From Crop to Click – Organic and Digital Transformation of Out-of-Home Catering Value Chains in Germany

Tamara Scheerer
Herman Hollerith Research Center
Reutlingen University
Reutlingen, Germany
tamara.scheerer@reutlingen-university.de

Prof. Dr. Dieter Hertweck
Herman Hollerith Research Center
Reutlingen University
Reutlingen, Germany
dieter.hertweck@reutlingen-university.de

Tim Hakenberg
Rottenburg University
Rottenburg, Germany
hakenberg@hs-rottenburg.de

***Abstract*—An important aspect of achieving global climate neutrality and food security is transforming our food system. To support the goal, Germany has set a national target of reaching a 30% share in organic farming. When looking at the transformation process from conventional to organic farming, it becomes apparent that measures need to be taken to reach the anticipated goal. Using Design Science Research, we model and analyze the as-is farm-to-fork value chain of public out-of-home-eaten meals to identify the central barriers and drivers of organic transformation. From the insights gained in the modeling process, we derive a digital platform model that addresses the current issues. We propose a digitally supported value network instead of a hierarchical value chain to share the co-design opportunities for different stakeholders more equally. We then elaborate on the potential to overcome the barriers to organic transformation with the network-based platform. To specify the main functionalities of the digital platform architecture, we map user requirements with the proposed to-be value network. The results further emphasize the need for a change in the current value chain perspective. We conclusively propose to further develop existing approaches under consideration of our identified requirements and the overall sustainability goal, rather than focusing solely on individual dimensions or metrics.**

***Keywords*— organic food supply chain, value chain, value network, environmentally reflected system modeling, sustainable food system**

I. Introduction

The European organic action plan contains clear objectives to achieve better sustainability, one of which is to reach a 25% share of organically cultivated agricultural land in the EU by 2030 [1]. Germany committed to this goal by aiming for a 30% share by 2030, reinforced by the new government in 2021 [2]. In line with the federal target, the state of Baden-Wuerttemberg is planning on reaching a 30-40% share of organically farmed land by 2030 [3].

A lever with high impact potential is the public out-of-home-catering (OOHC) as these canteens are organized and paid for by the public sector [4]. According to our research, the annual market volume for out-of-home-eaten lunches in public institutions, including hospitals, care homes, and prisons, is around 4.3 Billion €. For Baden-Wuerttemberg, we estimate this number to be at around 550 Mio. € p.a. [5]. In other dimensions, this translates to an amount of approximately 144 Mio. meals and about 77,000t of food (excluding production-related waste). This is equivalent to around 112,000t of CO_2e which correspond to the emissions produced by about 69,000 midsize passenger cars per year [5]. Therefore, innovative and useful transformation examples from the public sector can act as lighthouse initiatives for all OOHC initiatives as well as for the consumer behavior of citizens.

The intensifying need to take measures against climate change and the increasing international demands for CO_2 reduction and other ecological improvements by the UNO [6] and the EU [7] have led to numerous territorial implementation strategies. Part of this path to better sustainability is to progress with organic transformation, as agriculture is responsible for approximately 10% of all German greenhouse gas emissions and the majority of methane and nitrous oxide emissions [8]. In addition to the other impacts agriculture has on the environment (biodiversity, soil fertility, groundwater condition, etc.), the goal to increase the share of organic agriculture was formulated in 2002 for the first time [9]. Currently, the federal state of Baden-Wuerttemberg has reached a share of 13,2% organic acreage, surpassing the national average of 9,7% [10]. While this shows great potential, it also raises questions about the feasibility of reaching the anticipated goal by 2030 [11]. Conclusively, there must be barriers hampering a more rapid organic transformation and it is crucial to find appropriate methods to remove them, may this be by improving technology, enacting policies, or addressing society. Since organic and conventional products coexist in the same market and compete to a large extent for the same clientele, a corresponding demand for organic products is essential if we are to increase their share in agriculture. Although the demand for organic food is in a constant upward trend, the dynamic of the past 20 years has shown that natural growth will likely not suffice to achieve the 2030 goal. For this reason, ideas like increasing the demand *artificially* by introducing an organic minimum quota in (public) OOHC arose [4][12].

Against this background, the state of Baden-Wuerttemberg has initiated numerous research projects that deal with the ecological transformation of value chains in the out-of-home food supply sector. Some of the research projects, such as ÖkoTrans [13], are also investigating how digital systems can be used to overcome existing transformation barriers in farm-to-fork (F2F) value chains.

Hence, our two research questions for this paper are:

RQ1: What does the as-is farm-to-fork value chain look like, and what barriers and drivers to organic conversion can be identified along this chain?

RQ2: Can an ICT-based solution be proposed and how would it be designed to overcome the identified barriers?

II. Related Work

Digitalizing value chains (VC) and automatizing process steps have been an ongoing interest for both, the economy and research. This is also the case for the specific subdomain of the food supply chain (FSC). In general, two primary domains when it comes to measuring, enabling, or improving the sustainability of said FSC [14]: (1) the supply chain sustainability (SCS) (as in how sustainable is the FSC itself), (2) and the food product sustainability (FPS) (as in how sustainable is the food product and how does that change along the VC) In regards to our research question, we consider (3) the sustainability of the ICT-based solution [15] relevant as well.

(1) Qorri et al. [16] performed a comprehensive literature research on measurement approaches used to analyze the sustainability of VCs. It shows that many studies focus on evaluating the VC performance between a manufacturer and its suppliers, and how it is difficult to find relevant sustainability categories for the inter- and intra-organizational VC evaluation: On the one hand, there are processes and aspects within the direct control of a SC actor (like product design, business processes, and certifications), and on the other, there are practices with external dependencies (like the procurement processes, customer interactions, and distribution channels [17]. The most commonly used framework [18] to assess SC sustainability categorizes essential practices and has since often been used as a foundation. Building on this, further frameworks are being proposed [17, 19], describing constructs and measurement items for defining and analyzing the sustainability of a VC. As a common ground, their sustainability practice categories include Internal Sustainable Management, Purchasing, Production, Distribution and Packaging, Customer Cooperation, Reverse Logistics, Employee Social Practices, and Investment Recovery.

(2) When determining the sustainability of a product in general, a commonly used technique is the Life Cycle Assessment (LCA) [20, 21] which is also prominent in research. The strength of the LCA methodology lies in its "cradle-to-grave" perspective [22, 23] which means the evaluation takes all production and value creation steps into account. The general definition of LCA being a methodology for assessing environmental impacts describes a prominent shortcoming since sustainability consists of further dimensions. A common model to evaluate a product's sustainability holistically is the Triple Bottom Line, aiming to measure and manage the economic, social, and environmental values that a product adds or destroys [24]. In research, LCA is very commonly adapted and expanded by those missing sustainability assessment criteria [25]. A further advantage of this flexibility is that LCA can be mapped very well with evaluating SCS, as part of a product's life cycle is to go through the different steps of its VC. Remaining, in terms of assessing FPS is the difficulty of defining the exact metrics behind the economic, social, and environmental values of food products. This subject is also bound to change continuously, as scientific research progresses and societal expectations and habits change. Yakovleva et. al. [14],. for example, propose a set of sustainability indicators and respective measurement criteria for assessing FPS, hereby also addressing the critique on the often one-dimensional approach of equating economic with financial sustainability [24]. In addition, other endeavors are attempting to make FPS measurable by evaluating specific metrics, like the Product Environmental Footprint (PEF) proposed by the European Commission [26, 27] which is an LCA-based method to enable standardized evaluation for product groups. The PEF is criticized for only analyzing environmental impacts and for not being clear about the scope of the methodology [28]. To improve this, further labeling initiatives are aiming to enhance the PEF, like the Planet Score [29] or the Eco-score [30]. These have a clear set of metrics for assessing food products, but as they are intended to be printed on a product's packaging, they do not assess the potential impact of a product beyond the packaging process.

