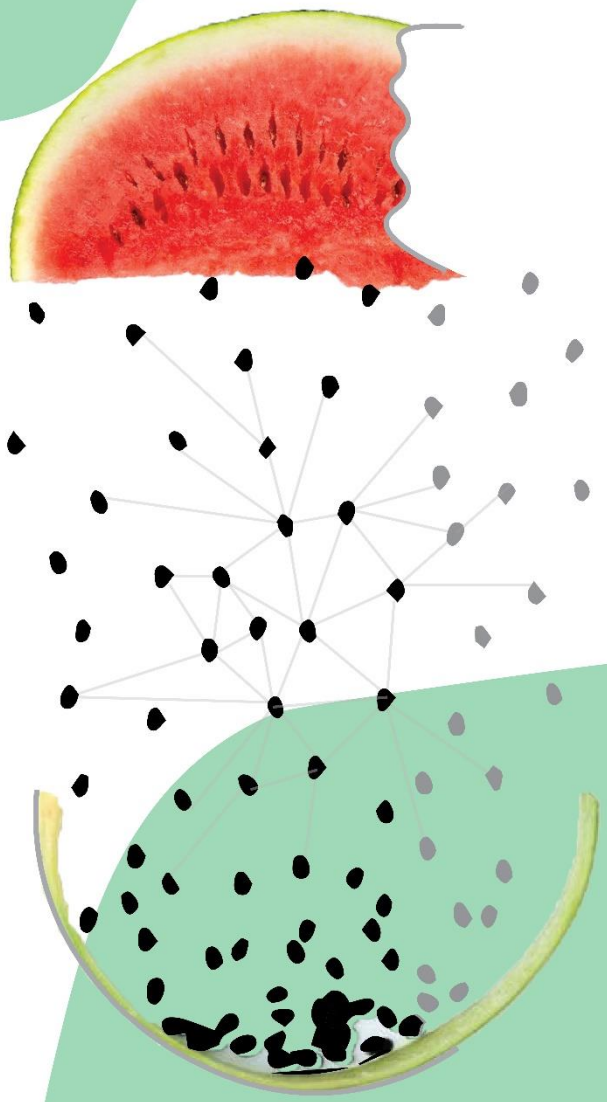
Master's Thesis – MSc Sustainable Business and Innovation

ECOSYSTEM BUILDING STRATEGIES FOR CIRCULAR START-UPS: THE CASE OF THE FOOD SECTOR



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Summary

The current industrial food system generates numerous environmental impacts due to the linear economic model of ‘’take-make-waste’’. In order to withstand current and future challenges the food system needs to transition towards a circular food production system. Whereas the focus amongst practitioners and academics in the circular field tends towards large companies, the circular start-ups represent the innovative entity that can generate new innovative business models and quickly adapt to changes. However, start-ups often have difficulty with generating viable business models. This study aims to determine how circular start-ups in the food sector can create a supportive external environment for the development and diffusion of circular business model innovations, in doing so supporting the transition towards a circular food production system. Building on existing literature of strategic collective system building.

Based on strategic management, technological innovation systems, and business ecosystems literature a theoretical framework has been created. The concepts of strategic collective system building, and the innovation system actor analysis have been operationalised within a semi-structured interview. And used to perform a multiple case study analysis of 13 circular start-ups in the food sector of the Netherlands to validate the strategic collective system building framework for circular business model innovations. The data collection included 21 semi-structured interviews and desk research.

The empirical findings showed that strategic collective system building appeared to be relevant for the creation of a supportive external environment for circular business models innovation. Also, this research validated the strategic collective system building framework with circular start-ups in the food sector. The empirical findings showed that in order to strengthen the CSUs ecosystem several refinements of activities are needed. These refinements included: incorporating a reciprocal relationship within the exchange of knowledge; add collaboration with the current regime as collaboration with competition; enrich collaborative marketing with creating behavioural change towards sustainable consumption; add reporting, monitoring and minimum standards in the standardisation of processes.

This refined framework complemented with insights on the barriers, structural problems and relevant actors within the innovation system for collaboration provide strategic insights for CSUs to create a supportive ecosystem. In this way the research contributes to the creation of a strong external environment for circular business models within the food sector to support the transition towards a circular food production system.

Acknowledgements

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Glossary

CBM – circular business model

CE – circular economy

CSU – circular start-up

IE – innovation ecosystem

IS – innovation system

SCSA – strategic collective system building activities

LNV – Ministry of Agriculture, nature and food and safety

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1. Introduction

The current industrial food system is based on a linear economic model of ''take-make-waste'', which assumes that economic growth can be realised due to an abundance of resources and limitless waste discarding (Jurgilevich et al., 2016). This generates numerous large environmental impacts e.g. increased CO_2 emissions, eutrophication and deforestation (Baroni et al., 2007; Tilman et al., 2001). Despites the importance of safeguarding the global adequate nutrition, approximately one third of the global food production is wasted (FAO, 2012). In Europe this results in 88 million tonnes of food waste every year, associated with costs estimated around 143 billion euros (Stenmarck et al., 2016). This in combination with depletion of natural resources, growing population and decreasing resource stability make the challenges for the future food system even greater (Westhoek et al., 2016). Correspondingly, the food system requires to transition towards a more sustainable system to withstand current and future challenges (Bloemhof & Soysal, 2017).

To transform the current food production and consumption patterns the linear economic model needs to change towards a circular economy (CE). This concept holds its origin in different schools of thought (e.g. industrial ecology, cradle 2 cradle) and challenges the obsolete take-make-waste model (Rizos et al., 2016). The concept is reducing the pressure on natural resources and decreasing food waste, has economic potential by offering new business opportunities, generates employment and strengthens competitiveness (Antikainen et al., 2017; Bastein et al., 2014; Ellen MacArthur Foundation, 2012; Wallace and Raingold 2012). Also, despite the importance for the Netherlands, working towards a CE leads to 54000 to 83000 added jobs and a 10% reduction in the yearly CO_2 emissions (Coenen et al., 2018). The food- and beverage industry has been identified as a sector with large circular potential, due to the characteristics of handling large volumes and addressing environmental and economic significance. Additionally, the food system is characterized by its central role of managing large amounts of various biological materials within supply chains (Vanner et al., 2014), which make circular methods more applicable. For the food and beverage industry in the Netherlands, TNO valued the CE's yearly benefits to be 930 million euros (Bastein et al., 2014). This makes the circular economy within the food sector an interesting topic for the transition towards a more sustainable food system.

Whereas the focus amongst practitioners and academics in the CE field is currently on large companies, nonetheless innovative start-ups have the ability to adapt new business model innovations quickly and give an example to the larger companies (Bocken et al., 2017). Mentink, (2014 pp. 24) defines these circular business models (CBM) as ''the rationale of how an organization creates, delivers and captures value with and within closed material loops''. The various circular business model innovations and strategies implemented by circular start-ups (CSU) will be elaborated upon in the theoretical review. These CSUs, representing this innovative part of the business entities, facilitate the change towards a circular economy by providing concrete examples of circular business opportunities (Antikainen et al., 2017). Until recently CSUs within the food sector are implementing circularity strategies (i.e. reduce, reuse and recycle), additionally trying to broadcast a message on preventing food waste. Some best practise examples of CBMs are seen within circular food start-ups. Varying from processing rejected vegetables into soups by Kromkommer, to extracting essential oils from orange peels and process it into cosmetics, food and cleaning products by PeelPioneers, or serving dishes of food products from supermarkets close to the expire date by Instock (Start-up Delta, 2018). These start-ups implement high circularity strategies by reusing food products for human consumption (Garcia-Garcia et al., 2017).

According to Bet & Truijens (2018) the circular economy in the Netherlands is very much driven by start-ups which bring ecological and societal impact to the world. However, these start-ups face difficulties with getting finance and developing viable business models. In order to overcome these barriers, it is relevant to understand collaborative innovation systems for the creation of collaborative networks of actors within sectors, that contribute to the fast diffusion of sustainable, including circular, innovations towards the transition of a circular economy. The TIS literature provides a system

perspective in which it focusses on the firm, named 'outside in thinking' (Hekkert et al., 2007; Schot & Geels, 2008; Hekkert & Negro, 2009). Whereas, the strategic nice management and ecosystem literature focus on the meso-level processes, relevant for firms to create a supportive environment for their sustainability innovation (Musiolik et al., 2012; Planko et al., 2017). These literature streams are combined in the strategic collective system building framework created by Planko et al. (2016) for entrepreneurs to collaboratively create an external environment for the diffusion of sustainability innovations, to accelerate the sustainability transitions. However, this strategic framework focusses on technological innovations without the validation for other innovation types. This thesis with the focus on CSUs in the food production system of the Netherlands, provides insights on how strategic collective system building can be applied not only for technological innovations, but also for circular business model innovations. Furthermore, the combination of the TIS (meso) and strategic management literature (micro) is a new approach. Implying the need for validation of the strategic collective system building framework created by Planko et al. (2016). Therefore, this research validates the applicability and usefulness of strategic collective system building when analysing the strategies of CSUs in the food production system of the Netherlands. Furthermore, providing insights for pioneering CSUs in the food sector by adding to the wider application of circular practices, contributing to the transition towards a circular food production system.

The aim of this thesis is to research the strategic collective system building activities of CSUs in the Dutch food production system through the lens of the TIS and business ecosystems. The scope of this research focusses on the food manufacturers, retail and hospitality sector. This sector aims to reduce and prevent food waste and losses within the food processing and service segments of the food production system. In order to gather empirical evidence in the sector on strategic collective system building activities, a multiple case study of 13 CSUs in the food production system was conducted. The data collection consists of literature research and semi-structured interviews with 13 CSU founders or managers in the food sector, complemented by 8 interviews with experts in the field.

Preliminary desktop research led to discovering literature on relevant theoretic frameworks for supporting the development and diffusion of circular business models by CSUs. The TIS framework provides a system level perspective on the structural dimensions of an innovation system, revealing structural problems in the innovation system of circular business model innovations (Hekkert et al., 2011). In addition, this framework uses an actor analysis which provide insights in possible collaborations opportunities between actors for the realization of strategic collective system building activities. Moreover, the ecosystem literature explains the role of leadership actors that initiate and push actors within the ecosystem to accelerate the diffusion of a sustainable innovation (Gomes et al., 2018). Furthermore, the strategic collective system building framework by Planko et al. (2016), demonstrates how entrepreneurs and entrepreneurial managers can create a supportive external environment for the development and diffusion of their sustainable innovation. By uniting these literature streams, a theoretical framework is created, operationalizing the analysis of the strategic system building process for the CSUs in the Netherlands. This research approach will answer the main research question in this study, introduced as follows:

How can circular food start-ups in the Netherlands create a supportive external environment for the successful development, diffusion and implementation of their circular business model innovations?

In order to answer the main research question, several sub-questions have been formulated:

- *What structural problems obstruct the diffusion and development of circular business models of circular food start-ups in the Netherlands?*
- *Which actors within the food production system of the Netherlands are relevant for collaborative efforts in order to create mutual benefits?*
- *What strategic collective system building activities are conducted and seen as important by CSUs in the food production system of the Netherlands?*

The scientific relevance in answering these research questions is related to the contribution of the theoretical knowledge of collective system building activities by Planko et al. (2016). First, by introducing a circular dimension, followed by applying the strategy framework of Planko et al. (2016) to Dutch circular start-ups in the food sector. Practically, this thesis provides actors in the Dutch circular economy niches with recommendations and insights to successfully develop their external environment, which can support a widespread adoption of circular strategies within the food sector.

The following chapter provides a detailed explanation of the theoretical background, elaborating on the CBM innovation, strategies and CSU typologies, the concepts of innovation systems and ecosystems for the diffusion of sustainability innovations and the strategic collective system building for entrepreneurs. Chapter 3 elaborates on the research methods, describing the data collection process and operationalisation of the theoretical concepts for the data analysis. Followed by chapter 4, which elaborates on the results of the research. Next, the discussion of the empirical data in chapter 5, including the limitations of the research funding the basis for suggesting relevant future research topics. Within chapter 6 the conclusion of the research is presented.

2. Literature

This section elaborates on the innovative business entities of circular start-ups (CSUs) in the food sector. By explaining circular business model innovations (CBMI) and circularity strategies implemented within the food production system by CSUs to work towards the circular economy. Followed by compiling a definition of CSUs and describing various CSU typologies. Furthermore, elaborating the concept of innovation systems and ecosystems for the diffusion of sustainability innovations, with a focus on the structural actor analysis. Next, the strategic collective system building activities for the development and diffusion of circular innovations by entrepreneurs are explained. Finally, these literature streams are combined in a theoretical framework which will form the basis of the research.

2.1 Circular economy in the food production system

As described in the introduction, this research focusses on CSUs in the food sector. In figure 1 the food production system is presented in a simplified version, to put this research in the context of the food production system towards the circular economy. As Rood et al. (2017) describes, within a circular economy the natural resources e.g. water, soil, minerals and biodiversity need to be managed and used effectively. Moreover, reducing food waste, eating less processed food and animal proteins and more vegetables is important for the optimal use of food. This relates to reducing pressures on the environmental and natural resources. Overall, trying to lose the lowest amount of biomass as possible by optimally reusing residue streams within the biological cycles of the food production system. According to the Ellen Macarthur foundation, cities play an important role when visioning a circular economy for food ''Cities send clear demand signals to support regenerative production and better food design, while turning by-products from food eaten in cities into organic fertilisers for peri-urban farmers to use'' (Ellen MacArthur Foundation, 2018 p.4).

Respectively, the various CSU typologies (elaborated upon in section 2.2) described by Henry et al. (2019) can be found in the agriculture and livestock management or within the food manufacturers, retail and the hospitality sector of the food production system. Since the CBM innovations and strategies differ between these two sectors, the focus of this research will be on the food manufacturers, retail and hospitality. This sector aims to reduce and prevent food waste and losses within the food processing and service segments of the food production system.

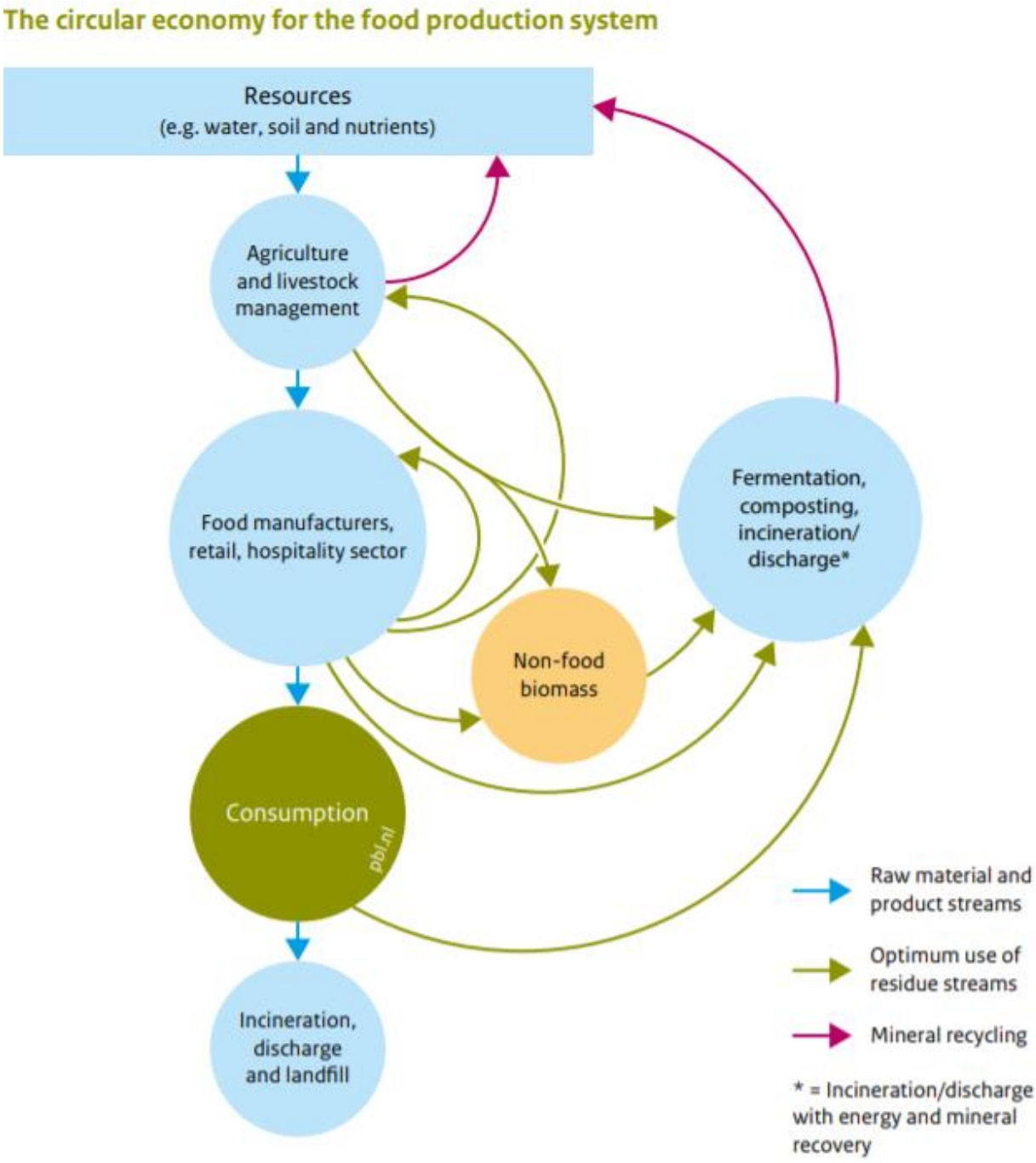

Figure 1 The circular economy of the food production system (adopted from Rood et al. 2017)

Within the food production system there are biological cycles of organic ´waste´ streams, containing nutritional value which can be recovered, recycled and reused to produce energy or renewable material resources (Mihai & Ingrao, 2018). According to Bell et al. (2018) by processing these streams into raw materials and renewable energy for circular products, significant economic opportunities and environmental benefits can be gained. The most common processes for the revalorisation of biological waste streams of food are currently: composting, animal feed, anaerobic digestion, land spreading, incineration, waste to energy and landfilling (Garcia-Garcia et al., 2017).

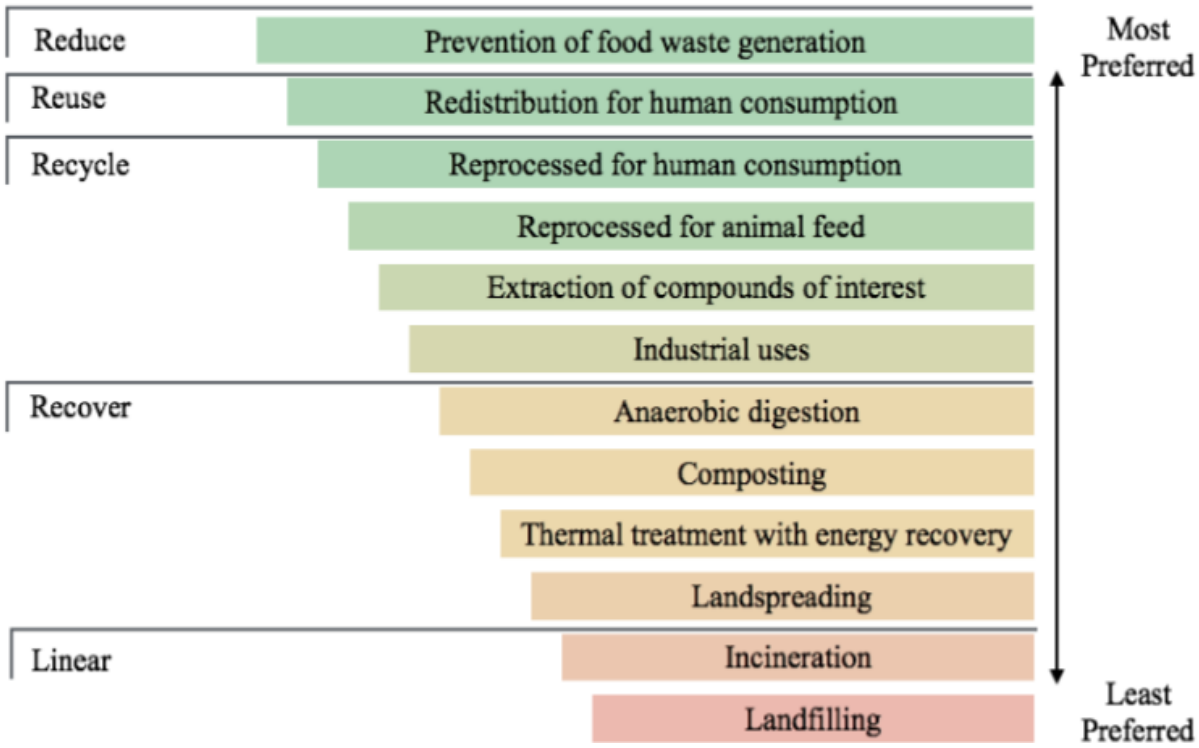

Figure 2 Circular strategies for the biological cycle of food (adapted from Garcia-Garcia et al., 2017, p.2215)

The activities for the revalorisation of food waste are ordered within the literature by prioritising the circularity strategies of reduce, reuse, recycle and recover (Garcia-Garcia et al., 2017; Imbert, 2017; Papargyropoulo et al., 2014). These activities are categorised and ordered based on the waste hierarchy by Vanner et al. (2014), to stimulate the optimum use of food towards a circular economy. With the least preferred activities at the bottom and the most preferred activities on top (see figure 2). However, the missing activity at the top of this framework is the proposed activity of regeneration of natural ecosystems by Henry et al. (2019). While the prevention of food waste is on top of this categorisation, the reuse, recycling and recovery activities are needed to harvest energy sources and renewable materials (Mihai & Ingrao, 2018). The CSUs within this research implement these various circularity strategies within their circular business models.

2.2 Circular start-ups

Within the CE literature the focus amongst practitioners and academics in the field is currently on large companies. However, within the innovation literature it is a common view that incumbents are often locked in by investments, existing business models and supply chains that are hard to adjust when fully developed (Clayton M. Christensen, 2000; Hill & Rothaermel, 2003; Johnson, 2010). Respectively, it has been argued if incumbents can fully implement 'radical' circular business models (Asif, Lieder, & Rashid, 2016). Since empirical data shows that incumbents are more likely to focus on common circular strategies e.g. recycling, which prevent the incumbents to change their primary business models (Stewart & Niero, 2018). Whereas, innovative start-ups are less bound to a technological mind-set and have the ability to adopt new disruptive circular business models quickly (Bocken et al., 2017), due to their flexibility and capability to respond to market developments (Bergset & Fichter, 2015; Hockerts & Wüstenhagen, 2010). Start-ups, representing this innovative part of the business entities, facilitate the change towards a circular economy by providing concrete examples of circular business opportunities (Antikainen et al., 2017), and providing new ventures which answer many environmental and social challenges (Hall et al., 2010).

This research focusses specifically on circular start-ups, the definition of a circular start-up compiled by Henry et al. (2019) is presented as ''new' (i.e. typically operating for four to six years) and 'independent' entrepreneurial ventures designed to effectively develop and validate a scalable, repeatable and at least break-even business model'' (Henry et al., 2019, p.7). Followed by the definition of circular business models, originating from earlier literature on business models (Osterwalder & Pigneur, 2010; Richardson, 2008), these literatures describe business models based on multiple elements: starting with the value proposition, key activities and resources, distribution channels, key partners, cost and revenue models. Whereas, Richardson (2008) consolidates the business model in a few components: the value proposition, value capturing system and the value creation and delivery system (Short et al., 2014) Additionally, circular business models are designed by incorporating CE principles in the business model design (Planing, 2014; Pieroni et al., 2019). Which refer to circular business operations that aim to close material and product loops by using the resources as long as possible through incorporating the 4 R's circular strategies of reducing, reusing, recycling or recovering to prolong the 'end-of-life' cycles (Kirchherr et al., 2017). Concluding, the definition of circular start-up (CSU) can be described as: 'New', 'independent' and 'active' entrepreneurial business entities incorporating CE principles in their business model designs, with the aim to close material and product loops throughout the entire value chain.

The research on various typologies and archetypes of circular start-ups (CSUs) has been conducted by Henry et al. (2019). Within this research 128 CSUs were identified and categorised based on a conceptual framework comprising CBM innovation types and CBM strategies. In which the authors explain that CBM innovations are the processes the firms use to implement their CBM strategies. And explain that the incorporation of circular principles within a business model refer to the business model innovation process, which can occur at various points in the value chain (Henry et al., 2019). Furthermore, these authors refer to (Urbinati et al., 2017), which states these points in the value chain can be categorised in downstream, upstream and full implementation of CBM innovations. In which downstream circular companies implement CBM innovations that focus on their customer interface and revenue model e.g. product service systems and consumers' active involvement, without making changes in their internal processes, product design or supply chain. The upstream CBM innovations make changes in the internal processes by interacting with suppliers and focussing on product and service design for the pre-customer and pre-usage face e.g. industrial symbiosis or circularity standards. Whereas, the full CBM innovations incorporate both the downstream and upstream CBM innovations at the source of the CBM e.g. core technologies or enabling technologies. The food system has strong interrelations and interdependencies, both down- and upstream along the food supply chain (Halloran et al., 2014). A prominent example of CBM innovations within the food sector of is the predictions of demand for future consumption, which causes more tailored production to the needs of the consumer demands and prevents overproduction, thereby preventing the excessive waste surplus and saving biological nutrients (Lewandowski, 2016).

Furthermore, Henry et al. (2019) uses the well-known R-framework by Kircherr et al. (2017) to identify the circular strategies. Respectively, these strategies include reduce, reuse, recycle and recover. Another circular strategy has been added by the authors, via inductively finding the Regenerate strategy within the empirical data. This regenerative strategy covers CSUs that focus on the regeneration of natural and biological ecosystems, by restoring or modifying ecosystems that increase and retain resources (Henry et al., 2019). These R-strategies can be used within both the biological and technical cycle of the CE (Ellen MacArthur Foundation, 2012). Based on empirical data collected of 128 CSUs and the previous described conceptual framework various typologies of CSU business models were defined. Since this research is the first conducting an analysis of CSU typologies, these typologies will be used for categorising the CSU start-ups analysed in this research:

- **''design-based CSUs**, adopting circular innovations mostly in the pre-market phase through source material minimization, product design or production process efficiency,
- **waste-based CSUs**, seeking to extract value from unexploited external waste streams,
- **platform-based CSUs**, pursuing business models built around B2B, B2C or C2C marketplaces,
- **service-based CSUs**, embedding products in service-systems to increase usage efficiency and
- **nature-based CSUs**, increasing the delivery of (products and) services based on nature-based systemic solutions''. (Henry et al., 2019, p.29).

2.3 Systems for the diffusion of innovations in the context of the circular economy

Within this section the similarities between the actor analysis of innovation system and ecosystems is elaborated upon, both supporting the assessment of relevant actors that contribute to the creation of a supportive external environment for the development of sustainability innovations.

Within the transition literature sectors (e.g. food production, energy supply) are conceptualised as socio-technical systems. These systems consist of multiple interrelated and dependent networks of actors. In this research area sustainability challenges have become the main focus for the socio-technical transitions, which are long-term transformation processes that shift socio-technical systems towards sustainable ways of production and consumption (Musiolik et al., 2012). Generally, in transition studies the incumbent firms operate within the existing regime structures, whereas start-ups mostly work in the niche level on radical innovations which do not fit the existing regime (Geels, 2011). Furthermore, part of the transition literature is the strategic niche management (SNM) literature which divides the transition in three levels: the landscape, socio-technical regime and niche level (Schot & Geels, 2008). Additionally, the SNM uses the niche market perspective in the context of evolving sustainable technologies to create societal transitions (Kemp, Schot, & Hoogma, 1998; Schot & Geels, 2008), similar to the transition from a linear to a circular economy. This study is going to investigate the sustainable developments in the food sector, where its effect on the environment and society are noticeable in radical changes of companies' business models innovations towards circular approaches (Garrone, 2017).

To support these socio-technical transitions through the diffusion of circular business model innovations the literature on innovation studies offers a systemic perspective. Within the field of innovation studies there is a broad consent that innovation happens collectively in the context of a general Innovation system (Bergek et al., 2008; Hekkert et al., 2007). Transitions require changes and reconfigurations within the whole IS, not only technological changes (Schot & Geels, 2008). Within the IS literature the technological developments and innovation happens within complex infrastructures, networks and actor interactions. Examples of actors within an IS are businesses, universities, research institutes and governmental organisations (Wieczorek & Hekkert, 2012).

