectively drive a sustainable transition. Central benefits are knowledge sharing, mitigation of risks, and exploration of new business models.

Literature Findings

Collaboration is critical to rapidly achieve a successful transition through knowledge sharing between actors (Hans, 2021). Moreover, sharing expertise and establishing a common perspective is essential to accelerate the transition and work toward a shared goal (EIT Food, 2021). Further, there is a need for closer collaboration to stimulate knowledge sharing to establish a holistic perspective of the value chain (PiiA, 2020). However, there is an identified high risk associated with primary production, exemplified through the imbalance between the speed of demand and supply due to rapidly changed consumer preferences and long lead times, potentially resulting in a market gap (European Commision, 2023), and excess capacity of various goods. Moreover, consumers' demand characteristics, e.g., openness to innovation, are impacted by external factors, resulting in increased demand uncertainty (Axel Johnson, 2023). Fluctuating prices on vital input goods further impact the financial risk (Landshypotek, 2022). Different primary producers manage risk through various strategies, however, some strategies align such as the widening of purchasing occasions and advising from within primary producers' proximity e.g., family (Landshypotek, 2022). Furthermore, collaboration can be exemplified through co-creation and increased actor communication (EIT Food, 2020), and could result in a more accurate market fit.

Interview Findings

The high associated risk within primary production, and the importance of risk mitigation through e.g., diversification is highlighted. The management of risk

mitigation can further be exemplified by pre-production contracts. A large majority of the interviewees further stress the requirement of value chain collaboration. Such collaboration is exemplified by potentially shared innovation activities, consumer behaviour data, and trends identification. Moreover, the importance of collaboration between all actors within the food industry is further stressed, by for instance, exemplifying Sweden Food Arena as an intermediary enabler. The aim of Sweden Food Arena is collective knowledge sharing to develop a sustainable Swedish food industry. Intermediaries are further considered as essential to enhance collaboration by identifying supply and demand of knowledge, resulting in connections among innovation system actors. As a result, the innovation activities within the Swedish food industry could potentially be increased. Moreover, the importance of collaboration is further highlighted to integrate the consumer perspective throughout the value chain. Finally, the potential impact of sharing sustainable solutions across the value chain to establish a product standard, seize the associated benefits, and drive the transition is further highlighted.

4.1.6 Validated Communication

Scienced based data was, based on the findings, found as essential to create valid product communication through enhanced transparency, which could impact purchasing choices. Moreover, to have an effective impact it is of importance to leverage associated business values.

Literature Findings

Communication about sustainability through accurate data points can guide consumers to make sustainable choices, increase consumers' engagement, and accelerate the adaptation of sustainable goods (EIT Food, 2021). Increased consumer interest and demand for validated information were identified (Singh & Sharma, 2022), which further stress the importance of transparency. Moreover, associated benefits with transparent communication are e.g., increased supply chain efficiency, validated product quality, and improved brand accountability (IBM, 2023a; World Economic Forum, 2019).

Several sustainability labels can be identified within the food industry (The Swedish Consumer Agency, 2020), however some scholars problematize the high intensity by raising the question of potentially reduced credibility and usefulness (Annunziata et al., 2019). A standardization is desirable to increase the trustworthiness, simplicity, and validation of sustainability communication (Thurner, 2023). Additionally, the problematization of constructing a sustainability standard that consider all aspects of sustainability, is trustworthy and feasible, and include accurately exhaustive data points is stressed (Gennari & Navarro, 2019).

Interview Findings

It is perceived as difficult for consumers to make conscious choices due to potential information overload or asymmetry. However, there is a large potential to utilize data for consumer communication. The contextual impact and variating characteristics in consumer behaviour were further stressed. It is highlighted that there potentially is a need for increased knowledge about consumer behaviour and associated required changed behaviours to achieve the transition. Hence, demand and supply should align to achieve SBM. Despite that consumer's choices are impacting the sustainable transition, the supply can similarly impact consumer's options based on available assortment. Furthermore, there is a value of establishing a sustainability standard, and a majority of the interviewees mention the critical aspects of science based data points. This is exemplified by the Science Based Targets Initiative, established by several global organizations. Finally, the high diversity of potential added values from products was highlighted. However, some alignments of added values were identified such as restoration of biodiversity and health benefits.

