Collaboration in a circular economy: Learning from the farmers to reduce food waste

Abstract

Purpose: Given the lacuna in sustainability studies which investigate collaborative supply chain relationships in the context of the Circular Economy, this study explores how farmers manage stakeholder relationship in the supply chain to reduce food waste within the circular economy framework.

Research design/Methodology: A qualitative approach using semi-structured interviews is used to collect primary data for this research. Interviews are conducted with farmers across different farming types in the UK. A thematic analysis is used to discuss the most prominent themes.

Findings: The findings extend previous research investigating collaboration in sustainability settings. Farmers adopt collaborative relationships to manage exchanges of food waste and to share knowledge of waste management practices. However, contrary to extant literature, the study finds that geographic proximity is still relevant in the Circular Economy framework, although its importance is determined by the type of exchange: i.e. physical or non-physical.

Contribution: The study contributes to the sustainability literature by adding new knowledge to the relatively new theory of the Circular Economy. It demonstrates that factors of collaboration identified in previous sustainability research are still relevant in the Circular Economy framework, and thus require further investigation into the significance of collaboration. The study is also of relevance to supply chain managers wishing to adopt the Circular Economy framework in the transition to more sustainable supply chains.

Recommendations: Based on the study's findings, recommendations for further research are proposed. The study also advises on practical considerations for supply chain managers wishing to adopt collaborative relationships to support circular models of supply chains.

Key words: Circular economy, Collaboration, Food waste, Supply chain, Farmer

Introduction

This study aims to understand farmers' current food waste management practices and analyse how they manage their stakeholder relationships in the supply chain from a circular economy perspective. Food waste management is well established in the sustainability literature; however, there has not been an investigation into how collaborating with supply chain stakeholders can support its management in the CE framework, especially from the farmers' perspective. Wasting food is not only economically inefficient, but also environmentally and socially damaging, with rising greenhouse gases (FAO, 2017), depletion of natural resources, such as water and energy (Darlington, 2009), and food insecurity becoming increasing concerns (Jurgilevich *et al.*, 2016; WRAP, 2017). According to WRAP (2017), 7.3 million tonnes of food and drink were wasted in 2015 in UK households, representing a 4.4% increase compared to 2012 figures; avoidable food waste represents 60.2% of that figure. Globally, roughly one-third, or 1.3 billion tonnes, of food is wasted (FAO, 2017).

There is growing consensus that the only way forward with sustainable production and development is to switch from our current industrial "linear" model to a circular economy (CE), offering tools to reduce waste generated in the food chain, including re-use/usage of food by-products and waste, and nutrient recycling to establish an efficient and sustainable food supply chain. However, there is a lack of empirical studies on food waste utilisations across the supply chain, which could be integrated in a productive CE cycle. For instance, farmers do not have information about the opportunity cost of the food waste that goes to landfill instead of being used for energy, compost or animal feed. In this regard, farmers lack information about *how to cost-effectively use, re-use or recycle food waste*. Additionally, farmers need to identify and

engage with other supply chain members to make the best use of their resources. To establish synergistic collaborations where waste and by-products can be exchanged, sold or transferred, it is crucial to determine how stakeholders can work together and develop potential applications for unwanted materials (Cimren et al., 2011).

The limited studies addressing the importance of collaborative relationships in sustainability settings validate the need to gain a greater understanding of how supply chain relationships can assist in the management of food waste within the CE framework. Preston (2012) highlighted that in the transition towards a circular economy, there is a need to collect and share data, produce exemplars, invest in innovation and facilitate business collaborations.

Leising, Quist and Bocken (2018) demonstrated that for successful implementation of the circular economy, there is a need for a variety of disciplines in the supply chain to be integrated upfront, with the co-creation of an ambitious vision, and extension of responsibilities to actors along the entire supply chain. Witjes and Lozano's (2016) study addresses the link between procurement and supply practices in a circular economy framework. Their framework is based on collaboration. Their research shows that collaboration between procurers and suppliers throughout the procurement process can lead to reductions in raw material utilisation and waste generation, whilst promoting a sustainable business model. Niesten *et al.* (2017) showed in their study that collaboration between firms is important to stimulate the transition by creating legitimacy of sustainable technologies, reducing waste and improving the firms' environmental and social performance. This is the key research gap that this project aims to address. Further, many studies concerned with the sustainability of food supply chains focus on demand-side aspects such as sustainable consumption and end-consumer behaviours in terms of food selection, physical flows and waste generation at household level (Harder et al., 2014). This study seeks to address sustainability aspects for the supply side of food chains by mapping food waste scenarios and potential by-product synergies in relation to farming, processing, and retailing.

To fill the aforementioned gap, this study examines how farmers currently manage their waste, and how they engage with supply chain members to support this. The data are collected through semi-structured interviews and thematically analysed to gain in-depth insight into the collaborative relationships formed to tackle food waste. The specific objectives of this research are:

1. To understand farmers' current food waste management practices from a circular economy perspective.
2. To analyse how farmers, manage stakeholder relationship in the supply chain to manage food waste within the circular economy framework.

Literature review

This section examines the body of literature concerned with collaborative relationships in the context of Closed-Loop Supply Chains, collaboration and food waste management. These are used to understand the implications of collaborative supply chain relationships for food waste management in the context of the Circular Economy.

Collaboration and closed-loop supply chains (CLSCs)

Guide and Van Wassenhove (2009) define CLSCs as maximizing value creation throughout the entirety of the supply chain, recovering value from materials over time. With this in mind, scholars have highlighted the importance of not only limiting the damaging impact of food waste on natural resources, but also creating value (Krikke *et al.*, 2013), as well as establishing collaborative relationships to create such value (Sarkis *et al.*, 2011; Bell *et al.*, 2013; Matopoulos *et al.*, 2015). However, focus is given to the impact of collaborative relationships on supply chain performance in terms of the economic value that can be derived from CLSCs (Guide and Van Wassenhove, 2009; Kumar and Banerjee, 2012; Bell *et al.*, 2013), neglecting the integration of sustainability issues (Miemczyk *et al.*, 2016).