Whereas, the technological innovation system (TIS) literature describes the sustainable socio-technical transition within a system, focussing on the development, diffusion and implementation of a certain technology (Bergek et al., 2008; Hekkert et al., 2007). The TIS is described as "a network or networks of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse, and utilise technology" (Carlsson & Stankiewicz, 1991, p. 94). An important process within the TIS literature is to change the external business environment, defined as system building: ''The deliberate creation or modification of broader institutional or organizational structures in a technological innovation system carried out by innovative actors. It includes the creation or reconfiguration of value chains as well as the creation of a supportive environment for an emerging technology in a more general way." (Musiolik et al., 2012, p. 1035).

Within the technological innovation system (TIS) Hekkert et al. (2007) identified seven system functions (SFs) which are divided in the strong and weak motors to analyse the successfulness of a TIS. These SFs are not directly applicable to CBM innovations, since circular innovations are not necessarily technological, but rather socio-institutional. Nonetheless, due to many interdependencies and similarities among the system approaches, these SFs can be applied to other ISs dimensions and systems (Jacobsson & Bergek, 2011). Respectively, Potting et al. (2017) explained the possibility of applying the theory to the CE. Since the transition towards a CE mostly concerns socio-institutional changes rather than radical technological innovations, the TIS literature can still be used as practical guideline for analysing the IS of circular business model innovations in the Dutch food sector. In this way the literature of IS can be used to analyse crucial actors contributing to the transition towards a CE.

Likewise, the literature on business and innovation ecosystems stresses the importance of collaboration among actors for the development and diffusion of a certain innovations. Firstly, applied in the management literature by Moore (1993) by proposing ''that managers should think of companies as part of an ecosystem, which consists of a loosely interconnected network of actors (a community), including companies and other entities, coevolving their capabilities around an innovation, sharing knowledge, technologies, skills and resources, cooperating and competing''. (Gomes et al., 2018, p. 39). Whereas, Gomes et al. (2018) conducted a systemic literature review of six research streams to define the specific definitions of business and innovation ecosystems. This research states, both ecosystems types have in common that they are composed of a '' interconnected and interdependent network actors, which includes the focal firm, customers, suppliers and complementary innovators''. Iansiti & Levien (2004a, p. 2). Moreover, they are built on a platform and lead by a platform leader (Gawer and Cusumano, 2008) or a keystone actor (Iansiti and Levien, 2004a). While facing competition and cooperation (e.g., Moore, 1993; Iansiti and Levien, 2004a), during a co-evolution process through the life cycle of the ecosystem (Moore, 1993).

These common concepts used within the ecosystem literature closely relate to the actor categories described in the IS literature. However, within the ecosystem literature one specific actor is mentioned explicitly, namely the platform leader or keystone actor as previously mentioned. Since Planko et al. (2016) uses the business ecosystem perspective to define entrepreneurial activities based on the system functions described in the TIS literature by Hekkert et al. (2007), the corresponding actor analysis could also complement each other. Whereas, the TIS literature analyses the presence and capability of actors contributing to the success of an innovation system (Hekkert et al., 2011), the leadership actor described in the ecosystem literature also contributes to this success (Gawer and Cusumano, 2008; Iansiti and Levien, 2004). Therefore, for CSUs to create a supportive external environment for their CBM innovation a business level perspective complements the system level perspective to analyse relevant collaboration opportunities. The actor analysis for the innovation system of CSUs in the food sector is therefore complemented with the inclusion of the leadership actor category. The inclusion of this perspectives results in the adaptations of the leadership role in the TIS actor analysis, as presented in figure 3. The categorisation of actors within this framework is used in this research to map the actors within the circular business model innovation sector of the Netherlands.

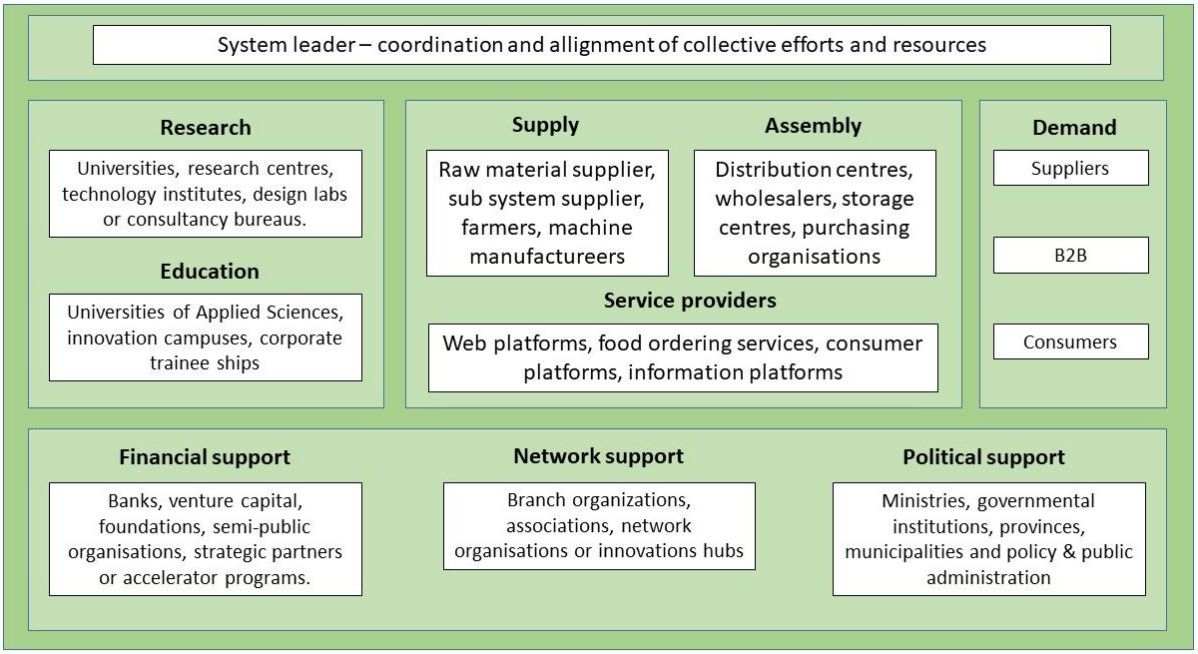

Figure 3 Innovation system actor structure based on Hekkert et al. (2007); Kuhlmann and Arnold. (2001); addition leadership actor based on Gomes et al. (2018)

The various actor types presented in figure 3 contribute with their actions and choices to the generation, diffusion and utilisation of a technology or innovation (Hekkert et al., 2011). The various types, their roles and examples of actors are presented in table 1. These descriptions of the various actor types will be used to map the actors involved in the circular business model innovation system of the Dutch food sector.

Table 1 Overview of actor categories based on Hekkert et al. (2011), addition of leadership actor based on Gomes et al. (2018)

Actor category	Type of actor	Definition	Examples
System leader		These leaders initiate and push the network of actors active in the circular field of the food production system to accelerate the diffusion of circular innovations towards a sustainable transition of the food production system.	Coalitions, foundations, frontrunners
Industry	**Supplier**	The *suppliers* referring to the producers of raw materials, machines or other practical resources	Farmers, food processors, machine manufacturers
	Assembler	the *assemblers* , these are the actors that create regional collaborations between various suppliers by collaborating and distributing their products collectively, often act as wholesalers.	Distribution centres, wholesalers, storage centres, purchasing organisations
	Service providers	These industry actors are supported by the maintenance and service parties, in this research these actors are named *complementors,* they meet the consumer specifications by creating complementary offerings.	Web platforms, food ordering services, consumer platforms, information platforms
Demand		the **market actors** on the demand side include various user types, the *consumers* themselves (B2C). Followed by the catering sector and larger retail parties that act as wholesaler, which are often more sustainable focused retailers (B2B).	Consumers, hotels, catering companies, supermarkets, food delivery services
Knowledge institutes	**Research**	The **research** actors conduct research, provide expertise, generate knowledge and consultancy. Furthermore, knowledge via research project, workshops or events is gained	Universities, research centres, technology institutes, design labs or consultancy bureaus
	Education	The **education** actors contribute to knowledge development and practical implementation of theoretical concepts within the industry as can be seen in other educational organisations, that are more focussed on the professional training and higher education.	Universities of Applied Sciences and innovation campuses or trainee ships within organisations
Network		The **network** supporting parties try to connect various actors and are dedicated to creating new networks and collaborations to provide access to markets	Branch organizations, associations, network organisations or innovations hubs
Financial		The **financial** supporting organisations provide entrepreneurs with resources for new venture creation or arrange co-development offerings with firms	Banks, foundations, semi-public organisations, strategic partners or accelerator programs
Political/ Government		The **political** supporting organisations influence laws and regulations to support entrepreneurship and the development of the innovation system, by providing favourable economic conditions and policies.	Ministries, governmental institutions, provinces, municipalities and policy & public administration

Within the TIS literature the systemic functions (SF) assess the success of the IS to create sustainable 'impact'. In this way the SFs serve as guidelines to examine the state of sustainable innovations. By assessing the SFs, the weaknesses and strengths within the IS can be determined, to define where improvements can be made. These SFs are focussed on giving guidance for policy makers or innovation managers for supporting the diffusion, development and implementation of a certain technology. This study aims to create a supportive external environment for improving the IS of CSUs within the food sector. Therefore, section 2.4 will elaborate on the configuration of these SFs for entrepreneurial managers and entrepreneurs to improve their business ecosystems.

2.4 Collective system building strategies for entrepreneurs

Within the early stages many start-ups collapse, only a third turns into companies (Vesper, 1990). The cause of these failures is caused by several problems, such as the lack of business knowledge, management issues, lack of financial access or technological lags (Núñez, 2007). Within this section the strategic collective system building strategies for entrepreneurs will be elaborated upon, in order to increase the likeliness of these start-ups to succeed.

The creation of a collaborative network among CSUs in the Netherlands could provide benefits for CSUs to overcome the previous discussed barriers, and by turning into successful businesses these CSUs support the transition towards a circular economy. As discussed in the previous section, innovation happens collectively in the context of a general Innovation system (IS) within complex infrastructures, networks and actor interactions (Hekkert et al., 2007). Similarly, the strategic management literature discusses the collaboration among various actors within a business ecosystem to create a supportive external environment for the diffusion and commercialisation of a sustainable technology (Planko, 2018).

To achieve this collaboration between various actors within an ecosystem Planko et al. (2016) introduces strategic collective system building as "the strategic activity of networks of entrepreneurs and entrepreneurial managers to build up a supportive environment and infrastructure for their innovative sustainability technology" (Planko et al., 2016, p. 4). The key aspect of this concept is the creation of value within a collective ecosystem of businesses. As Planko et al. (2018) assumes that the success of an individual firm depends on the business network it operates in. The framework defines how to strategically build a supportive external environment for successful adoption and diffusion of sustainable concepts and technologies to have an increased chance to succeed.

Planko et al., (2016) created this framework by combining the technological innovation system (TIS) literature with the strategic management literature. Within the strategic management literature, the need for collaborative networks of companies and the constant adaptation in shifting business ecosystems is crucially when competing with other technologies (Planko et al., 2016). The strategic management literature contains the knowledge on successful adoption and diffusion of a sustainable technology, using collaborative networks or industry clusters by building a favourable business environment for the technology. This in combination with the knowledge from the TIS literature to strategically create a supportive external environment, results in the concept of strategic collective system building. As Plank et al. (2018) describes ''the TIS key processes take place at the system level, but firms operate on the micro level, the TIS processes have to be broken down into strategic activities which can be carried out by firms''.

With the use of these system building activities, networks of entrepreneurs can create and achieve system building goals. In order to define practical strategies, a framework is created for entrepreneurs and entrepreneurial managers to define system building activities. The framework contains four categories of activity clusters; technology development and optimizations, market creation, socio-cultural change and coordination (Planko et al., 2016). The first three categories refer to system building goals for entrepreneurs, the coordination category refers to all the management and alignment activities for system building efforts, which combines resources and forces for acceleration of the system building process (Planko, 2018). These collective system building activities presented in figure 4 will have an important role in this research, through analysing the strategies for the creation of a favourable environment for CSUs in the food sector. Since these collective system building activities focus on the activities for entrepreneurs to conduct on a meso-level perspective, the leadership role mentioned as important in the business ecosystem literature will be added to the actor analysis.

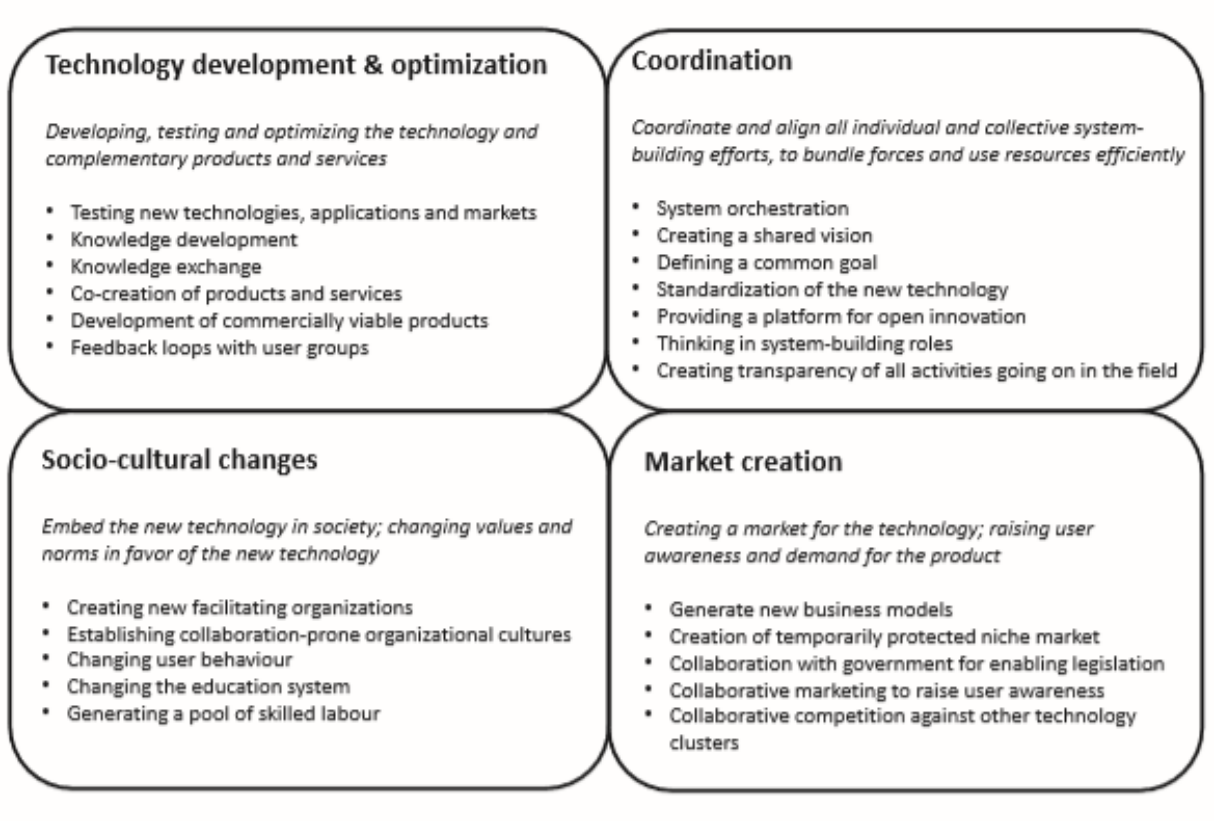

Figure 4 Framework for strategic collective system building activities (adopted from Planko et al. 2016)

The benefits resulting of collaborations in networks are seen in the smart grid sector by Planko. (2018) consisting of sharing of costs and risks, reduction of uncertainties, more access to knowledge and resources, improve product and service range, market creation, getting a supportive institutional environment and increased competitive advantage. Within the food production sector, the collaboration benefits of circular food start-ups have not been researched. However, for short food supply chain start-ups the benefits of collaborative efforts have been defined by EIP-Agri. (2015): Improved product range, maintaining infrastructure, increased negotiating power, increased support from new ventures, decreased competition and increasing shared processing facilities. This shows the relevance of creating a collaborative network and bundling collective efforts.

Within the research of Planko et al. (2016) the focus is on sustainable technologies and the development of collaborative networks within the smart grid sector. Whereas, this thesis research focusses on the collective system building strategies concerning CSUs in the food sector. As mentioned by Planko et al. (2016) the strategy framework is applied to one field, testing the framework in other technological fields is a next step. Therefore, this research applied the framework on an empirical study of the Dutch food sector. First, by testing the strategic framework to determine if the collective system building activities are implemented in other sectors, in this case the food sector. Secondly, by applying the framework on CBM innovations, which according to Potting et al. (2017) mostly concerns socio-institutional changes rather than radical technological innovations.

2.5 Theoretical framework

The previous discussed literatures all contribute to the sustainability transition research. The combination of these research streams is relevant for the creation of collaborative networks of actors within sectors, and contribute to the fast diffusion of sustainable, including circular, innovations towards the transition of a circular economy, the concepts are combined and presented in figure 5.

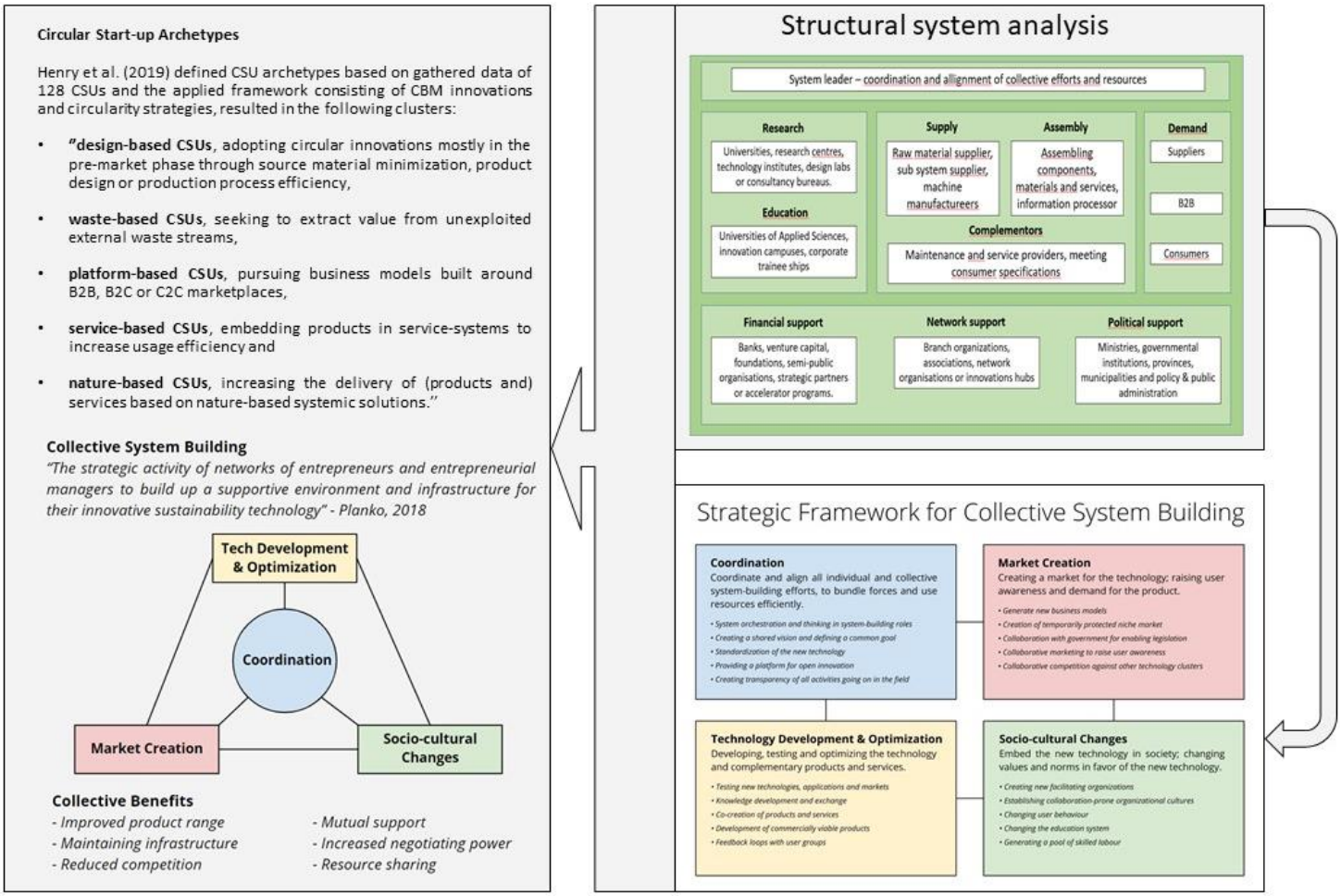

Figure 5 Integrated conceptual framework to analyse system actors of CSUs and strategic collective system building activities for the creation of a supportive ecosystem. Based on Hekkert et al., 2011 (system actor analysis); Henry et al., 2019 (CSU archetypes); Planko, 2018; Planko et al., 2015 (strategic collective system building, see Appendix J for larger version.

3. Methodology

The previous section elaborated on the integrated conceptual framework derived from literature, focussing on strategic collective system building for CSUs in the food sector. These theoretical concepts need to be operationalized in order to conduct a multiple case study which can answer the research question of this thesis. This chapter elaborates on the ways this integrated conceptual framework is used in this research, followed by the methods for data collection and analysis. In order to find empirical evidence in the sector on strategic system building activities and collective system building efforts, a multiple case study of various CSUs in the circular food production sector of the Netherlands was conducted. The motivation for choosing multiple case studies was to suit with the explorative strategy of this research, giving the ability to explore similarities and differences between cases. Whereas an explorative strategy refers to answering a 'how' research question, leading to multiple case studies, makes this an appropriate research design for this research (Yin, 2003). This thesis conducted two research approaches within an iterative process, with the combination of desktop research and interviews. This approach enables the researcher to gather and process varied information in a systemic way. The desk research contributes to the collection of academic knowledges, the interviews provide qualitative data and complemented by quantitative data collection through a survey validation. In this way insights are gained in order to answer the research questions.

3.1. Case study selection

The food production sector in the Netherlands has been chosen due to the entrepreneurial activity and the possibilities it offers to transition towards a circular economy. Since the food production system has been identified as a sector with large circular potential, due to the characteristics of handling large volumes and addressing environmental and economic significance. Additionally, the food system is characterized by its central role of managing large amounts of various biological materials within supply chains (Vanner et al., 2014), which make circular methods more applicable and close need for collaboration among actors crucial. The Dutch food production system is very efficient (Rood et al., 2017), which enables entrepreneurs to develop even higher levels of circular business practices within this sector. Respectively, many Dutch entrepreneurs have established circular food start-ups, there are even collaborative networks of CSUs established. The European Union and the Dutch government likewise support the transition towards the circular economy, an overview of these collaborative networks is presented in table 2.

Table 2 Overview of circular collaborative networks in the food sector (Taskforce Circular Economy in Food, 2018; Verukkelijk, 2019; Voor de Wereld van Morgen, 2019).

Name	Description
Verspilling is Verukkelijk	Collaboration platform of 18 CSUs named Verspilling is Verukkelijk, circular entrepreneurs combine their forces through collaborative marketing and coordinating collective efforts to support the circular transition within the food sector.
Samen tegen Voedselverspilling	Sectoral network of circular actors within the food production and hospitality sector. Around 60 partners have joined the foundation Samen tegen voedselverspilling.
Blue City	Within this circular innovation hub various circular entrepreneurs are developing viable circular businesses, showcasing circular best practices that support the transition towards the circular economy within the Netherlands.

REFRESH	Community of experts that collaboratively try to tackle food loss and waste within Europe through the sharing of best practices, knowledge and innovations

Likewise, the Dutch government aims for a circular economy in 2050, and therefore supports social and sustainable entrepreneurship by supporting collaborative networks of actors with guidance and funding to accelerate these collaborations within the food production sector (Government of Netherlands, 2016) . The governmental support and collective actor network efforts taken by CSUs in the food production sector make this a suitable case to analyse the entrepreneurial strategic collective system building processes.

3.2. Data collection

The data collection included the use of various techniques, named triangulation, to guarantee that the collected data is valid, reliable and rich (Saunders et al., 2009). The techniques included literature research of scientific articles on network management, innovations systems, ecosystems, strategic collective system building, circular business model innovations, circularity strategies, entrepreneurship literature, internal report, semi-structured in-depth interviews and observations.

Starting with a desk research to find relevant background information on the ecosystems and system building efforts of circular start-ups in the food sector. By searching via platforms such as Google Scholar and Scopus, with the following terms: sustainable food system, circular food systems, circular start-ups, circular strategies, food waste start-ups, food waste, sustainable supply chains, short supply chain, circular business models, circular Agri- and food sector, collaborative networks, business ecosystems, innovation ecosystems, collective system building, strategic network management, entrepreneurship, sustainable entrepreneurship. This method provided insights to generate a deeper understanding of the circular food production system in the Netherlands. One achievement of this methods was to map the most important actors and structural elements within this innovation system. The result of this desk research is Appendix E, the structural innovation system analysis has led to insights which were relevant to incorporate within the formulation of certain questions during the interviews. Since this new circular business field and market is constantly developing and updating, new insights have been gathered throughout the whole research process.

This desk research contributes to the presentation of general knowledge in this thesis and improved the interviews. Also, this supported the actor analysis of circular actors within the food production system. As a selection of CSUs and key actors were found multiple times within the desk research, a foundation was formed for mapping the various actors in the innovation system. By visiting various communication channels e.g. network platforms, partnership websites and other webpages additional relevant actors were found. Moreover, the desk research contributed to the understanding of the innovation system of circular business models innovations within the food sector of the Netherlands. By conducting research based on the structural innovation system analysis the various structural elements and problems within these elements contributed to the overall understanding of the innovation system. Additionally, it provides a flow of information within the constant developing entrepreneurial circular food sector, enabling to better understand relevant topics which were currently important within the ecosystem. Insights of this literature research were used to complement the analysis of relevant SCSA and will be elaborated upon in the discussion section.

For the collection of empirical data 21 in-depth semi-structured interviews were conducted with key actors in the sector as presented in table 3. First, a database was compiled with 30 circular food start-ups in the food sector through searching via platforms such as Google Scholar, Scopus, LinkedIn,

Google and the Start-up Delta database (see Appendix I). In addition, the attendance of entrepreneurial and food related events resulted in the contact formation with several circular start-ups which provided insights on key actors, partnerships and collaborations platforms within the field. These 30 CSUs were approached for conducting an interview, 12 were able to make time available in their agenda. These interviewees were the owner or manager of the CSU. Based on gained information from these interviews and the previous described desk research, eight experts within the field were selected for an interview, by selecting a representation of experts per actor type described in section 2.3 and insights gained within the desk research. These eight experts were mentioned as important players in the field by the interviewees and represented various actor types of which two network supporting actors, two industry actors, two research actors, an education actor and a financial actor.

Table 3 Overview interviewees (see appendix I for further details on the CSUs)

Code	CSU type	Function	#employees	Location	Year of foundation
CSU1	Waste-based CSU	Co-owner	2	Utrecht	2016
CSU2	Waste-based CSU	Co-founder	2	Amsterdam	2016
CSU3	Waste-based CSU	Founder	4	Wageningen	2018
CSU4	Service-based CSU	Co-founder	4	Amsterdam	2017
CSU5	Service-based CSU	Founder	4	Wageningen	2016
CSU6	Waste-based CSU	Co-owner	5	Amsterdam	2010
CSU7	Platform-based CSU	Founder	6	Amsterdam	2019
CSU8	Platform-based CSU	Founder	18	Amsterdam	2018
CSU9	Service-based CSU	Founder	1	Rotterdam	2018
CSU10	Service-based CSU	Founder	9	Utrecht	2018
CSU11	Waste-based CSU	Co-founder	2	Geldermalsen	2016
CSU12	Waste-based CSU	Founder	1	The Hague	2016
CSU13	Waste-based CSU	Founder	2	Utrecht	2017
	Actor type				
CE1	Network	Board member			
CE2	Network	Board member			
CE3	Consultant	Projectmanager			
CE4	Consultant	Projectmanager			
CE5	Leader	Researcher			
CE6	Knowledge support	Lectorer			
CE7	Industry	Owner			
CE8	Financial support	Financial expert			

The semi-structured interviews consisted of three parts (Appendix B) and appeared to be used more as a guideline. First, the circular strategies and business model innovations were discussed in order to categorise them in the various CSU archetypes. Within the expert interviews the first part focussed on how these experts contributed in the transition towards a circular economy in the food sector (Appendix C). In the second part, the interviewees were asked per strategic collective system building

activity cluster what system building activities were conducted in the sector, and in collaboration with which actors. Subsequently, the system building activities that were not named by the interviewee, were asked to be reflect upon in terms of the interviewees involvement, and their actual implementation, and their relevance for system building. In the third part, the various relevant actors were determined by the interviewees, based on the structural actor analysis framework (section 2.4).