4.2 Analysis & Discussion of Research Study 1

The identified findings during research study 1 were combined with previous research presented in chapter 3, to analyse and discuss the Swedish sociotechnical food system's impact on a sustainable transition, strategies for diffusion of SBM, and proposing the concept of a Dynamic Market Fit. Moreover, associated implications for innovation system actors were concluded in Table 6. Finally, traceability was identified as a key accelerator for a sustainable transition. Therefore, this factor was utilized to define the scope for research study 2.

4.2.1 Sociotechnical System's Impact on the Sustainable Transition

Based on the present findings, SBM are considered to be in an early stage of the s-curve. Critical indicators for the conclusion are e.g., several explorative examples such as regenerative farming, Industrial Symbios, and *The Anatomical Business*. Moreover, several external shocks have recently impacted the food industry. For instance, the current inflation, the ongoing European war, and the previous Covid-19 pandemic. Direct impact, from these shocks are for instance, increased prices on input goods and consequential consumer goods, a shortage of input goods, and increased awareness of the vital elements of food. The external shocks have further resulted in disruptions within the sociotechnical system. For instance, the results present a rapid change of soft institutions with regards to increased consumer focus on price, and a decreased consumer focus on sustainability aspects. The development of these soft institutions is considered to problematize the transition, due to the increased difficulty in achieving SBM.

Additionally, the negative diffusion impact on sustainable food is further presented. Hard institutions have been developed over a longer time period compared to the recent soft institutions, and the mentioned political actions e.g., EU policies and national Swedish strategy, are viewed as a result of a long-term increased awareness of sustainability. Despite the long-term perspective, these political regulations are perceived as a strategy to manage negative externalities caused by unsustainable consumer behaviours. Moreover, no conclusion can yet be made regarding the impact on hard institutions from these recent external shocks. However, the external shocks' rapid disruption of the regimes critically highlights the volatility and vitality of the industry. Therefore, to achieve a sustainable transition resulting in SBM in the long term, the mentioned five factors; Research & Innovation; Value Generation; Innovation System; Value Chain Collaboration; and Valid Communication, are critical. These factors impact all actors within the sociotechnical system, and therefore all actors are responsible to achieve a transition. However, recent external shocks can be argued to have destabilised the Swedish food system due to e.g., changed consumer preferences, resulting in potential windows of opportunity. The destabilisation could be a diffusion opportunity for plant-based alternatives e.g., lentils, despite their associated potentially radical changed consumer' behaviours, due to their combined sustainable and financial benefits. The potential benefits could be argued to match the changed soft institutions. Therefore, actors could utilize this opportunity to communicate the benefits of these products.

4.2.2 Strategies for Diffusion of SBM

A sustainable transition can considerably be made through two main strategies. Either through stimulating the demand to buy more sustainably conscious products e.g., transitioning from meat to plant-based substitutes or alternatives, or solely securing SBM through adjusting the available assortment.

The diffusion on the demand side can be argued to be in an *Early Adopters* phase due to the required added value yet open to higher prices, however, an *Early Majority* requires proved value and no higher prices. Apart from ensuring the affordability of traceable products, the diffusion of an innovation must be managed by satisfying the requirements from the *Early Majority*. Due to the required higher level of acquired innovation value and low levels of risk-taking when adopting an innovation, reaching the *Early Majority* is considerably a large challenge. However, satisfying the requirements of a specific sub-category within the *Early Majority* can be a successful strategy. For consumers, specific sub-categories within the *Early Majority* can for instance be identified through shared values and interest, e.g., time spent in a retail store or food preferences. To exemplify, consumers with a large amount of time spent in the retail store with an interest in sustainability. This group could be reached by providing additional and

easily available and transparent information in stores, e.g., storytelling through QR-codes. Moreover, another sub-category could be consumers who prefer traditional food, e.g., Swedish meatballs. The plant-based substitutes should then be developed to have similar taste and be easily replaceable, to meet the requirements and develop market leadership within this sub-group.