(3) As the objective of this paper is to propose an ICT-based solution, it is important to also take aspects of sustainable software design into account [31]. In theory, software can also be considered a product and would therefore simply fall under the sustainability assessment of product sustainability. Software has not only become an integral part of our everyday lives but is also a major support system for our global FSCs. Software can also be the pivotal point in determining the sustainability of these technically supported FSCs and the products processed along them [32], not only by influencing the SCS or FPS but also by the effects of ICT itself on sustainability [33]. For this reason, research suggests including two more dimensions to the Triple Bottom Line perspective to engineer sustainable ICT: the individual and the social dimension [34].

Efforts to address sustainability in the FSC with ICT-based solutions and addressing the above-mentioned sustainability domains are progressing and becoming more and more prominent in research and the economy. There are important digital suggestions for improving sustainability aspects in VCs, such as:

- Analyses on the potential of platforms on (German) regional Food Systems [35, 36]
- Reducing Food Waste [37, 38]
- Enabling Carbon Mitigation [39]
- Improving FSC traceability and thereby enabling measuring any potential metric from F2F with [40–42] and without the use of blockchain [43]

The gap in research that this paper is trying to address, is combining attempts to define metrics to evaluate FPS with efforts to achieve SCS with an ICT-based solution designed with software sustainability in mind. The main scope of the solution is to propose a system where ICT-based measurement of any individual sustainability metrics (see list above) can be implemented and tracked along the entire F2F VC or food product life cycle [44].

III. Research Design

The main objective of this paper is to gather insights gained by the design process of an artifact to achieve essential environmental, humanitarian, and economic goals in F2F VCs Hence, this work follows the Design Science Research Methodology [45]. Applying the specific approach by Johannesson and Perjons [46], the work begins with creating a profound understanding of the underlying problem. Once the

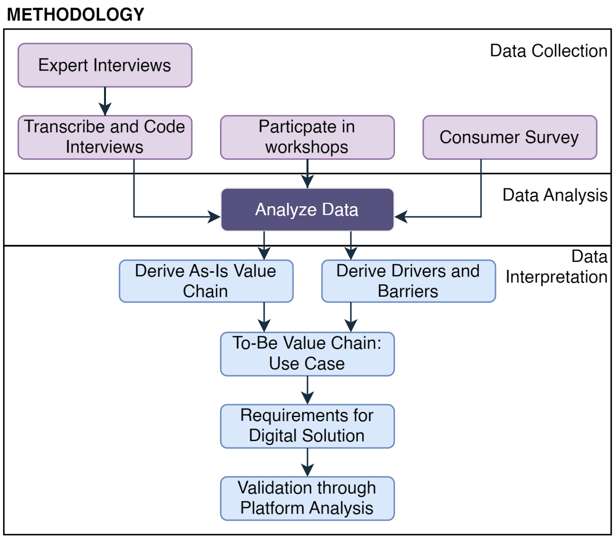

Figure 1 Overview Methodology

problem is explicated, requirements for solutions are identified, and following, an artifact is designed. The artifact design is then demonstrated to the target audience and subsequently evaluated. This paper will focus on three steps of the methodology: We will create a deeper understanding of the problem by comparing the as-is to the to-be state, based on the aforementioned political and societal goals. The knowledge will be further deepened by analyzing the drivers and barriers along the value chain. Based on these insights, we aim to derive requirements for an ICT-based solution, offering either incremental or disruptive innovation to the current status quo. And lastly, our solution design will be evaluated and completed by comparing it with existing ICT solutions to analyze the current status-quo of the domain and to identify further research needs.

IV. Methodology

To gain an in-depth understanding of the problem and to design a solution that addresses the identified barriers, we performed extensive primary research to add to the insights gained from reviewing existing literature. In this section, the applied methods are explained and summarized in three sections, data collection, data analysis, and data evaluation, following the suggested qualitative research design by Creswell [47].

A. Data Collection

(1) To understand the as-is state of the value chain of organic and conventional food products, we interviewed industry representatives and experts. The insights were then used to model the value chain including all three subsystems: farmers, intermediaries[1], and canteens.

(2) The second approach is to develop a grounded theory [48, 49] to understand the problem of (too) slow organic conversion. Therefore, we collected the barriers and drivers of organic conversion along the entire value chain.

For both objectives, we conducted 38 semi-structured interviews with actors from the VC from September 2020 – May 2022, for which a set of open questions were defined for each participant group. The categorization and the respective number of interviewees are shown in Table 1, further details on the interviewees need to remain secret due to NDAs. We categorize the interviewees for this work into the three groups of *Farmers*, *Intermediaries*, and *Canteen Representatives* which is a direct result from analyzing the As-Is VC, as described later in the paper (see chapter V.A) and shown in Figure 1 (cf. an extended abstract on preliminary results [44]).

In addition to the semi-structured interviews, we participated in workshops, discussions, and round tables with other involved and/or interested parties like organic transformation consulting companies, value chain managers, and members of similar (research) projects to triangulate the gathered interview data.

As a first result of the interviews, we realized the necessity to include the end consumers into the data collection process, especially for correctly identifying barriers and drivers of organic conversion in the canteen system. Therefore, we additionally performed a consumer survey aiming to identify their perspective on sustainability in canteens, covering the topics organic, food waste, meat consumption, and price. The survey was conducted in two Baden-Wuerttemberg state institutions who contacted the project after announcing the opportunity via the regional state news [50] and via the associated organic model regions of the project. The survey addressed all employees of these two state institutions, reaching approximately 2.000 possible candidates of German legal working age (ranging from 15 to 67, but may also include retired senior experts) and varying income. We received a total of 528 valid responses. The surveys were conducted in February 2022 and in October 2023, offering valuable insights for a pre- and post-Ukraine war perspective).

Table 1 Interviewee Details

	Farmers	**Intermediaries**	**Canteen Representatives**	**Other**
Amount	11	8	16	3
Operating in	Baden-Wuerttemberg	Baden-Wuerttemberg	Baden-Wuerttemberg	Baden-Wuerttemberg
Structure	11 small and medium sized private farmers	2 organic wholesalers 6 regional organic food processing firms	5 large companies 11 small and medium sized companies	3 value chain and regional organic transformation managers
Other			Cater to or represent canteens of public institutions	

[1] In this paper, when referring to "intermediaries", we collectively mean trade organizations such as wholesalers, retailers, etc., and processors like the food industry, food craft, etc., including the connecting logistics processes. When defining the solution requirements, we will consider logistics separately, but still, combine trade and processors.

B. Data Analysis

The data is then analyzed with a qualitative approach: collecting data, organizing and summarizing data, classifying data, visualizing data, and validate visualization [51]. Since the interviews served the two purposes of modeling the value chain and identifying the drivers and barriers, the interview results were classified using two methods:

(1) A qualitative content analysis [52] was performed to comprehend the systematic processes of the interviewees' daily businesses and to be able to model the value chain accordingly. The created model is then verified in further discussions and by cross-checking with initial data and comparing it to published use cases [53–55].

(2) Barriers and drivers identification of organic conversion along the value chain by encoding the interview transcripts using MAXQDA [56] in an iterative and inductive process [47]. The codes used were as follows:

- Barriers (covering all aspects that the interviewees consider barriers to organic or sustainability conversion)
- Drivers (covering all aspects that the interviewees consider drivers to organic or sustainability conversion)
- Trends and innovations (covering all topics that the interviewees consider trends in regard to OOHC, canteens, food, sustainability)
- Tool support today (covering all mentioned processes which are supported by digital tools)
- Solution requirements (covering all aspects that the interviewees mentioned as potential necessities for an ICT-based solution to enhance conversion)
- Non-transparency of current VC (covering all topics mentioned of non-transparency in the VC, especially in regard to product origin and traceability)
- Process steps (covering all aspects mentioned to verify and improve the As-Is VC model).