The interviews lasted between 45 to 90 minutes and have been conducted between March 2019 and July 2019. The interviews were stopped when the phenomenon was understood, and no new information was gained after 3 sequential interviews. Within the literature this thematic saturation occurs at an average amount of 30 interviews (Ragin, 1994). However, thematic saturations occurred to a certain level in this research, as repeating answers were given by some interviewees, for example the need for the creation of a shared vision, consumer awareness, supportive legislation and transparency within the food production system. Twelve of the interviews were conducted via telephonic interviews, the other nine interviews were face-to-face interviews. All interviews were recorded and transcribed with the use of Express Scribe software. If requested these transcripts were sent to the interviewees and adjusted when needed. Half of the interviews were in Dutch, in the result section the used quotes were translated to English.

3.3 Data analysis

All the interviews were analysed by using NVivo software. The interviews were analysed through thematical coding. The various interviews were assigned with a unique code which refers to the actor type and interview number (table 3). The concepts of the integrated conceptual framework were used as sensitizing concepts. The coding framework was based on the literature review by formulating the understanding of collective system building activities, the actor analysis and financial mechanisms (Bryman, 2008). The formation of the coding framework was an iterative process which was redefined with the outcomes of the interviews, and new concepts were derived and added from the empirical data (Saunders et al., 2009). This coding process included the selecting of coding units by their content, followed by grouping these units into categories (Bryman, 2008). The coding categories needed to be 'all-inclusive', meaning that the most relevant responses are ordered in a specific dimension. The concepts also must logically fall within the same categories, referred as being 'mutually exclusive'. The strategic system building activities that were mentioned as important in the food sector, but were not included in the framework, were added within the concepts.

To validate these results an online survey was constructed, in which the interviewees were asked to rate the importance of the system building activities and add new system building activities when these were missing. The interviewees could score the importance of the system building activities on a 5-point Likert-scale, starting with 'very unimportant' to 'very important' for system building. The surveys were filled in by all the 12 interviewed CSU entrepreneurs and six SFSC entrepreneurs, which helped in validating the results for the CSU sector. Additionally, the cross-case analysis with the comparable SFSCs case pointed out the differences and similarities between these sectors collective system building strategies, in that way validating the empirical data of the CSUs case. Accordingly, the interviews were analysed more thoroughly to underline relevant phrases and words to select representative extracts of text to amplify the categories into themes. The coding process allowed the researcher to compare multiple interviews based on the content of similar topics. This allowed the researcher to summarize the results of multiple interviews, considering the same topic by giving an overview of the frequency given within the data. Furthermore, it allowed the researcher to locate examples within the transcript in the original context, ordered on any category.

Moreover, the structural actor analysis of the innovation system was conducted as described within the theory. The information was gathered within the second part of the interview which focussed on mapping the important actors within the circular food production system according to the interviewees. This data contributed to the actor analysis within the structural system analysis. The analysis of the other structural dimensions including the institutions, infrastructures and networks was completed with insights from the interviews and complemented with desktop research. For the analysis of the structural network element the various partnerships mentioned within the interviewees were gathered and supplemented with information from company websites and grey literature about circular projects and collaborations within the food production system. By combing the actor dataset and partnership information a preliminary network overview was created. This overview offers the possibility to find actors for collaboration that could contribute to the realisation of certain SCSA towards the building of a supportive external environment for the CBM innovations within the food production system.

The data and relevant insights have been gathered for this research through semi-structured interviews and desk research. The basis of a structural system analysis and preliminary network overview of influential actors within the circular food production system was created. The combination of these data sets provides a holistic view of the circular food production system in the Netherlands and provide insights in the strategies for CSU to strengthen their ecosystem.

3.4 Research quality

To guarantee internal and external validity and reliability of the research considerable measures were taken. The first issue considers the internal validity, since one person conducted all the interviews. Followed by using a qualitative research design focussing on one case study and using illustrations of a comparable case, which lead to external validity issues. Lastly, the fast development phase of the sector could result in different opinions or shifting importance of activities when interviewing these actors in the future.

These issues were solved with the use of triangulation, which means the collection of data from different sources to gain rich, reliable and valid data (Saunders et al., 2009). These data sources entailed the desktop research, semi-structured interviews, online survey and observations. The interviews were conducted with internal stakeholders being the CSUs and complemented by perspectives of external stakeholders being experts in the field. Additionally, to improve the internal data validity a coding framework was created (Appendix I). Besides, to generalize the multiple CSUs case studies to the broader food production system or other industries, the CSU case studies were related and compared to literature on strategic collective system building and network management.

4. Results

The key findings and outcomes of the research are presented in this chapter. The first section displays an analysis of various CSUs within the Netherlands. Followed by the empirical findings on the strategic collective system building activities found within the interviews and validated by an online survey. The second section presents the most common barriers mentioned by CSUs and experts during the interviews. Lastly, the innovation system actor analysis retrieved from the qualitative the 21 interviews is presented.

4.1 Circular food start-ups in the Netherlands

The multiple case studies of CSUs in the Netherlands represent various typologies of CSU business models as defined by Henry et al., (2019) and will be elaborated upon in this section. Since this research is the first conducting an analysis of CSU typologies, these typologies are used to analyse the various CSUs present in the Dutch food sector. Within this section these CSU types are elaborated upon and examples given, a broader overview is presented in Appendix A.

The design-based start-ups often work in the pre-market phase, within the food production system this is related to food packaging. These circular packaging designs are often high investments and therefore mostly implemented or developed by larger firms instead of CSUs. Therefore, are these CSUs less represented within the food production system. Some examples of start-up which created circular design-based innovations within the food production system are presented in Appendix A.

Whereas, the waste-based CSUs are the most common typologies represented within the food production system and in this research (CSU1, CSU2, CSU6, CSU11, CSU12, CSU13). By mainly focussing on Industrial symbiosis using unexploited food surplus to create products for human consumption, these CSUs implement the highest level of revalorisation for food. The revalorisation of food waste can be communicated within a clear message, by preventing 1/3 of the food waste these environmental resources and economic value can be gained. This is a value proposition that can be marketed and understood by the consumer. These consumers have a great influence with their purchasing choices and power to steer the course of the food production system towards the prevention or reduction of food waste and losses (interviewee CS1, SC2, CS8, CE8).

The platform-based CSUs have business models focussed on the sharing of knowledge, infrastructure, products or services with the use of data analysis based on algorithms to generate forecasting and increase efficiency within systems (CSU7, CSU8). These CSUs are focussing on various market places to create their value proposition. The B2B aims at the hospitality sector to improve their procurement and service processes to reduce food waste and losses. Within the B2C marketplace the platforms focus on reducing the food waste generated within the retail sector, optimizing the procurement processes to prevent excess stocks and engaging consumers to change their mindset when buying products in the supermarkets through dynamic pricing. The C2C market focusses on the sharing economy principles, which are often initiatives or consumer collectives, or foundations or initiatives that not have a business model like CSUs.

Another typology of CSUs are the service types which implement a product as a service model, to increase the efficiency of usage (CSU4, CSU5, CSU9, CSU10). This increasing of usage efficiency can be achieved through various approaches e.g. providing a tool to provide insights, a workshop for education on efficiency and sustainability or reduce the food packaging waste by incorporating a food container service e.g. looped and shared packaging.

Whereas the nature-based CSUs tend to work more in the agricultural sector of the food production system. Since these typologies are based on biological cycles within ecosystems to create a regenerative system. These solutions include building-integrated/urban agriculture, community gardens or aquaponics solutions. The scope of this research is focussing on the food manufacturing, retail and hospitality sector. However, these nature-based CSUs tend to focus more on agricultural practices and are therefore not included within the interviews.

Overall, as described various types of CSUs are represented within the cases of this research. The waste-based CSU are highly represented, followed by the service-based and platform-based CSUs. The clarification of the various CSUs and their CBM in the food sector provide relevant insights for understanding the strategic choices these different CSU types implement, which are elaborated upon in the following section.

4.2 Strategic collective system building within the CSU ecosystem

In order to strengthen the external environment for CSUs in the food production system within the Netherlands, the collaboration between actors can offer many benefits. This section focuses on the strategic collective system building activities for CSUs in the food production system.

In line with the strategic collective system building framework, section 4.2.1 presents and explains the system building activities found in the interviews with CSUs and experts in the field and the raring of importance, validated with an online survey amongst the CSUs. Followed by section 4.2.2 that describes the importance of collaboration through strategic collective system building to overcome barriers described by CSUs. Finally, section 4.2.3 describes the most important actors identified to collaborate with for the successful implementation of the SCSA.

4.2.1 System building activities found in the CSU sector

This section explains and presents the SCSA retrieved from the empirical data. These system building activities are divided and presented within their original cluster as described by Planko et al. (2016), as follows: technology development and optimization, socio-cultural changes, market creation and coordination. The findings from the interviews display how often the SCSA are performed within the Dutch food sector (figure 6, left bars). These insights complement the understanding and perception on these SCSA, contributing to the refinement of some activities for CSUs in the food sector. The importance of the activities has been validated through an online survey amongst the CSU entrepreneurs. As figure 6 (right bars) provides an overview of the importance of the system building activities based on the survey results using a 5-point Likert scale, varying from very unimportant (0) to very important (5), (appendix G presents the database).

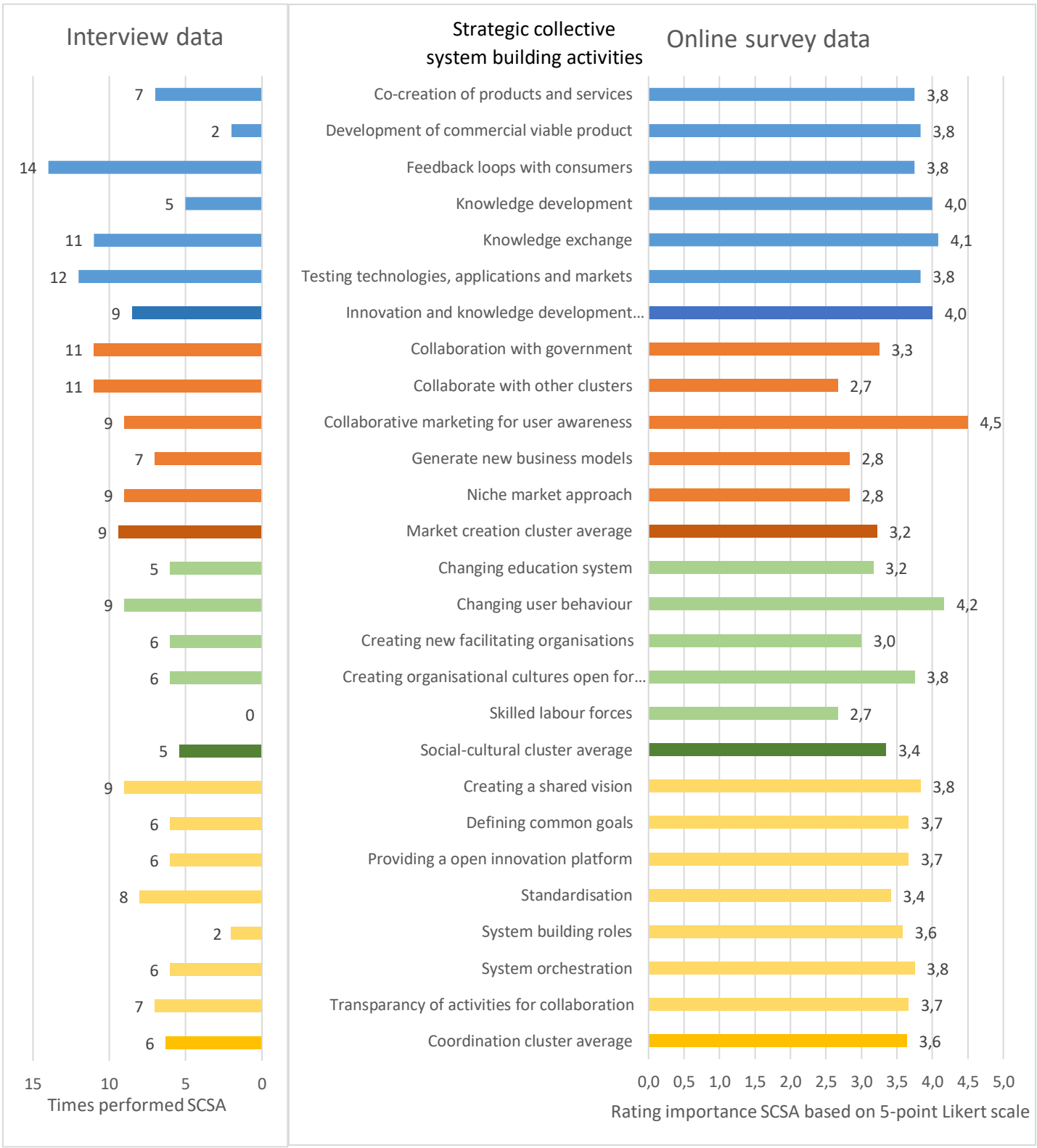

figure 6 Combined overview of the performed strategic collective system building activities by CSUs (left bars, interview findings) and survey ratings based on importance for collective system building (online survey, 5-point Likert scale)

Technology development and optimization

These activities *for technology development and optimization* described by Planko et al. (2016) refer to specific technological innovations. The technological processes mentioned by interviewees for circular innovations focus on optimizing the food processing and ordering processes, logistics and services. Additionally, for the CSU sector these developments and optimizations also refer to the CBM innovations established by entrepreneurs to implement certain circularity strategies in their business models. The most mentioned collective activities in the interviews are testing new technologies, applications and markets, knowledge exchange, knowledge development and feedback loops with consumers groups. The survey confirmed that the technology development and optimization cluster is important for the CSUs. Specifically, the knowledge development and exchange activities are 'very important' for the technological optimization and development cluster, followed by the rest of the activities in this cluster being also ´important´ ranging between an average of 3,75 and 3,83 on a 5-point Likert scale.

Most of the interviewees mentioned the *knowledge exchange* as an important collective activity, which is focussing on the best practices within the circular food sector. This exchange of knowledge can be divided within different levels. First among circular entrepreneurs, which are the frontrunners and through experience develop a lot of knowledge, it is seen as important for these parties to exchange this knowledge among each other. Besides sharing experiences among each other, it is seen as valuable to learn from professional parties within the food production system (CSU2, CSU3, CSU7, CSU11, CSU12, CE3, CE4). As confirmed by expert interviewee CE5 ''*More and more, during our stakeholder meetings you see that knowledge is exchanged and ideas are generated, and coalitions are formed to solve the wicked problems''.* However, it is important to have a reciprocity relation within this knowledge exchange, both parties need to benefit from this exchange of knowledge according to CSU6. Second, on a higher network level to support a circular transition within the system, knowledge is shared within more formal coalitions to solve wicked systemic supply chain problems (CSU7, CSU8, CE2, CE4, CE5). For example, within the coalition Samen tegen Voedselverspilling, the REFRESH or CARVE research coalitions (Appendix B knowledge infrastructure). The activity of *knowledge exchange* is rated with a 4,1 average, which confirms this is seen as a very important activity according to the CSUs.

The development of knowledge is mentioned by four CSUs and three experts as a strategic activity CSUs conduct. Some parties collaborate with Universities conducting research on circular business models, consumer behaviour, product innovation or sustainable supply chain management. For example, CSU1 explains *''Wageningen University is a very important player. We also collaborate with the HAN and the HAS Universities of Applied Sciences, this includes mostly specific research projects, for example consumer research. Wageningen has a broader perspective within this field of research, my companion studied at Wageningen University. Therefore, there is a close relation with this University''.* In addition, researcher CE5 states *''There have been created a lot of innovations, but if the businesses don't implement them it has no impact. Within the last 5 years, the societal aspect and consumer aspects around research and innovations has increased. And start-ups in the last years have been an important drive for innovation''.* This *development of knowledge* is rated as very important as well with a rating of 4,0 average.

Furthermore, the *co-creation of products and services* are mostly realised within the existing collaborations of circular food start-ups and happens organically. An example given by CSU13 *''There's a business in Rotterdam, which is working with Rotterzwam by making bio-plastics from coffee grounds, so they are making products from coffee grounds. We want businesses like that to connect with us so that we can have a smarter and larger logistic operation, sort of a package deal that we can*

present to companies''. Other interviewees agreed that there is a lot of potential impact to create within the food sector when co-creation of product and services is realised between the circular start-ups (CSU7, CSU11, CE2, CE5). Additionally, CSU11 stresses the importance of an inclusive collaboration for this co-creation among all actors e.g. governments, education institutes, research institutes, consumers and entrepreneurs. Overall, this activity is rated as a relatively important by the CSUs with an average score of 3,8 on a 5-point Likert scale.

For the *testing of new applications, technologies and markets* ten interviewees gave examples of CSUs performing this activity, CSU7 explains *''The product is now being tested within the Metropole area Amsterdam, which includes 33 municipalities from Haarlem to Zaanstad, Diemen Almere''.* In addition, CSU5 states *''We tended to look at different kinds of food and hospitality businesses, like healthcare business cafeteria and restaurants in hotels''.* Whereas, CSU12 elaborates *''There was a chutney and I tested it in my own network, with little burger shops, one tosti-shop and the company named butler''.* Examples of this SCSA are complemented by insights of researcher CE5 *''The living labs, where they test if you can implement what you have thought off, to use the innovation for the positioning on the market or something else. For example, a living lab where we can test things in a certain environment with 30.000 customers every week''.* Other interviewees (CSU2, CSU3, CSU11, CSU13, CE2, CE3) gave more examples of testing new applications, innovations and markets. This illustrates the importance of this activity according to the interviewees, with a survey rating of 3,8 confirming this activity is relatively important for CSUs.

The *development of a commercially viable product* is not been mentioned often in the interviews as an important activity to conduct. Two examples were given by CSU 6 and CE3, as interviewee CSU6 explains *''Important is looking at which products have added value in the different supply chains. And we look at it, together with chefs we develop products and they are successful. We create innovations that aren't there yet, there's just a need for it''.* This is complemented by CE3 stating *''In terms of innovation you need to look at the market, try to see where the gaps are''.* This activity is rated as relatively important by the CSUs with a score of 3,8 average on a 5-point Likert scale. However, besides all the examples given on the *testing of new applications, technologies and markets* and the *development of a commercially viable product,* these activities have not been mentioned by the CSU interviewees as being an activity to carry out in a collaborative manner and are often realized by the actors themselves.

Finally, the continuous *feedback loops with the consumers,* are broadly discussed and performed by CSUs in the food sector. These feedback loops are conducted via surveys, direct consumer feedback, living labs or via community building in which feedback is accumulated and broadcasted. As elaborated upon by CSU5 *''It is new and we are challenging our business model by providing our services to the users and the buyers to validate: what is it worth, how do you use it, what are the benefits and continuously asking our users, which are the chefs and buyers which are managers, what is the added value what you see and what to you want to pay for. There are feedback loops on different levels''.* Another innovative way in getting consumer feedback is performed by CSU11 *''We have 220 friend members and are now going to a larger corporation model. The friend members are consumers who think along, and it is now important that we have as many friends as possible in the model. We also have other members who want to engage more actively, by becoming ambassadors, by telling stories where people are proud of the products they buy''.* More examples were given by interviewees CSU2, CSU3, CSU6, CSU7, CSU12, CE2, CE4, CE5, showing the importance of this activity. The frequent contact with consumers is often a standard for CSUs, which supports the continuous feedback from the consumers and improves the relationship between consumers and CSUs. This is another key activity rated as relatively important by the CSUs scoring an average of 3,8 on a 5-point Likert scale. These

feedback mechanisms with consumers are applied by many CSUs, however this valuable information is not shared among these CSUs as a collective inventory for strategic implementations.

Social cultural changes

The activities within the social-cultural change cluster were often mentioned by interviewees or found in documents and observations, due to the social connection that is accompanied with food cultures and consumption patterns. These activities to create socio-cultural changes are overall rated as important except from the generation of a pool of skilled labour forces (rated a 2,7 average), the most important activity in the creation of social cultural changes seems to be the changing of consumer behaviours with a score of 4,2 average.

The activity of *changing user behaviour* is mentioned most within this cluster as very important by the interviewees and seen in observations. According to CSU12 *''The challenge is to reach the larger public and to find the right mentality about food waste. Mostly, it only includes the monetary value of food when preventing food waste''.* Many interviewees agree that providing insights in the amount of food that is being wasted, will contribute in the perception of consumers and support change in consumer behaviour (CSU3, CSU5, CSU8, CSU10, CE2, CE5). Additionally, interviewee CSU11 sees an opportunity to change consumer behaviour via community building and creating social connections between businesses and consumers. Moreover, changing the mindset of consumers about the true value of food and how to support sustainable consumption can be realised according to CSU9 by improving *''The lack of communication and how it is communicated to the individuals with the shaming and blaming makes it a very big topic that make people feel powerless and think they can't change anything. I feel that my workshops can flip that switch to make it fun and appealing, it does not have to be a burden to make sustainable choices it is as simple as that''.* The concept of steering consumers towards certain consumption choices is referred to as nudging by CSU12 and consultant CE3. The importance of this activity is confirmed by CSUs with a rating of a 4,2 average on a 5-point Likert scale.

To support this social cultural change within society via *changing the education system* is performed by six CSUs. According to CSU1 this is an important activity, giving the example *''For example the project for a school education program, which teaches young children that curved vegetables are perfect as well. We want to explain how food and vegetables grows, how nature works''.* According to many interviewees the social cultural changes within society can be realised within various stages of the education system. Starting with the primary and secondary schools by educating young children not to waste eatable food and show them what ways they can prevent food being wasted by CSU1 and CSU2. The change within these lower educational system levels is lacking according to CE2 *''The awareness among students of the of the environmental impacts of food is lacking, definitely in primary and secondary school''.* This is complemented by interviewee CE5 stating *''In our new approach we focus on including educational levels within our strategy. On a professional level, from applied sciences to theoretical education there are challenges formed within education institutes, yet there is a lot to do''.* Other interviewees agree that changing the education system is an important activity in order to support social cultural changes within society (CSU3, CSU6, CSU10, CSU11, CE2, CE3, CE4). This activity is rated as nor important nor unimportant by CSUs with a score of 3,2 average on the 5-point Likert scale.

The need for change within the education system is linked to the creation of *available skilled labour forces*, which is rated the lowest by CSUs meaning this activity is unimportant. According to researcher CE5 the pool of skilled labour forces is *''It is absolutely growing, compared to ten years ago if you would organise something on food waste the room would be empty. Now there are food waste conferences almost every day''.* However, this activity is not specifically performed by CSUs as a collective activity.

To communicate these values towards consumers and support the long-term collaborations among companies within the sector there is a need for *facilitating organisations*, this activity is according to six interviewees performed within the food sector. According to CSU12 this could be facilitated by *''Many ministries could participate in this, social affairs, economic affairs and LNV. But ministries will tend to change focus every four years. The director generals need to be behind a program that will run for the following 20 years on the topics of food''.* Whereas, CE2 sees an opportunity to take on this activity *''You see that many initiatives come from the same angle and have the same motivation. To create partnerships that is one of the few things we can do from a communication platform''.* Expert interviewee CE8 sees promising developments for facilitating organisations *''You see that there are more parties active there, funds, governments, institutions. There are many more working groups and alliances''.* The organisations mentioned by the interviewees for fulfilling this facilitating role are the Nederland Circulair Versnellingshuis, the Samen tegen Voedselverspilling foundation, the nutrition information centre and the Environment & Nature Federation. The survey amongst CSUs shows this activity is nor important nor unimportant with an average score of 3,0 on the 5-point Likert scale.

The activity on the *establishment of collaboration-prone organisational cultures* is according to six interviewees conducted by CSUs. The opinions on this activity are divided among the interviewees. The CSUs interviewees state that the entrepreneurial cultures are based on collaborations and supporting each other (CSU4, CSU9, CSU13). Elaborated by CSU9 ''This entrepreneurial environment is very open and helpful, so very inclusive. With bigger companies I don't have any experience with''. Whereas, the experts in the field mention the competitive advantage that prevents the collaboration among actors in the field (CE3, CE4, CE6). As explained by CE3 ''They are interested to hear what is going on in other businesses, but they want to keep some parts for themselves. Which I think is fair, if you work in the same niche then it becomes difficult''. Overall, this activity has not explicitly been mentioned as a collective effort by the interviewees. This activity is rated as relatively important by the CSUs with a score of 3,8 average.

Market creation

Within the interviews the creation of a good market position is one of the clusters which is thoroughly discussed. Within this segment the activities on collaboration with competition, government and the niche market approach are mainly elaborated upon. The surveys show that the activity of collaborative marketing to create user awareness is rated as very important (average of 4,5), furthermore, the collaboration with the government for the enabling of legislations was neither seen as important nor unimportant. Whereas the rest of the activities in this cluster were rated as unimportant (ranging from 2,67 to 2,83 average).

Starting with the *niche market approach*, half of the interviewees stated that circular food start-ups are supporting the transition towards a circular food system. They all agree that it is not a niche market anymore, which is confirmed by researcher CE5 *''It is not a niche market anymore, there are even scale-ups already. Those are the ones that consider the whole circular economy as a narrative, not only valorisation of waste streams''.* Overall, the niche market approach is described by the interviewees as challenging the current regime and supporting transitions within the food production system (CSU2, CSU3, CSU6, CSU5, CSU7, CSU8, CSU11, CE4). As stated by Kromkommer *''As a start-up we have the responsibility, separate of all the barriers the larger firms have, like being stuck in by large organizational structure. We as start-ups don't have these structures, so our role is to challenge these larger firms''.* Remarkably, besides the number of examples given on the implementation of this strategic activity, this activity is rated as unimportant with an average score of 2,8 on a 5-point Likert scale.

To achieve this market transition within the food production system, parties need to collaborate on multiple levels. The *collaboration with competition against other clusters* is a highly discussed topic within the interviews, divided in collaborations with other circular start-ups, or collaboration with the competition referred as the current regime. As some of the interviewees see the collaboration with other start-ups as an important collective system building activity, due to the common values shared among these parties and the possible mutual benefits resulting from these collaborations, as CE2 states *''We don't see each other as competition, there are even producers with the same products. The market segment in the prevention of food waste is large enough. We need to compete with the larger firms, we have a message to tell together''.* This corresponds with the strategic activity described by Planko et al. (2016). The other half of the interviewees see the possibility to work with the current regime to create a bigger impact, by creating a hybrid collaboration in which the infrastructure and expertise of the regime is utilised, and the values of the circular economy are pursued. As elaborated upon by CSU7 ''Catering in the food business has a larger scale and are important players (…) We now work together with Apel catering in Haarlem they are also very progressive''. This collaboration with the current regime is accompanied with the risk for circular start-ups of cannibalising their circular value proposition and being used for green washing, stated by researcher CE5 *''Big companies tend to take those social innovators and use them for greenwashing. They use it as an excuse not to do anything themselves, and many of these social innovators are not aware of that''.* Opposite of the findings in the interviews, the survey shows the CSUs rated this activity as unimportant with a rating of 2,7 average.