With a focus on economic performance rather than loop-closing, Kumar and Banerjee (2012) examined specific activities and their importance to collaboration. The findings of their study are congruent with extant literature, highlighting the need for sharing knowledge (Leeuw and Fransoo, 2009) and mutuality of interests (Abreu *et al.*, 2009) for effective supply chain collaboration. Nonetheless, Kumar and Banerjee's (2012) research methodology presents limitations which could have impacted the results. While the methodology accurately reflects

the study's aim by using a multi-industry sample, investigating a specific industry would have given an in-depth understanding of the framework's applications in a specified context. This is observed in Miemczyk *et al.*'s (2016) study, which closely examined two case studies within similar industries (commercial carpets and composite textiles) to ensure consistency of results, thus generating "rich insights into CLSCs" (Miemczyk *et al.,* 2016, p.457). Hence, further research is warranted into the framework's micro-level applicability in different industries. Moreover, using an online-based survey allowed data to be gathered in various locations (Kumar and Banerjee, 2012); however, the study exclusively investigated industries in India, possibly limiting a truly broad understanding of collaboration. Although results may be generalizable, given the multi-industry sample, country-specific factors such as culture may play a role in the legitimacy of these results. Consequently, the study lacks external validity and further research into industries in different countries is needed to validate the framework. Moreover, despite Kumar and Banerjee's (2012) study introducing the knowledge-sharing component of collaborative relationships, previously lacking from the Industrial Ecology (IE) and Industrial Symbiosis (IS) literature, the focus is on the improved economic performance that can be derived from this. Hence, a sustainability perspective and a framework for this are still lacking.

Supply chain management in the CE framework

The Circular Economy is "an industrial economy that is restorative or regenerative by intention and design" (EMC, 2013, p.07). In attempting to achieve a "closed sphere of human activity" (Boulding, 1966, p.1), three activities have been deemed essential: reducing, reusing, and recycling (Sakai *et al.,* 2011; Su *et al.,* 2013; Jurgilevich *et al.,* 2016; Winans *et al.,* 2017) – the 3Rs. However, some scholars extend these to include repair, remanufacturing, refurbishing, long-lasting design, and maintenance (Geissdoerfer *et al.,* 2017). From these activities, it is clear to see that the general applications of CE have focused on the manufacturing and construction industries (Lieder and Rashid, 2016; Nasir *et al.,* 2016) and its mathematical modelling (George *et al.,* 2015; Genovese *et al.,* 2017). Hassini *et al.*'s (2012) vision of sustainable supply chains incorporates 'reuse' into a recycling function and neglects the reduction of waste altogether. Similarly, Dey *et al.* (2011) incorporate reuse and recycling into an 'end of product lifecycle', as an afterthought rather than as a process to be incorporated throughout all the supply chain stages.

These models place greater emphasis on the recycling of materials than is traditionally observed in the literature (Jurgilevich *et al.,* 2016; Ghisellini, *et al.,* 2016), which sees reuse and recycling as remedial actions to waste generation. As such, the resource-efficiency nature of waste reduction ensures that the greatest economic, environmental and social benefits are achieved (Ghisellini *et al.,* 2016), and thus deserves greater attention from scholars. Nonetheless, the nature of the food industry lends itself to the seamless application of waste reduction strategies. This highlights the importance of investigating specific industries to gain in-depth understanding of the micro-level applicability of sustainability models, consistent with Miemczyk *et al.*'s (2016) investigation of CLSCs within similar industries for data consistency.

CE principles and food supply chain applications

The main CE principles (the 3Rs) have significant applicability to the food industry, appropriately highlighting the waste reduction principle previously overlooked in literature's investigation of other supply chains in the CE context. In the food system, CE principles apply to the reduction in the amount of waste generated, reuse of food through redistribution channels, nutrient recycling, and by-product utilisation (Jurgilevich *et al.,* 2016). In conceptualising a circular food supply chain, Jurgilevich *et al.* (2016) highlight the criticality of implementing the 3Rs at every stage of the supply chain. Laso *et al.* (2016) use a similar model to demonstrate the opportunities for applying CE in the canned anchovy industry. Hence, the model provides opportunities for wider applications to varying food supply chains; however, this is still lacking in the current literature. Moreover, a disconnect is observed between the CE supply chain applications and a desirable hierarchy of activities in food systems. Papargyropoulou *et al.* (2014) and Sert *et al.* (2014) argue that successfully tackling food waste requires a structured approach with specific activities ranked from most to least desirable. The scholars' pyramids show models consistent with the CE hierarchy identified in the literature (Sakai *et al.,* 2011; Su *et al.,* 2013; Jurgilevich *et al.,* 2016). However, Papargyropoulou *et al.* (2014) and Sert *et al.* (2014) fail to link this to the CE framework despite clear similarities between the concepts, causing a disjointed approach in the search for a solution to current inefficiencies. Furthermore, the importance of collaboration, which gained momentum in IS and CLSCs studies, is only

briefly considered in the CE literature by Genovese *et al.* (2017). They argue that the CE concept presents a framework for the creation of shared value through the collaborative engagement of businesses within and beyond their supply chains. Thus, a clear gap is identified in the extant literature, warranting investigation into the importance of collaborative supply chain relationships in the successful application of the CE framework. Overall, the literature fails to investigate how supply chain relationships can assist this transition. The next section incorporates the factors identified in previous literature, using these as the basis for achieving collaborative supply chain relationships in the CE framework.

