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Triads in sustainable supply-chain perspective: why is a collaboration mechanism needed?

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ABSTRACT

This research explores focal actors and their dyads, addressing their sustainable collaboration in triads and its relevance in the agri-triads that share information along the supply chains. We employ a multiple-case approach and presents two triads through 42 interviews, observation and documentaries. An abductive approach, Transaction Cost Economics (TCE), conceptually guides the analytical iteration stages between theory and data. The findings describe the collaboration mechanisms of focal actors at triad levels and the development of their dyads capabilities for sustainable supply chains. Eight triad approaches emerge in the present research; these are grouped into three aggregated levels according to the intensity of information-sharing between focal and associate actors in each triad. The research has identified six contextual factors that are linked to the TCE dimensions of asset specificity, uncertainty and frequency, and offers key propositions. The research gained insights into how focal actors in dyadic triads choose between the available approaches based on different intensity levels of information-sharing. This research presents a conceptual framework informing the choice of triad approaches reflecting collaboration mechanism strategies, and thus the intensity of information-sharing and sustainability performance. The study elaborates on the application of TCE and extends it empirically to the literature.

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Triads; sustainable supply-chain; collaboration; case studies; interviews

1. Introduction

The decision-making processes controlling production in supply-chain management have developed from simple origins into the complex innovative strategies for value-adding activities that underlie the current triadic approach (Esfahbodi, Zhang, and Watson 2016; Vedel, Holma, and Havila 2016). More importantly, chain actors tend to reevaluate their competitiveness and enhance their sustainable buyer-seller relationships by specialising within their collaboration mechanisms as dyads (Aggarwal and Srivastava 2016) and sharing information within their triadic supply-chain (Mena, Humphries, and Choi 2013). In the context of dyadic collaboration (Bailey and Francis 2008), information-sharing assumes growing importance for triads in sustainable supply chains. Diverse actors are involved, exhibiting different levels of collaboration in triads linked to the focal actor. Triad management involves not only direct and indirect dyads but also the interdependencies between them in transactional supply chains. Traditionally, dyad portfolio models

have been employed to represent supply-chain triads. However, whilst empirical studies show that such models might be followed by practitioners (Choi and Wu 2009), academics have viewed them sceptically owing to their lack of an integrative explanation of how dyads and triads work in supply chains (Mena, Humphries, and Choi 2013). The research gaps are important motivation to carefully explain to actors how the collaboration is going to reinforce their individuality in order to bring better situations: to maintain a certain level of intimacy with other actors and to build the whole group as an undifferentiated one which brings better external demand. Such situations have been discussed for instance by Choi and Wu (2009) and Mena, Humphries, and Choi (2013). For example, the concept of a triadic sourcing strategy is to bring benefits from cooperation between more than two actors and competition between two suppliers with partially overlapping capabilities (Dubois and Fredriksson 2008). Indeed, whatever the benefits of triadic supply, the core of the collaboration remains the value of the

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new set of relationships as an innovative dyad-to-triad transformation (Wu, Choi, and Rungtusanatham 2010).

This research considers complex decision-making processes regarding collaboration between direct and indirect dyads and triadic supply chains in agri-industries. It also examines the interdependencies associated with them. It focuses on how these triads are formed, the extent of involvement of the focal actor regarding assets and uncertainties, as also how dyads influence the collaborative triads in sharing information as well as influencing sustainability performance. This study aims to examine the nature, creation, contextual factors and impacts of collaborative triads within the supply chain of a focal actor. This leads to the following Research Questions:

- RQ1. What approaches types of collaboration mechanisms exist within focal-actor triads?
- RQ2. How do direct and indirect dyads emerge and develop within triadic portfolios?
- RQ3. How do these dyads exert sustainability impacts on the actors involved within focal-actor triads along the supply chain?

Groundwork analysis of these issues will clarify the potential benefits but also the limitations of triadic collaboration and the dyadic information-sharing effects on the sustainability performance of triads containing direct and indirect business dyads. A key contribution is to identify the different collaborative approaches of triads in sustainable supply chains beyond the more basic explanations delivered by dyadic portfolio models.