The collaborative marketing to create user awareness, described by Planko et al. (2016) refers to the creation of awareness for the use of a new technology. Whereas, the creation of awareness according to the interviewees refers to establishing behavioural change amongst consumers towards more sustainable consumption patterns. This collaborative marketing to create user awareness has according to the interviewees the potential to improve the market position of circular start-ups. As stated by CSU5 *''We try to build awareness but also connection to make a combined proposition to do something together''.* Various collaborative marketing initiatives already have been formed and mentioned by the interviewees e.g. Verspilling is verukkelijk, Samen tegen voedsel Verspilling or collaborations with supermarkets and other food service providers. As explicated by CSU2 *''We have collaboratively created a food waste product shelf with Verspilling is Verukkelijk. In this way we want to create more awareness around the topic, also branding''.* And network supporting expert CE2 *elaborates ''All the initiatives are pushing communication towards consumers. Now there is a big drive going on from Samen tegen voedselverspilling to create awareness. With the '#hoe verspillingsvrij ben jij' campaign''.* Within this approach of marketing it is stated as important to use a positive approach *''People don't need to buy the product out of guilt''.* (CSU2). Which is complemented by the statement of researcher CE5 ''*The more you focus on the problem, the more you lower the interest of consumers to reduce it. Latest research is focused on creating positive social norms, what you can do in your own bubble to use everything and prevent food waste''.* Overall, the collaborative marketing to create awareness among consumers is seen as one of the most important activities within all the clusters. Confirmed with the rating as ´very important´ with the highest average of 4,5 within the survey among CSUs.

Furthermore, the *collaboration with governmental* organisations to enable legislations is not seen as a promising activity by interviewees CSU6, CSU8, CSU9, CSU12, CE1 and CE5. According to researcher CE5 *''There is a range of legislation over hundred areas that are linked to food waste. Because food waste is linked to every food chain link with their own regulations''.* Whereas, CSU8 states ''We can't wait for legislations to change, this takes over 3 years, we need to act now''. Nevertheless, according to CSU1 *''I think in the Netherlands we have a pro-active minister at the chair of LNV, they are putting a lot of effort in this transition (…) Which is Carola Schouten, she addresses the most important topics*

within the food sector. The development is noticeable, we are ourselves part of the lobbying party in the Hague. There is a motion accepted, which is called the Krommotion within LNV. This includes the specifications and demands which Brussel makes on fruit and vegetables and what the quality guidelines are''. This activity is rated as nor important nor unimportant with a score of 3,3 average. Overall, the collaboration with governments to enable legislation is performed frequently by CSUs and therefore a rather important activity accompanied with slow changes.

The *generation of new business models* is elaborated upon by a few CSUs. As explained by consultant CE4 *''You have several companies that work with waste, that consider themselves having the solution of the food waste problem. It is challenging to make an analysis on the spot, but it's often start-ups or small companies use the foods that often would go to waste''.* According to a financial expert CE8 *''The circular economy is trending; every company tries to implement it within their business. However, only a few real circular business models have proven themselves so far''.* Additionally, CE8 states *''We think the most important thing that the new models are developed and that it shows to other parties to continue, we find the movement more important than the success of a start-up itself''.* The activity is rated as an unimportant collective system building activity with a score of 2,8 average. Mostly examples were given on the generation of new circular business models, it has not been rated nor mentioned to be a strategic collective system building activity.

Coordination

The coordination and alignment of all individual and collective system building efforts within the circular food production system is still in the development phase. The interviewees agreed that there is a need for system orchestration, the creation of a shared vision and standardisation within the food system to transition it towards a circular system. However, there is no unanimous consensus among the interviewees which organisation or coalition is facilitating the coordination of the ecosystem. The activities within the coordination cluster seem to be overall more or less important (ranging averages from 3,42 to 3,83), the activity rated as most important is the creation of a shared vision, the lowest rated activity is the standardisation of the innovations.

Starting with the *system orchestration*, which is according to five interviewees performed within the ecosystem. However, there is not a clear agreement on which actor fulfils the system orchestration role. Whereas, CSU3 and CSU12 see MVO Nederland fulfilling this role *''MVO Nederland is coordination some efforts within the Verspilling is Verukkelijk platform''.* Others are not aware of any system orchestration (CSU4, CSU10 and CSU11), as CSU11 states *''There is not a party that has the direction in hand, but Kromkommer is a leading example within this sector''.* According to network expert CE2 *''My personal and our vision, is the broader the platform, the more people can develop their own thoughts and process, the quicker we move forward. As soon as you centralise this it could obstruct developments, you can do that in particular parts, but to centralise the coordination is not always the right strategy''.* Yet, according to multiple interviewees the foundation of a system orchestration is being made by Samen tegen Voedselverspilling (CSU7, CE2, CE4, CE5), as CE4 states *''I do think that Samen Tegen Voedselverspilling is a good effort''.* Complemented by CE2 *''To align the various initiative under one heading or organization Samen tegen Voedselverspilling is definitely one of the initiatives that will drive and coordinate it''.* Conformingly, this activity is rated as a relatively important activity with a score of 3,8 average.

The previous discussed activity corresponds with the next collective activity, being the creation of a *shared vision.* Half of the interviewees agreed that a shared vision among circular food actors would improve the coordination and effective use of efforts and resources. As stated by CSU6 *''We all have the same mission, changing the food system, all in our unique way, that brings us together''.* Moreover, CSU10 addressed the role of the government in creating a shared vision *''The government needs to*

facilitate more. They set the aim to have a circular economy in 2050, they need to facilitate this to help starters achieving this vision. The SDG's are already helping, there are even specific SDG's for the prevention of food waste''. Whereas, CSU7 says *''You now have the platform Samen tegen Voedselverspilling, that developed within the last 1.5 or 2 years. Before that everybody worked by themselves, that doesn't work''.* Additionally, the research expert CE5 describes this process *''There were several stages within the process, what was key is to build a joint agenda based on the input and ideas of the companies during workshops. The next step was the Dutch government put in funding to make it happen and set up the basic structure''.* This activity is rated as being almost important as well, scoring a 3,8 average within the survey among CSUs.

The creation of a shared vision is closely linked to the activity of *defining common goals* among circular food actors. According to CSU8 aligning common goals is the most difficult part *''What Wageningen University is doing is quite impressive, you have the board level of AH, Jumbo and Aldi and a lot of the producers. The fact that they are talking together and subscribing to the goals and vision is a big step. But they are also competing, so you can't ask them to align all their best practices''.* In which CSU 8 adds *''If there is a shared vision but there are no milestones in achieving that vision what we need to do then we are not getting to that vision''.* According to consultant CE4 *''A couple of ingredients that can help are establishing clear rules of the game, working towards quick wins and set milestones towards a vision on the horizon. And for larger or transformative coalitions you need a trusted intermediary to facilitate this collaboration, being a neutral party''.* This activity is rated as being slightly less important than the creation of a shared vision with an average score of 3,7. Overall*, t*he creation of a shared vision and common goals within the ecosystem are both seen as important collective system building activities, now is the momentum for a certain party or coalitions to exploit this activity in order to support the circular transition within the food production system.

The division of various *system building roles* has only been mentioned twice within the interviews. Whereas, CSU10 states *''There is not a clear role division amongst start-ups to coordinate this ecosystem, it is hard enough for start-ups to run their business''.* And research expert CE5 explains the professional organisation structure of Samen tegen voedselverspilling *''It is a foundation with a board and stakeholder team, ambassadors and a management team that coordinate different actions''.* This activity is rated as nor important nor unimportant with an average of 3,6 on a 5-point Likert scale.

Furthermore, the activity of *providing an open innovation platform* is performed according to interviewees CSU2, CSU3, CSU7, CSU10 and CE2 that mentioned forms of innovation platforms, as CSU10 elaborates ''*MVO Nederland is creating platforms like this, by bringing parties together, for example the Verspilling is Verukkelijk platform. And Climate KIC is supporting our processes through funding and establishing a network of sustainable start-ups''.* In addition, CSU7 adds *''The program we are in now start-up in residence, which brings start-ups and government together, is a good example of an innovative platform''.* These examples relate to the creation of an open innovation platform, in which exchange of knowledge, information and determination of common goals can be facilitated. As confirmed by researcher CE5 open innovation platforms are already formed ''*There is a clear interest for start-ups to work with the retail sector, start-ups can pitch their solutions in order support collaboration. Moreover, by setting up a cluster of companies that have a problem and with scrum sessions facilitate co-creation to solve problems together''.* This activity is rated as more or less important with an 3,7 rated average. Overall, the need for a platform to share this knowledge is brought up multiple times, multiple parties are mentioned to facilitate the provision of open innovation platforms e.g. Samen tegen voedselverspilling, Verspilling is verukkelijk, MVO Nederland or frontrunner CSUs themselves (CSU2, CSU7, CSU10, CE2, CE5).

The activity of *the standardisation* of circular products and services is according to the interviewees an important activity to support the transition towards a circular economy in the food sector. An important addition to the implementation of new circular innovations according to interviewee CSU8 is the inclusion of changing the standards within the market in order to implement these innovations successfully. Furthermore, some of the interviewees state that *the standardisation* of monitoring and measuring food waste will contribute to the transition towards a more circular food system (CSU5, CSU8, CE3 and CE5). As consultant CE3 explains ''First of all we need a good way of measuring the food waste and see where improvements can be made, everybody is working on it''. In addition, consultant CE4 explains *''It would be great to have statistics to steer much better altogether. If it is specifically about waste and what companies do waste, there is a lack of transparency (…) Yet, for some company sharing information on waste streams, might be a reputational risk''.* The role of the government to act and enforce the standardisation process is mentioned by interviewees CSU6, CSU9, CE5 and CE6. Correspondingly, CSU10 states *''If the government raises the taxes on food waste then the practices of preventing food waste will be more incentivised''.* However, according to experts CE5, CE6 and CE7 the Dutch market which is focussed on the export model will not transition progressively towards higher taxation schemes since this will obstruct the market position of the Netherlands being a trading country. As CE7 describes *''The Dutch model is not sustainable within a transit country, and if we tax parties that do not contribute socially or ecologically with a higher tax, they will just avoid the Netherlands. We cannot bear this economically with our spending pattern''.* According to CSU6 and CE7 the developments within true cost accounting offer possible support for the standardisation of circular practices, since non-circular food products will have a higher carbon footprint the prices of circular food products will be lower. This activity was rated with a 3.4 average, meaning it is neither important nor unimportant, this can be related to the differences in strong opinions on this activity.

Finally, the *creation of transparency on activities* within the food production system is mentioned by more than half of the interviewees as an important activity to overcome the lack of awareness and urgency to support the transition towards circular food production system. Illustrated by interviewee CE2 stating *''We do a lot of consumer research, and one thing we see changing especially in Western Europe is that consumers do not pay a price for the product but pay a contribution of the product that is made via a certain process. More and more consumers are buying with that intention, if the process is not right or transparent then they won't buy the product anymore''.* However, eight interviewees confirmed the lack of transparency within the food chains, the information on food waste within companies is often kept for themselves (CSU2, CSU3, CSU6, CSU7, CSU8, CSU10, CE3, CE4). As researcher CE5 elaborates *''There is no good data across the whole food chain, nobody knows exactly how much food is wasted. This lack of information can be used as a strategy within the food system to profit from''.* The activity is rated as relatively important with a rating of 3,7 average on a 5-point Likert scale. Overall, the creation of transparency is agreed upon among the interviewees as an important collective activity for circular actors in the food system, to support a sustainable transition within the food system.

Different strategies amongst CSU types

The various types of CSUs each have their own focus of strategies and collective activities, figure 7 presents an overview of the SCSA each CSU type rated as important. Starting with the platform-based CSUs, the results show that the most important activities are rated within the innovation and knowledge development according to these CSUs. This can be related to the technological focus of the circular innovations implemented by these CSUs, by analysing processes within the food production system to provide systemic solutions for the optimisation of these processes to reduce food waste and losses.

Followed by the service-based CSUs that mainly rate the coordination cluster as important, in addition the creating social-cultural change cluster and the exchange and development of knowledge are important activities according to these CSUs. These activities relate to the circular innovations implemented by these CSUs to support behavioural change amongst consumers towards more sustainable consumption patterns.

Lastly, the waste-based CSUs rate the coordination and technological optimization and development cluster as most important. In addition, the activities of creating social cultural change among consumers and in the education system, are highly rated by waste-based CSUs. This can be related to the drivers for environmental and social impact creation these CSUs strive for. Through the circular business models and their value proposition these CSUs aim to revalorise resources and enforce behavioural changes of consumers towards sustainable consumption patterns.

This shows that among entrepreneurs, which share the same values and motivation to work towards a circular food production system, there are still differences in strategies to achieve this. Nonetheless, all CSUs agree that conducting collaborative marketing to achieve awareness, knowledge exchange and development and creating a shared vision are key strategic collective system building activities.

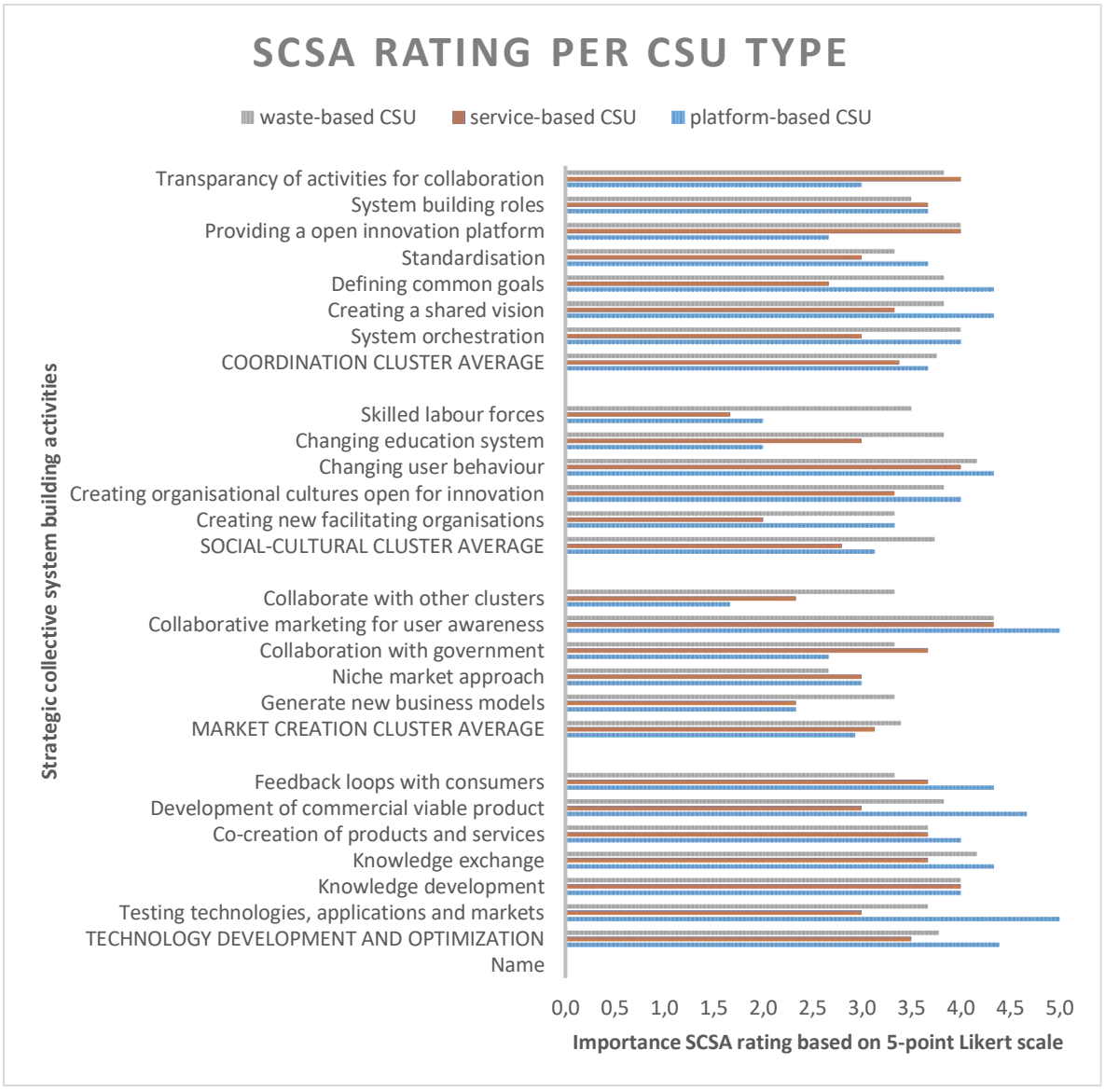

figure 7 Overview SCSA rating per CSU type based on the online survey with a 5-point Likert scale

In conclusion, the findings showed 20 of the 23 system building activities described within the strategic collective system building framework are performed often by CSUs in the food production system (as presented in figure 6, left bars). The less performed SCSA found in the interviews include the development of a commercially viable product, the generation of skilled labour forces and the division of system building roles. In the survey results 19 SCSA are rated as important, varying from relatively to very important. The activities which are rated below 3 points on a 5-point Likert scale are unimportant according to the CSUs, including; the creation of a pool of skilled labour forces, the niche market approach, the generation of new business models and the collaboration with other clusters for competition (as presented in figure 6, right bars). Between the activity clusters a ranking in importance is noticed. The cluster of Technology development and optimization is ranked highest, followed by the coordination activity cluster, social cultural changes and the market creation cluster. This order of importance does not correspond with the amount of performed SCSA mentioned by the interviewees, except for the cluster technology development and optimization which is elaborated upon extensively by the interviewees. According to the performed SCSA found in the interviews, the following order originates; technological development and optimization, market creation, coordination and social cultural changes. The differences between these orders of importance are discussed in the validation section 5.2.1 of the next chapter. To conclude, the survey shows that the previous described collective system building activities are important to collectively build a system for CSUs in the food production system, including some refinements which are discussed in chapter 5.

4.2.2 Barriers for CSUs in the food sector

The interviewees were asked what barriers are mostly experienced within the development and diffusion of circular business model innovations in the food production system, an overview in table 4 shows that these barriers can be divided in four categories; technological, market, organisational and regulatory barriers (retrieved from coding, see Appendix I). The most discussed barriers are product and process development, large scale infrastructures, lack of consumer awareness, financial access and lack of knowledge and expertise. Some insights on these barriers are provided by the findings of the desktop research, referring to the structural analysis of the CBM innovations system of CSUs in the Dutch food sector (Appendix E). The various structural elements of actors, institutions, networks and infrastructures were assessed based on their presence and capabilities or qualities and presented in an overview (table 5). This analysis provides insights in the structural problems that obstruct the development or diffusion of circular business model innovations within the food production system of the Netherlands and complement the clarification of the barriers found in the empirical data.

Table 4 Overview barriers for circular start-ups and relevant collective system building activities to overcome these barriers

#	Barriers	Definition	example
Times mentioned	**Regulatory barriers**		
4	Laws and regulations	The use of waste streams is accompanied with many obstacles, referring to the safety protocols, certifications, licences and laws which obstruct the utilisation and reuse of waste streams.	'We need to certify all the waste streams, which takes a lot of effort''
1	Political barriers	The political system in the Netherlands is focussed on keeping a trading position, the taxes system is preventing the inclusion of true cost pricing. That would make circular solutions economically more viable.	'The Dutch culture is too liberal to push new taxation schemes through and become successful.''
Organisational barriers			

4	Lack of skills and expertise	The lack of skills and expertise of entrepreneurs when setting up a business from an ideology without having experience or skills in the field of business management.	'The majority is after 2or 3 years broke, they won't survive the valley of death at all. Why? Because they have no idea what they are doing.''
3	Lack of Financial access	The subsidy requests are often too large for start-ups to apply for. Besides, the circular business models are often seen as risky investments, due to the lack of proof on successful CBM.	Investing companies who are interested in investing in businesses like this, when you mention that you only need 250,000 euros, they say: "we actually start investing at 1 million or so".
Operational barriers			
6	Large scale infrastructures	The food sector in the Netherlands is designed on the export model, handling large quantities. Small food CSUs in the food sector have difficulties competing within this large-scale oriented market segment.	'That is one of the things we encountered, due to the fact that you are a small player within a market segment, you don't have any economics of scales.''
6	Product and process development barriers	Working with waste streams is accompanied with uncertainties and variables, asking for a flexible production process.	'To handle waste streams and turn them into food is quite costly because you have to be very flexible in your production, you need to have some extra operations as well.''
Market barriers			
5	Lack of consumer awareness	The consumer is not aware of the amount of food being wasted in the food production system. In addition, the consumers don't know of the higher cost price included in the production process of circular products, resulting in less sales due to the higher price.''	'Many people think it is waste, and therefore it should be cheaper.'' and ''People don't see the ecological or economic impacts of wasting, we try to balance that by giving more insights of the ecological food print of food waste.''

The various structural problems found in the structural analysis of CBM innovations within the food sector can be related to the barriers stated by the interviewees. The barriers on laws and regulation are related to the structural problems found within the hard institutions. These hard institutions being laws and regulations, or protocols are highly present within the food production system. However, these institutions ensure food safety and quality, often these regulations and protocols are too strict and have negative effects by increasing the amount of food being wasted.

Whereas the barrier on the lack of consumer awareness can be explained within the structural problem of the soft institutions. These soft institutions are highly present due to the high linkage between food and traditions, cultures and consumer habits. However, when analysing the sustainable or circular food consumption the behaviour and mindset of consumers is contradictory. People agree on the fact that food waste should be prevented, but actual implementation of change towards sustainable consumption and reducing food waste is lacking. The motivation, abilities and opportunities are often aspects that prevent the reduction of food waste within households. Additionally, the customers perspective on circular food products is also dissonant since they expect circular food products to be cheaper because the resources which are used are cheaper or for free. However, due to the extra costs and efforts accompanied with the production of these products the cost price is higher and the products can therefore not be cheaper than conventional products. The implementation of true cost pricing, which would include the negative externalities within the price of the products could change this consumer perspective.

Table 5 Structural analysis of the CBM innovation system of CSUs in Dutch food sector, based on Hekkert et al. (2011), summary of Appendix B

Structural dimensions	Subcategories		Presence	Capabilities and quality
Actors:	Demand		Low	Lack of knowledge and availability in offers
	Circular food start-ups		Medium	Lack of resources and coordination
	Industry: SMEs, Incumbents, Multinationals	Suppliers	Low	Lack of pressure from demanding parties, lack of knowledge and guidance
		Assemblers	Low	Lack of transparancy and pressure
	Knowledge institutes	Research	High	Ability to support enabling of supportive policies, sharing of knowledge and expertise
		Education	Low	Lack of education requirements and demand of industry for Applied research
	Network		Medium	Ability to create mutual benefits by collective strategic activities
	Financial		Medium	Ability to support circular businesses developments and projects
	Political/ government		High	Ability to enable legislation, coordination and creating a shared vision
Institutions:	Hard: rules, laws, regulations, instructions		High	Ability to ensure food safety and quality, with unforseen effects on increasing the amount of food being wasted
	Soft: customs, common habits, routines, established practices, traditions, ways of		High	Dissonance in statements and acts, lack of awareness, capabilities and knowledge on how to implement circularity
Interactions:	At level of networks		Medium	Ability to create synergies and coordinate collective efforts to generate mutual beneftis, lacking the inter-network collaborations to use the full potential
	At level of individual contacts		Medium	Ability to generate mutual benefits, lacking the resources, time and trust to make use of the full potential due to clustered group formations
Infrastructure:	Physical: artefacts, instruments, machines, roads, buildings, networks, bridges,		High	Focused on conventional production systems, not suitable for small scale, diverse and tailored circular strategies and innovations
	Knowledge: knowledge, expertise, know-how, strategic information		High	Ability to share knowledge, best practices and expertise. And the ability to enable policies through research and advice. Need for practical implementation within the Industry with the use of consultancy and Applied Sciences programs and projects.
	Financial: subsidies, fin programs, grants etc.		High	Ability to fund circular businesses and projects. But funding often is assigned to large players in the research field, ousting the opportunity for CSUs to development of circular practices

The barriers within the operational category are related to the structural problems found in the physical infrastructure within the Dutch food production system, which is very efficient and advanced. These physical infrastructures are adapted to large scale and conventional food production processes and transportation. The circular business model innovations and strategies are not suited for these conventional and large-scale physical infrastructures. These tailored and specialised production and transportation processing infrastructures are lacking within the current food production system.

Whereas, the barriers on the lack of skills, expertise and knowledge can be elaborated upon with insights on the structural problems within the knowledge infrastructure. There are many structures on many levels. However, these various infrastructures could improve their interaction and sharing of knowledge. These collaborations support the diffusion of knowledge, expertise and know-how. Unfortunately, the educational knowledge infrastructure is lacking according to the interviewees and needs to be activated and participating through circular programs, projects and courses. This lack of the education knowledge infrastructures obstructs the practical implementations from theory to business practices.

Lastly, the lack of financial access is related to the financial infrastructure within the food production system. Most of the financial access is gained and utilised by incumbents active within the current regime. Additionally, the investment in new innovative circular business models is seen as a high risk. The funding and investments for CSUs is therefore low and prevents the development and diffusion of circular business models within the food production system.

To conclude, the strategic collective system building activities could alleviate these barriers mentioned by the interviewees, through collaborative efforts mutual benefits can be gained and collectively solutions can be established to overcome these barriers. The research approach was not designed to provide insights on the correlation between these defined barriers and specific strategic collective system building activities. Nevertheless, these results can provide insights for policy recommendations in order to overcome structural systemic problems.

4.2.3 Relevant actors for strategic collective system building

To overcome the previous discussed barriers, it is of importance to strategically perform these collective system building activities with certain actors. The second part of the interview provided insights on the most important actors within the ecosystems of CSUs in the Dutch food sector. This actor analysis gives an overview of the most relevant actors for collaboration (table 5) to successfully perform the strategic collective system building activities according to the interviewees, for an overview of all the mentioned actors within the interviews see Appendix G.

Table 6 Overview of key actors for collaboration per strategic collective system building activity based on Planko et al. (2016)

Strategic collective system building activity	Actor category	Key actors mentioned by interviewees
Technology optimization and development		
Testing technologies, applications and markets	Research, service providers	Too good to go, wastewatchers, wasteless, Zero foodwaste, Winnow and other CSUs see Appendix G
Knowledge development	Research, education	Wageningen University, CARVE, REFRESH, Utrecht University
Knowledge exchange	Research, education, network	REFRESH, Hoge Hotelschool the Hague, Wageningen University, Greendish consultancy, Milgro, Food line-up
Co-creation of products and services	Suppliers and assembler	Kipster, Sligro, AH, Jumbo, Agrifirm for other suppliers and assemblers see Appendix G
Development of commercially viable product	Service providers	Verspillingsfabriek, Kromkommer, Instock, Soupalicious, Krusli, Twisted, Utregs Supersap, Peel Pioneers, Seamore for other CSUs see Appendix G
Feedback loops with consumers	Demand	Albron, Apel catering, Circle, Vermaat for other demanding actors see Appendix G
Market creation		
Generate new business models	Financial, service providers,	Rabobank, Stichting DOEN, Kitchen Republic, Start-life, Impacthub Amsterdam, BOM, MVO Nederland. And all the CSUs see Appendix G
Niche market approach	Service providers (CSUs)	Kromkommer, Instock, Toogoodtogo and all other CSUs see Appendix G
Collaboration with government	Government/ political	Ministry of LNV, Economic affairs and Transitie Coalitie Voedsel
Collaborative marketing for user awareness	Network	Verspilling is Verukkelijk, Samen tegen Voedselverspilling
Collaborate with other clusters	Suppliers and assembler	AH, Jumbo, Unilever, Hutten catering, Kipster, Lidl, Sligro, Apel catering, Macdonalds, Milgro, Albron, Bidfood. And other supplier and assemblers see Appendix G
Social- cultural changes		
Creating new facilitating organisations	Network	Samen tegen Voedselverspilling, No waste Network, the nutrition information centre, the Environment & Nature Federation and Nederland circulair versnellingshuis

Creating organisational cultures open for innovation	Network and all industry actors	Samen tegen Voedselverspilling, MVO Nederland, Horecava, Kitchen Republic, Koninklijke Horeca Nederland, Dutch Cuisine, LTO Nederland, Blue City Rotterdam, Flevo Campus, Foodhub
Changing user behaviour	Service providers	Buurtbuik, Kromkommer, SFYN and all the CSU see Appendix G
Changing education system	Education	Hoge Hotelschool the Hague, Utrecht University, Brightlands campus Greenport Venlo, HAS University of Applied Sciences
Skilled labour forces	Education	Dutch Cuisine, Hoge Hotelschool the Hague
Coordination		
System orchestration	Leader	Samen tegen Voedselverspilling,
Creating a shared vision	Political and Leader	LNV, Nederland Circulair Versnellingshuis, Samen tegen Voedselverspilling
Defining common goals	Political and Leader	Samen tegen Voedselverspilling, Verspilling is Verukkelijk, Transitie Coalitie Voedsel, Ministry of LNV, Alliantie verduurzaming voedsel
Standardisation	Government/ political	The government - not specified - and food waste monitoring start-ups e.g. Wastewatcher, Zero foodwaste, Winnow
Providing an open innovation platform	Network	No waste Network, Climate KIC, Kitchen Republic, Milgro, RVO Nederland
System building roles	Leader	Samen tegen Voedselverspilling, MVO Nederland
Transparency of activities for collaboration	Suppliers and assemblers (Leader)	All the supplier and assemblers see Appendix G. Samen tegen Voedselverspilling could facilitate this process.