The consumer surveys were conducted using SoSci Survey and analyzed using Excel and SPSS. They were evaluated in two steps. First, the results were evaluated descriptively, primarily using frequency distributions. Second, we extended the analysis by looking into correlations, attempting to answer the following questions:

- What is consumer-perceived sustainability in canteens?
- How can a greater organic-share be achieved?
- How important is meat in canteen prepared meals?

C. Data Evaluation

As a result of the qualitative data analysis, the as-is state of the value chain is modeled as a successive sequence of the processes of multiple actors within a specific system [57]. Based on Porter's concept [58] of a general-purpose value chain to understand and represent inter-organizational value creation, we modeled the as-is state of the F2F VC. Although it is necessary to distinguish between the three subsystems, it is important to look at the entire process of value-addition across all actors. Hence, we understand and model the entire chain as one combined system, directly allocating the identified barriers.

We then derive the solution requirements. It is a key objective to carefully consider the interface connecting the two ends (farm and fork) of the VC. The problem explication shows great potential for digitalization and barrier removal – especially in those intermediary steps. The barriers regarding this VC section are highlighted and a draft of a solution architecture is proposed. A UML Use Case diagram [59] describes the intended functionalities, defining use cases for all involved parties. The model provides the necessary framework to match user interactions with the system and how this system is supposed to meet those requirements and address identified barriers in a representative and easily comprehensible model [60]. To validate the proposed solution, we used existing digital platforms used to improve regional value chains. Based on the use cases for the to-be state of the VC, we derived functional requirements for an ICT-based solution. We identified five digital platforms across Germany and tested their functionalities based on our use cases. Further input for the analysis were the interviews conducted with the respective responsible persons.

V. Results As-IS and To-Be Value Chain

According to the defined approach, we will present the as-is VC model, followed by an overview of the identified drivers and barriers of organic conversion. We will then define an optimized to-be VC and evaluate how the barriers will be addressed by it.

A. As-Is Value Chain Model

Upon modelling the VC and the indefinite and varying number of participants, the necessity arose to divide it into subcategories and analyze them individually. Based on the design of the research project and the partners involved, the three subsystems were selected as follows, and proved useful throughout the entire project:

- Subsystem 1: Farmers
- Subsystem 2: Intermediaries
- Subsystem 3: Canteens

For each subsystem, we were able to determine a set of generally applicable process sections. It was necessary to find a rather general level of perspective, as we consider the VCs of all food items of all target-convenience stages. Figure 2 shows the abstracted value chain from F2F based on the defined processes (also see [44, 61]), including the allocation of the identified barriers, as numbered in Table 5.

1) Farmers

For Farmers, we identified two primary fields of value creation: livestock and crop cultivation which we find necessary to distinguish, as the processes varied profoundly, as shown in Table 2. For the presentation of the abstracted value chain, we have combined the processes into one agricultural value chain section, as this allows for a better representation of the adjacent barriers.

Table 2 Famer value creation

Livestock	**Crop-Cultivation**
- Raise livestock	- Plan production
- Sell livestock	- Prepare production
- Process livestock products	- Sowing/planting/Maintenance
- Process livestock	- Harvest
- Sell livestock products	- Process/Transport harvest
	- Sell harvest

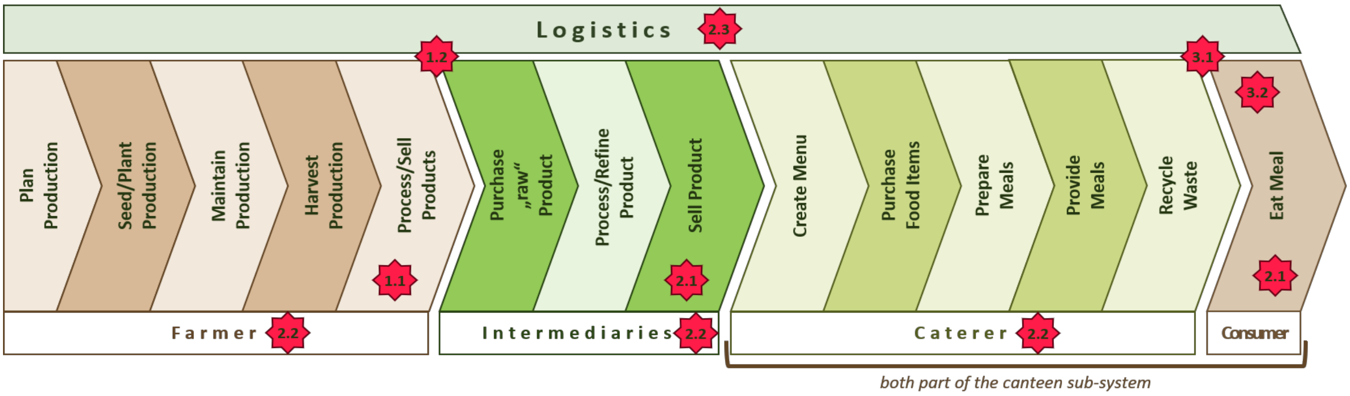

Figure 2 Abstracted value chain farm-to-fork with allocated barriers, based on [44][61].

2) Intermediaries

The intermediaries reported the least about their value-creation processes. In addition to the limited amount of information received for this work, non-transparency is a major obstacle to VC analysis or attempts at change. It has already been pointed out that retailers and wholesalers have great power over the dynamics of the food market [62]. By making decisions about what customers can buy, they influence supplier prices, purchase prices for other B2B purchases, and retail prices. In conclusion, the current intermediary, but especially the retail/wholesale system, manipulates the general market rules regarding supply and demand mechanisms [63]. By being the "bigger" buying power, a non-negligible part of the demand power is taken away from the final consumers [62]. Nevertheless, Table 3 shows the process steps of the intermediaries for their value creation, as shown in Figure 2.

Table 3 Intermediaries value creation

- Purchase "raw" product - Process product - Sell product

3) Caterers

For canteens, the first obstacle was finding an appropriate definition and as a result, the performing actor/role of the process. When speaking about a canteen, one generally speaks about a place where OOHC-meals can be purchased and consumed, usually in a work, school, or hospital context [64]. Looking at a canteen in more detail, we can distinguish between three different stakeholders: 1. the hosting business (usually also the physical location of said canteen), 2. the caterer, and 3. the end customer (consumer). Regarding enhancing organic conversion, it plays an important role in clearly distinguishing between these actors, because no one claims responsibility for changing the current modus operandi. From the value creation perspective, the caterers play a major role. In the F2F VC, they will represent the canteen system. The encoding categories used to define their main processes are:

Table 4 Caterer value creation

- Tender-related (relevant for the specification of public canteens) - Menu Planning - Purchase/procurement - Meal creation/provision - Waste recycling

B. Drivers and Barriers of Organic Conversion

For the barriers and drivers, we also grouped the results per subsystem to a first differentiation. As expected, the barriers were talked about more and in a larger variety than the drivers. According to the coded amount, there is a proportion of 2:1, that is two mentioned barriers per mentioned driver. Hence, the drivers were not divided into sub-categories for or during the coding process.

Table 5 Main barriers to organic conversion

Nr.	**Main Barriers**	**Subsystem**
1.1	Distribution Channels	Farmer
1.2	(Electronic) Data Sheets	Farmer
2.1	Demand / Supply	Intermediate / Processor
2.2	Digitalization / Data Flow	Intermediate / Processor
2.3	Logistics	Intermediate / Processor
3.1	Price sensitivity of public institutions	Caterer
3.2	Different customer focus	Caterer

1) Farmers

Barrier 1.1. Distribution channels

In general, there are no sales difficulties for organic products in southern Germany. Organic associations plan the conversion of interested farms well to avoid oversupply. This also means that there may be waiting lists for farmers who want to offer goods that are in high supply, e.g., dairy farms. Sales reliability is a crucial argument for farmers interested in converting, as economic factors play a central role. The most preferable distribution channels for organic farms are traditional ones with the most favorable prices. Particularly, selling products directly in the own farm shop or on local farmer's markets were highlighted often. Both marketplaces offer the opportunity to sell goods at self-determined prices and to expand one's offer by cooperating with farmers and producers of complementary products. One of the least favorable distribution channels was direct cooperation with OOHC-companies. The main barriers are the mismatch between price expectations, delivery volumes, and convenience levels. Farmers often perceive purchasers of catering companies as inflexible regarding menu habits, product availability and quality, and transportation (time).