However, a sustainable transition could also be achieved from a supply perspective by only offering sustainable products to the consumer, hence the consumers do not have to make the choice themselves. This can be supported through digital solutions, e.g., blockchain, where all actors are held accountable, and valid, reliable, and science based data are used to present all information about the products. Furthermore, from an innovation diffusion perspective, food industry actors can limit the assortment and hence influence later adoption categories by solely offering sustainable products. Due to the potentially high impact from value chain actors, there is a high need to also stimulate the adoption of sustainable products from actors. However, profitability is considerably an adoption requisite, hence proved business value is essential for stimulating the supply side. Additionally, associated financial risk within the early stages of development, required new skills and knowledge, and required an innovative mindset are identified barriers for adoption. Therefore, co-development of products should increase to secure a market fit by shared expertise, decreased individual risk through shared investments, and enhanced knowledge sharing within the value chain. Additionally, by empowering enthusiastic individuals to inspire an open mindset and stress the products' potential the intention is to stimulate an innovative and collaborative environment.

Concludingly, the theory of innovation diffusion is critical to utilize from both a supply and demand perspective to achieve a sustainable transition. The question is which strategy is the most efficient and impactful to achieve a sustainable transition? The perception is that one strategy's speed is non-sufficient, and hence the recommendation is to stimulate both perspectives simultaneously by implementing digital solutions, while continuing the development of sustainable products and marketing these towards consumers to reach a larger majority. The aim is that a large majority of consumers will purchase sustainable food, resulting in a transition, regardless if the choice is conscious or non-conscious.

4.2.3 Proposing the Concept of Dynamic Market Fit

In addition to the critical five factors presented in Figure 6, the concept of a Dynamic Market Fit was further developed due to the identified importance of both considering and influencing the existing demand. A dynamic market fit should be applied as a constant aspect to consider, in addition to the five factors. A product-market fit ensures that commercialized products and services meet

demand. However, the identified gap between the existing and required demand requires new sustainable consumption behaviours, and actors' dynamic capabilities are of importance to simulate the necessary changed consumer demand.

A dynamic market fit is considered beneficial, regardless of sustainable product focus, e.g., meat alternatives or substitutes. By balancing the adoption to disrupted regimes, e.g., changed consumer values, with impacting consumer behaviour, SBM can considerably be achieved. The main factor is that sustainable lifestyles can be developed through the influence on consumer behaviours, while profitability can be secured through adopting to disrupted regimes e.g., external shocks or changed consumer behaviours. Furthermore, it is critical to consider all aspects of SBM to develop attractive products that will achieve product-market fit, and collectively result in a sustainable transition. However, to diffuse sustainable products successfully it is important to reach a large group of consumers by e.g., attracting the *Early Majority.*

4.2.4 Barriers and Enablers for Innovation System Actors to Achieve a Sustainable Transition

Innovation system actors have an important role in driving the transition to a sustainable food industry. To achieve a sustainable transition, prioritized barriers and enablers for innovation system actors were identified and are presented in Table 6. These implications were conducted based on the five developed key factors in Figure 6, and associated sections 4.1.2, 4.1.3, 4.1.4, 4.1.5, and 4.1.6.

Table 6

Identified barriers and enablers for innovation system actors to achieve a sustainable transition.