5. Discussion

The findings of the structural analysis show what systemic problems are obstructing the development and diffusion of CBMs in the food production system. Additionally, the actor and network analysis provide insights in possible collaboration opportunities for the realization of the strategic collective system building activities. Moreover, the findings show that the strategic collective system building framework supports the building of supportive external environments by CSUs in the food production system. However, the empirical findings revealed that refinement of these strategic collective system building activities are important for CSUs in the food production system. These activities complement the described activities by Planko et al. (2016). This section starts with elaborating on the structural problems. Followed by the description of the new strategic collective activities found in the empirical data. Finally, discussing the influence of these activities on the strategic collective system building framework.

5.1 Refined system building activities for CSUs in the Netherlands

Some system building activities need to be refined for CSUs in the Netherlands. Within the technological development and optimization and market creation cluster the need for refinements of strategic collective system building activities have been found in the empirical data, which are elaborated upon in this sections.

5.1.1 Reciprocity knowledge exchange

The exchange of knowledge among CSUs is seen as an important collective activity, which is focussing on the best practices within the circular food sector. This exchange of knowledge can be divided within different levels. First among circular entrepreneurs, which are the frontrunners and through experience develop a lot of knowledge, it is seen as important for these parties to exchange this knowledge among each other. The relation within this exchange of knowledge should be beneficial for both parties, this is often not the case according to interviewee CSU6. Moreover, a platform for the sharing of this knowledge has not yet been established, there is no consensus among the interviewees on which party should lead this. However, some parties are mentioned to uptake this role e.g. Samen tegen voedselverspilling, Verspilling is Verukkelijk, MVO Nederland or frontrunner CSUs themselves.

The perspective of the knowledge-based view within strategic management literature considers the knowledge assets within a firm to create value. This view states that the knowledge resources and capabilities are a source to gain a sustainable competitive advantage. The knowledge exchange is described by Grant, (1996) as interfirm interaction patterns that regularly transfer, combine or create specialized knowledge. This knowledge exchange supports the absorptive capacity of partners and incentives the creation of transparency with the outcome of discouraging free riding. The concept of the free riding principle relates to the knowledge exchange with beneficial outcomes for both parties. Correspondingly, within the comparable case of the SFSC sector, the *exchange of knowledge* between SFSC parties seems to be a sensitive subject, since many initiatives struggled during the first development phases of the businesses, they expect something in return for their efforts of gaining this specific knowledge. Often when knowledge is shared among parties it is a one way, therefore it is important to have mutual benefits when sharing knowledge and expertise.

Overall, the exchange of knowledge has been stated as an important collective system building activity. Planko et al. (2016 p. 2334) stated ‘’The three system-building activities (1) testing new technologies, applications and markets, (2) knowledge development and (3) knowledge exchange were derived from the TIS framework’’. Within the case study of Planko et al. (2016) the interviewees stated that these activities are one. This was not the case for the CSU entrepreneurs, but an additional perspective on the knowledge exchange was mentioned often. The new definition for this activity is proposed as: *the knowledge exchange with a reciprocal relationship preventing free riding.*

5.1.2 Collaboration with the current regime

The collaboration with competition to compete with other clusters is described by Planko et al. (2016) as a strategic collective activity. This activity aims to compete with other cluster of similar technologies to improve the market position, referring to collaborations with other entrepreneurs. Within the empirical data a refinement of the strategic activity has been addressed, the collaboration with the current regime as being a competitor to CSUs. Whereas, half of the interviewees see the possibility to work with the current regime to create a bigger impact, by creating a hybrid collaboration in which the infrastructure and expertise of the regime is utilised, and the values of the circular economy are pursued. An important risk was addressed by researcher CE5, these collaborations with the current regime are accompanied with the risk for CSUs of cannibalising their circular value proposition and being used for green washing by the incumbents.

Within the strategic management literature, the building of relationships to innovate with external actors within an organizational ecosystem is explained through the relational view of firms. An important aspect within this view is related to using the opportunities and taking advantage present within the environment of the firms. These collaborations depend on the proximity between firms, including the geographical and innovation space. The establishment and management of these ecosystems with relevant partners is linked to the key capabilities and resources the partners cultivate and benefits from within a strong ecosystem. These include relation-specific assets, knowledge sharing routines, complementary resources and capabilities and the effective governance of these relationships (Dyer & Singh, 1998). The relation-specific assets include site specific assets, human assets of know-how and physical assets of capital investments. Through sharing these assets multiple advantages can be gained e.g. reduction of transport costs and smaller inventories, less communication errors, improved product quality and differentiation. The complementary resources and capabilities are defined as '' distinctive resources of alliance partners that collectively generate greater rents than the sum of those obtained from the individual endowments of each partner." (Dyer & Singh, 1998, pp. 666) This sharing of relation-specific assets and complementary resources correspond with the potential collaboration benefits with the current regime CSUs mentioned within the interviews. The knowledge sharing routines and effective governance are included in other SCSA clusters.

To conclude, the empirical data show that the collaboration with competition to compete with other clusters is defined by the interviewees. Additionally, the collaboration with the current regime to make use of relational assets and create complementary resources and capabilities need to be included within this definition. Therefore, changing the definition into: *collaborative competition with the current regime, to share relation specific assets and generate complementary resources.*

5.1.3 Collaborative marketing to support behavioural change

The collaborative marketing to create user awareness, described by Planko et al. (2016) refers to the creation of awareness among future users for the use of a new technology. However, the creation of awareness by CSUs refers to establishing behavioural change amongst consumers towards more sustainable consumption patterns. As explained by interviewee (CE8) ''This is related to the creation of social support, the marketing of circular products is now done by entrepreneurs who need to convince consumers or clients who says you are right, but the price should be equal to the common products''. Complemented by circular entrepreneur (CSU5) ''We try to build awareness but also connection to make a combined proposition. It is more about collaboration and networking and to roughen up the proposition to stand stronger together''. Additionally, the feedback loops from consumers towards CSUs is a main activity, the sharing of this consumer data for collaborative marketing and education purposes could result in mutual benefits for CSUs. However, as mentioned by interviewee CSU1 it should be noted that the sharing of strategic information within a sector can

be seen as the creation of a monopoly position and will be prevented by the authority of consumers and markets in the Netherlands (ACM, 2017).

The literature on collaborative marketing within networks illustrate the generation of mutual benefits. As an example, findings on collaborative relationships within supplier-buyer relations share downstream information on marketing channels from wholesalers and producers within the Dutch plant and flower industry (Pimentel Claro & Oliveira Claro, 2010). This study shows the importance of collaborations for joint actions to achieve mutual benefits through marketing channels. Additionally, more collaborative actions are formalized by strategist and planners in collaborative networks to create marketing plans (Neves, 2007). However, the liberalized food market in transitional economies offers opportunities for small holder farmers to access high-value markets, it includes the risk of being exposed to competition. Common recommendations by politicians and development workers to overcome barriers for these farmers is to create collaborative marketing groups. For the successful generation of benefits a certain level of trust in communities and social capital needs to be achieved (Murray-Prior, 2008). In which the social capital refers to the networks and norms which enable collective action (Grootaert & Van Bastelaer, 2001). More extensively explained as '' the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions. Social capital is not just the sum of the institutions which underpin a society—it is the glue that holds them together" (World Bank, 1999). The concept of social capital relates to the generation of behavioural change for sustainable consumption patterns in this case.

Similar activities are seen within the SFSC sector, almost all interviewees acknowledged that re-connection the consumer with the local producers being one of the most important means of SFSCs. Multiple ways are utilised to change the behaviour of consumers and facilitate this re-connection between farmer and consumer through e.g. farm excursions and events, storytelling about the local farmers or creating information platforms.

To conclude the collaborative marketing for the creation of user awareness described by Planko et al. (2016) referred to the awareness creation for future user of the technology. Within the case of CSUs this activity includes more than only the marketing of a new technology. The empirical data confirms that the collaborative marketing for the increase of consumption of circular food products is validated. The additional component for the successful generation of mutual benefits through collaborative marketing includes the importance to create a community of trust and social capital. Resulting tin the new defined description of this activity: *The collaborative marketing to create consumer awareness through community building and creation of social capital.*

5.1.4 Refinement of the standardisation of processes

The lack of transparency on food waste and losses within the food chains is mentioned by more than half of the interviewees as a reason for the lack of awareness and urgency to support the transition towards circular food production system. As researcher CE5 states *''There is no good data across the whole food chain, nobody knows exactly how much food is wasted. This lack of information can be used as a strategy within the food system to profit from''.* Other interviewees confirm the lack of transparency within the food chains and the fact that information on food waste within companies is often kept for themselves.

The literature on transparency stress the importance of monitoring and reporting. In which the differences between horizontal and vertical transparency are two different concepts. The horizontal dimension includes the provision of information from companies towards stakeholders and consumers on their taken measures and policies (Wognum et al., 2011). Whereas, the vertical transparency refers to the legislations and requirements for all the companies within a specific supply chain, referring to the inclusion of minimum requirements and standards to support the creation of transparency in the

food supply chains (Kalfagianni, 2006). Overall, the inclusion of standardisation by reporting, monitoring and the use of minimum standards are broadly elaborated in literature for the creation of transparency in supply chains through standardisation process.

The concept of true cost pricing could use these monitoring and reporting statistics to create a transparent price of products by including the externalities in the price the consumer pays. With externalities being environmental costs e.g. CO_2 emissions, along the food chain from producer to consumer, according to the polluter pays principle. This mandatory inclusion of externalities supports the need of monitoring within the value chain. Resulting in less transport (CO_2 miles) and fair competition for circular producers which will be paying less externalities (Maxwell, 2008).

Within the agricultural industry various exemptions within environmental regulations are protecting the agricultural practices. Additionally, subsidies are supporting the large-scale agricultural practices that cause resource depletion and impacting the environment. These measures within the agricultural system result in externalisation of the pollution costs (Negowetti, 2017). The inclusion of these externalities within the prices of food will possibly lead to higher prices, which will incentivise consumers to waste less food. The changes in consumer behaviour achieved by these policies will send a message to farmers and food processors to change their production systems. However, the realisation of true cost pricing needs to be realised by creating synergy between consumers, producers, retailers and other food companies to support the transition towards a healthy, safe, authentic and sustainable food system. The establishments of these collaborations and the implementation of this concept requires political support, commitment, resources and time (Fresco & Poppe, 2016)

To conclude, it can be reasoned that the activity of the standardisation of processes should be refined by introducing the concepts of monitoring, reporting and the use of minimum standards, rephrasing the activity as: *the standardisation of processes by reporting, monitoring and the use of minimum standards.*

5.2 Empirical enhancement and validation of the strategic collective system building framework for circular entrepreneurs within the food production system

The need for validation of the strategy framework was argued by Planko et al. (2016), due to the single case study implementation. For the development of the framework it needed to be tested to other fields or sectors. Within this research a validation of the strategic framework was made by gathering empirical data within the food sector. Section 5.2.1 provides a recap of the validation process. Within section 5.2.2 the refinements found in the findings are included into a refined version of the strategic collective system building framework as presented in figure 8.

5.2.1 The strategic collective system building framework validation

Within their research Planko et al. (2016) stated that the SCSA might differ in other sectors or industries. The findings of this research confirm that the SCSA needed some refinements in the case of the food sector for circular business model innovations, as can be seen in figure 6 not all SCSA are rated as important according to the case studies. Moreover, the interviews with CSU entrepreneurs and experts in the field validate and elaborate on the implementation and importance of these activities, and the different perspectives and strategies among the CSU types. These findings showed 20 of the 23 system building activities described within the strategic collective system building framework are often performed by CSUs in the food production system. As presented in figure 6, of these activities 19 are rated as important for the realization of strategic collective system building.

The findings gained from the interviews on the most performed SCSA can be validated with the survey results. The technology development & optimization cluster is rated as most important, but examples given by the interviewees on the development of commercially viable products is low. Which can be explained by the focus on CBM innovations instead of development of a certain technology. Within market creation cluster the generation of new business models, the collaboration with competition against other clusters and the niche market approach are all rated as unimportant. However, these activities have been mentioned numerous times within the interviews. An explanation for the low rating of the niche market approach is related to the higher development phase of the innovation system. Due to the higher number of scale ups, SMEs and incumbents involved in the CE transition this is seen as a less important strategic activity by the CSUs anymore. As complemented by the refinement of collaboration with competition to compete with other clusters, it is noticed that collaboration with the current regime is seen as important for the transition towards a circular food system. The generation of new business models was not elaborated upon as being a strategic activity, mostly examples were given on the development of new CBMs. However, the generation of new circular business models is proof of successful circular business cases, which indicate higher viability and provides proof to convince investors. Furthermore, in the social cultural change cluster the generation of skilled labour forces is not been mentioned by the interviewees and is rated as unimportant. This can be related to the increasing interest for sustainability and circularity in the future generation, which will organically generate skilled labour forces that incorporate circular business model innovations in the food sector. Lastly, the cluster of coordination activities was relatively important according to the interviewees, only the division of system building roles was unrepresented in the data. This activity is not been performed by the entrepreneurs themselves, the efforts of Verspilling is Verukkelijk and Samen tegen Voedselverspilling were mentioned as conducting this activity.

Although not all the SCSA have been performed or rated as important by the CSU cases, it cannot be concluded that these activities must be excluded from the framework. Since this framework has been based on extensive literature research and a case study conducted by Planko et al. (2016). Hence, it can be argued that many SCSA might be important for strategic collective system building, although not all SCSA are generalisable and some activities could be case specific. Overall, it can be concluded that the strategic collective system building framework by Planko et al. (2016) has been validated in this research for circular business model innovations. Since, this framework is focussed on the strategic collective system building for a certain technological innovation, it is suggested to refine the use of the technology concept into the use of the concept of innovation.

5.2.2 Refined strategic collective system building framework

The findings of this research suggest several refinements of the SCSA that enable strategic collective system building. These activities were found in interviews and literature and validated within the survey, as described within section 5.1. Therefore, these activities are believed to be important refinements to improve the strategy framework. As presented in Figure 8 (see Appendix H for larger version), it is recommended to refine strategic collective system building activities i.e. collaboration with the current regime for market creation, collaborative marketing to create behavioural change, the standardisation of processes and the exchange of knowledge should be refined.

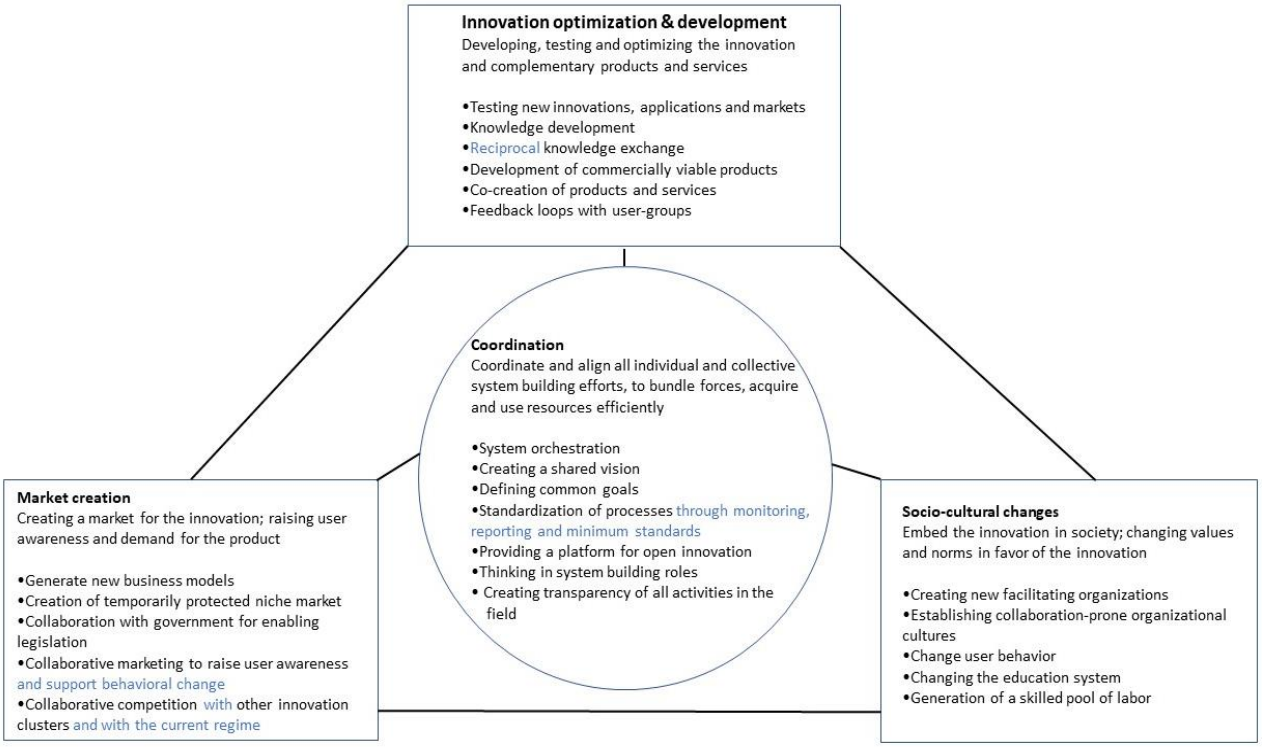

Figure 8 Strategic collective system building framework adjusted to empirical case study CSUs (adjustments shown in blue)

5.3 Limitations and future research

The limitations of this research are discussed in this section, these limitations provide interesting areas for future research. The first shortcoming of this research is about the data collection and representation of all actors and CSUs perspectives in the sample, this is solved by including the perspectives of experts in the field. Followed by the issues on validity and generalisability of the findings, overcome by using data triangulation. Furthermore, some shortcomings on the correlations between SCSA and barriers and the actor network analysis, these fund as a basis for future research. Whereas, more interesting topics for future research include the relation between SCSA and the phases of development of innovations systems. And lastly, the future research topic on the risk of competition within collaborations in ecosystems. Overall, the strategic collective system building literature seemed to be relevant for this research, with the result of generating many interesting topics for future research.

One shortcoming within this research was the collection of data, since many CSU founders or managers had limited time due to the lack of resources and personnel. Also, the lack of observations and documentation access within this sector limited the collection of strategic insider information. Nevertheless, the interviews with experts in the field complimented this lack of strategic insider information, by providing information on the meso-level perspective of the innovation system. This information also filled some knowledge gaps of new entrepreneurs in the field, which had not yet obtained a meso-level perspective like the experts in the field. Moreover, the missing actor and CSU types within the research sample could bring additional insights. The actor types of demand and political support are not included within the interviewee sample. Yet, the 13 CSUs interviewees have many feedback loops with their consumers and much customer knowledge and experience within the field. Also, the interviewees often had contact with municipalities and governmental organisations. The perspectives of these actor types are referred by within the interviews. However, future research could include the insights of these actor types to better understand what strategic collective system building activities are important. Similar, the nature-based, and design-based CSU types are excluded

from this research, due to the aim of the scope being on food manufacturers, retail and hospitality segment. These excluded CSU types are active within the agricultural and forestry sector or the food packaging sector. For future research the inclusion of these CSU types could be an interesting addition towards the analysis of strategic collective system building within the entire food production system.

Furthermore, the use of a multiple case study design is accompanied with external validity issues, which make the generalisation of the findings difficult. Therefore, rich empirical data has been gained through interviews with CSUs and important experts in the field, with higher organisational positions (sustainability manager, industry leader, CEO etc.) which have much sectoral and circularity expertise. Also, the use of triangulation, which means the collection of data from different sources to gain rich, reliable and valid data (Saunders et al., 2009). These data sources entailed the desktop research, semi-structured interviews and the online survey to validate the findings found in the interviews. To generalize the multiple CSUs case studies to the broader food production system or other industries, the CSU case studies were related and compared to literature on strategic collective system building and network management.

Whereas, the shortcoming on the proof of correlation between the defined barriers and the SCSA could be interesting for future research. The research approach was not designed to provide insights on the correlation between these defined barriers and specific strategic collective system building activities. Nevertheless, the barriers found in the empirical findings can fund as a basis to build on and provide input for the creation of systemic policy instruments in order to improve the functioning of the circular business model innovations system in the food sector.

Similarly, the network analysis within the structural system analysis has some shortcomings, but funds as a basis for future research. This preliminary network analysis is created by combining the actor analysis and partnerships found in the interview data and desk research. This analysis can fund as a basis for an extended network analysis based on specific metrics like centrality, closeness and the nature of the connections. Additionally, according to education interviewees many researches have been conducted on analysing the circular actors, it can be useful to collect and analyse previous related researches within education systems in the Netherlands. For future research a network analysis of these partnerships could provide valuable insights on collaborative relationships between network actors.

Another interesting topic for future research is the inclusion of the various phases of development of the innovations system. Hekkert et al. (2011) discusses that the system functions (SF) are related to the specific phase and the structure of the IS, as the development phase and state influence the IS structure. The IS has a different structure in the various development phases, in which different SFs are more relevant than in other phases. For this reason, it is a relevant contribution to assess the development phase, to focus on specific strategic collective system building activities, that originate from the SFS which contribute to the success of an IS. Hekkert et al. (2011) described four phases with relevant SFs per phase, including the: pre-development, development, take-off and acceleration phases. The relation between these various development phases and the strategic collective system building activities could be included in future research. In order to provide specific strategic insights on the SCSA per development phase for the creation of an external supportive environments for CSUs.

Moreover, the collaboration with competition in ecosystems brings benefits and risks. Future research could investigate this dilemma of competition and collaboration within ecosystems that implement a sustainable innovation or technology in a collective manner. As Planko et al. (2018) provided an overview of enablers, risks and benefits of collaboration with competition based on the coopetition literature.

To conclude, the strategic collective system building literature seemed to be relevant for this research. In order to develop the SCSA framework various interesting topics for future research have been addressed. Also, to validate the framework and refinements found in this research more case studies could be conducted for different circular innovations, sectors and industries. The validation of these activities on other innovations, sectors or industries might provide different perceptions on the importance of the activities and in this way contribute to the further development of the SCSA strategic framework.

6. Conclusion

The aim of this research was to understand the creation of a supportive external environment for their circular business model innovations and strategies through strategic collective system building. By understanding the innovation system in which these CSUs are developing their circular business model innovations, through performing a multiple case study research to find out what strategic collective system building activities are performed by circular entrepreneurs and which key actors are involved in this innovation system. In this manner, providing strategic insights for the execution of collective system building activities by CSUs in the food sector. In order to enable the development and diffusion of circular business practices within the food production system, supporting the transition towards a circular economy.

In order to answer the main research question, several sub-questions have been formulated. These sub-questions incorporate theoretical and practical perspectives and provide relevant insights for academics and actors in the circular entrepreneurial business field. The themes within these sub-questions include: 1) Gaining insights in the systemic problems and barriers within the innovation system. 2) Mapping relevant actors for collaboration within the ecosystems. 3) Validating the strategic collective system building framework for circular entrepreneurs in the food sector. By answering these sub-questions strategic knowledge and insights were gathered in order to answer the main research question.

For the operationalisation of the theoretical concepts to answer the described sub-questions a theoretical framework was built. This theoretical framework uses the lens of sustainable transition theories to explain the formation of supportive external environments for sustainable innovations by combining the literature of strategic management, technological innovation systems, and business ecosystems. Although the sustainability transition literature focusses on the transformations of systems through sustainability innovations, rather than a specific innovative technology as in the TIS literature, all the literature streams focus on collective action or collaboratively changing the business ecosystems. Also, all three describe the sharing of knowledge, developing a shared vision, collaborations and co-creation needed to create a supportive external environment for the innovation to become more sustainable or successful. In order to build such collaboration within these networks, strategic collective system building provided relevant activities.

First the various circular business model innovations and strategies present in the food sector of the Netherlands were analysed. Furthermore, to provide background information on the innovation system a desktop research has been conducted to analyse the relevant actors, institutions, networks and infrastructures. This structural analysis provided knowledge that contributed in the understanding of the structural problems obstructing the development and diffusion of circular business innovations within the food production system of the Netherlands. Specifically, this analysis included an actor analysis framework, which provided an overview of interesting actors for collaboration to perform the strategic collective system building activities as presented in table 6.

Furthermore, within the interviews with CSUs the main barriers experienced by circular entrepreneurs in the food sector were discussed. The most discussed barriers were product and process development, large scale infrastructures, lack of consumer awareness, financial access and lack of knowledge and expertise. The structural system analysis provided insights in the underlying processes that could cause these barriers to arise. However, the relation between the barriers found in the empirical data and the performance of SCSA to overcome these barriers was not defined, this is suggested as an interesting topic for future research.

Finally, to determine what SCSA are performed and rated as important by CSUs in the food sector the strategic collective system building activities were analysed through 21 interviews with 13 CSUs and 8 experts in the field and validated with an online survey amongst 12 CSU interviewees. The scope of the thesis on the food manufactures, retail and hospitality sector resulted in the exclusion of nature-based and design-based CSU types. For future research the inclusion of these CSU types could be an interesting addition towards the analysis of strategic collective system building to gain a holistic perspective of the food production system.

According to the qualitative data collection several strategic collective system building activities are needed to create a stronger ecosystem for CSUs. The strategic collective system building activities found in the case study correspond with 19 of the 23 system building activities from the strategic collective system building framework as showed in figure 6. Furthermore, the empirical findings showed that in order to strengthen the CSUs ecosystem several refinements of activities are needed. Therefore, this research proposes new activities by refining the strategic collective system building framework by Planko et al. (2016), suggesting:

- Stress the importance of reciprocal relationships within the strategic activity of knowledge exchange in order to prevent free riding;
- Add the collaboration with the current regime besides the collaboration with competition being other entrepreneurs, to share relational specific assets and generate complementary resources;
- Enrich the collaborative marketing to raise user awareness with creating behavioural change towards sustainable consumption through community building and creation of social capital;
- Add to the standardisation of processes the inclusion of reporting, monitoring and minimum standards to support the overall transparency within the sector.

For the validation of the collective system building activities defined by Planko et al. (2016) a survey among the interviewed CSU founders and managers was conducted. These results showed the various opinions on the importance of certain activities between the different CSU types (figure 7). Overall, the CSU types agreed that conducting collaborative marketing to achieve awareness, knowledge exchange and development and creating a shared vision are key strategic collective system building activities.

The need for validation of the strategy framework was argued by Planko et al. (2016). This research contributed to the literature of strategic collective system building by validating the framework through a multiple case study approach among circular start-ups in the food sector. The findings showed that the framework seems adequate, including some refinements of certain activities. Therefore, this thesis provides theoretical contribution through the validation and refinement of the SCSA framework, addressing the different strategies amongst CSU types based on the circular business model innovations of CSUs in the food processing and catering sector.

Overall, the strategic collective system building activities seemed to be relevant for this research. The refined strategic collective system building framework enables circular entrepreneurs within the food sector to build a strategic collective system. The implementation of these SCSA can support CSU entrepreneurs to control collaborations in order to successful development and implementation circular business model innovations. These activities complemented with insights on the barriers, structural problems and relevant actors for collaboration provides strategic insights for CSUs to create a supportive ecosystem. In this way contributing to the creation of a strong external environment for circular business models within the food sector to support the transition towards a circular food production system.