In terms of drivers, farmers find it more attractive to convert when several actors along the value chain do so together. If, for example, a wheat farmer, miller and baker, and caterer convert together, the risks are spread across several players, while also being able to supply large customers. In addition, already existing trade relations can be maintained, which is important because trust plays a central role in food supply chains [65]. Many farmers stated that personal relations with customers are preferable to high-scale, high-volume generic purchase contracts. Another driver is the general interest among farmers to use and develop new distribution channels, especially as they are aware of the declining importance of current methods. Many farmers are already experimenting successfully with social media presence and subscription boxes.

Barrier 1.2. (Electronic) data sheets

The European food declaration regulation demands product information for processed foods. The six mandatory labels are: (1) product name, (2) ingredients, including marked allergens, (3) best before date, (4) filling quantity, (5) last processor's contact details, and (6) nutrient amounts [66]. In the as-is value chain, the declaration information gets calculated and labeled by the processing intermediaries. When caterers purchase preprocessed products, they conclusively receive the information directly, depending on the utilized ERP systems automatically and electronically. If the intermediaries were to be eliminated from the value chain to enhance direct distributions between farmers and caterers, the following two issues become a barrier: (1) Either the farmer or the caterer has to carry out the food information declaration process, which involves additional costs and requires appropriate skills. (2) Either the farmer or the caterer has to process the raw products, which is currently unfavorable for both parties.

2) Intermediaries

Since this subsystem heavily relies on the actors before and post their value creation level, many mentioned factors are related to the producers or the buyers. For example, when first interviewed, one potato processor, who is also a purely conventional potato farmer, stated in May 2021 that the main barrier to him not processing more organic potatoes was the lack of demand for it. When re-interviewed in 2022, he explained that he had stopped processing organic potatoes, since the demand for organic processed potatoes began to put pressure on his conventional potato production and processing.

Barrier 2.1. *Demand / Supply*

In conclusion, this example shows how intermediary actors have a primary economic motivation of producing what is most beneficial for their business model. Looking at the processes of a processing manufacturer or an intermediary trader, there is no difference between using organic or conventional base products. Looking at the abstracted value chain in Figure 2, the steps for the middle subsystem remain unchanged when adapted to the target state of processing organic goods[2]. Another main barrier for most actors is the price – farmers worrying about reduced income due to the yield gap albeit higher selling prices and canteens and consumers having higher purchasing costs – yet, this is almost no concern for the intermediaries since they usually produce and sell goods for which they earn the desired margin. Hence, it is far more important to the intermediaries how a product performs in the general business model.

Barrier 2.2. *Digitalization / Data Flow*

Another barrier, especially for distributors, is the issue of digitalization. For example, one wholesaler explained the importance of collecting all the necessary information for product data sheets, especially when you are the last stop before a canteen. In addition to the generally required information (ingredients, additives, allergens), some intermediaries are providing as much relevant information as possible (e.g., the form of diet the product is suitable for). Depending on the preceding steps, this information is very difficult to collect or the data format in which it is provided, is incompatible. A lot of effort is therefore put into integrating the suppliers into the system. The importance of personal relationships between suppliers and customers was also mentioned, especially for organic products. The more intermediaries a product passes through, the more the information about the producer is lost, along with the identity that created a personal relationship with the producer or customer. The European requirement to label the origin of a product lays the foundation for addressing this issue. But since stating if the main component of the product was produced in the EU or not is enough, the exact origin of the components remain voluntary information [67].

Barrier 2.3. *Logistics*

Lastly, it is important to mention the broad barrier of matching demand with supply and logistics capacity. As a wholesaler, it is important to offer a certain availability of products. Based on the product, is more or less forgiving in terms of shortfalls. To compensate for potential fluctuations or crop failures, trading communities are often established. When processing commodities, manufacturers often require a certain quantity of a base product before making significant profits. The same applies to supplying caterers in terms of logistics, if they do not reach a minimum purchase amount, delivery is uneconomical logistic-wise.

3) Canteen system

For the canteen system, we identified numerous sham barriers which we only present briefly – primarily because although easy to get past, to many they are the commonly or firstly named obstacles. The two most significant ones are: 1. Insufficient availability of organic convenience products, and 2. structural efforts like the necessity to store organic products separately or the high costs/effort of the certifying process. These apparent barriers were partially negated in other or even the same interviews, and partially by simply not being relevant (e.g. it is not necessary to have an organic certificate to purchase and use organic products, it is only necessary when you explicitly want to use organic products as a marketing aspect of any kind).

[2] Small exceptions occur when both (conventional and organic products) are being processed. In this case, it is necessary to clearly separate organic goods, for example cleaning the milk processing machines thoroughly before processing organic milk. Handling both product types adds additional steps which would be allocated to the organic process, since it is unnecessary for conventional produce.

The relevant barriers in the canteen system are:

Barrier 3.1. Price sensitivity of public institutions

Public institutions are price sensitive and are obliged to tender Europe-wide.

Barrier 3.2. Different Customer Focus

The focus of customer requests is on regionality and vegetarian/vegan as opposed to organic food. As for the barriers, we want to highlight the statement given by multiple interviewed caterers: the responsibility of creating or changing dietary habits in the context of canteen-eaten meals lies primarily with the caterers.

C. To-Be Value Chain

When first transitioning from logistics management to supply chain management, a key aspect proposed by Stevens [68] is taking customer wishes strongly into consideration instead of merely focusing on the product. This straightforward approach introduced the importance of adding value along a product's journey but also highlighted the necessary flow of information alongside the product itself. Cooper, Lambert, et al. [57] added to this idea by extending the view of supply chain management beyond the organizational boundaries and regarding the supply chain from base-product availability to customer requirements. Looking at the fundamentals of consumer market mechanisms, this perspective is applicable. Demand and supply are interdependent and have a strong influence on the price and the perceived value of goods [63]. But what happens, if the necessity to produce more food organically exceeds the demand for this product category by far?

Having a clear market pull from the end customer or creating one with an interesting product enables a linear value chain. Figure 3 shows a graphical representation of this dynamic, where the consumer requirements motivate the value creation of all other actors along the chain. As long as the end product is as desired, the number of intermediaries passed is of low transparency and importance. Given the economic principles [63], the price of a product is defined by supply and demand. The suppliers along the chain attempt to cover their input costs and gain a profit by selling their value-added products. Assuming all products are identical in quality, the producer with the highest production efficiency, best output amount/quality, and the lowest input costs is in the best position. They still get to sell the product at market-level prices, but their profit would be higher. This means, in a globalized world: energy-intensive actions are performed in countries with low energy prices, base produce gets grown in countries with the lowest possible production prices, transportation cost, routes, and capacity utilization get optimized, etc. As a result, the power position of intermediaries is further strengthened since the worth of their value creation is difficult to gather.