This paper first addresses the theoretical background to supply-chain actors from portfolio and Transaction Cost Economics (TCE) perspectives followed by research methodology. Key findings of case analyses, theoretical contributions and managerial implications are discussed. Finally, conclusions and future research and limitations are incorporated.

2. Literature review

The development of industrial supply-chain management has been shifting from the original simple issuing of directives by focal actors and now entails complex decision-making processes regarding collaboration between direct and indirect dyads in triadic supply-chains (Esfahbodi, Zhang, and Watson 2016; Wilhelm et al. 2016). Dyadic actors now buy and sell different resources such as products, technology, information and other facilities in order to collaborate more effectively at a higher level in value-adding triads (Choi and Wu 2009;

Bastl, Johnson, and Finne 2019; Danese, Lion, and Vinelli 2019). In this environment, the specifics of the focal actor's role provide the foundation of management for any particular triad. The literature on focal-actor portfolios is reviewed as part of the conceptual background of this research, underscoring key strengths, and introducing the TCE perspective (Yigitbasioglu 2010; Wu, Choi, and Rungtusanatham 2010; Busse, Meinschmidt, and Foerstl 2017) as this helps towards attempting closing research gaps in understanding of direct and indirect collaboration between actor dyads in triadic supply-chains. The research gaps are important to carefully explain to actors how the collaboration is going to reinforce their individuality in order to bring better interaction between focal actors and other actors in triads for better sustainability performance along triadic supply chains.

The idea of sustainable performance gained traction after sustainable development as a concept came into being. Sustainable performance can be described to be the blend of a practice's social, economic and environmental performance. In such an approach, the holistic incorporation of output brings to fruition a consistency within the causality models between the three elements and this, in turn, links a number of variables from different dimensions (Huo, Gu, and Wang 2019)

The sustainable output is the reflection of a corporation's lasting competitive advantage in terms of economic returns; and this rings true if one were to take into account the impact of such output on the natural environment as well as on human society while not ignoring stakeholders' needs (Paulraj 2011). Sustainable performance is expressed through the triple bottom line (TBL) that combines the three aspects of social, economic and environmental performance (Margolis and Walsh 2003). The term economic performance used in this research encompasses productivity as well as the financial returns on assets. A return that is above average can be possible if firms ensure better efficiency at resource investment than their competitors.

The natural system of business activities is generally estimated by the environmental component of the triple bottom line. Extant research focussed on environmental performance to be of strategic concern. Such performance would typically be understood as the reduction in energy consumption, hazardous material usage as well as waste discharge (Glavas and Mish 2015). The societal and public contribution of firms, external to their economic and profit-based interests, is assessed in terms of their social performance (Dahlsrud 2008). Furthermore, Pasandideh, Niaki, and Gharae (2015) show that the vital aspects of sustainable performance and lowered costs can only be ensured by multi-level supply chains,

which, incidentally, also includes a variety of components and constraints.

2.1. Supply chain triads and portfolio perspectives

Sustainable supply chains have been viewed as underpinned by concepts linked to sustainable processes of production, the flow of information and products, supply and demand, relationships, logistics, contracting, risk, pricing, revenue, and value-adding activities (Esfahbodi, Zhang, and Watson 2016). Studies stress the increasingly important role played by focal actors for achieving successful outcomes in their sustainable buyer-seller dyads through their collaborations in triads (Esfahbodi, Zhang, and Watson 2016). Studies have focussed on how these activities motivate focal actors to collaborate within their dyads to improve their overall sustainability performance (Flynn and Flynn 2005; McAdam, Hazlett, and Anderson-Gillespie 2008; Park et al. 2015; Niall and Rich 2015). No *ideal* sustainable dyad type exists to achieve this goal, and the formation of an optimal dyad is by its very nature conditional upon many factors (Pagell and Shevchenko 2014; Tasca, Nessi, and Rigamonti 2017). Focal actors must, therefore, decide on the triad approaches to adopt as a collaboration mechanism with each focal actor in a triad and on how to allocate resources (e.g. information-sharing) between actors in a dyad (Wu, Choi, and Rungtusanatham 2010).