Table 1 Literature review

Author	**Method**	**Theory**	**Key points**
Abreu *et al.*(2009)	Theoretical exploration	Collaborative networks; Virtual organisation breeding environment	1. Mutual interest alignment. 2. Seeking of shared core values in collaborative networks. 3. Incompatibility of core values generates conflict.
Bansal & McKnight(2009)	Qualitative (interviews with firms in Ontario)	Industrial symbiosis	1. System level waste reduction opportunities. 2. Potential effectiveness of IS requires collaboration among partners. 3. IS: partnerships created from flow of by-products. 4. IS offers opportunity to explore social, economic and environmental value in using waste within a system.
Bell *et al.* (2013)	Conceptual paper	Natural resource scarcity; resource-advantage; closed-loop supply chains	1. Sustainable competitive advantage can be achieved through strategically employing NRS, resource-advantage and CLSCs theories. 2. Economic value for the firm through adoption of these theories.
Boons *et al.* (2011)	Conceptual paper	Industrial symbiosis	1. Keys to IS are collaboration and synergistic possibilities offered by geographic proximity. 2. Promoting culture of collaboration towards environmental challenges. 3. Increase in "connectiveness" is good for IS.
Carter and Rogers (2008)	Conceptual paper	Supply chain management; sustainable supply chain management	1. Conceptualisation of sustainability into supply chain management theory 2. Up to this point, meaning of sustainability in supply chain management has been disjointed, looking at environmental, social and economic factors separately.
Chertow (2000)	Review of literature and concept of eco-industrial parks	Industrial symbiosis	1. Limited IS literature. 2. IS brings traditionally separate industries into a collective network to achieve competitive advantage. 3. Collaboration and geographic proximity are key. 4. Advantages to each party of collaborative exchange need to be well understood.

Chertow and Ehrenfeld (2012)	Theory modelling (discontinuous three-stage model of IS)	Industrial symbiosis	1. Circular economy in context of eco-industrial parks. 2. Collaborative networks in waste management. 3. Need for geographic proximity.
Chertow (2007)	Comparative study	Industrial symbiosis	1. Collaborative supply chain relationships 2. Geographic proximity enables exchange of materials in collaborative relationships
Dey, LaGuardia & Srinivasan (2011)	Theory building	Reverse logistics; social responsibility	1. Reuse and recycle. 2. Measures are added at the end of supply chain rather than throughout.
Ehrenfeld and Gertler (1997)	Case study	Industrial ecology	1. Geographically bound industrial systems in industrial ecology setting. 2. Two or more firms needed to produce constant stream of by-products for effective loop-closing (physical exchanges).
Geissdoerfer *et al.* (2017)	Literature review	Sustainability; circular economy	1. Focus on reuse/recycle of materials through repair, remanufacturing, refurbishing, etc. 2. Increasing popularity in CE research, although still small numbers compared to general sustainability research.
Genovese *et al.* (2017)	Mathematical modelling	Circular economy; environmental assessment models; product lifecycle; environmental input-output; hybrid LCA	1. Increasing interest in CE developments. 2. Mathematical modelling of CE applications. 3. Engagement of suppliers through closer supply chain collaborations.
George *et al.* (2015)	Mathematical modelling	Circular economy; Environmental Kuznets Curve	1. Equations for social, waste, pollution and optimal growth rates in CE. 2. Economic waste as a useful economic resource.
Geyer and Jackson (2004)	Theoretical exploration and modelling of supply loops	Loop closing; industrial ecology	1. Reuse and recycle. 2. Highlights three issues with loop-closing model: limited access to end-of-life products, limited demand for remanufactured products and limited feasibility of reprocessing end-of-life products.
Ghisellini *et al.* (2016)	Meta-analysis	Circular economy	1. Overview of CE roots, models and implementation at three levels. 2. CE and food supply chain (briefly). 3. Linear vs. circular economic models. 4. Design, reduction, reuse, recycle.
Guide & Van Wassenhove (2009)	Theoretical exploration	CLSCs	1. Definition of CLSCs. 2. Business emphasis; focus on profitable value recovery from returned products.

Gupta, Abidi and Bandyopadhaya (2013)	Theoretical exploration	Innovation in supply chains; green SCM; SSCM	1. Green and sustainable supply chain management. 2. Key difference is utilizing human capital: therefore, social aspect should be included. 3. SSCM considers economic, social and environmental factors. 4. Triple bottom line.
Hassini, Surti and Searcy (2012)	Case study	Sustainable supply chain management (SSCM)	1. Sustainable supply chain functions (reuse, recycle, return - neglects "reduce"). 2. Their defined 3Rs are an 'end of product life' remedial action. 3. Triple Bottom Line focus of metrics. **4. Recommendation:** industry-specific research should be given more attention.
Jacobsen (2006)	Case study	Industrial symbiosis	1. Reuse and recycle (neglects "reduce"). 2. IS as a sub-discipline of IE. 3. IS focuses on resource optimization.
Korhonen and Snakin (2005)	Case study (Uimaharju industrial park)	Industrial ecology; industrial symbiosis	1. Recycling and cascading. 2. Increasing diversity in actors within industrial ecosystem contributes to increasing "roundput flows". 3. Increased diversity leads to increased cooperation. 4. Argue that diversity should be kept to a minimum to avoid divergence of interests.
Krikke *et al.* (2013)	Mixed; interviews and questionnaires (uses only questionnaires in analysis)	CLSCs; reverse and forward logistics	1. There is value in "returns". 2. "Returns" can be a value rather than a cost for the business. 3. Integrating forward and reverse logistics can create more value in CLSCs. 4. Used multiple industries and regions.
Kumar and Banerjee (2012)	Questionnaires	Supply chain management; collaboration	1. Conceptual framework development (knowledge-sharing). 2. Multi-industry. 3. Focus on India. 4. Focus on improved economic performance derived from collaboration.
Laso *et al.* (2016)	Case study	Circular economy; LCA framework	1. Food waste management within circular economy (canned anchovy industry - niche). 2. Applies CE model in food context.
Leigh and Li (2015)	Case study	Industrial ecology; industrial symbiosis	1. Collaboration between supply chain members to form better relationships. 2. Collaboration towards reducing overall negative impact of firms on the environment. 3. Opportunities for organisations to apply IS are no longer limited in geographical proximity. 4. Sustainable approaches should be applied at different stages of supply chain.