Transforming the value *chain* to a more value *network*-like approach by offering a corresponding digital platform architecture would break open the black box of intermediaries and hence, confront this issue. Although the term *network* is already used in literature analyzing food supply [69], it is still primarily represented and understood as a VC. Figure 4 shows a use case diagram for a digital platform that enables an actual F2F value *network*. The benefit of this structure is that the actors can partake as individual and independent

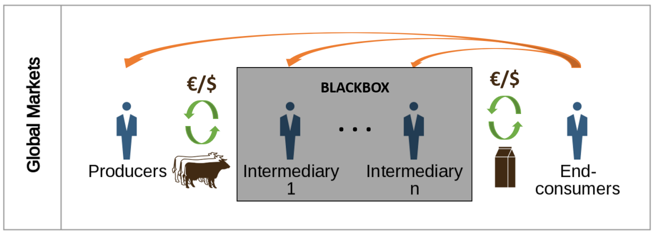

Figure 3 Market pull representation

value creators rather than merely function as producers or suppliers. The platform idea, as designed in Figure 4, primarily contains the processes of acquiring business opportunities and procurement. It is crucial to cater to every actor's needs in those regards, to present a valid alternative to current structures and to enable all FSC actors equally. Therefore, the diagram contains all use cases the individual FSC actors must be able to perform on a platform solution and are categorized into logical subsystems / application components for a better overview:

1 Describes the necessity of all user groups to be able to communicate with each other. This reaches from providing and requesting information on one's business and products, over discussing potential business opportunities, to conclusions of contracts.

2 Describes the use cases for the caterers and intermediaries to support the procurement processes with the platform.

3 Describes the use cases for the farmers, intermediaries and caterers to support the sales processes with the platform.

4 Describes the separate use cases of logistics as a separate actor, since its business model and thus its processes are very different from those of the other intermediaries.

The necessity to rethink the food VC to enable value co-creation instead of hierarchically distributing products has been the subject of research proposals before [70]. Furthermore, a platform enabling such trading relation networks addresses various of the aforementioned barriers:

Barrier 1.1. Distribution Channels

Providing an additional distribution channel for farmers which is structurally like direct marketing, offers the farmers the opportunity to have a certain autonomy regarding the pricing. However, a shared marketplace also provides the opportunity for producers to compare their offers, prices, and products to those of others. Furthermore, the purchasers of the agricultural produce can also make comparisons across vendors. Additionally, the other participants of the value network would be able to communicate specific product needs, requests, or opportunities for the farmers to potentially fulfill.

Barrier 1.2. (Electronic) Data Sheets

Having a central platform where the product is re-inserted after every value-adding step, also enables food data tracking. Assuming the necessary information and data are identical for food products independent of the processing stage, having a central database, and more importantly, a standard data format, represents a great opportunity for all parties.

Barrier 2.1. *Supply and Demand*

Providing a communication tool to not only purchase the supply but also addressing demands and opportunities can be

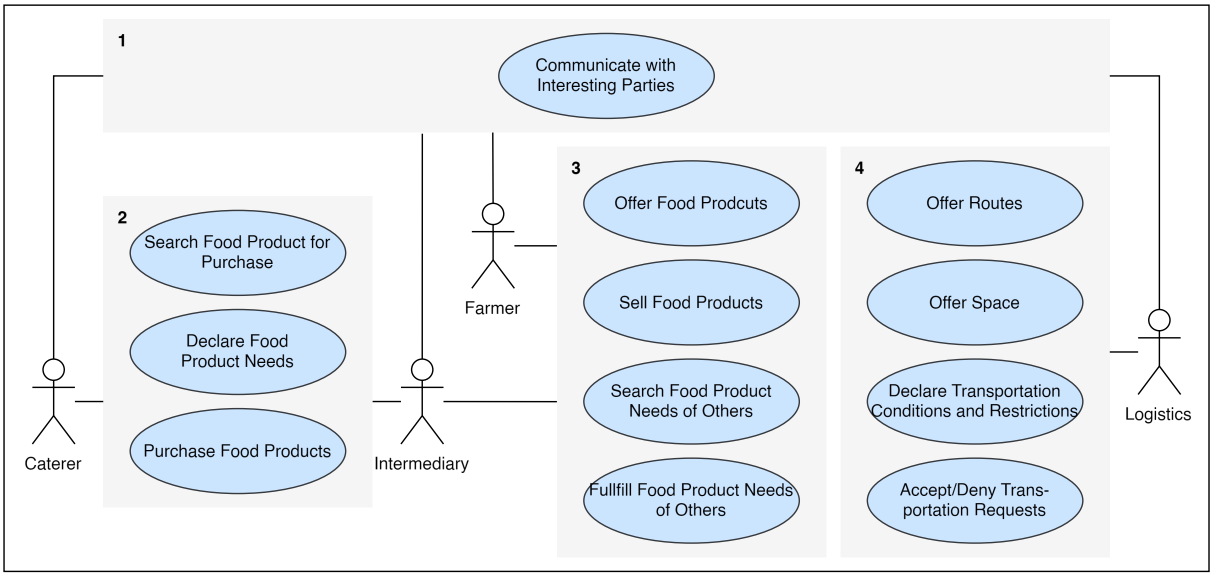

Figure 4 Use case diagram of a network value chain enabling platform

a great chance of shifting the power dynamics in a way that equally represents all actors of the network. Although reducing the power of intermediaries may not be in their interest at first sight, there are also advantages and opportunities: If all parties of the value chain have a platform to communicate needs and interests, it allows intermediaries to better adapt their business model to the exact market requirements. Additionally, having a transparent insight into logistics contributes to optimizing capacity utilization.

Barrier 2.2. *Digitalization/Information Flow*

Similar to barrier 1.2, having a central platform is an optimal prerequisite to having a uniform and consistent data structure and quality.

Barrier 2.3. *Logistics*

By including logistics as a fourth subsystem for the use case model, we try to address the issue of finding a party to handle the logistics matters between all other actors. If logistics are considered a separate player, new business models can arise, or old ones can be adapted. At the same time, logistics can still be handled by one of the other players as part of their business.

Barrier 3.1. Price sensitivity of public institutions

Although a platform enabling a value network will most likely change nothing about the price sensitivity of public institutions per se, it holds the potential to change the perspective on the matter of buying the cheapest possible. Although the European tender regulation states the necessity for public institutions to choose their suppliers regarding the taxpayer's best interests, it does not rule out taking further criteria besides the price into account and weighing them accordingly [71]. Having a platform offering transparency of origin, the path of value-adding, and a standardized data model with measurable quality criteria besides the price, can help develop a way to enforce sustainability metrics in food-related tenders.

Barrier 3.2. Customer requirements

The interviews and the consumer survey show a high interest in regionally produced and sourced products[3]. Although the definition of "regionally sourced" is up to interpretation (albeit that probably being part of the reason as well), it shows a general interest of consumers to counteract this non-transparency.

VI. Results Solutions Evaluation

To evaluate and complete the solution design according to the identified use cases, an analysis of digital food network platforms is performed. The results will help to determine the current market situation in regard to the availability of ICT-based solutions to address the barriers and drivers of organic and sustainability conversion.

1) *Current platforms overview*

There are already various platforms for regional product marketing and distribution in Germany. Many of these platforms are the result of initiatives by different German states. The analysis of the platforms is performed by conducting interviews with the responsible persons and, if applicable, by testing the functionalities of these platforms. We only tested one platform in depth which was already running and allowed access to non-business users. Table 6 shows an overview of the interviewed and analyzed platforms:

Table 6 Analyzed platforms

Platform	**Interview**	**Functional test**
Wirt sucht Bauer [72]	yes	Yes
Regio Verpflegung [73]	yes	No, under construction
Nearbuy [74]	yes	Yes
Green Canteen [75]	yes	No, out of service
Bauer sucht Koch [76]	yes	No, out of service

[3] In the survey, "regionality" rated amongst the top three of the most important qualities of food products, among "good taste" and "free choice of meal components". It scored first place 8% of the time, second place 20% of the time and third place 12% of the time.