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Appendices

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Appendix A Overview CSUs in the food sector

CSU types	Description	Name	Circular business model	Employees	Location	Foundation year
Design-based	Adopting circular innovations mostly in the pre-market phase through source material minimization, product design or production process efficiency,	Krown packaging	Produces packaging form fungi and biomass	1	Hilversum	2015
		A TOP packaging	paper and bioplastic packaging for food and bevevarge	4	Europe	2016
Waste-based	Seeking to extract value from unexploited external waste streams	**Kromkommer***	make soup from rejected vegetables	2	Utrecht	2016
		Potverdorie*	make jams and chutneys from rejected fruits	2	Amsterdam	2016
		Krusli*	Produces breakfast cereals from beer and fruit waste streams	4	Wageningen	2018
		Utregs Supersap	Produces fruit juices from rejected fruit streams		Utrecht	
		Betuwse Krenkelaar*	Produces ciders from rejected fruit streams	2	Geldermalsen	2016
		GRO*	Produces mushrooms on coffeeground residue streams	5	Amsterdam	2010
		Glorious Bastards*	Produces ketchup and chutneys from rejected tomato streams	1	The Hague	2016
		Peel pioneers	Produces cosmetic products of fruit waste streams	1 to 10	Son	2016
Platform-based	Pursuing business models built around B2B, B2C or C2C marketplaces,	**Wasteless***	Platform for retailers to introduce dynamic pricing for products to reduce food waste in supermarkets	18	Amsterdam	2018
		Bestelbewuster/ Get Chefs*	Platform for consumers to get left over meals from restaurants, and platform for municipalities to tailor catering demands for lunches	6	Amsterdam	2019
Service-based	Embedding products in service-systems to increase usage efficiency and	**Wastewatchers***	Food waste monitoring tool and consultancy worshops for kitchen staff to give insights in the amount of foodwaste and actionable insights in food losses in fields of procurement, planning and efficiency within the kitchen.	4	Wageningen	2016
		Zero foodwaste*	Fully automated food waste monitoring system for the catering industry. Solution for restaurants to quantify huge volumes of wasted food through image recognition in combination with a smart scale will provide real-time actionable insights in food losses in fields of procurement, planning and efficiency within the kitchen.	9	Utrecht	2018
		Oma's Soep*	Collective activitiy with lonely elderly by making soups from waste streams, the soups are consumed together and surplus of soups are sold within retail chains.	4	Amsterdam	2017
		Piece of Plate*	Sustainable cooking workshop with food waste streams from retail supply chains. Education on seasonal, local, organic, vegan and vegetarian concepts translated in accessible, affordable hacks to everyday life and create a delicious planetary cuisine.	1	Rotterdam	2018
		Ozarka	Food packaging retour system for restaurants and take-away services.	1 to 10	Rotterdam	2016
Nature-based	Increasing the delivery of (products and) services based on nature-based systemic solutions.	Vleesch&Co	The maintenance of grassland in nature reserves by grazing cows to preserve the landscape. The aggressive fighting bulls are taken from the herd and processing all eatible parts into meat products. These organic meat products are sold, supporting a regenerative ecosystem in the nature reserves.	1 to 10	Almere	2016
		Café de Ceuvel	The usage of an aquaponics system for watertreatment to close the nutrient cycles by using the fish feases for nurtering the vegetables. Both food sources are providing ingredients for the restaurant dishes, creating a regenerative closed nutrient cycle.	1 to 10	Amsterdam	2014
		GrowX	Indoor vertical farming, utilising empty buildings for growing vegetables in a circular Plant Factory with Artificial Ligthing (PFAL) system.	1 to 10	Amsterdam	2016
		Plantage lab	Urban farm implementing various circular practices to close the nutrient loops within urban areas and growing vegetables for the community.	1 to 10	Amsterdam	2014

Overview CSUs in the Netherlands, CSU typologies adapted from Henry et al., (2019), (**interviewed CSUs*)**

Appendix B Interview guide CSUs

Thank you for taking the time for this interview. This research focusses on the roles of circular start-ups contributing to the transition of the circular economy in the food production system. For this, multiple startups in a series of 45-60 minutes expert interviews are interviewed, to analyze their general background, their business model, their interactions with other actors and their funding mechanisms. The results of this research will be published in my thesis paper and shared among all participants. In the presentation of the results, I will make sure that only the organization will be mentioned to remain a certain level of anonymous. Please answer the following questions to the best of your knowledge.

A. Introduction

1. Could you please tell me a little more about yourself? Such as your name (for the recording), job description, educational background and career path?

B. Circularity and business model

2. Please describe the **business model** of the company you work for.

3. Do you consider the sustainability/**circular** component of your business model part of your unique selling point? With 'sustainability' we mean that your firm simultaneously aims to accomplish positive environmental, economic and social impacts. Has circularity, as defined previously, played a central role in your product/service design process from the very beginning?

4. What was your initial **motivation** to start this business? Can you please explain how the idea and your business model emerged?

5. What were the **problems** you encountered while **launching** your start-up and how did you deal with them?

C. Strategic collective system building activities

6. Could you explain which of the following strategic activities are realized, and which actors are linked to these activities?
(reminder → start already to mind map the ecosystem during the following questions)

A. Do you aim to **develop/test/optimize** your circular business model innovations or technology?
And which actors are linked to these activities?
Check the following activities:
- Test new innovations, **applications** and **markets**
- for example **co-creation** of products and services?
- by **exchanging knowledge and development?**
- Commercially **viable product**/ user **feedback** loops?

B. How do you aim to improve your position within the **market**?
And which actors are linked to these activities?
Check the following activities:
- Generating new or improved business models (**BMI**)
- Creating a **niche market**
- Collaborate with government for enabling **legislation**/
- Collaborative marketing to raise **use awareness**
- Creating **transparency** of all activities

C. How do you see your innovation/process/technology adding value for **society**?
And which actors help to realize this value for society?
Check the following activities:
- Is it creating new **facilitating organizations**?
- Is it changing **user behavior**?
- Is it changing the **education system**? Draw
- Are you generating a complementary **pool of skilled labor**/human resources?
- Is your **organizational culture** open for collaborations?

D. Do you think it is important to **coordinate** the previous discussed activities within your collaboration network?
And which actors take this coordination role?
Check the following activities:
- What do you think the **shared vision** of this network is?
- Are there **common goals** to achieve this vision?
- How are the goals managed / **orchestrated**? What is according to you the added value of this network?
- Is the innovation **standardized**, to realise co development?

- Are there **open innovation platforms** to share knowledge/innovations which could potentially speed up knowledge development and product optimization.
- Do you consider the companies within your network having different **system building roles?**

+ Are there any activities missing within these categories which we discussed?

7. Was the current collaborative network already existing? Or did you actively develop these collaborations? If so, please explain how?

D. Actor analysis

8. Could you map the ecosystem of circular actors within the food sector?

Checklist for categories:

- ✓ Leadership role
  - Coordination and visioning
  - Partnership/ collaboration creation
  - Platform building

- ✓ Supply chain actors
  - Suppliers (main producers that focus circular strategies and innovations)
  - Assemblers (wholesalers or retailers that incorporate circular strategies or innovations)
  - Service and maintenance (Logistic partners, IT development parties that make circular innovations easy to implement)
  - Demand (Restaurants, events, customer groups that actively incorporate circular practices and innovations)

- ✓ Supporting actors
  - Research (Universities, Research Institutes, consultants)
  - Network (Networking parties, market managers that try to bring actors active within the CE of the food sector together)
  - Political (Regulating parties that support the transition towards a circular food system)
  - Financial (Financial parties that invest money in the circular businesses and projects)

- ✓ Entrepreneurial roles
  - Circular Entrepreneurs

9. Which of these roles are explicitly missing or underdeveloped within the ecosystem/ network?

10. Please explain the major barriers within the current innovation ecosystem?

E. Financing mechanisms

11. How did/do you generate funding at the different stages of the development of your business (seed stage, growth stage, later stages)? E.g. through bootstrapping, crowdfunding, family members, investors, startup awards, state subsidies, (traditional or social) bank loans, the business model.

12. What were the barriers, if any, that you have encountered while searching for funding?

13. Would you think the existing sources of funding are suited to a business like yours? If not, what would you think should change?

F. Closure

14. Is there anything else you would like to add?

15. Are there any parties I must talk to?

Appendix C Interview guide Expert interview

Thank you for taking the time for this interview. This research focusses on the roles of circular start-ups contributing to the transition of the circular economy in the food production system. For this, multiple startups in a series of 45-60 minutes expert interviews are interviewed, to analyze their general background, their business model, their interactions with other actors and their funding mechanisms. The results of this research will be published in my thesis paper and shared among all participants. In the presentation of the results, I will make sure that only the organization will be mentioned to remain a certain level of anonymous. Please answer the following questions to the best of your knowledge.

A. Introduction

1. Could you please tell me a little more about yourself? Such as your name (for the recording), job description, educational background and career path?

B. Circularity and business model

2. In what way does your business/ organization support the circular transition within the food sector?

3. What are the largest barriers for the circular economy within the food production system from your perspective?

4. What are the largest motivational factors for companies to practice circularity?

C. Innovation system building activities

6. Could you explain which of the following activities are realized within the food sector, and which actors are linked to these activities?

A. What circular innovations are developed and tested in the food production system?
And which parties develop/test/ implement these innovations?
Check the following activities:
- Are circular food innovation processes or products tested or applicated in markets?
- Are there any parties co-creating new services or products to prevent food being wasted?
- To what level is knowledge developed and exchanged in the food sector?
- Are there many commercially viable product/ user feedback loops?

B. In what way can circular businesses with circular products or services improve their market position?
And which actors are linked to these activities?
Check the following activities:
- To what extend do companies in the food sector implement circular strategies or circular business model innovations?
- Are circular products and services a niche market within the food sector?
- Do companies collaborate with government for enabling legislation which supports circular products or services?
- Are circular food companies implementing collaborative marketing to raise user awareness
- How transparent is the food sector about their activities? And how transparent are circular parties in the food sector?

C. How do you see your circularity and circular innovations adding value for society?
And which actors help to realize adding these norms and values within the society?
Check the following activities:
- Are there any facilitating organizations that help integrating this mindset in society?
- How is user behavior changed towards lower consumption and food waste patterns?
- How does the education system fit with this philosophy of circularity in the food production system?
- Will there be a large enough pool of skilled labor/human resources?
- Are current organizational culture open for collaborations?

D. Do you think it is important to coordinate the parties within the ecosystem of the circular food production system?
And which actors take this coordination role?
Check the following activities:
- What do you think the shared vision of this network is?
- Are there common goals to achieve this vision?
- How are the goals managed / orchestrated?
- What is according to you the added value of this network?
- How can the prevention of food waste be standardized, focussing on a circular food system?
- Are there open innovation platforms to share knowledge/innovations which could potentially speed up knowledge development and food process optimizations.
- Do you consider the companies within your network having different roles?

7. Did this network already exist? Or did you actively develop these collaborations? If so, please explain how?

8. Is there a specific order in which the discussed activities are realized?

9. What could be improved to increase the effectiveness of this ecosystem?

D. Actor analysis

10. Could you map the ecosystem of circular actors within the food sector?

Checklist for categories:

- ✓ Leadership role
  - Coordination and visioning
  - Partnership/ collaboration creation
  - Platform building

- ✓ Supply chain actors
  - Suppliers (main producers that focus circular strategies and innovations)
  - Assemblers (wholesalers or retailers that incorporate circular strategies or innovations)
  - Service and maintenance (Logistic partners, IT development parties that make circular innovations easy to implement)
  - Demand (Restaurants, events, customer groups that actively incorporate circular practices and innovations)

- ✓ Supporting actors
  - Research (Universities, Research Institutes, consultants)
  - Network (Networking parties, market managers that try to bring actors active within the CE of the food sector together)
  - Political (Regulating parties that support the transition towards a circular food system)
  - Financial (Financial parties that invest money in the circular businesses and projects)

- ✓ Entrepreneurial roles
  - Circular Entrepreneurs

11. Which of these roles are explicitly missing or underdeveloped within the ecosystem/ network?

E. Closure

12. Is there anything else you would like to add?

13. Are there any parties I must talk to?

Appendix D Interview transcripts

In order to provide a clear and compact overview of the interview transcripts, the following google drive map was created:
https://drive.google.com/open?id=1Qm7C3CrjSWssp7ef2vWOkP4cNq542UBdiY

Appendix E Structural analysis of the CSU innovation system

This section provides background information on the Dutch innovation system of circular business model innovations conducted by CSUs in the food production system. This analysis brings insights into the various structural dimensions i.e. actors, institutions, networks and infrastructure of the CSUs innovation system. With the aim to find various systemic problems within these structural dimensions, by analysing the presence and capabilities of the actors involved and the presence or quality of the institutions, networks and infrastructure. In order to provide background information on the innovation system of circular business model innovations in the food sector, providing insights on these structural problems to understand the underlying problems of certain barriers experienced by circular entrepreneurs in the food production system.

Actors:

This paragraph gives an explanatory overview of various actor types, all contributing to the development of the circular food production innovation system. Starting with the supply related companies (supplier, assembler, complementor), demanding parties (B2B, suppliers, consumers), the research and educational organisations, the financial and network supporting organisations and finally the political supporting parties. As a result, the specific companies and organisations representing the various actor types are presented below (figure 9). Within this figure only the key actors are displayed, for an entire overview of the various actors active in this innovation system see Appendix G.

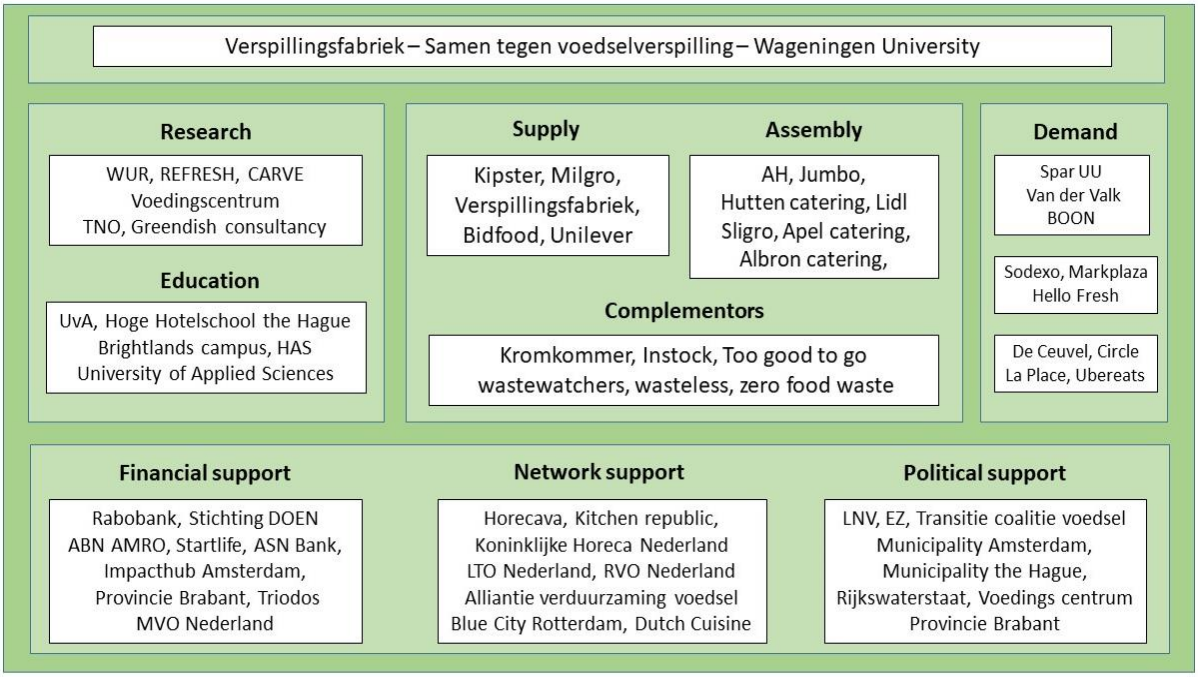


figure 9 Overview of key actors in the circular food production system, based on the structural analysis framework by Hekkert et al. (2011), and additional leadership actor based on Gomes et al. (2018).

Supply

Within this segment there are several categories of companies, first the ***suppliers*** themselves being the farmers that grow produce and the food processing companies that produce shelf products for wholesalers and retail. These supplying parties that provide the market of food products are often highly advanced organisations. However, only a few frontrunners in this section exist that incorporate circularity strategies in their businesses. For the producers a prominent example is Kipster, which incorporates several circular innovations for the breeding of their chickens. Starting with using waste

streams of bakeries for feeding the chickens, followed by growing the roosters at another farm instead of killing them and finally using circular and compostable packaging for the eggs (Kipster, 2019). Within the food processing branch another frontrunner is well-known for the circular innovations and the scale of this operation, named de Verspillingsfabriek. The Verspillingsfabriek is a food processing plant that uses residual and waste streams to revalorise these streams into soups, sauces and stew dishes (Catering, 2019). Moreover, some CSUs realise the same circular practices within the supply of circular food products, the revalorisation of residual and waste streams is showcased by one frontrunner in the sector Kromkommer, others are Utregs supersap, Potverdorie or Betuwse Krenkerlaar and Krusli. Other circular growers include GRO, Seamore, burgs food and the Fungi factory.

The following actors within the supply section of the innovation system are the **assembling** parties. Generally referring to the wholesalers and retailers within the food sector, which collect, store and distribute food products. These parties mostly consist of large SME's or incumbents e.g. Sligro, Bidfood, Hanos, Jumbo and Lidl. However, one frontrunner start-up which is a spin-off from the Ahold and Delhaize group is Instock. This CSU has a distribution centre focussing on the processing of residual and waste streams of supermarkets, in addition supplies their own restaurant chain in which dishes are made with residual and waste streams. Other parties assembling food and preparing it for consumption are hospitality firms e.g. Hutten catering, Sodexo or Apel catering. Another prominent example within this supply actor category is Albron catering, which run the Greenhouse in Utrecht and Circle in Amsterdam. These are circular restaurant that use as much ingredients that would have been wasted or can be preserved otherwise, with a focus on dishes with a low environmental impact (Circle and Greenhouse).

Finally, the supply segment ends with the ***complementors*** which meet the consumer specifications by creating complementary offerings. For example, app developers that create an ordering app for consumer to make the purchase of food that would have been otherwise waste easier e.g. Too good to go or Get chefs. Other companies focus on the prevention of food waste by analysing the amount of food waste in hotels and hospitality services to give insights on how to align the consumer demand and production of food e.g. Wastewatchers, No food waste, Winnow or a larger firm lean path. New development that complements consumer offerings is the incorporation of dynamic pricing, which includes that products with an earlier best before data are priced lower then products that have a later best before date. This dynamic pricing is introduced to the retail sector by the CSU Wasteless. For more examples of suppliers, assemblers and complementing parties see Appendix G.

Demand

The demand side providing food products and services to consumers. These parties are very interlinked with the assembling parties, since they are often part of one company acting as a wholesaler and retailer. The demand for sustainable, fresh and local food products is rising (ABN AMRO, 2018). There are various sales channels forming the demand of these food products, often created by the demand of the green consumers segment. Followed by business to business channels, these parties mostly consist of hotels, restaurants, corporate catering, healthcare institutions and municipalities. The catering industry is also part of the demand side, providing extra service for the consumers. The largest catering companies within the Netherlands are: Sodexo, Albron, Compas Group, Vermaat, Paresto, Hutten Catering, Koninklijke van den Boer groep and Appèl (Misset Horeca, 2017). These parties have a very influential position within the current food sector, ordering large amount of food supplies to run their businesses. Some frontrunners within this field that incorporate circularity strategies within their catering concepts are café de Ceuvel and Circle in Amsterdam. Furthermore, on the demand side the B2B types includes larger retail parties that also fund as wholesalers, few examples of these firms include: BOON supermarkets, Ahold&Delhaize, Jumbo, Lidl, Sligro, Hanos and Marqt. The parties that

focus on the delivery and services of food towards the consumer include Hello fresh, Ubereats and Picnic. Some examples that focus on including circular innovations in their business is Too good to go and Get Chefs, that try to sell food products that otherwise would have been discarded.

Research

These parties conduct research, provide expertise, generate knowledge and consultancy. Furthermore, education via research project, workshops or events is gained. Some examples within this category are Universities, research centres, technology institutes, design labs or consultancy bureaus. The specific activities of these actors will be elaborated upon in the section knowledge infrastructure.

Educational organisations

The contribution of knowledge development can be seen in other educational organisations, which are more focussed on the practical knowledge development and provide a skilled pool of workforces. Some examples of educational organisations are Higher Agricultural Schools, Higher Hospitality schools or Food innovation campuses.

Financial organisations

Within this segment there are organisations that support the development of circular businesses by sponsoring or providing financial access to these companies. Most of the circular business invested themselves in the implementation of circular business model innovations or including circularity strategies, some companies retrieved subsidies mainly when the business has a social impact. Furthermore, other financial supporting organisations are banks, foundations, semi-public organisations, strategic partners or accelerator programs. The various activities and financial structures for the circular food production system are elaborated upon in section financial infrastructure.

Network organisations

The network supporting parties try to connect various actors and are dedicated to creating collaboration to provide access to markets. Examples of these types are branch organizations, associations, network organisations or innovations hubs. Some influential and leading parties within the food sector that try to support the collaboration among circular actors are Samen tegen voedselverspilling, Verspilling is verukkelijk, SFYN, No Waste Network and MVO Nederland. Other circular innovation hubs related to food are Blue City in Rotterdam, Dutch Cuisine and the Impacthub in Amsterdam. The various levels of networks and individual networks are elaborated upon in section networks, for more examples of network organisations active in this field see Appendix G.

Political

These organisations influence laws and regulations to support the development of the innovation system, by providing favourable policies and economic conditions. The organisations representing this category include ministries, governmental institutions, provinces, municipalities and policy & public administration. The parties most prominent in supporting the transition towards a circular food production system are the Ministry of LNV, the Ministry of Economic affairs, Transitie Coalitie voedsel and the Municipalities of the Hague and Amsterdam are actively supporting circular projects and enabling legislations.

Leaders

These actors initiate and push the network of actors active in the circular field of the food production system to accelerate the diffusion of circular innovations towards a sustainable transition of the food production system. Within the field of circular business practices in the food production system there are four leaders. Starting with Kromkommer who created the awareness amongst consumers on the problem of food waste. Followed by the Verspillingsfabriek which showed how circular business model

innovations could be scaled to an industrial level. Furthermore, the Wageningen University and especially researcher Timmermans who conducted research for many years on the prevention of food waste and strategically created collaborations among circular frontrunners in the food production system. This all lead to the formation of the Taskforce Samen tegen Voedselverspilling, which is a collaboration platform of various actor types working towards the circular transition of the food production system in the Netherlands. However, the difficulty within an ecosystem of actors is the lack of ownership, it is often based on voluntary efforts of representative organisations with a joined agenda. As described by interviewee WUR '' It is more about the willingness and motivation of these organisations and the individuals that contribute. Because, no organisation can solve these wicked problems by themselves, the core group creates the impacts''.

Institutions:

¢ *Hard: laws and regulations, rules or instructions*

When looking at the laws and regulations within the food production system two main pillars can be defined, one focussing on agricultural practices and the other on food processing and retail practices. For the agricultural practices the various certification processes for biological or sustainable production methods are most relevant for circular food production. Whereas, the food processors and retailers have to oblige various food safety guidelines and protocols. The REFRESH community of experts conducted a research on EU policies that are related to the generation of food waste. Several policy areas were analysed including ''waste and resource policies, food safety and hygiene regulation (including the special case of surplus food use for animal feed), agricultural policy (CAP), fisheries policy (CFP), unfair trading practices (UTPs), and bioenergy'' (Wunder et al., 2018, p.4). Resulting in ongoing research for policy recommendations divided in four areas: ''use of surplus food to animal feed, building of voluntary alliances between business and policy actors, behaviour change of consumers, and unfair trading practices'' (Wunder et al., 2018, p.4). All these areas include hard institutions that are related to food waste and losses and could be improved to work towards a circular food production system.

The previous discussed EU policies are differently exploited within the member states. Within the Netherlands the Wageningen University conducted a research on the barriers within legislation for businesses. This research showed the main barriers are formed in two areas, the regulation on provision of food information and the hygiene codes for food services. In addition, some findings were made in the strict regulations on contamination limits, which companies set even higher to prevent reputational damage in the case of a contamination scandal (Waarts et al., 2010). The food safety guidelines and protocols linked to food processing and retail companies are related to hygiene regulations and product liabilities. To elaborate, for the processing and transportation of food products a food safety plan is mandatory, these plans are based on the HACCP hygiene protocols. Additionally, municipalities set protocols for waste processing, building codes, coolants, and transport restrictions (Rabobank, 2019). When an organisation has taken the right measures and ensure food safety in their supply chain, they are certified with BRC Food and IFS Food standards (Normec, 2019). Eventually, the Dutch Food and Consumer Product Safety Authority checks if companies carry out the food and safety protocols. Within the food service sector, a lot of food is wasted due to these strict hygiene protocols. Additionally, much food waste is caused due to the regulations on food information referring to the expiration's dates. Half of the European consumers don't exactly know the rightful meaning of best 'use by' and 'best before' dates on food products (European Commission, 2017)

One of the barriers named previously in the REFRESH report relates to the waste and resource policies. According to some CSUs in the food sector, these guidelines are not always applicable on circular practices (CSU1, CSU2, CSU6). An example given by GRO is the documentation of coffee grounds as a

waste stream instead of a resource stream. This misfit within regulations causes conflicts with the administration authorities with a fine as a result. In this way circular practices are obstructed by regulations. This was confirmed within an expert interview of the Wageningen University, which stated that the regulation barrier is often used as an excuse by incumbents and SME's to not implement circular business innovations.

Moreover, sustainability standards in other fields like biological, fair trade and ethical standards are examples of hard institutions. For the technological side of the circular economy there are standards created to rate the circularity of an material or product e.g. cradle2cradle. However, for the food sector there are no specific circular certifications, only guiding methods for agricultural practices are determined within food label certification schemes. The various labels that are often used within the food sector are EKO, Milieukeur, Demeter, the EU organic label with a SKAL certification, Beter leven, UTZ, Fairtrade Max Havelaar, MSC, ASC, RSPO and Rainforest alliance. Which are all certificates audited by a third party, based on the production methods and environmental factors resulting in these certified products. However, over 450 labels are in use, many barriers are accompanied with these labels. For example, customer confusion, greenwashing, high cost of use and lacking advantages for the branding. Therefore, creating a label that displays the circularity of a product would not be a viable strategy. Watanatada & Mak., (2011) argue about the need for a collaborative model to achieve sustainability outcomes. In addition, the importance of creating stronger relations with the consumers, the brand displaying sustainability and the use of partnerships and regulations to support this sustainability transition within the food sector is stated by these authors. This can be a viable strategy for CSUs to create a circular transition within the food production system.

Figure 10 Examples of ecolabels within the food sector

Furthermore, when looking at new developments within food and agricultural policies some policy innovations are gaining ground. Starting with the true cost pricing of food by including the externalities in the price the consumer pays. With externalities being environmental costs e.g. CO_2 emissions, along the food chain from producer to consumer, according to the polluter pays principle. Resulting in less transport (CO_2 miles) and fair competition for organic farmers which will be paying less externalities. Moreover, including externalities within the prices of food will possibly lead to higher prices, which will incentivise consumers to waste less food. The changes in consumer behaviour realised by these policies will send a message to farmers to change their production. However, the realisation of true cost pricing needs to be realised by creating synergy between consumers, producers, retailers and other food companies to support the transition towards a healthy, safe, authentic and sustainable food system(Fresco & Poppe, 2016).

¢ Soft: traditions, routines, norms, common habits, customs, expectations

Within this section the soft institutions on food consumption are elaborated, to give a view on the social aspects that are accompanied with circular mindsets and consumer behaviour related to food. These soft institutions are formed within different social groups that have their own norms and values,

as for many cultures which have their own traditions and habits. These factors form the way people make daily choices, for this instance on food consumption and food waste management.

According to a European research by Eurobarometer (2015), the majority of European citizens (76%) acknowledge that the consumers have a role in preventing food waste, and 49% state that the state needs to act. Furthermore, more than half of the Europeans think that retailers, shops, the hospitality sector and food producers have a responsibility in the prevention of food waste. Regarding personal responsibilities 63% of the Europeans agree that improved meal planning and shopping could contribute to a reduction of food waste. Whereas, the checking of 'best before' and 'use by' dates is done by 58% of the Europeans (Safety, 2015). These opinions on reducing and preventing food waste are reflecting the various soft institutions regarding food consumption and food waste management among European consumers.

Within the Dutch society there are many societal groups, all with different norms and values which lead to various routines and habits. According to decennium worth of empirical research by Motivaction 8 different social environments can be described within the Dutch society (Motivaction, 2019). These societal segments share the same norms and values which form a certain lifestyle and consumption pattern. When looking at the consumption of local products three aspects are important: tradition, price, sustainability and the service level to receive local products. According to the motivation typologies sustainable societal segments are the traditional citizens, cosmopolitans and post-materialists. Motivaction grouped the 8 different social environments into 5 sustainability groups. The 'dutiful citizens' (13% of the Dutch consumers) highly value their traditions and have conservative and economical consumption patterns, this combined with feeling responsible for future generations result in sustainable consumption patterns. Followed by the 'responsible feeling' group (22% of the Dutch consumers) who believe in a collaborative approach towards sustainable practices, with everyone bearing their own responsibility. These citizens are aware of local and global developments considering sustainability and are willing to achieve a balanced sustainable lifestyle. These norms and values correspond with circular consumption patterns and therefore these citizens will be likely to consume circular produced products and together represent 25% of the Dutch consumers.