Lombardi and Laybourn (2012)	Theoretical exploration	Industrial symbiosis	1. Geographic proximity neither "necessary nor sufficient". 2. Collaborative networks.
Matopoulos *et al.* (2015)	Conceptual paper	Natural resource-based view; SSCM; closed-loop supply chains	1. Value chains. 2. Collaboration for higher economic performance.
Miemczyk *et al.* (2012)	Case study	Closed-loop supply chains; natural resource-based view	1. Sustainability in supply chains. 2. Uses two case studies of companies within two similar industries for consistency of results and to generate rich data. 3. CLSCs still need further empirical testing.
Leeuw and Fransoo (2009)	Theoretical exploration	Closed-loop supply chains; collaboration	1. Collaboration brings advantages to members in CLSCs. 2. Information-sharing element of close collaboration.
Mirata and Emtairah (2005)	Case study	Industrial ecology; industrial symbiosis	1. Forming IS networks. 2. IS networks help in "fostering environmental innovation."
Pagell and Wu (2009)	Case study	Sustainable supply chain management	1. Sustainability in supply chains. 2. Ten case studies in different industries (findings could be richer if industry-specific).
Papargyropoulou *et al.* (2014)	Qualitative (interviews)	Sustainable production and consumption	1. Presents a food waste management hierarchy consistent with CE. framework but does not link to CE 2. Reduction should come first. 3. Food waste and food surplus distinction. 4. Avoidable and unavoidable food waste.
Posch (2010)	Quantitative (surveys)	Industrial ecology; industrial symbiosis; sustainability	1. Sustainability-oriented collaboration emerges from intention/goal to be sustainable. 2. Distinction between cooperation and sustainability-oriented cooperation in industrial symbiosis networks.
Sakai *et al.* (2011)	Qualitative (workshops)	Circular economy	1. CE trends in various countries. 2. Gives hierarchy to 3Rs (reduce, reuse, recycle, in that order).
Sarkis *et al.* (2011)	Theoretical exploration	Complexity theory; green supply chains; sustainability	1. Talks about closing loops but does not use CLSCs theory. 2. Economic values associated with greening of supply chains. 3. Stakeholder theory in sustainability settings. 4. Supply chain relationships in supporting economic value.
Sert *et al.* (2014)	Theoretical exploration	Surplus food management; sustainability	1. Surplus food management hierarchy. 2. Hierarchy consistent with CE framework (does not explicitly consider this).

Seuring (2004)	Theoretical exploration	Industrial ecology; life cycle assessment; integrated chain management; environmental supply chain management	1. Focus on geographic boundaries of industrial ecosystems is unique to IE. 2. Geographic proximity is essential to IE.
Su *et al.* (2013)	Case study	Circular economy	1. Does not explicitly propose a hierarchy for CE principles. 2. Focus of pilot cities is on reducing waste (implicit hierarchy).
Winans *et al.* (2017)	Literature review	Circular economy	1. 3Rs and 6Rs principles of CE. 2. 'Recycling' is given a lot of attention. 3. Covers applications in various industries - briefly touches food industry. 4. Discusses EIPs.
Yu *et al.* (2013)	Theoretical exploration (bibliometric analysis)	Industrial ecology; industrial symbiosis	1. Geographic proximity not so strongly emphasised in IS although still present. 2. Improved environmental performance through collaboration networks. 3. Competitive advantage of IS.
Yuan and Shi (2009)	Case study	Industrial ecology; industrial symbiosis	1. Closed-loop material systems can improve competitive advantage of industrial systems by reducing costs and improving environmental performance 2. Briefly mentions collaboration of case study firm with professional institute

Conceptual framework and theoretical underpinnings

Theoretical underpinnings

Industrial Ecology (IE) theory propagated the impact of geographic proximity on the ability to form industrial ecosystems (Ehrenfeld and Gertler, 1997; Seuring, 2004); however, it neglected the importance of collaborative relationships in establishing industrial ecosystems. Subsequently, Industrial Symbiosis (IS) extended IE by incorporating the collaborative dimension to industrial symbiosis networks (Boons *et al.*, 2011; Leigh and Li, 2015); however, it did not address the factors necessary for the establishment of collaborative supply chain relationships. Consequently, CLSCs addressed the importance of knowledge-sharing (Leeuw and Fransoo, 2009; Kumar and Banerjee, 2012) as a factor for establishing collaborative relationships; nonetheless, it focused on improving economic performance, failing to address the sustainability aspect of collaborative supply chain relationships. Finally, CE complements previous models by providing a framework for sustainable economic development and briefly considering the need to derive shared value from collaborative engagements (Genovese *et al.*, 2017). However, collaboration, which previously received empirical attention, fails to be given adequate consideration in the CE literature. Hence, the conceptual framework incorporates elements of the progressive development of sustainability models to address this gap. The framework extracts the three key constructs of collaborative relationships identified throughout the literature and applies these as the basis for working collaboratively within the CE framework.