The platform ‚Green Canteen‘ was taken out of service in July 2021, after the initial interview was conducted, but before the testing for this work could be performed. The platform ‚Bauer sucht Koch‘ was also taken out of service. Hence, testing was not possible, but an interview was conducted. The platforms of ‚Meck-Schweizer'[77] and ‚Wer liefert was'[78] were removed from the scope before conducting an interview. Although they claim to be an initiative for regional product distribution, the origin of many products is either non-transparent or the intermediary is regional, but their products are imported [79].

Based on the barriers that need to be overcome to enhance organic conversion and the basic functional necessities identified for the VC actors, we designed a first set of requirements for a platform solution. The goal is to gain a first insight into the market maturity and the scope and focus of already available platforms. The following results provide, above all, a connecting point for further in-depth research. The requirements used are provided in Table 7.

Table 7 Platform requirements

N°	Description
Req1	Include farmers, intermediaries, logistics, and caterers as potential users of the platform
Req2	Enable all user groups to create product offers
Req3	Enable all user groups to create product requests
Req4	Include a search function for offers and requests
Req5	Enable contacting other users of interest
Req6	Enable the use of a uniform product data sheet, and provide data sheet generation, if input data and output data correspond to the defined data standard
Req7	Provide (platform-) universal metrics to evaluate product sustainability

2) *Evaluation of existing platforms*

Figure 5 shows a comparison of all analyzed platforms. The overview includes all of the previously identified key requirements to enable the use cases shown in Figure 4. Although several platforms already exist, the market is still in its infancy with high volatility. Throughout the research period for this work, substantial changes happened to the available platforms, especially, as most platforms are or were still in the process of being developed.

For all platforms, the biggest challenge is handling the logistics. Handling here means finding any solution to the problem of bringing the product from the farmer to any following actor in the value chain. The difficulties include acquiring, managing, and organizing the necessary logistical processes (interviews May 2021). There are also cases where previous initiatives that attempted to link actors in the food value chain regionally faced similar problems and ultimately failed. [80].

Regarding the derived requirements for a value network-enabling platform in this work, we want to highlight the concept of the platform ‚nearbuy'. Originating in the German state of Hessen, the platform has evolved from a minimum viable product with basic functionality to a comprehensive tool covering the most of this work's requirements, compared to others. Above all, this shows there is development in the market heading in "the right direction" and future research can benefit from looking into some of those platform designs in detail or even anticipate research and development co-operations to close remaining gaps.

VII. Conclusion

A. *Summary of Results*

1) *Research Question 1: VC Model, Barriers & Drivers*

In this work, we were able to answer the introductory research questions. We analyzed and modeled the as-is state of the VC and mapped the barriers to organic conversion to it, addressing research question one. The conventional F2F VC is sequential and includes a varying number of intermediaries, depending on the convenience level of the product purchased by the end consumer. In the context of canteen meals, the number of intermediate steps is assumed to be above average, firstly because caterers often rely heavily on convenience products, and secondly, because the prepared meal is another value-adding processing step itself. As a result, the farm-to-OOHC VC is particularly difficult to analyze in detail, since the processors and retailers often do not want to participate in this kind of research. Furthermore, we assume that intermediaries benefit from, and hence preserve this non-transparency. The more difficult it is to trace the path of a (food) product, the less impact the demand-and-supply-mechanisms (end consumers/farmers) have. When organic and conventional products pass through the same value chain they compete in the same market and their primary comparison criterion is the price. And the often higher price of organic food discourages caterers, canteen operators, and, to some extent, end consumers from choosing it.

Furthermore, many barriers related to the intermediary steps of the VC were identified. On the one hand, choosing suitable distribution channels is a key issue for farmers. On the other hand, caterers rely on processing of the raw farm produce. Handling logistics between all parties is a difficult task for all actors. As a result, both ends of the chain are usually completely disconnected since the VC section of the parties responsible for bundling and distribution are non-transparent. In addition, we have seen a greater interest, particularly from end consumers, in locally sourced food rather than organic food, to improve sustainability. In conclusion, there is a need to increase the share of organic products to meet policy targets and to offer more regional meals to meet customer demand. But given the challenge of tracing a product's origin along the VC, restricting a caterer to buying local organic food limits the options and often severely increases effort and costs.

2) *Research Question 2: ICT-based solutions*

A digital platform design enabling a value network can address the aforementioned barriers in several ways, addressing research question two. By connecting all participants equally, a network improves transparency by offering a tool where the product does not have to leave the one system before being purchased by a caterer. The platform provides a targeted overview of relevant stakeholders and enables simple and direct communication channels. This further allows pricing to be based on supply and demand but also provides

	Req1	Req2	Req3	Req4	Req5	Req6	Req7
Wirt sucht Bauer*	✓	✓	✓	○	✓	✗	✗
Regio Verpflegung*	✗	✓	✓	○	✓	✗	✗
Nearbuy	✓	✓	✓	✓	✓	✗	✗
Bauer sucht Koch*	✓	✓	○	○	✓	✗	✗

* Information solely based on interview

○ Information not obtainable

~ Function exists to some extent

✓ Function exists

✗ Function does not exist

Figure 5 Platform comparison

a certain degree of flexibility to the contracting parties. And lastly, aiming for a ICT-based solution suitable for all participants lays the foundation for reliably and comparably tracking metrics that are more representative of a product's sustainability than "regionality" or "organic". These sustainability metrics provide public institutions with a measurable indicator that can compete with the current primary winning determinant "price" in tenders.

B. Limitations

Given the research framework, influenced by the national target to increase organic production and our research, there was little questioning of the goal itself in this work. Numerous studies show the benefits of organic agriculture compared to the average conventional practices. Optimizing organic farming and how it can solve other problems besides the climate crisis, such as food security, is a major focus of the organic agricultural society. Without downplaying the important benefits of organic farming, we would like to emphasize the importance of keeping the overall goals in perspective. Furthermore, we aim to see sustainability in food production as more than pesticide use, stable size, and a carbon footprint. Sustainability includes a whole range of metrics that need to be (1) carefully determined by the scientific community, (2) reliably measured on our behalf as a global society, and (3) put in relation to each other that represents a significant amount of meaning.

Basing this research in large parts on interviews and consumer surveys, it is important to regard its validity with caution. On the one hand, this research was specifically aimed at representing the federal state of Baden-Wuerttemberg which may affect its global relevance. On the other hand, there is the threat of influencing interviewees or survey participants by the questions asked and thereby bias the results. Furthermore, it became very apparent throughout the course of this research that external shocks and events (COVID pandemic, Ukraine war) can have substantial impact on the food industry and hence also on the opinions of its stakeholders, potentially outdating research results within a matter of months.

Although our platform design represents a solution to several barriers identified along the as-is value chain, we do not claim to have addressed or even identified all. The proposed solution addresses the barriers with a special focus on the intermediary steps. It improves communication and aims to achieve a stronger sense of community and cooperation among actors from a regional perspective. Starting from this foundation, it is important to go into more detail. The functional and technical requirements need to be developed more specifically and different versions must be compared and weighed up against each other. Additionally, three important questions need to be analyzed in further research: (1) How scalable is such a solution, especially in a global context? (2) How does the governance of such a platform model need to be designed, to prevent the power from shifting in favor of one group of actors? (3) Which technological improvements can further be integrated to enhance transparency, like for example a blockchain-based system [81] or applying IoT from F2F [82]?

C. Outlook on potential future research

The work presented in this paper covers the first steps to disrupt the currently common global wholesale channels to strengthen regional food sourcing, organic agriculture, and the transformation to a more sustainable F2F VC. The proposed ICT-based platform solution is a holistic but generic model that details its purpose and the barriers it aims to remove. Therefore, future research is needed to further develop the platform model. It is important to continue the DSR cycle and demonstrate as well as evaluate the design, and perform further DSR iterations. Rather than modeling or building a new solution from scratch, it may be beneficial to use the insights from this research to improve an existing platform instead, follow an action research design.