Another research conducted for the REFRESH research program, by van Geffen et al., (2016) focussed on the specific behaviours and drivers of consumer behaviours towards food waste. The main findings were the various constructs effecting consumer food waste consisting of four categories; ability, distal factors, motivation and opportunity, explained as '' Motivational constructs that drive food waste are attitudes, awareness and social norms. Although a majority of consumers express negative attitudes towards food waste, only a minority agrees that their household is generating too much food waste. This lack of awareness has been reported repeatedly in several studies and is suggested to be a reflection of the fact that food waste is the result of a complex of behaviours. Ability refers to a person's proficiency to solve problems that he or she encounters when changing behaviour. Changing routines in household food management in order to pay increased attention to food waste prevention, requires skills and knowledge. The key challenge of managing the food supply and making sure that only low levels of food are being discarded seems to be connected to a large variety of personal and household aims. Opportunity refers to the availability and accessibility of materials and resources required to change behaviour. Relevant aspects as shown in prior literature are time and schedule, material and technologies, and infrastructure. Distal factors concern socio-demographic constructs, which likely have an indirect effect on household food management, through motivation, ability, and opportunity''. (Van Geffen, Van Herpen, & Van Trijp, 2016, p.8). These soft institutions forming the behaviour of consumers are displayed in the consumer food waste model in figure 11.

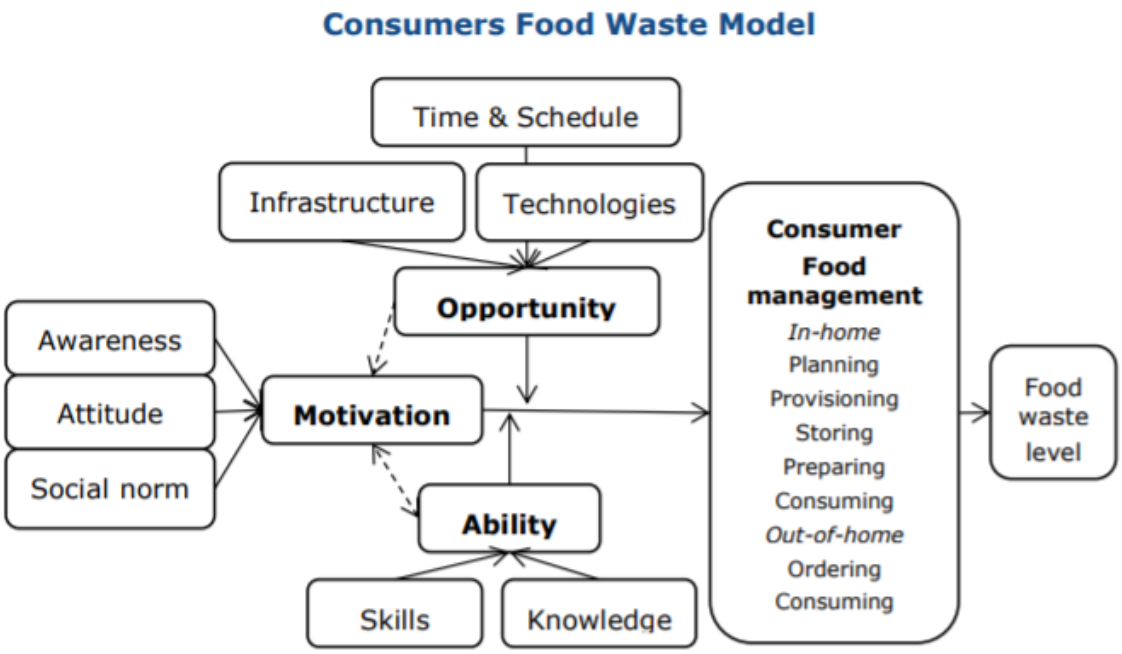


figure 11 Consumer food waste model adapted from Geffen et al., (2016), explaining the soft institutions of consumers for food management and consumption patterns

Interactions:

¢ *At level of networks*

When analysing interactions within networks various levels can be determined e.g. local, regional, national and European levels. The various network levels focussing on circular transitions within the food production sector will be elaborated within this section.

Starting with the European network level interactions, in which the European commission adopted a Circular Economy Action Plan to work towards a circular economy. With the aim for a global competitive advantage and generation of jobs and sustainable growth (Europese Commissie, 2019). Accordingly, the EU will achieve the SDG 12.3 target of reducing the food waste by 50% by 2030. In order to do so the commission will assist in creating a methodology for measuring food waste, set up a multi-stakeholder platform and clarify food waste legislations on food information labelling and food for animal feed. Which resulted in the formation of the EU platform on food losses and food waste (European Commission, 2018). Moreover, on a global level 30 leaders of businesses, NGOs and governments set up an initiative called ‘we mean business’ aiming to halve the amount of food waste by 2030.

On the European level the first research project on the prevention and reduction of food waste was named FUSIONS. With collaborations among 21 project partners divided over 13 member states the project generated strategies and a shared vision to reduce and prevent food losses throughout the entire supply chain with the use of social innovations (Stenmarck, Jensen, Quested, & Moates, 2016a). This research provided a foundation for the REFRESH program, which is a community of expert’s platform. Within this platform best practices, researches and collaborations are displayed all contributing to the prevention or reduction of food waste and losses.

When looking at the nation level of networks, a few organisations influence the development of circular practices. For example, the CARVE project was formed through a collaboration between Alliantie Verduurzaming Voeding and the Wageningen Food & Biobased Research. This collaboration

between research institutes and large incumbent firms in the retail and food processing industry is realised on the meso-level, these parties form the status quo. Similarly, the Transitie Coalitie Voedsel is a national coalition of frontrunners within the Netherlands that support the transition of the food system towards a more sustainable state, through awareness creation, knowledge and strategy sharing, supporting collaborations and lobbying.

Followed by a sectoral network level considering the network of circular stakeholders within the food production and hospitality sector. Around 60 partners have joined the platform Samen tegen voedselverspilling in which these parties join forces to collectively give insights in the amount of food that is being wasted in the Netherlands, enable legislation for circular practices, support collaborations among actors in the sector and create user awareness amongst consumers through social innovations.

Furthermore, when focussing on the business level of networks, the collaboration platform of 18 CSUs named Verspilling is Verukkelijk has great influence in the sector. Within this platform circular entrepreneurs combine their forces through collaborative marketing and coordinating collective efforts to support the circular transition within the food sector. Another business level network in the form of a circular innovation hub is the Blue City in Rotterdam. Within this circular hub various circular entrepreneurs are developing viable circular businesses, this combination of circular entrepreneurs within various sector results in collaborations and synergies which showcase circular best practices that support the transition towards the circular economy within the Netherlands. On a local level amongst farmers and food producers there is a party functioning as a broker named Milgro and Agrifirm trying to connect various parties with biological residual and waste streams with demanding parties of these streams. The individual level of networks will be elaborated within the following section.

¢ At level of individual contacts

The importance for collaboration amongst actors to realise circular practices is stressed multiple times in the previous sections. Therefore, the individual level of contacts within the circular food production system is explained in this section. For the analysis of the individual level of contact a partnership analysis has been made with the data collected during the interviews and the partnerships found on websites and platforms. This analysis includes in total 314 organisations, CSUs, network actors, research actors, educational institutes, industry (being SMEs and incumbents), financial actors, the demanding parties and political actors referred to as nodes (see Appendix G). The size of the node shows how many connections the actor has with other actors. The interconnectedness within the network is very high, observing the density of actors and the high amount of connections between the various elements. This visualisation of these partnerships can be useful to identify possible interesting collaboration opportunities for the strategic collective system building activities.

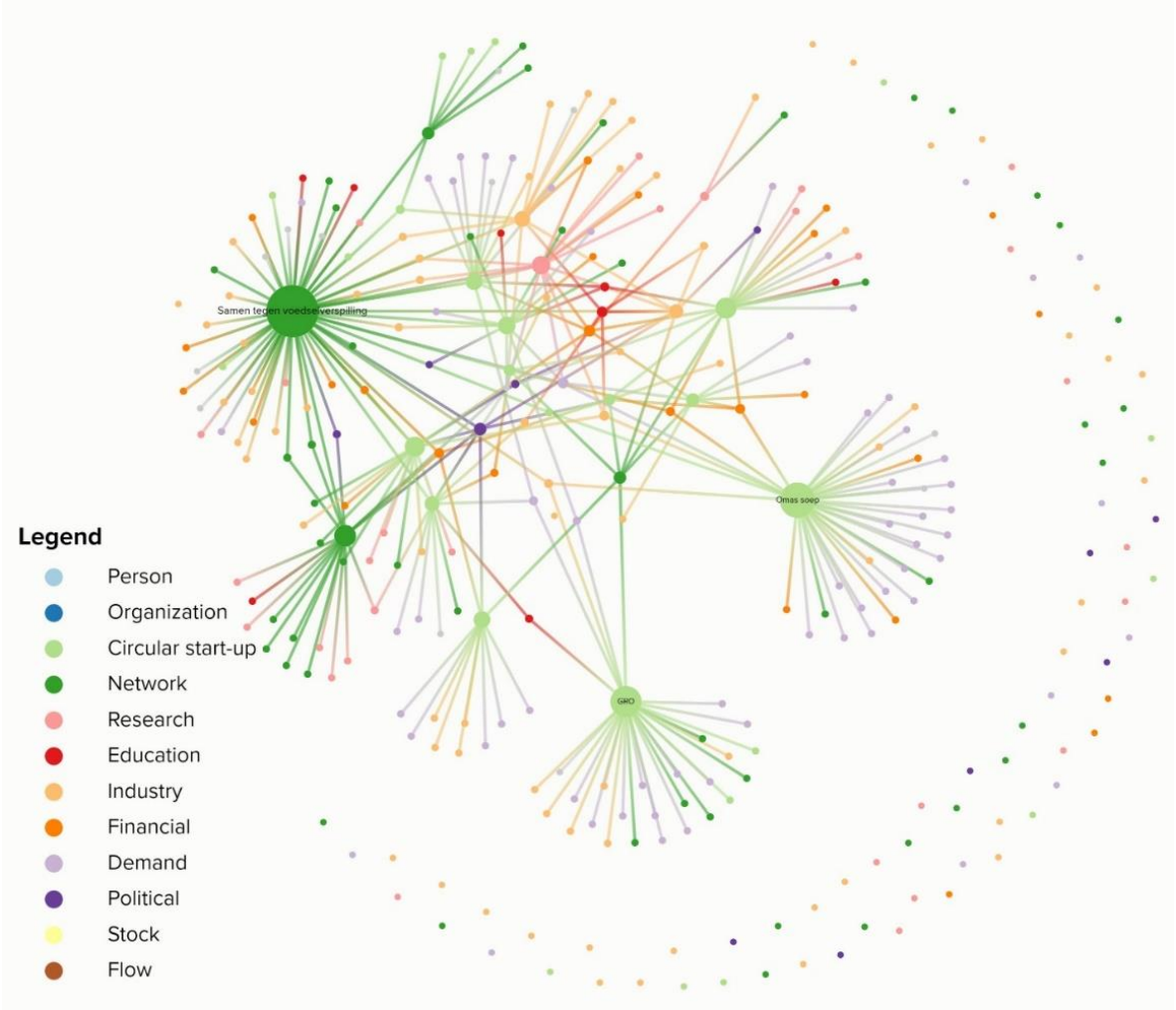


Figure 12 Network overview CSUs and actors in food production system, for an interactive version of this network analysis click on the figure or use: https://embed.kumu.io/127373abe4af5756ee888b31a6ff26fc

Overall the various collaborative networks within the circular food sector e.g. Verspilling is Verukkelijk, Samen tegen Voedselverspilling and Blue City indicate that the collaboration amongst these CSUs and actors is present. Furthermore, it is noticeable that the network actors are connected to the CSUs and are also linked to the political actors. Whereas the research actors are mainly connected with the industry and network actors. And the education institutes are only connected to the industry, to translate the research to a practical implementation level. The link between the CSUs and research and education is missing. The financial actors are mostly connected to the CSUs and the research actors, this indicates that there is financial incentive to develop circularity within the food production system. However, according to the interviewee (CSU6) this financial input is often directed to the larger research programmes and institutes.

Moreover, at the individual contact level among CSU entrepreneurs in the food sector many state that it is based on 'saving yourself first' principles (CSU2, CSU6, CSU5, CSU8). Since establishing a viable circular business is accompanied with many barriers and challenges and start-ups have limited time and resources available. One interviewee explained the importance of mutual benefits within these individual connections stating ''I often notice that it is only taking, there are limits to it''(CSU6).

Infrastructure:

¢ *Physical: buildings, machines, instruments, roads, harbours*

The infrastructure within the Netherlands is well developed, due to the export model forming the Dutch market. Starting with the position of the Netherlands with a large European hinterland, combined with highly developed infrastructural systems and large main ports as harbours and airports. These large-scale infrastructures are in the hands of incumbent firms, being the purchasing offices and supermarket organisations, which dominate the food supply chain in the Netherlands (PBL, 2012). This

highly developed infrastructure is focussed on large scale practises, which forms challenges for the specific processing of residual and waste streams within the food processing facilities as mentioned by various CSUs (CSU1, CSU2, CSU3, CSU12, CE8). As explained by interviewee CSU1 ‘’Being a small player with a mission driven activity, you want to work in a market segment which is dominated by very big powerful players that have all the resources and can work in an efficient way and dominate the market, that is another barrier we encounter’’.

¢ Knowledge infrastructure

The so called ''Golden Triangle'' forms the basis of knowledge development, by creating synergy between research, business and education the most fruitful generation of knowledge, know-how expertise and strategic information can be gained (Prepelita-Raileanu, 2010; Wright, 2014). This generation of knowledge and expertise support the competitive advantage of a nation. Therefore, many trajectories are created to try and gain this knowledge. Within this segment various programs, projects and platforms working on the knowledge development for circular practices in the food production system are discussed.

On a global level project Draw down brings advice to sectors on how to improve their sustainability directly to reduce the carbon footprint build-up within the next 30 years. This research project states that the prevention of food waste and losses is the third most impactful solutions to reverse the carbon footprint globally. This compiled work of research on sustainable solutions state that ‘’There are numerous and varied ways to address key waste points. In lower-income countries, improving infrastructure for storage, processing, and transportation is essential. In higher-income regions, major interventions are needed at the retail and consumer levels. National food-waste targets and policies can encourage widespread change. Beyond addressing emissions, these efforts can also help to meet future food demand’’. (Drawdown, 2017, webpage).

On the European level knowledge is developed and gained through research project. The research program focussing on the prevention and reduction of food waste started with the Fusion project. This research program brought together Universities, consumer organisations, knowledge institutes and business to establish a platform that generates social innovations to reduce food loss and waste within supply chains. This research established a framework to identify drivers and the definition of food waste, a method to gather reliable food waste data, an analysis of regulations and policies related to food waste and ways of social innovations to reduce food waste (“The Netherlands | REFRESH,” 2019). This research program found the basis of the REFRESH program, which is a community of experts that collaboratively try to tackle food loss and waste within Europe through the sharing of best practices, knowledge and innovations. Additionally, to develop and apply knowledge and expertise to prevent food loss and waste on the industry level the Wageningen Food & Biobased Research together with Alliantie Verduurzaming Voeding initiated the CARVE project. Through collaborations with large food processing and retail companies various research pilots are being set up to prevent or reduce the food loss and waste. However, the effects of these collaborations are noticed among CSUs, as the interviewee CSU6 states ‘’lot of the research subsidies goes to the larger firms or research institutes, start-ups have no chance in getting access to these funds’’.

When focussing on the production part of the food production system the EIP-AGRI research network conduct research and creates a network to ‘’foster competitive and sustainable farming and forestry that 'achieves more and better from less'. It contributes to ensuring a steady supply of food, feed and biomaterials, developing its work in harmony with the essential natural resources on which farming depends’’. (EIP-AGRI, 2019, webpage). In 2015 the European commission introduced the circular economy package, this initiated EIP-AGRI to conduct research for determining the drivers and

opportunities of the CE in the agriculture and forestry sector. The research by EIP-AGRI was followed by a yearly factsheet of for the circular bio economy, listing best circular practices and projects. Resulting in a catalogue of best practices organisations and projects in 2019, to inspire other businesses and start incorporating the strategies and innovations by these examples (Kopmels, 2018). In this way the sharing of knowledge, expertise and know-how is facilitated by the EIP-AGRI research program towards the realisation of a circular food production system.

Moreover, relevant thematic networks within the Horizon 2020 program contributing to the development of sustainable knowledge and innovations for entrepreneurship and food are Climate KIC and EIT food. Furthermore, regional knowledge networks formed within the Netherlands. In which specific knowledge and innovations are gained through collaborations between Universities, business and top sector businesses e.g. Foodvalley, Future Food Network, Wageningen University & Research and Utrecht Science Park. Sometimes these institutes organise certain Hackatons, where challenges are solved within a competition through an open innovation approach. The team with the best solutions wins the competition, through this approach the combination of strategic knowledge and expertise is generated with low research costs. An example is the Foodwaste Hackaton organised by Syneratio and Food waste experts, in finding a quick solutions to prevent food waste and losses for challenges of incumbents in the food sector (Growcampus, 2019). Another example is the Food Waste Challenge initiated by Rabobank, Samen tegen Voedselverspilling, Horecava, Hoge Hotelschool the Hague and Samen tegen voedselverspilling. Within this challenge 300 restaurants are being monitored with the help of Wastewatcher and the Hoge Hotelschool the Hague to provide consultancy for these organisations to prevent food waste and losses within their business practices.

Moreover, from an educational perspective various Universities of Applied Science support the synergy within the golden triangle. The Universities of Applied sciences that are contributing to the development of knowledge and expertise for the food sector are mainly; HAS University of Applied Sciences, van Hall Larenstein, Flevocampus, Groene Campus and Hoge Hotelschool the Hague. This is often realised by initiating projects in collaborations with companies in the food production system. However, these projects are initiated to a certain extent, many interviewees agree that there should be a higher focus on circularity and sustainability within the educational institutes (CSU5, CSU2, CSU1, CSU10, CSU11, CE2, CE5, CE3).

The know-how and strategic information infrastructures are incorporated within the CSUs and consultancy bureaus. However, the experiences of CSUs are not widely nor in a structured way diffused by the various start-ups. Therefore, the Samen tegen voedselverspillings foundation facilitates the collaboration between experienced parties, in order to share strategic information and work coherently towards collaborative solutions for circular strategies within the food production system. This can be seen as an evolving knowledge infrastructure. Finally, few consultancy firms within the Agri- and food sector are attributing their knowledge to support circular practices in consolidating their strategic decisions and management models, some examples are Greendish, Milgro and Fair Treep.

¢ *Financial infrastructure*

This section discusses the various financial structures that influence the development of CSUs in the Netherlands. There are a few types of financial supporting streams for CSUs e.g. subsidies, venture capital, grants, foundations or accelerator programs.

Starting with European subsidy streams of the Horizon 2020 program, which aims to support knowledge and innovation development to secure Europe's global competitiveness. This programs budget of almost EUR 80 billion will be utilised to coupling innovation and research in order to create a single market for knowledge, innovation and research (European commission, 2019). Within this

program two innovation programs are funded by the H2020 program and are relevant for the development of a circular economy. Starting with REFRESH program which is a community of experts that is funded through the H2020 program.

Followed by the European Institute for Innovation and Technology that aims to create collaboration between companies, educational institutes and research. These knowledge and innovation communities are named KICs. The Climate KIC community focusses on challenges within climate change (RVO, IenW, EU wijzer, & NKWK, 2018). Within this, the EIT Food community follows a method with the vision to ''put Europe at the centre of a global revolution in food innovation and production, and its value in society. EIT Food will engage consumers in the change process, improve nutrition and make the food system more resource-efficient, secure, transparent and trusted'' (EIT institute, 2019, p.1). In this way, the creation of innovation and knowledge sharing within the food sector can be funded by these projects, which makes these communities interesting financial supporting parties.

Furthermore, on a national level the foundation Samen tegen voedselverspilling is funded by Ministery of LNV, Wageningen University & Research, Provincie Noord-Brabant, Foodtech Brainport, Rabobank and Meijerstad. This foundation invests resources and money to collectively give insights in the amount of food that is being wasted in the Netherlands, enable legislation for circular practices, support collaborations among actors in the sector and create user awareness amongst consumers through social innovations.

For the agricultural part of the food production system referring to the agricultural and forestry practices the subsidies are allocated by the European parliament through the Common Agricultural Policy (CAP), which aims to maintain food security and supporting farmers in Europe. The total budget consists of EUR 408.31 billion, which is divided amongst two pillars for national or regional rural development programmes. The first pillar is meant for market measures and direct payments with EUR 308.73 billion. The second pillar is for rural development and contains a budget of EUR 99.58 billion (European Commission, 2016). Respectively, the rural development budget of pilot 2 in the Netherlands is used to support the export model of the agricultural system (named POP3), by investing in efficiency increase and agricultural innovation developments. Remarkably only the Netherlands, Ireland and Denmark use this budget to fund innovation within the agricultural sector to increase the production and suppress the negative effects of the export model. Whereas, Sweden and Austria use these budgets to support the development of local food systems, by investing in the local distribution infrastructure and creation of local food apps (van der Schans, 2018). However, for circular business model innovations by agricultural actors there is no specific budget.

Besides governmental institutions that allocate subsidies for the development of circular practices in the food sector, there are private organisations that allocate money within the food production system. Starting with some accelerator programs that invest in companies with capabilities to support sustainable transitions and create competitiveness within certain regions. Some examples are; the Brabantse Ontwikkelings Maatschappij (BOM), REWIN West-Brabant, Oost NV, I-fund and Innovation Quarter, these organisations are driven by top sector companies. Another accelerator program is initiated by Impact Hub Amsterdam and is funded by Stichting DOEN, which supports initiatives that have positive environmental, social or cultural impact. This foundation is funded by three large lotteries in the Netherlands; the Nationale Postcode Lotterij, the Vrienden Lotterij and the Bankgiro Lotterij. Another foundation focussing on socially responsible investments is fonds 1818, this foundation invests in initiatives and companies in the Province of North-Holland.

Lastly, Banks within the Netherland with a focus on sustainability are for example Triodos and ASN Bank. However, for the Agri- and food sector the Rabobank is the most influential financial supporting

bank, due to their origin in the agricultural sector their greatest interests and investments lie within this sector. However, according to many interviews with CSUs the retrieval of a bank loan is difficult, bankers argue the targeting of a smaller market segment with unproven novel business models result in a high-risk investment. Within the interviews the barrier of financial access is mentioned multiple times. The collective effort of requesting a subsidy or loan could increase the likeliness of retrieving financial access.

Summary structural innovation system analysis

Within the entrepreneurial infrastructure some financial barriers were mentioned by the interviewees. First managing a viable business model with the accompanied challenges of CBM innovations and strategies costs more resources and time. Often it is seen that theses CSUs are developing new innovative circular business model and when this business model is viable and scalable the company will be taken over or the practices will be copied by large incumbents, this merging is called spin-inn. According to CSU1, CSU6, CSU7 and CSU8 when this spin-inn occurs the values of the start-up are being diminished and often for CSUs the concept is purely used as a marketing tool to promote sustainability. This power of the current-regime to maintain the status quo upholds the faster diffusion of circular practices within the food production system.

The findings of the structural analysis showed the various structural elements forming the innovation system of CBM innovations by CSUs in the Netherlands. The various structural elements of actors, institutions, networks and infrastructures were assessed based on their presence and capabilities or qualities and presented in an overview (see table 5). This overview provides insights in the structural problems that obstruct the development or diffusion of circular business model innovations within the food production system of the Netherlands. The functional problems will be assessed based on the strategic collective system building activities conducted by CSUs in the Netherlands. The combination of insights on the structural and functional problems for CSUs will result in comprehensive and holistic recommendations for CSUs to create a supportive external environment for circular business practices within the food production system.

Table 5 Structural analysis of the CSU innovation system, based on Hekkert et al. (2011)

Structural dimensions	Subcategories		Presence	Capabilities and quality
Actors:	Demand		Low	Lack of knowledge and availability in offers
	Circular food start-ups		Medium	Lack of resources and coordination
	Industry: SMEs, Incumbents, Multinationals	Suppliers	Low	Lack of pressure from demanding parties, lack of knowledge and guidance
		Assemblers	Low	Lack of transparancy and pressure
	Knowledge institutes	Research	High	Ability to support enabling of supportive policies, sharing of knowledge and expertise
		Education	Low	Lack of education requirements and demand of industry for Applied research
	Network		Medium	Ability to create mutual benefits by collective strategic activities
	Financial		Medium	Ability to support circular businesses developments and projects
	Political/ government		High	Ability to enable legislation, coordination and creating a shared vision
Institutions:	Hard: rules, laws, regulations, instructions		High	Ability to ensure food safety and quality, with unforseen effects on increasing the amount of food being wasted
	Soft: customs, common habits, routines, established practices, traditions, ways of		High	Dissonance in statements and acts, lack of awareness, capabilities and knowledge on how to implement circularity
Interactions:	At level of networks		Medium	Ability to create synergies and coordinate collective efforts to generate mutual beneftis, lacking the inter-network collaborations to use the full potential
	At level of individual contacts		Medium	Ability to generate mutual benefits, lacking the resources, time and trust to make use of the full potential due to clustered group formations
Infrastructure:	Physical: artefacts, instruments, machines, roads, buildings, networks, bridges,		High	Focused on conventional production systems, not suitable for small scale, diverse and tailored circular strategies and innovations
	Knowledge: knowledge, expertise, know-how, strategic information		High	Ability to share knowledge, best practices and expertise. And the ability to enable policies through research and advice. Need for practical implementation within the Industry with the use of consultancy and Applied Sciences programs and projects.
	Financial: subsidies, fin programs, grants etc.		High	Ability to fund circular businesses and projects. But funding often is assigned to large players in the research field, ousting the opportunity for CSUs to development of circular practices

The presence and capabilities of the various actors within the innovation system of CSUs in the Netherlands is divided in various actor types. First the demanding actors for circular food products and services is low, the consumers are represented within the sustainable consumer segment, which are according to the Motivaction model 35% of the Dutch population. The other demanding parties include hospitality and retail businesses, only a few frontrunners have been mentioned within this segment by the interviewees. The support of these parties is growing through the Samen tegen Voedselverspilling foundation but is still in the development phase. This is like the industry actors referring to the suppliers of circular products and assembler which are mainly food distribution centres. The lack of awareness amongst these actors on circular practices and the low availability of circular products and services prevent the implementation and use of circular business models that create products and services. The whole ecosystem of circular actors within the food production system is growing, and the number of CSUs according to interviewee WUR *''Is about 50 start-ups, of them I call ten serious, there is a whole range of SME companies and scale-ups as well''.*

The knowledge institutes are highly present within the innovation system, being larger research institutes linked to optimisation research for the food production and processing industries. These research actors can enable changes in policies through research and to support the development and exchange of knowledge within the innovation system. Whereas, the education actors within the system are lacking according to the interviewees, relevant educational institutes are Universities of Applied Sciences for agriculture or hospitality. However, the offer of courses and the realisation of project related to the circular economy are lacking within these educational portfolios (CSU1, CSU2, CSU9, CE3, CE5). The network actors are represented on a medium level, there are many types of networks within the Netherlands supporting the transition towards a sustainable food production system, with specific networks focussing on circular transitions. These networks support the creation of mutual benefits by implementing strategies collaboratively with members within the network. As for the financial actors these are represented on a medium level. These actors can support the development and realisation of circular projects or businesses.