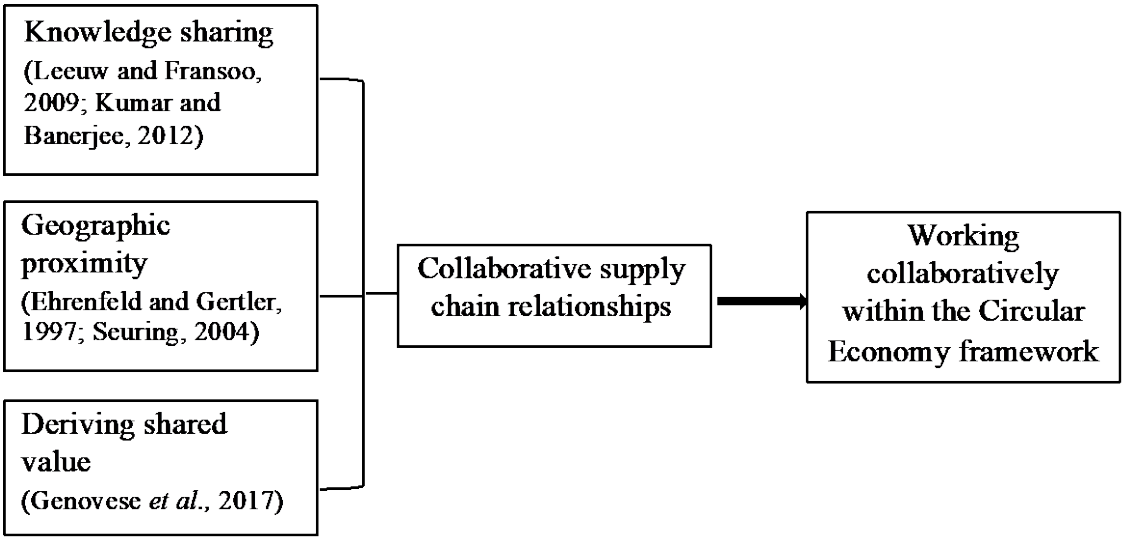

Figure 1 Conceptual Framework

Methodology

This section illustrates the adopted research strategy, data collection process, and limitations of the present study. The research philosophy adopted takes an interpretivist, axiological approach. Interpretivism describes research where the researcher takes an "empathetic stance" (Saunders *et al.*, 2009, p.116) and seeks to understand the subject's point of view, taking a non-positivist approach. The axiological approach accepts that values are a guiding tool to human action (Heron, 1996): therefore, the researcher's values are used to make judgements about the way in which the research is conducted. This approach is most commonly used when undertaking qualitative research, using small samples to conduct in-depth investigation (Saunders *et al.*, 2009). Contrastingly, a positivist approach assumes a theory-neutral stance to observation and adopts the ontological assumption that the researcher is separate from reality (Weber, 2004). Furthermore, it neglects the importance of acknowledging the effects of one's own biases and assumptions on one's research, although both philosophies seek to enhance one's understanding of the world, despite contrasting approaches to reporting research (Weber, 2004).

Hence, a positivist approach is valuable in the collection of quantitative data, allowing it to be statistically interpreted, thus eliminating the need for consideration of bias. This statistical data-gathering allows the researcher to identify the relationship between variables (Saunders *et al.*, 2009). Nonetheless, the aim of the research is to understand, rather than predict, human behaviour: hence the appropriateness of the chosen philosophy. Consequently, the data-gathering process generated rich data about actual behaviours regarding supply chain collaboration and the motivations behind this.

The research adopted an inductive approach. Saunders *et al.* (2009) describe this as a method used to collect data, and then identify common themes within it. It permits a more flexible structure, enabling the researcher to shift research emphasis as it progresses. Subsequently, an in-depth analysis was conducted. Due to the qualitative nature of the research project and the interpretivist philosophy adopted, an inductive research approach was considered most appropriate.

Data collection

Considering the limited availability of literature which focuses on supply chain collaboration within the CE framework to analyse food waste, primary data will be used to investigate the research aim. As explored in the literature review, the majority of studies have focused on theory-building (Dey *et al.*, 2011; Jurgilevich *et al.*, 2016) and framework development (Boons *et al.*, 2011; Kumar and Banerjee 2012). Hence, a need was identified to investigate supply chain collaborative relationships within the CE framework in a specific industry. The research adopted a similar data collection method to Pagell and Wu's (2009) study by using semi-structured interviews; it built upon this by focusing the sample on one industry, as per Hassini *et al.*'s (2012) research objectives.

The research adopted a mono-method of data collection: nine semi-structured interviews were conducted with different farmers to explore the research topic. Participants were identified through LEAF; the farming sector was not part of the inclusion criteria to allow flexibility in investigating experiences and behaviours.

Table 2 Participants' details

Farmer	Farming Type	Experience	Interview Duration
F1	Arable	40y	40min
F2	Fruits	22y	60min
F3	Fruits	16y	30min
F4	Arable, Dairy	2y	65min
F5	Arable, Dairy	41y	60min
F6	Tomatoes	32y	40min
F7	Arable, livestock	37y	60min
F8	Fruit & vegetables	27y	45min
F9	Sweet Peppers	30y	40min

In semi-structured interviews, the researcher has an interview guide with questions and topics that need to be covered. This method allows interviewees freedom of response and ensures that key research areas are covered, allowing room to explore other points of relevance that emerge from the discussion, without steering too far from the research aim (Bryman and Bell, 2015). However, it is recognised that semi-structured interviews have considerable limitations, including subjectivity in the interviewer's interpretation (Bryman and Bell, 2015), lower reliability and validity as compared to structured interviews, and difficulties in research replication (Saunders *et al.*, 2009). Nevertheless, this method was considered most appropriate for the present study due to the interpretivist approach adopted; it is also of relevance given previous studies' use of this method (Pagell and Wu, 2009). The current study adopted a similar research methodology with a different focus to further contribute to the literature.

Participants were gathered through homogenous purposive sampling, focusing on a group where members are similar. This allowed data collection to be information-rich (Patton, 2002) rather than statistically representative, thus enabling the group to be studied (Saunders *et al.*, 2009).

Twenty-eight individuals were targeted from farms across Southern England, of whom fourteen responded, and nine agreed to participate. The participants were firstly contacted via telephone, subsequently being emailed further information about the research. Six face-to-face interviews and three telephone interviews were scheduled. Eleven guideline questions formed the basis for the interviews, although participants were able to add comments emerging from the discussion. This structure ensured that unexpected topics were explored (Sampson, 1972), contributing to the information-rich nature of the sampling approach. Interviews lasted between 65 to 30 minutes, depending on participants' level of cooperation. Answers were recorded and a verbatim transcript was produced.

Data analysis

Given the interpretivist approach to data gathering, a thematic analysis was conducted (Strauss and Corbin, 2008). Additionally, a computer-aided qualitative data analysis software tool, NVivo, was used to identify the most frequently used keywords related to the identified themes. This approach was considered most appropriate because it maintains the value of qualitative methods whilst achieving the structure and direction observed in quantitative data (Boyatzis, 1998). Unstructured interviews are conversational (Burgess, 1984); the interviewer uses an *aide-mémoire* as prompts to ensure that a variety of topics are discussed (Bryman and Bell, 2015). This method is more widely used in exploratory scenarios where interviewees can discuss the topic freely (Saunders *et al.*, 2009). Although this enables a vast amount of data to be gathered, it may lead to the discussion of loosely related topics and is more time-consuming than alternative data collection methods (Saunders *et al.*, 2009; Bryman and Bell, 2015). Due to the time constraints present within this research, a semi-structured approach was considered most effective in collecting data. In contrast, structured interviews follow a set protocol; they are used to collect quantifiable data and do not allow exploration of related sub-topics, limiting participants' ability to express their thoughts (Saunders *et al.*, 2009). Given the research's aim

to understand farmers' interactions with supply chain members, a deeper understanding of such relationships was necessary.