	Barriers	Enablers
1.	Innovation gap	1. Knowledge diffusion from research to industry 2. Increase investment opportunities
2.	Implementation gap	1. Leverage existing technologies 2. Leverage existing & alternative business models 3. Verify and present potential business value of sustainable actions 4. Educate actors in skills and knowledge
3.	Investment gap	1. Verify and present potential business value of sustainable actions 2. Increase investment opportunities
5.	Dependency on foreign supply chains	Increase national resilience
6.	Lack of sustainability standards	1. National food strategy for sustainability 2. Standard for sustainability analysis 3. Standard for communication of sustainability
7.	Untapped business potential due to hesitation or unawareness to change	1. Collaborations between actors within & outside the industry 2. Enthusiastic individuals 3. Educate actors about industry trends
8.	Profitability-sustainability dilemma	1. Verify and present potential business value of sustainable actions 2. Political regulations

Note. This table presents identified barriers and enablers for innovation system actors to achieve a sustainable transition. The implications are based on the data collection of research study 1. Despite the numerical order, no step is more prioritized than the others.

4.2.5 Proposing Traceability as a Key Accelerator for a Sustainable Transition

Based on the findings in research study 1, the intention was to delimit the scope for research study 2. It was identified that traceability was a common theme among the five factors with a potential to leverage the factors' potential and hence a sustainable transition. Traceability increases the transparency of the food value chain through enhanced accountability of related product actions (World Economic Forum, 2019). Traceability is enabled through creation of data, data collection methods, and data sharing technologies (World Economic Forum, 2019).

The perceived potential to leverage the five factors, can be exemplified through that traceability within the food industry is an emerging opportunity that potentially could reduce the innovation gap, leverage new value generation, and increase communication validity within the industry. However, it was perceived that further actions and collaboration from actors at all levels within the sociotechnical system are required to achieve the full potential of traceability. The perception of the potential with traceability is further studied in chapter 5.

5. Research Study 2

The section describes the perception of the potential with traceability in general, the Swedish environment of data sharing, and related requisites and technologies. Additionally, the associated unlocked potential with traceability in Sweden is further described. Moreover, these findings are discussed and analysed. Table 7 presents the potential business value for value chain actors and other stakeholders. Further, implications of traceability for value chain actors and innovation system actors are presented in Tables 8 and 9.

5.1 Findings from Research Study 2

Findings from research study 2 includes an investigation of how traceability can leverage value creation, an exemplification of two global examples that are using traceability, and a description of the Swedish context of traceability. Research study 2 presents findings that are based on a combination of literature findings and interview findings. Section 5.1.1 and 5.1.2 are solely based on secondary resources, while the other sections are mainly based on interviewees, however combined with literature findings.

5.1.1 Investigating how Traceability can Leverage Value Creation

Despite consumers' rapidly increased price awareness (McKinsey & Company, 2022), previous studies indicate a pre-inflation increasing sustainability focus from consumers (Gatzer & Roos, 2021; Axel Johnson, 2023). Studies indicate that the sustainability awareness is sustained yet stress the complexity in price-setting to identify a sustained product-market fit (Differ, 2023). Additionally, it is identified that the value of sustainability needs to be complemented by additional values, to increase the willingness to pay to a level that enables social optimum (Differ, 2023). Traceability can be used as an enabler to respond to the increased sustainability requirements from consumers (Moysiadis et al., 2022). Additionally, several studies highlight the great potential with traceability within the food system associated with food quality & safety, resulting in transparent consumer communication (Feng et al., 2020; Menon & Jain, 2021; SAP, 2020). Consumer communication is usually performed through a digital solution e.g., a QR-code (Köhler & Pizzol 2020). Additionally, transparent data can apart from consumer communication, be a tool to reward primary producers for the positive outcomes of their work (World Economic Forum, 2022). Digital technologies e.g., sensors, are essential to gather production data (World Economic Forum, 2019).

Today the high level of digital technologies at farm level generates large volumes of data, however, this is mainly kept in silos instead of shared throughout the value chain (Kenney et al., 2020). Therefore, a shared method for data sharing to enable value chain transparency is critical (World Economic Forum, 2019). Several studies have highlighted blockchain as an enabling technology for data sharing within the food value chain (World Economic Forum, 2019; Moysiadis et al., 2022; Stranieri et al., 2021). However, to enable a traceable and transparent food value chain through blockchain, it is critical that all value chain actors manage data through an efficient and reliable method (Bumblauskas et al., 2020; Köhler & Pizzol, 2020). Additionally, it is critical to stress the continuous development of the blockchain technology and the non-established standard, increasing the associated technological risks regarding e.g., scalability (Köhler & Pizzol, 2020).