In addition, it is important to visualize and make the benefits of organic food products comparable in order to make organic products more attractive for public OOHC. Standardized sustainability metrics should be measured along the entire VC to make these products more relevant for tenders in public institutions. Having a set of relevant metrics and a meaningful and understandable way to collect and visualize that data helps to make informed decisions rather than relying on non-standardized concepts like regionality. And while the organic label provides such a clearly defined set of requirements, and there is a lot of research available on the benefits of these farming practices, it does not cover most of the subsequent production and transportation processes. The literature review in chapter II provides an overview on current research on developing metrics to define food product sustainability. Further research can build on these results and improve ICT-based solution designs to automatically and dynamically measure these metrics.

Another relevant topic for future research is to evaluate the sustainability impact of an ICT-based solution compared to the current state. When developing any kind of ICT-based solution, it should be a common practice to consider its impact, as suggested by [83], for example.

VIII. References

[1] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee Of The Regions: *On an action plan for the development of organic production,* 2nd ed. Brussels, 2021.

[2] SPD, Buendnis 90/Die Gruenen, and FDP, Koalititionsvertrag 2021-2025: *Mehr Fortschritt wagen* (Koalitionsvertrag zwischen SPD, Buendnis 90/Die Gruenen und FDP), 2021.

[3] Ministry of Food, Rural Areas and Consumer Protection Baden-Wuerttemberg, Der weiterentwickelte Aktionsplan "Bio aus Baden-Wuerttemberg". Stuttgart, 2020.

[4] German Federal Ministry of Food and Agriculture, Eckpunktepapier: Weg zur Ernaehrungsstrategie der Bundesregierung, 2022.

[5] T. Scheerer. "Calculations." https://github.com/tamaraquja/food-calculations/wiki Accessed: Apr. 26, 2024.

[6] Working Group III, "Climate Chance 2022: Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change,"

[7] European Commission, Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee Of The Regions: *Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people*. Brussels, 2020.

[8] German Federal Environmental Agency, "Beitrag der Landwirtschaft zu den Treibhausgas-Emissionen," Mar. 2022.

[9] Deutscher Bundestag, "Bericht der Bundesregierung über die Perspektiven für Deutschland – Nationale Strategie für eine nachhaltige Entwicklung," Apr. 2002.

[10] D. Schaack, C. Rampold, and T. Boenigk, "AMI Markt Bilanz Oeko-Landbau 2023," Bonn, 2023.

[11] J. Becker, "Zum Stand der oekologischen Landwirtschaft in Baden-Wuerttemberg 2020: Ökologische und konventionelle Landwirtschaft im Vergleich," Jul. 2021.

[12] J. Klöckner. "Bio-Anteil in Kantinen des Bundes wird auf 20 Prozent erhöht." https://shorturl.at/QRTV4 Accessed: Feb. 6, 2023.

[13] Oekolandbau Forschung Baden-Wuerttemberg. "OekoTrans - Oekologischer Landbau im Kontext gesellschaftlicher, oekonomischer und oekologischer Transformationsprozesse." https://tinyurl.com/4havht2a Accessed: Apr. 26, 2024.

[14] N. Yakovleva, J. Sarkis, and T. W. Sloan, "Sustainability Indicators for the Food Supply Chain," in *Environmental Assessment and Management in the Food Industry*, Woodhead Publishing Series in Food Science, Technology and Nutrition, Ed., 2010, pp. 297–330.

[15] C. Becker *et al.,* "Requirements: The Key To Sustainability," pp. 56–65.

[16] A. Qorri, Z. Mujkic, and A. Kraslawski, "A conceptual framework for measuring sustainability performance of supply chains," *Journal of Cleaner Production*, no. 189, pp. 570–584, 2018.

[17] A. Qorri, S. Gashi, and A. Kraslawski, "Performance outcomes of supply chain practices for sustainable development: A meta‐analysis of moderators," *Sustainable Development*, no. 29, pp. 194–216, 2021.

[18] Q. Zhu, J. Sarkis, and K. H. Lai, "Green Supply Chain Management: Pressures, Practices and Performance within the Chinese Automobile Industry," *Journal of Cleaner Production*, no. 15, pp. 1041–1052, 2007.

[19] A. Qorri, S. Gashi, and A. Kraslawski, "A practical method to measure sustainability performance of supply chains with incomplete information," *Journal of Cleaner Production*, no. 341, 2022.

[20] Scientific Applications International Cooperation, Ed., "Life Cycle Assessment: Principles and Practices," May. 2006.

[21] European Commission, Ed., "International Reference Life Cycle Data System (ILCD) Handbook: General guide for Life Cycle Assessment - Detailed guidance," Luxembourg, Mar. 2010.

[22] "cradle to grave," in *EEA Glossary*, European Environment Agency, Ed.

[23] T. Dyllick and Z. Rost, "Towards True Product Sustainability," *Journal of Cleaner Production*, 2017.

[24] J. Elkington, "25 Years Ago I Coined the Phrase "Triple Bottom Line." Here's Why It's Time to Rethink It.," Jun. 2018.

[25] J. Fiksel, J. McDaniel, and D. Spitzley, "Measuring Product Sustainability," *The Journal of Sustainable Product Design*, 1998.

[26] European Commission, Commission Recommendation on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations: *(EU) 2021/2279*, 2021.

[27] I. Verweij-Novikova, R. Broekema, and K. Boone, "Product Environmental Footprint: Overview of EU and national public and private initiatives in agro-food," Wageningen University & Research in *Wageningen Economic Research*, nr. 2022-093, 2022.

[28] E. Pedersen and A. Remmen, "Challenges with product environmental footprint: a systematic review," *The International Journal of Life Cycle Assessment*, no. 27, pp. 342–352, 2022.

[29] Planet Score. "Planet Score." https://www.planet-score.org/en/

[30] Eco-score. "Eco-score." https://docs.score-environnemental.com/

[31] C. Becker *et al.,* "The Karlskrona manifesto for sustainability design," May. 2015.

[32] L. Duboc *et al.,* "Requirements engineering for sustainability: an awareness framework for designing software systems for a better tomorrow," *Requirements Engineering*, no. 25, pp. 469–492, 2020.

[33] L. Hilty, P. Arnfalk, L. Erdmann, J. Goodmann, M. Lehmann, and P. Waeger, "The relevance of information and communication technologies for environmental sustainability – A prospective simulation study," *Environmental Modelling & Software*, no. 21, pp. 1618–1629, 2006.

[34] B. Penzenstadler, A. Raturi, D. Richardson, and B. Tomlinson, "Safety, Security, Now Sustainability: The Nonfunctional Requirement for the 21st Century," *IEEE Software*, pp. 40–47, 2014.

[35] S. Cuno, E. Kramer, N. Reithinger, and P. Laemmel, "Datenplattformen und KI-Werkzeuge zur Stärkung der regionalen Ernährungssysteme," *Stadtforschung und Statistik: Zeitschrift des Verbandes Deutscher Städtestatistiker*, no. 34, pp. 91–96, 2021.

[36] N. Kampffmeyer, M. Motschall, C. Scherf, and M. Weber, "Nachhaltigkeit und Regionalität digitaler Plattformen in den Bedürfnisfelder Ernährung und Mobilität," Berlin, 2021.

[37] G. Suciu, I. Pop, A. Pasat, S. Calescu, R. Vatasoiu, and I. Suciu, "Digital Solutions for Smart Food Supply Chains," *International Symposium for Design and Technology in Electronic Packaging*, no. 27, pp. 378–381, 2021.

[38] F. Ciulli, A. Kolk, and S. Boe-Lillegraven, "Circularity Brokers: Digital Platform Organizations and Waste Recovery in Food Supply Chains," *Journal of Business Ethics*, pp. 299–331, 2019.