Practical considerations considered included time constraints and participant sample size. Furthermore, interviewer bias is a limitation to response interpretation (Easterby-Smith *et al.,* 2008) as the data gathered is open to the researcher's interpretation (Kvale and Flick, 2007). To address this, interviews were recorded and transcribed verbatim, allowing accurate and unbiased reporting. Nonetheless, it must be considered that the researcher's interpretation inevitably influenced the analysis of the data. Finally, the theoretical limitations considered included a lack of reliability, validity and generalisability. Due to the limited sample size, the data can lack reliability if universally applied. However, findings derived from this method are not intended to be repeatable (Saunders *et al.,* 2009), given the complexity of supply chain relationships. Furthermore, despite the degree of subjectivity present in qualitative research, the study is of high validity, given that it meets the research aim. Moreover, this research method is intended to reflect reality at the time of data collection (Marshall and Rossman, 1999); hence, it is unsuitable for replication and generalisability. Nonetheless, given the theoretical compatibility of the findings to existing literature, the research demonstrated that it is of broad theoretical significance (Marshall and Rossman, 1999), thus counteracting generalisability limitations.

Findings, analysis and discussion

This section focuses on the main themes derived from the interviews; the analysis and discussion focus on how the information gathered corroborates or deviates from extant literature.

Theme 1: Collaborative supply chain relationships are key to achieving sustainability within the CE framework

A key finding which surfaced from the interviews was that of collaborative relationships enabling the achievement of sustainable practices. In accordance with extant literature (Chertow, 2007; Porsch, 2010; Boons *et al.,* 2011; Lombardi and Laybourn 2012; Leigh and Li, 2015; Sarkis *et al.,* 2011; Bell *et al.,* 2013; Matopoulos *et al.,* 2015), collaborative relationships are essential to transitioning towards more sustainable supply chains, as observed in IS, CLSCs and CE studies. Participants were emphatic about the role that collaboration plays in their sustainable waste management activities. To the question, *"How important is collaboration with different members of your supply chain to reduce food waste?"* F2 replied:

> *"You can't survive on your own and you couldn't even not try to work with other people; however, it's not straightforward: it takes time to build trust"*

F6 extended this view by saying:

> *"Vital. It's the only way you do it […]. We need to share that best practice between producers, but also need all the stakeholders in the whole supply chain to interact to be able to get a message across to the consumer"*

These excerpts corroborate literature emphasising the need for collaboration in symbiotic relationships (Lombardi and Laybourn 2012; Leigh and Li, 2015) and closed-loop supply chains (Sarkis *et al.,* 2011; Bell *et al.,* 2013; Matopoulos *et al.,* 2015), and thus could be easily applied to relationships within the CE framework. Additionally, this supports the movement observed throughout the literature, from IE concepts emphasising geographic boundaries (Ehrenfeld and Gertler, 1997; Seuring, 2004) and the reuse and recycling of materials (Geyer and Jackson, 2004; Jacobsen, 2006) as primary determinants of sustainability, to frameworks supporting higher levels of sustainable practices through the incorporation of collaboration. Hence, higher levels of sustainable practices require greater involvement with supply chain members, as each theory of sustainability – IE, IS, CLSCs and CE, respectively – incorporates a further element to close the loop of material flows.

Theme 2: Knowledge-sharing as a means of supply chain collaboration

A collaborative culture became a prominent theme throughout the interviews. When asked how collaboration takes place in their supply chains, interviewees consistently pointed to 'knowledge-sharing' as the basis of most collaborative relationships. This is consistent with Leeuw and Fransoo's (2009) and Kumar and Banerjee's (2012) research, which suggests that collaborative relationships may suffer in the absence of a culture of knowledge and skill

sharing. To explore the role that a collaborative culture plays in supporting supply chain members to work within the CE framework, the researcher asked, "*How do you collaborate with other stakeholders?"* F6 replied:

> "*We went out to the University of Berkley California, linked to the green science department of your university, […] and we've found that we can […] make the basis for a carton punnet to put our tomatoes in. […] we're working with a commercial company and another university, […] we've made cellophane out of the cellulose in tomato leaves."*

This response clearly demonstrates the role that knowledge-sharing plays in supporting collaborative relationships in exploiting opportunities to recycle waste – a key component of the CE framework (Sakai *et al.*, 2011; Su *et al.*, 2013; Winans *et al.*, 2017).

F5 commented on the role of knowledge-sharing as a means to increase the percentage of produce meeting specifications, which in turn reduces waste, demonstrating an understanding of the importance of achieving the first 'R' of the CE hierarchy (Sakai *et al.*, 2011; Su *et al.*, 2013; Jurgilevich *et al.*, 2016). He said:

> "*We collaborate closely with all our packing customers, who help and advise on how to get the perfect spec for different products, and we have our own agronomist specialist in each sector […] and they help us to try and get as much of our crop into spec as possible"*.

F3 extended the notion of waste reduction by sharing knowledge of produce through their Open Farm Sundays:

> *"We do Open Farm Sunday, we meet different customers, we take them around the farm and talk about fruit with different people – that's our exposure to the customer […] and you hope with years to come every farmer is participating in that, that something will change"*.

This was also observed in F6's interview, in which he stated his role as a knowledge-sharer:

> *"[…] I'm communicating into the Government that way, […] I do lots of things like Open Days for LEAF. […] as busy as I am, […] I still do gardening, doing speeches and things to try and promote what we do, […] particularly around sustainability of the way we produce"*.