The political actors are highly represented, the European Commission, the Dutch government and specifically the Ministries of EZ, LNV and IenM are enabling policies and supporting programs and taskforces towards the transition for a circular food production system. These actors can create a shared vision and support circular projects and programs in the Netherlands. Overall for the transition towards a circular food production system some actors are missing according CE5 *''we need much more companies and I think a crucial element is missing, which are the farmers and the branch organisation.''*

The next structural element includes institutions, both hard and soft institutions. The hard institutions being laws and regulations, or protocols are highly present within the food production system. However, these hard institutions ensure food safety and quality, with negative effects on increasing the amount of food being wasted caused by too strict regulations and protocols. Followed by the soft institutions which are highly present due to the high linkage between food and traditions, cultures and consumer habits. However, when focussing on sustainable or circular food consumption the behaviour and mindset of consumers is contradictory. People agree on the fact that food waste should be prevented, but actual implementation of change towards sustainable consumption and reducing food waste is lacking. The motivation, ability and opportunity are often aspects that prevent the reduction of food waste within households. Additionally, the customers perspective on circular food products is also dissonant since they expect circular food products to be cheaper because the resources, they use are cheaper or for free. However, due to the extra costs and efforts accompanied with the production of these products the cost price is higher and the products can therefore not be cheaper than conventional products. The implementation of true cost pricing, which would include the negative externalities within the price of the products could change this consumer perspective. Nevertheless, the developments of this true cost pricing methodology are just in the pre-development phase. Another methodology to create change in these soft institutions is seen within the SFSC institutions,

by forming a critical basis for trustful relationships through the re-connection between the consumer and the producer.

These relationships are also created within networks, which is the following structural element within the analysis. To summarize, the formations of networks is realised within the micro, meso and macro-levels of the food production system. The presence of networks is medium, there is some interlinkage between networks e.g. Samen tegen voedselverspilling is collaborating with some actors of the Verspilling is Verukkelijk network. However, these networks are clustered and are not yet collaborating with each other to their full potential. The lack of commitment, shared strategies and vision towards a circular food production system is lacking. The individual level of contact between actors is present, but the effective collaboration and coordination of these collaborative efforts is missing due to the often-voluntary origin of these efforts and limited time and resources CSUs and other actors have.

Lastly the physical-, knowledge- and financial infrastructures within the food production system are analysed. The physical infrastructure within the Dutch food production system is present and very efficient and advanced. However, these physical infrastructures are adapted to large scale and conventional food production processes and transportation. The circular business model innovations and strategies are not suited for these conventional and large-scale physical infrastructures. These tailored and specialised production and transportation processing infrastructures are lacking within the current food production system. Followed by the knowledge infrastructure is forming, there are many structures on many levels. However, these various infrastructures could improve their interaction and sharing of knowledge. These collaborations support the diffusion of knowledge, expertise and know-how. Specifically, the educational knowledge infrastructure is lacking according to the interviewees and needs to be activated and participating through circular programs, projects and courses. To conclude, the financial infrastructure within the food production system is present on many levels. However, most of the financial access is gained and utilised by incumbents active within the current regime. Additionally, the investment in new innovative circular business models is seen as a high risk. The funding and investments for CSUs is therefore low and prevents the development and diffusion of circular business models within the food production system.

Appendix F Overview SCSA rating by CSUs

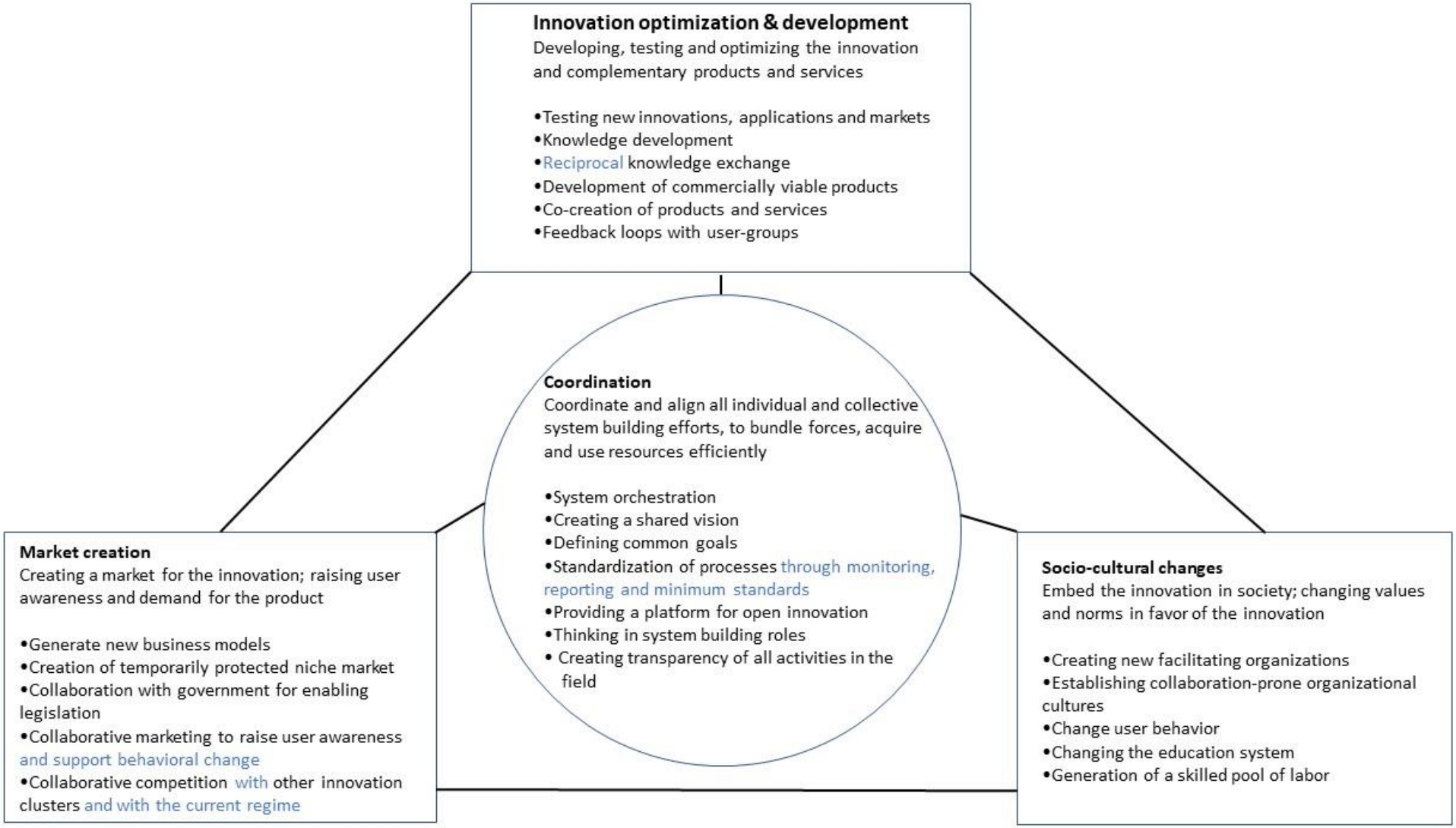
CSU type	platform-based CSU	service-based CSU	waste-based CSU	platform-based	platform-based	service-based	service-based	service-based	service-based	waste-based	waste-based	waste-based	waste-based	waste-based	waste-based
TECHNOLOGY DEVELOPMENT AND OPTIMIZATI	4,4	3,5	3,8												
Testing technologies, applications and markets	5,0	3,0	3,7	5	5	5	5	2	2	4	1	4	4	5	4
Knowledge development	4,0	4,0	4,0	5	3	4	5	4	3	4	2	5	4	5	4
Knowledge exchange	4,3	3,7	4,2	5	4	4	4	3	4	4	3	5	4	4	5
Co-creation of products and services	4,0	3,7	3,7	5	4	3	3	4	4	4	2	4	4	4	4
Development of commercial viable product	4,7	3,0	3,8	5	5	4	5	2	2	4	5	5	4	1	4
Feedback loops with consumers	4,3	3,7	3,3	5	3	5	5	2	4	4	3	4	4	2	3
MARKET CREATION CLUSTER AVERAGE	2,9	3,1	3,4												
Generate new business models	2,3	2,3	3,3	3	1	3	3	2	2	4	3	3	2	4	4
Niche market approach	3,0	3,0	2,7	3	4	2	5	2	2	3	2	4	2	1	4
Collaboration with government	2,7	3,7	3,3	3	1	4	3	5	3	3	2	4	4	3	4
Collaborative marketing for user awareness	5,0	4,3	4,3	5	5	5	4	4	5	4	5	5	4	4	4
Collaborate with other clusters	1,7	2,3	3,3	1	3	1	3	2	2	3	2	4	4	4	3
SOCIAL-CULTURAL CLUSTER AVERAGE	3,1	2,8	3,7												
Creating new facilitating organisations	3,3	2,0	3,3	3	2	5	1	2	3	3	2	4	2	5	4
Creating organisational cultures open for innovation	4,0	3,3	3,8	4	3	5	5	2	3	4	2	4	4	5	4
Changing user behaviour	4,3	4,0	4,2	5	3	5	5	2	5	3	5	5	5	4	3
Changing education system	2,0	3,0	3,8	1	1	4	1	4	4	4	1	5	4	5	4
Skilled labour forces	2,0	1,7	3,5	1	2	3	1	2	2	3	1	5	4	5	3
COORDINATION CLUSTER AVERAGE	3,7	3,4	3,8												
System orchestration	4,0	3,0	4,0	4	3	5	3	4	2	3	4	5	4	5	3
Creating a shared vision	4,3	3,3	3,8	5	3	5	2	4	4	3	4	4	4	5	3
Defining common goals	4,3	2,7	3,8	5	3	5	2	4	2	3	4	4	4	5	3
Standardisation	3,7	3,0	3,3	4	5	2	4	3	2	3	2	4	4	5	2
Providing a open innovation platform	2,7	4,0	4,0	2	3	3	4	4	4	5	1	5	4	5	4
System building roles	3,7	3,7	3,5	5	2	4	4	3	4	4	1	4	4	5	3
Transparancy of activities for collaboration	3,0	4,0	3,8	4	2	3	4	4	4	5	2	4	3	5	4

Appendix G Innovation system actors

The table presented below include actors that are participating in circular practices within the food sector. The list is divided in the role categories discussed in section 2.3 of this research.

Start-ups		SME, Incumbent, Multinational		Knowledge institutes		Network		Financial	Political/ government
				Research	Education				
Kromkommer	Instock	De verspillingsfabriek	Friesland campina	WUR	UvA	Samen tegen voedselverspilling	Green protein alliance	Agrifood capital	Municipality the Hague
Too good to go	GRO mushrooms	AH	Greenery	REFRESH	Universiteit Maastricht	Verspilling is verukkelijk	Greenport Oostland	Rabobank	Transitie coalitie voedsel
Wastewatchers	Potverdorie	Jumbo	Groenten fruit huis	Hoge Hotelschool the Hauge	University of applied science the Hague	MVO Nederland	GS one	Stichting DOEN	Zaanstad
Wasteless	Glorious Bastards	Unilever	Hanos	Utrecht University	Dutch Cuisine	Horecava	Kneus Amsterdam	ABN AMRO	Ministry of Agriculture, nature and foodsafety
Zero food waste	Bokken Bunker	Hutten catering	Hocras	CARVE	Hoge Hotelschool the Hague	Kitchen republic	LIOF (Limburg entrepeneur network)	Kitchen republic	Ministry of economic affairs
Soupalicious	De lekkere man	Kipster	Holland Casino group	greendish consultancy	Brightlands campus Greenport Venlo	Koninklijke horeca Nederland	LIONS international (volunteer organisation)	startlife	Alliantie verduurzaming voedsel
Krusli	Cheese trade	Lidl	holy foods	HAS	HAS University of Applied Sciences	LTO Nederland	Milieu centraal	ASN Bank (the world price) impacthub amsterdam (incubator/accelarator)	Municipality Amsterdam
No food wasted	Thijstea	Sligro	Iglo	Voedingscentrum	Unilever food solutions	RVO Nederland	Natuur en Milieu federatie		
Peel pioneers	De tweede jeugd	Apel catering	Instock	Accenture		ZLTO	No waste network	Provincie Brabant	NEN institutes
Twisted	The ketchup project	Macdonalds	Macdonalds	ATC advies		Alliantie verduurzaming voedsel	NRC	Triodos	Ministry of social affairs
Utregs supersap	Yespers New nature	Milgro	lamb weston meijer	BOM Brabantse ontwikkelingsmaatschappij		Blue City Rotterdam	NVRD	MVO Nederland	Rijkswaterstaat
Winnow	Betuwse Krenkelaar	Albron catering	Lekkerland	Deloitte		Centraal bureau levensmiddelenhandel	Pakhuis de Zwijger	BOM	
Rotterzwam	BeeBlue	Bidfood	Maison van den boer	Food tech brainport		circular economy group	Project Draw down	de goede doelen loterij	
Seamore	Coffeebased	Aldi	Moonen packaging	FUSION		Climate KIC	Royal Cosun	fonds 1818	
Treasure cake	Peel pioneers	Arla foods	Nature's Pride	Heyday		Dutch cuisine	SFYN	Fonds Sluyterman van 100 ouderen projecten	
Fungi factory	De tweede jeugd	Ateaternus	Oerlemans packaging	intelligent food		easydish	Start-up Delta	Foodtech Brainport	
Krown	Cococonserven	Blue berry grower	Picnic	McKensy		Flevocampus	the school of life	NOM	
Ozarka	ResQ	boer Hameling Weberdingen	Plus supermarkets	Milgro		FMFB facility managmener food and beverage	Vechtclub Utrecht	Oost NL	
Shared packaging	Thijsthee	Vegetarian butcher	Protix	Neyerode (consumer behavior study)		Foodhub	Veneca	social agri nature foundation	
Burgs food	Toogoodtogo	Carre at Artis	Hero	Nijmegen Uni		Foodservice institute Nederland (FSIN)	Voedingscentrum	Swedish venture capital	
bugzz	Jacob's juice	Darling ingredients	Royal A-ware food group	Rabobank		Foodtech brainport	weecanteen	VSB fonds	
Wasbeans	Brouwbrood	de Graaf Purmerend	Sodexo	Rijkzwaan		futureproof.community		Wageningen	
Too good to goo	Rozenbunker	Deen	Sonneveld Group	TNO				Foodhub	
Toast Ale	Verdraaidgoed	Eco groothandel	Spar University	Top insitutute food & nutrition (TIFN)				Oranje fonds	
Toost	Botanic Bites	Foodsquad	Contronics dry misting	TU Delft				Rockstart	
Basement chefs	Trashure taarten	Four seasons Nieuwkuik porcessor	Marqt	Univerity Eindhoven				start-up residence (incubator)	
		Lamb Weston Meijer	van de Bosch Betuwe	UvA					
		Loye tomato grower	Suez	Wageningen					
		Meation (blue pig)	Vers en veilig						
		Scelta mushrooms	Vroegop						
		Struik soups	Yellowship						
		Verijsen	etland						
		Woerkomp Nieuwegein	Fruit masters						
		Intersnack	Gelder groente en fruit						

Appendix H Refined strategic collective system building framework



Appendix I Coding framework

Categorie	Topic	Definition	keywords	example
Barriers				
	Regulatory barriers			
	Laws and regulations	The use of waste streams is accompanied with many obstacles, referring to the safety protocols, certifications, licences and laws which obstruct the utilisation and reuse of waste streams.	regulations, protocols, certifications, laws, waste streams	'We need to certify all the waste streams, which takes a lot of effort''
	Political barriers	The political system in the Netherlands is focussed on keeping a trading position, the taxes system is preventing the inclusion of true cost pricing. That would make circular solutions economically more viable.	Culture, liberal, taxes system, governmental support	'The Dutch culture is to liberal to push new taxation schemes through and become successful.''
	Organisational barriers			
	Lack of skills and expertise	The lack of skills and expertise by the entrepreneurs when setting up a business from an ideology	social entrepreneurs, ideology, business skills, experience	'The majority is after 2or 3 years broke, they wont survive the valley of death at all. Why? Because they have no idea what they are doing.''
	Lack of Financial access	The subsidy requests are often too large for start-ups to apply for. Besides, the circular business models are often seen as risky investments, due to the lack of proof on succesful CBM.	financial, funding, subsidies, investments	Investing companies who are interested in investing in businesses like this, when you mention that you only need 250,000 euros, they say: "we actually start investing at 1 million or so".
	Operational barriers			
	Large scale infrastructures	The food sector in the Netherlands is designed on the export model, handeling large quantities. Small food CSUs in the food sector have difficulties competing within this large scale oriented market segment.	large scale, infrastructure, economies of scale, high costprice, volumes, dominate market	'That is one of the things we encountered, due to the fact that you are a small player within a market segment, you don't have any economics of scales.''
	Product and process development barriers	Working with waste streams is accompanied with uncertainties and variables, asking for a flexible production process.	production, process, operations, workplace, facilities, products	'To handle waste streams, and turn them into food is quite costly because you have to be very flexible in your production, you need to have some extra operations aswell.''

	Market barriers			
	Lack of consumer awareness	The consumer is not aware of the amount of food being wasted in the food production system. In addition, the consumers don't know of the higher costprice included in the production process of circular products, resulting in less sales due to the higher price.''	consumer + awareness + purchasing choices, food waste amount, lack of knowledge + environemntal impact + circular production costs	'Many people think it is waste, and therefore it should be cheaper.'' and ''People don't see the ecological or economical impacts of wasting, we try to balance that by giving more insights of the ecological foodprint of foodwaste.''
Financial mechanisms				
	Self financed	All phrases mentioning the financing of the business from the own capital of the CSUs founder	started, own capital, invest myself	''I've been working part-time and full-time and I invest myself it is private investments.''
	Foundation support	All phrases mentioning the financing of the business by support of an foundation or subsidy.	sponsored, foundations, subsisdies	''We were sponsored by cooking shop by pans, after half a year he started his own shop on the Amstelveense road. So they helped foundation, which foundations helped us to start.''
Collective system building activities				
Innovation and knowledge development		Developing, testing and optimizing the technology and complementary products and services		
	Co-creation of products and services	Phrases that explain collaboration among actors to develop new circular food products or services that support circular practices in the food sector	co-creation, collaboration, working together,	''This was a way of co-creation, for the production parties this was a great opportunity to achieve advantages of other distirubtion channels or marketing channels. These collaborations are essential to support these start-ups.''
	Development of commercial viable product	Sentences that state the development of circular business cases	business case	''We have developed two business cases, for people with chewing and swallowing problems.''
	Feedback loops with consumers	Phrases including the receiving of feedback from consumers or customers to improve the circular food product or service	feedback, survey, members + community, opinions, user platforms, consumer contact, asking input	''we have a lot of feedback from the clients, such as rural business caterers in the Netherlands''
	knowledge development	Sentences that include statements on the development of knowledge, through research, gaining experience and collaborations with research institutes	research + questions + projects, universities, students, invention, development + knowledge	''We also collaborative with the HAN and the HAS Universities of Applied Sciences. This includes mostly specific research projects, for example consumer research.''

	knowledge exchange	Phrases stating the exchange of knowledge and expertise on circular business model innovations, products or services between circular actors wihtin the food production system	knowledge + exchange, expertise, solutions, help out, sharing+ networks, experience, consultancy	''during our stakeholder meetings you see that knowledge is exchanged and ideas are generated and coalitions are formed to solve the wicked problems.''
	testing new technologies, applications and markets	Sentences that imply the development, applying and testing of circular product or service innovations within the food sector	pilot, living labs, innovations, test+ product + service + application	''The product is now being tested within the metropool area Amsterdam, which includes 33 municipalities.''
Market creation		Creating a market for the technology; raising user awareness and demand for the product		
	Collaboration with government	Phrases which refer to the collaboration with governmental organisations to enable supportive legislations and policies.	government + support, legislations, policies, laws, protocols, rules, taxes	''Changing the rules of the game, taking responsibility and also working with governments how they can change legislation to become more resillent for change''.
	collaborative competition	All sentences that name collaborations with competition within their own cluster to generate mutual benefits.	collaboration + competition +others, coorperation, partnerships	''We don't see each others as competition, there are even producers with the same products. The market segment in the prevention of foodwaste is large enough''.
	NEW: collaborative competition with current regime	All sentences that name collaborations with the current regime to generate mutual benefits.	collaboration + large parties/ firms / companies	''And now you see the collaboration between the start-ups and larger firms start to develop, that is quite recently yet.''
	collaborative marketing	All phrases including the strategies of collaboration within marketing to promote the consumption of circular food products or the use of circular services and platforms within the foodsector	collaboration/ together/ joined + marketing, story telling, customer data, branding, awareness, proposition	''We want to have various food products, you want to have a complete line of products under one brand. If you sell the upsides being more impact and monetary benefits, this might be possible.''
	Generate new business models	All phrases stating the establishment of new circular business models within the food sector	business models, business concepts + exploring, new models, operations	''We are now having three different concepts, we have four flavours. We translated them on an on the go concept. And we have the regular form package and the two kilograms pack. ''
	Niche market approach	The sentences in which the strategy of a niche market approach to transition the current regime is stated.	niche + market, rising demand, growing market, sustainable entrepreneurship, front runners, barriers + incumbents + larger firms, scale-up, main stream, new system	''it is not a niche market anymore it is growing quickly, especially with the global companies partaking in this topic. You see already some start-ups that become scale-ups now. ''

Social-cultural		Embed the new technology in society; changing values and norms in favor of the new technology		
	changing education system	Phrases in which the changing of the education system towards more sustainable and circular inclusiveness is mentioned.	education + system + programs + institutes, students, studies, courses, primary/secondary + schools, workshops,	''We are open to stimulate it within education by cooperating with educational institutions through feasibility studies, educational questions and internships.''
	changing user behaviour	Sentences that include the activities related to creating change within the user or consumer behaviours towards more circular oriented behaviour.	change the society, nudging, sustainable concumption, consumer behaviour/ choices, social change, consumer research,	''The creation of a positive experience on this topic on how individuals can implement some of these ways of changing everyday choices.''
	Creating new facilitating organisations	Sentences that refer to the creation of organisations that facilitate social- cultural changes within society by broadcasting the circular vision.	communication + platform + channel, message, working groups, alliances, coorperations, awareness,	''Many initiatives come from the same angle and have the same motivation to easily copy or lift them. To create the partnerships that is one of the few things we can do from a communication platform.''
	Skilled labour forces	The phrases including the generation of future skilled labour forces which work on the transition towards a circular economy.	next generation, proffesionals, university programs, conferences,	''young professionals that are in the end of their studies or researches of young professionals that starting with their new roles within companies, that is the group that is so valuable for new modern and open thinking.''
	Establishing collaboration- prone organizational cultures	Phrases that refer to the establishment or organizational cultures tailored the facilitation of collaborations between companies.	collaboration + culture + organisation + relationships, partnerships, networks, business environment,	''This entrepreneurial environment is very open and helpful, so very inclusive. ''
Coordination		Coordinate and align all individual and collective system- building efforts, to bundle forces and use resources efficiently		
	creating a shared vision	Sentences that are related to the creation of a shared vision towards a circular economy among actors within the food sector.	vision/ agenda + long term + collective + shared, mission, circular economy, SDG's,	''We all have the same mission, changing the food system . That all focusses on the same vision, each in it's unique way, that has brought us together.''
	defining common goals	All phrases related to the defining of common goals to achieve the shared vision towards a circular economy within the food sector.	goals, steps, milestones, work together, forming alliances, defining needs,	''You need each other to make quick steps, but there must also be a shared way of thinking in those start-ups.''

	Transparency of all activities to support sustainability transition	All sentences related to the creation of transparency of activities within the food sector to support the sustainable transition of the food sector.	transparency, share information, trust, communication, validation, showing, openness,	''One of the reasons why there is lack of awareness and urgency is due to the lack of transparency. There is no good data across the whole foodchain, nobody knows exactly how much foodwaste we have.''
	Providing a open innovation platform	Phrases related to the establishment of an open innovation platform, which facilitates the coordination, and accelaration of knowledge development and service and production optimization.	innovation + platform + program + community, knowledge + development + exchange, sharing expertise + best practices, problem solving.	''Set-up a cluster of companies that have the same problem, and with scrum sessions have co-creation and together with their own expertise solve problems for another company and the following week solve a problem for their company with other companies.''
	Standardisation of activities	All phrases related to the standardisation of circular business processes within the food sector.	monitoring, taxation schemes, procurrement mechanisms, true pricing, true cost accounting,	''Ofcourse monitoring is important, setting targets, innovation focussing on consumers and what we add to this approach is the change the rules of the game related to legislation, barriers or create incentives or look at how common companies can take responsibility and impact combined in economic impact.''
	System building roles	Sentences that mention the thinking in system building roles to achieve the common objectives in building a circular economy in the food sector.	organisation, levels, coorperation, division + roles + actions	''Yes it is a foundation with a board and stakeholder team, ammbasadeurs and a management team that coordinate different actions. So it is a proffesional organisation. ''
	System orchestration	Phrases related to the allignment and management of collective system building efforts.	coordination, coordinating mechanisms, organising + collaboration + organisations + commitment + networks,	''Yes it is very important, that is why we unite against foodwaste we are the coordinating mechanism and in some case we start things, we facilitate, call for action, create coalitions.''

Appendix J Integrated conceptual framework

Structural system actor analysis

System leader – coordination and allignment of collective efforts and resources

Research
Universities, research centres, technology institutes, design labs or consultancy bureaus.

Education
Universities of Applied Sciences, innovation campuses, corporate trainee ships

Supply
Raw material supplier, sub system supplier, machine manufactureers

Assembly
Assembling components, materials and services, information processor

Complementors
Maintenance and service providers, meeting consumer specifications

Demand
Suppliers
B2B
Consumers

Financial support
Banks, venture capital, foundations, semi-public organisations, strategic partners or accelerator programs.

Network support
Branch organizations, associations, network organisations or innovations hubs

Political support
Ministries, governmental institutions, provinces, municipalities and policy & public administration

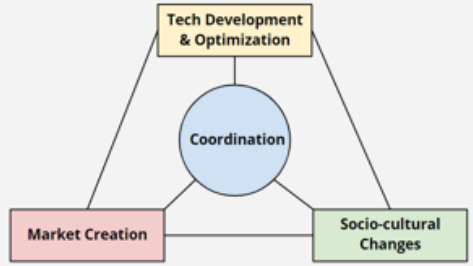
Circular Start-up Archetypes

Henry et al. (2019) defined CSU archetypes based on gathered data of 128 CSUs and the applied framework consisting of CBM innovations and circularity strategies, resulted in the following clusters:

- **"design-based CSUs**, adopting circular innovations mostly in the pre-market phase through source material minimization, product design or production process efficiency,
- **waste-based CSUs**, seeking to extract value from unexploited external waste streams,
- **platform-based CSUs**, pursuing business models built around B2B, B2C or C2C marketplaces,
- **service-based CSUs**, embedding products in service-systems to increase usage efficiency and
- **nature-based CSUs**, increasing the delivery of (products and) services based on nature-based systemic solutions."

Collective System Building

"The strategic activity of networks of entrepreneurs and entrepreneurial managers to build up a supportive environment and infrastructure for their innovative sustainability technology" - Planko, 2018



Collective Benefits

- *Improved product range*
- *Maintaining infrastructure*
- *Reduced competition*
- *Mutual support*
- *Increased negotiating power*
- *Resource sharing*

Strategic Framework for Collective System Building

Coordination
Coordinate and align all individual and collective system-building efforts, to bundle forces and use resources efficiently.

- *System orchestration and thinking in system-building roles*
- *Creating a shared vision and defining a common goal*
- *Standardization of the new technology*
- *Providing a platform for open innovation*
- *Creating transparency of all activities going on in the field*

Market Creation
Creating a market for the technology; raising user awareness and demand for the product.

- *Generate new business models*
- *Creation of temporarily protected niche market*
- *Collaboration with government for enabling legislation*
- *Collaborative marketing to raise user awareness*
- *Collaborative competition against other technology clusters*

Technology Development & Optimization
Developing, testing and optimizing the technology and complementary products and services.

- *Testing new technologies, applications and markets*
- *Knowledge development and exchange*
- *Co-creation of products and services*
- *Development of commercially viable products*
- *Feedback loops with user groups*

Socio-cultural Changes
Embed the new technology in society; changing values and norms in favor of the new technology.

- *Creating new facilitating organizations*
- *Establishing collaboration-prone organizational cultures*
- *Changing user behaviour*
- *Changing the education system*
- *Generating a pool of skilled labour*

Integrated conceptual framework to analyse system actors of CSUs and strategic collective system building activities for the creation of a supportive ecosystem. Based on Hekkert et al., 2011 (system actor analysis); Henry et al., 2019 (CSU archetypes); Planko, 2018; Planko et al., 2015 (strategic collective system building)