[39] Z. Luo, J. Zhu, and T. e. a. Sun, "Application of the IoT in the Food Supply Chain—From the Perspective of Carbon Mitigation," *Environmental Science & Technology*, pp. 10567–10576, 2022.

[40] L. Herm and C. Janiesch, "Anforderungsanalyse für eine Kollaborationsplattform in Blockchain-basierten Wertschöpfungsnetzwerken," Working Paper, Betriebswirtschaftliches Institut, Julius-Maximilians-Universität, Würzburg.

[41] D. Bechtsis, N. Tsolakis, A. Bizakis, and D. Vlachos, "A Blockchain Framework for Containerized Food Supply Chains," *Computer Aided Chemical Engineering*, 1159-1164, 2019.

[42] M. Kramer, P. Bitsch, and J. Hanf, "Blockchain and Its Impacts on Agri-Food Supply Chain Network Management," *Sustainability*, no. 13, 2021.

[43] Z. Li, G. Liu, L. Liu, and X. Lai, "IoT-based tracking and tracing platform for prepackaged food supply chain," *Industrial Management & Data Systems*, no. 117, pp. 1906–1916, 2017.

[44] T. Scheerer, D. Hertweck, and T. Hakenberg, "Extended Abstract - Like Two Peas in a Pod - Organic and Digital Transformation," *Joint Proceedings of ICT4S 2023 Doctoral Symposium, Demonstrations & Poster Track and Workshops*, 2023.

[45] A. Hevner, S. March, J. Park, and S. Ram, "Design Science in Information Systems Research," *MIS Quarterly*, no. 28, pp. 75–105, 2004.

[46] P. Johannesson and E. Perjons, An Introduction to Design Science. Springer, 2014.

[47] J. Creswell and J. D. Creswell, Research Design: *Qualitative, Quantitative, and Methods Approaches,* 5th ed. Sage Publications.

[48] B. Glaser and Strauss Anselm, Discovery of Grounded Theory: *Strategies for Qualitative Research,* 1st ed. New York: Routledge, 1999.

[49] J. Corbin and A. Strauss, Basics of Qualitative Research: *Techniques and Procedures for Developing Grounded Theory,* 4th ed. London: Sage Publications, 2014.

[50] Landkreistag Baden-Württemberg, Ed., "Landkreis Nachrichten Baden-Württemberg," Stuttgart, Jul. 2022.

[51] J. Creswell, Qualitative Inquiry & Research Design: *Choosing Among Five Approaches,* 2nd ed. California: Sage Publications, 2007.

[52] P. Mayring and E. Brunner, "Qualitative Inhaltsanalyse," in *Qualitative Marktforschung: Konzepte - Methoden - Analysen*, R. Buber and H. Holzmueller, Eds., Wiesbaden: Gabler, 2007, pp. 669–680.

[53] Bundesanstalt für Landwirtschaft und Ernährung (BLE). "Oekolandbau.de: The information website." https://www.oekolandbau.de/ Accessed: Apr. 26, 2024.

[54] Ministry of Food, Rural Areas and Consumer Protection Baden-Wuerttemberg. “Bio-Musterregionen Baden-Wuerttemberg.” https://biomusterregionen-bw.de/Startseite Accessed: Jan. 30, 2023.
[55] City of Augsburg *et al*. “Biostaedte.” https://www.biostaedte.de/ Accessed: Apr. 26, 2024.
[56] Kuckartz Udo and S. Raediker, Fokussierte Interviewanalyse mit MAXQDA: *Schritt für Schritt* (Lehrbuch). Wiesbaden: Springer; Springer VS, 2021.
[57] M. Cooper, D. Lambert, and J. Pagh, “Supply Chain Management: More Than a Name for Logistics,” *The International Journal of Logistics Management*, no. 8, pp. 1–14, 1997.
[58] M. E. Porter, The Competitive Advantage: *Creating and Sustaining Superior Performance*. New York: The Free Press, 1985.
[59] Object Management Group. “Unified Modeling Language.” (OMG UML™). https://www.omg.org/spec/UML/2.5/PDF Accessed: Apr. 26, 2024.
[60] B. Dobing and Parsons Jeffrey, “The Role of Use Cases in the UML: A Review and Research Agenda,” *Advanced Topics in Database Research*, vol. 2002, no. 1, 367-382.
[61] T. Scheerer, D. Hertweck, and T. Hakenberg, “Like two Peas in a Pod: Organic and Digital Transformation in the Out-Of-Home-Catering Sector,” 2023.
[62] C. Nicholson and B. Young, “The relationship between supermarkets and suppliers: What are the implications for consumers?,” Jul. 2012.
[63] Alfred Marshall, Principles of Economics: *Palgrave Classics in Economics,* 8th ed. London: Palgrave Macmillan, 2013.
[64] Cambridge University Press 2023, “canteen,” in *Cambridge Dictionary*.
[65] V. Pejic, I. Gorenak, and S. Orthaber, “The Role Of Trust In The Food Supply Chain,” *Business Logistics in Modern Management*, no. 13, pp. 33–39, 2013.
[66] The European Parliament and the Council of the European Union, Regulation of the European Parliament and of the Council on the provision of food information to consumers: *(EU) 1169/2011*, 2011.
[67] European Commission, Commission Implementing Regulation: *(EU) 2018/775*, 2018.
[68] G. C. Stevens, “Integrating the Supply Chain,” *International Journal of Physical Distribution & Materials Management*, pp. 3–8, 1989.
[69] C. Verdouw, J. Wolfert, A. Beulens, and A. Rialland, “Virtualization of food supply chains with the internet of things,” *Journal of Food Engineering*, pp. 128–136, 2015.
[70] D. Patterson, B. Tomlinson, G. Hayes, M. Mazmanian, and L. Dombrowski, “ICT4S 2029: What will be the Systems Supporting Sustainability in 15 Years? -: Food Packets: Network graphs for food distribution,” *International Conference on ICT for Sustainability*, pp. 36–37, 2014.
[71] The Government of the State of Baden-Wuerttemberg, Landeshaushaltsordnung für Baden-Wuerttemberg: *LHO*, 1971.
[72] “Wirt sucht Bauer.” https://www.wirt-sucht-bauer.de/ Accessed: Feb. 3, 2024.
[73] “Regio Verpflegung.” https://www.regio-verpflegung.bayern/ Accessed: Feb. 3, 2024.
[74] “Nearbuy.” https://www.nearbuy-food.de/ Accessed: Feb. 16, 2023.
[75] “Green Canteen.” https://greencanteen.org/ Accessed: Feb. 16, 2023.
[76] “Bauer sucht Koch.” https://www.bauer-sucht-koch.de/ Accessed: Feb. 16, 2023.
[77] “Meck Schweizer.” https://meck-schweizer.de/ Accessed: Feb. 3, 2024.
[78] “Wer liefert was.” https://www.wlw.de/ Accessed: Feb. 3, 2024.
[79] K. Schwarz, “Optimierung digitaler Food Supply Chains,” Master Thesis, Reutlingen University, Reutlingen, 2021.
[80] Aachener Stiftung Kathy Beys, Ed., “Regionalvermarktung von Lebensmitteln,” Aachen, 1999.
[81] K. Salah, R. Jayaraman, N. Nizamuddin, and M. Omar, “Blockchain-Based Soybean Traceability in Agricultural Supply Chain,” *IEEE Access*, 2019.
[82] H. Sundmaeker, C. Verdouw, S. Wolfert, and L. Pérez-Freire, “Internet of Food and Farm 2020,” *Digitising the Industry Internet of Things Connecting the Physical, Digital and Virtual Worlds*, pp. 129–151, 2016.
[83] C. Becker *et al.,* “Sustainability Design and Software: The Karlskrona Manifesto,” in *2015 IEEE/ACM 37th IEEE International Conference on Software Engineering*, Florence, Italy, vol. Florence, Italy, 2015, pp. 467–476, doi: 10.1109/ICSE.2015.179.