These responses are consistent with Kumar and Banerjee's (2012) framework as well as the established hierarchy within the CE framework (Sakai *et al.*, 2011; Su *et al.*, 2013; Jurgilevich *et al.*, 2016). Interviewees acknowledged the role played by knowledge-sharing in the ability to work collaboratively within the principles of reducing, reusing and recycling waste, doing their part to varying degrees. However, F7 commented on the detrimental effect he believes knowledge-sharing can have:

> *"People say it's a great thing, but you know […]. We're getting much more out of the resources and that's what I want... well, as a producer that's what I want: I wouldn't want the whole industry to do that, otherwise […] the price would just plummet'.*

His view on knowledge-sharing contradicts the importance Kumar and Banerjee (2012) placed on this element of their framework. However, it follows the traditional view that sharing unique knowledge may hinder the business's competitive advantage, posing "a dilemma for firms seeking to explore collaborative links" (Miemczyk *et al.*, 2016, p. 454). This is consistent with Esty and Porter (1998), who considered sharing core knowledge to hinder market advantages. This was thought to have been disproved by Singh and Power (2014), who argued that knowledge-sharing in supply chains acts as a contributor to improve different aspects of performance. However, this view is only shared by one interviewee, with all others considering knowledge-sharing as key to working with the CE framework. This may call for further research to determine whether fear of losing competitive advantage deters knowledge-sharing in supply chain collaboration towards CE. Nonetheless, it reinforces the need for all stakeholders

to derive shared value from the collaboration, which CE advocates and emphasises as crucial for sustainable economic development to be achieved (Genovese *et al.*, 2017).

Theme 3: Local supply chain relationships facilitate collaboration within the CE framework

Another emergent theme was that of keeping supply chain relationships local, defined in IE and IS literature as geographically bound industrial systems (Ehrenfeld and Gertler, 1997; Seuring, 2004; Yuan and Shi, 2009; Yu *et al.*, 2013). Interviewees frequently mentioned that their waste disposal methods were influenced by the proximity of collaborating stakeholders. To investigate drivers of supply chain collaboration, the researcher asked, "*What facilitates collaboration with other stakeholders?"* F2 replied:

> "*Our main waste contractors are about 10 miles away, so we do like to keep it all nice and local. It's easier to build a relationship"*

This was expanded by F3, who explained how their choice of waste management stream is based on a local supply chain member:

> *"We already have the business from the factory that supplies that anaerobic digestion power […] and we just go on the piggyback of that really: it's easier for us as a farm […]."*

In support, F9 explained the benefits derived from local disposal of fruits which are unfit for human consumption:

> *"Fruit that we've got like that or any that we've got in the pack-house that they grade out, that will go to a local farmer who will feed it through his cattle […]. It's the convenience of it […] the farmer makes a lot of sense for the fruit part of the equation"*

Given farmers' emphasis on locally developed relationships, a clear deviation from recent research (Lombardi and Laybourn, 2012; Leigh and Li, 2015) is observed. Although Lombardi and Laybourn (2012) and Leigh and Li (2015) do not dismiss the importance of geographic proximity, they place it as a secondary contributor to achieving sustainable development, which is contrary to the present study's findings that geographic proximity of supply chain members involved in collaborative relationships is still critical to achieving supply chain sustainability. This is due to geographic proximity allowing supply chain members to "build a relationship" (F2) and due to "the convenience of it" (F9), in line with previous studies (Ehrenfeld and Gertler, 1997; Seuring, 2004), which places equal importance on geographic proximity and relationship building. However, whereas previous studies (Ehrenfeld and Gertler, 1997; Seuring, 2004) investigated geographic proximity and collaborative relationships as separate factors contributing to frameworks of sustainable development, the findings of the present research show that these factors are, in fact, interlinked: the formation of collaborative relationships is facilitated by geographic proximity, showing a cause-effect relationship between the factors.

Nevertheless, these findings may be unique to the industry, and more specifically, to the supply chain members under investigation. Interviewees revealed that "you don't want big lorries thundering down the countryside, moving what is effectively fuel" (F4) and "the actual green waste, all we do with that is we will chop that up and we will spread that on farmland adjacent to the Nursery" (F9). The comments reiterate that collaborative relationships formed locally are for "the convenience of" (F9) physical movements of waste, or potential waste, which are introduced as value into another stakeholder's system. This demonstrates that the nature of the exchange determined the importance of having local collaborative relationships, as F6, due to the nature of the produce, preferred to deal with waste and potential waste "in house" (F6), instead forming long-distance collaborative relationships with the University of Berkley (F6), which revolved around exchange of knowledge and information, thus not requiring physical proximity. Consequently, this prompts the need for research investigating the role of geographic proximity in different stages of a supply chain, as well as in different industries, to assess whether the importance of geographic proximity is dependent upon industry or exchange type. Additionally, the cause-effect relationship hereby observed should also be investigated further in different contexts, to assess whether the same interrelation is found in different industries.

Theme 4: Criticality of achieving mutual benefits in collaborative supply chain relationships

The final emergent theme was the importance of achieving mutual benefits from the collaboration in the management of food waste. Genovese *et al.* (2017) termed this 'shared value' and argued that the CE concept provides a framework which enables the creation of such value. To further investigate this, the researcher asked, *"What incentivizes collaborative relationships in the context of reducing, reusing and recycling your food waste?"* F9 replied:

> *"because […] there's a mutual benefit for everybody, it has that strength to hold the relationship together. If there was a disadvantage to somebody […] then it would probably struggle a bit."*

Although not acknowledged in sustainability literature, F9 presents the view that their supply chain relationships are supported by goal congruence (Angeles and Nath, 2001; Cao *et al.*, 2010), "because there's a benefit" (F9), which demonstrates that it is secondary to the possibility of achieving advantages from the collaboration. Similarly, interviewees frequently described the intensity of collaboration as being relative to the activity from which they could derive the highest shared value. F4 described how "somebody had the bright idea" of using linseed straw to build a "temporary wall of bale alongside the silage camp" as it could not be used as an immediate fertiliser. Similarly, F6 pointed to the creation of a separate business as a method of dealing with "fruit which is literally just knocked on the floor and there's nothing wrong with it" and described this solution as "one of our most profitable parts of the business". These efforts demonstrate that most collaborative relationships centred around waste prevention are those from which the highest value can be derived, consistent with the CE hierarchy (Sakai *et al.*, 2011; Su *et al.*, 2013; Jurgilevich *et al.*, 2016) and its ability to create shared value (Genovese *et al.*, 2017).