5.1.2 Examples of Traceability through Blockchain

Traceability initiatives through blockchain have been initiated by several actors, however, IBM and TE-Food are considered pioneers due to successful implementations (Köhler & Pizzol, 2020).

IBM is an American information technology company (IBM, 2023b), providing the blockchain-based *IBM Supply Chain Intelligence Suite: Food Trust* within the food industry with the aim to ensure safety, sustainability, and enable improved efficiency (IBM, 2023c). IBM's blockchain technology follows the principle of that only granted participants can access the data (Köhler & Pizzol, 2020). IBM established blockchain collaborations in 2017 with global food incumbents such as Walmart, which validated the relevance and emerged the interest of the technology (Menon & Jain, 2021). Additionally, Carrefour is an adoptee actor that has implemented the technology to several food products (Carrefour, 2023), potentially indicating the business potential with traceability. Similarly, the Norwegian Seafood Association is further an adopter, resulting in the enablement for fish producers to communicate the fish's journey from sea-to-fork to the consumers in a trustworthy way through a QR-code (Sønsteby, 2021). One of the participating primary producers, Kvaroy Fiskeoppdrett, identified a business potential through added customer value through increased understanding of the production journey, resulting in an increased willingness to pay from customers (Sønsteby, 2021). A validated indicator of the business potential can be exemplified through the city of Helsingborg, Sweden, that has started purchasing traceable Norweigan fish (Sønsteby, 2021). Additionally, the required value chain collaboration facilitated by the technology, improved knowledge sharing and leveraging of each other's expertise between the seafood industry actors (Norwegian Seafood Trust AS, 2023).

TE-Food is a German traceability company, providing a blockchain solution that aims to provide all actors within the food system with a more transparent value chain, resulting in enhanced actor' control e.g., increased supplier understanding, and supported consumers' in making knowledge-based purchases (TE-Food, 2023). TE-Food's blockchain technology combines the principle of access rights, similar to IBM, however, it also adds the factor of using digital financial solutions as consumer adoption incentives (Köhler & Pizzol, 2020). TE-Food further provide several consumer communication solutions e.g., an app and physical stations, in combination with digital financial incentives to e.g., increase consumer engagement (Köhler & Pizzol, 2020). Well-established actors such as Deloitte and GS1 are two of TE-Food's over 6000 collaborative partners (TE-Food, 2023). Moreover, the well-established French food retail company Auchan initiated the implementation of TE-food's blockchain technology in Spain, Italy, Portugal and Senegal in 2018 through the use of QR-codes (Auchan Retail, 2019).

5.1.3 Investigating Traceability in Sweden

The following section aims to describe the state of art of how traceability is utilized in Sweden by describing the data sharing environment, associated requisites and highlighting emerging technologies.

The Data Sharing Environment

The interviewees stress the business value of data, resulting in perceived willingness to secure ownership and control of data. However, the data knowledge base and matureness vary between different actors in the value chain. For instance, the perceived knowledge, interest, and willingness to share data vary among primary producers. The perception of data further varies due to factors such as data reliability and security, for instance, the trustworthiness of not sharing previously shared data with another actor. However, there is a perceived high willingness to share data and to be transparent. Despite a high willingness, added values are requisites for adoption. Moreover, data flows are mainly unidirectional from primary producers, along the value chain, to consumers. However, some retailers' offer the opportunity to purchase product sales data to their suppliers. Similarly, the company NielsenIQ (2023) provides purchasable data regarding market analytics. The interviewees describe that the unidirectional shared data mainly includes production data such as product volumes and fuel consumption, however, in some cases shared data further includes economic information about e.g., inputs. Finally, the importance of reliable data quality is highlighted.