However, F2 presented a different viewpoint:

> *"[…] the end result really does interest me because I'm always fascinated with these new things […] trying to find how to sort it* [waste] *but it's got to work for us as well, and I think that's why it's not really taken off."*

F2's statement shows further discordance with Angeles and Nath's (2001) and Cao *et al.*'s (2010) studies; he explains that, although the congruence of their goals created the opportunity to form a collaborative relationship, it did not present enough mutual benefits: hence, the collaboration had not "really taken off" (F2). Nonetheless, F3 explained that they maintain relationships with their retailers despite the misalignment in goals. F3 described their efforts to reduce waste by attempting to loosen supermarket specifications; however, the latter "have to make money" (F3) and do not pursue waste reduction, although they have "the power to change that [customers'] perception" (F3). Hence, contrary to F9 and F2's observations, there is a possibility of forming collaborative relationships, albeit not a satisfactory one, despite a divergence in goals. Consequently, supply chain power disparity strongly influences which supply chain goals will be pursued and how.

These excerpts shift the emphasis observed in the literature on goal congruence as the relevant factor in collaborative relationships and place greater significance on the possibility and extent to which mutual benefits can be derived. This is especially significant in sustainability settings and reiterates Genovese *et al.*'s (2017) argument for the creation of shared value as a result of partaking in collaborative supply chain relationships in a sustainability setting, particularly the CE framework. Hence, scholars should place greater emphasis on the creation of shared value and should consider investigating this as a catalyst for collaboration in supply chains in the context of CE.

Despite most findings aligning with extant literature, key divergences were observed: firstly, shared value creation, which previously had not received enough attention, emerged as a critical factor in establishing collaborative relationships in the CE context. Secondly, goal congruence was highlighted with varying degrees of importance among interviewees, suggesting that further research is warranted into this construct as an important factor in sustainability settings. Lastly, geographic proximity was highlighted as a catalyst to collaborative supply chain relationships, thus disagreeing with current research which identifies it as separate from collaborative relationships. Overall, the identified themes are relevant in the synthesis of previous research.

Conclusion and contribution

The most prominent themes identified were collaboration as a foundation for working within the CE framework; knowledge seeking and geographic proximity as catalysts for collaboration; and the need to derive shared value for the formation of successful collaborative relationships. These are in line with the proposed conceptual framework; specifically, they reiterate that factors identified in IE, IS and CLSCs studies are applicable to the CE literature. In particular, the research findings corroborate existing literature, reinforcing the recurring argument that collaborative relationships are essential to transitioning towards more sustainable supply chains (Chertow, 2007; Posch, 2010; Boons *et al.*, 2011; Lombardi and Laybourn 2012; Leigh and Li, 2015; Sarkis *et al.*, 2011; Bell *et al.*, 2013; Matopoulos *et al.*, 2015). Additionally, the findings echo Genovese *et al.*'s (2017) argument that CE provides a platform where shared value enables collaborative relationships.

Conversely, the interviews revealed that, contrary to Seuring's (2004) study, geographic proximity is not a prerequisite for the formation of collaborative relationships where the nature of the collaboration entails the exchange of information and knowledge. Nonetheless, the findings suggested that this is still relevant where exchange of materials takes place. Finally, the findings uncovered the construct of goal congruence, not previously identified in sustainability literature. However, in contrast to Angeles and Nath's (2001) and Cao *et al.*'s (2010) studies, goal congruence is secondary to the possibility of achieving shared value, demonstrating that the latter is most relevant.

The most significant limitation to the study was the limited accessibility to the selected sample: i.e. farmers. A larger sample size would have ensured the data was more representative and reliable, giving a better representation of how farmers in the UK are working collaboratively to manage food waste. Additionally, a mixed method approach to data collection, using surveys, would have overcome the replicability concerns present with qualitative data; moreover, it would have addressed the sample size limitation by giving access to farmers whose contact details were kept private by the organisations to which they are affiliated.

The main findings suggest that interviewees are interested in forming collaborative relationships which help them to manage their food waste more efficiently. As such, the creation of formal networks where different supply chain representatives can gather to share knowledge and best practice may be useful for farmers. This is especially valuable for the early stages of the supply chain, which can be neglected by upstream supply chain members who hold considerable power. Additionally, farmers can benefit from greater support from retailers in the prevention of food waste. Retailers can do this by creating a platform for communication between farmers, who have the knowledge of produce, and buyers, who hold the decision-making power in purchasing their produce.

Theoretically, the study contributes new knowledge to the sustainability field, bringing together factors of collaboration previously investigated separately, namely knowledge sharing, geographic proximity, and shared value, and applying them to the relatively new model of sustainable economic development, the Circular Economy. Additionally, it investigates these factors in relation to food supply chains, where the pillars of CE can be easily applied, given the nature of the industry.

In practice, the study is of use to supply chain managers wishing to transition towards CE practices by highlighting the key elements needed in establishing collaborative relationships within their supply chains. Furthermore, it incentivizes farmers who have shown reluctance to share knowledge to do so through informal and formal networks, supporting industry-wide collaboration.

The discrepancies observed between the identified themes and the existing literature reveal avenues for further research. Specifically, future research should investigate whether fear of losing competitive advantage deters knowledge-sharing in supply chain collaboration towards CE. Furthermore, as the importance given to geographic proximity by interviewees differs from that in the extant literature, scholars should consider examining this variable further. Particularly, it should be studied in relation to different industries and different types of exchange: i.e. knowledge or physical exchange. Finally, the significance of shared value

identified in the interviews warrants further research into its role as a catalyst for collaboration in supply chains in the context of CE, as current studies of this aspect are limited.

The investigation met its aim to understand how supply chain stakeholder relationships can contribute to food waste management within the CE framework, and particularly how farmers engage with different stakeholders to achieve this. It recognizes its limitations, contributes new knowledge to existing CE literature, and provides practical recommendations for further studies. This is among the first studies to investigate how farmers in the supply chain can engage and recognise opportunities to work as partners in a circular model. Policy makers can derive lessons in how they can facilitate farmers, who can benefit from moving beyond current market dynamics towards a circular food system.

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