Several authors have introduced the triadic relationship in supply chains as the focus of their research works (e.g. Wu, Choi, and Rungtusanatham 2010; Pagell and Shevchenko 2014; Wilhelm et al. 2016). According to Choi and Wu (2009), the triad is considered as the smallest unit of the network of the supply chain, making possible the observation of the specific influence of one triad on another (Dubois and Fredriksson 2008). Nevertheless, more works are called to understand the specific dyad-to-triad transformation as the specific focus of these works. Hence, for achieving an optimal sustainable dyad, one key solution proposed in the literature is to employ selective portfolio approaches to identify which actors should be chosen for collaboration at higher information exchange levels and to designate actors for less-intense information-sharing relations. Such portfolio approaches have been presented as mechanisms to manage balanced collaboration in direct dyads (Pagell and Shevchenko 2014; Tasca, Nessi, and Rigamonti 2017) and some indirect dyads (Esfahbodi, Zhang, and Watson 2016; Formentini and Taticchi 2016), as best serving the shared interests of focal actors in their supply-chains. The first major conceptual development of this scenario presented a triadic structure of business relationships (at horizontal or vertical level) as described by Choi and

Wu (2009). This structure posited a logical-collaborative approach for examining how one dyadic sustainable relationship is affected by another in a supply chain. Three types of triadic collaborative approach were proposed: cultivated, concerted and directed collaborative triads. *Cultivated collaboration* occurs where all three actors in their sustainable dyads collaborate at an *effective level*. The dyads of sustainable buyer-seller relationships are well maintained and all actors are *essential* in forming the triad. *Concentrated collaboration* occurs where the three actors collaborate at an effective level with a focus on fixed contracts. *Directed collaboration* occurs where a focal actor collaborates with one actor at an effective level, but with another actor at a level of lower effectivity.

The selection of contextual factors reflects the previous development of portfolio approaches and is challenging. Challenges exist in selecting the most appropriate factors, evaluating them correctly, and incorporating sustainability considerations: economic, social and environmental impacts have been highlighted (Formentini and Taticchi 2016). Furthermore, Turnbull (1990) and Zolkiewski and Turnbull (2002) discuss the notion of portfolio approaches as being compatible with the logic of realistic-collaborative approaches – decisions made in different contexts being interdependent for sharing resources and requiring information-sharing activity by managers to achieve an appropriate balance of outcomes across these contexts. It is pointless to designate some firms as *passive* actors when supply-chain strategy needs to be based on the collaboration of expanded actor networks (Aggarwal and Srivastava 2016). Hence, the challenge for managers is to know how to link different actors, as certain types of portfolio approach do not always generate the requisite solutions (Busse, Meinlschmidt, and Foerstl 2017).

By avoiding inflexible portfolio approaches, supply chain triads will become effective between the focal actors and their network actors (Wilhelm et al. 2016). Hence, this is important to be linked with dynamic approaches, particularly triadic collaboration approach, at triad, chain and market levels with in-built information-sharing processes across both direct and indirect dyadic relationships (Pagell and Shevchenko 2014). This approach aims to engage all options for existing collaborative activities and assets with few or no uncertainties (Williamson 2008; Busse, Meinlschmidt, and Foerstl 2017; Despoudi et al. 2018). Harnessing all the possible sustainability benefits from relevant actors could thus achieve the desired economic, social and environmental outcomes in supply chains (Niall and Rich 2015; Tasca, Nessi, and Rigamonti 2017). Management of the sustainable supply chain is defined by Seuring and Müller (2008, 1700) as

the management of material, information and capital flows as well as cooperation among companies along the supply-chain while taking goals from all three dimensions of sustainable development of economic, environmental and social, into account which are derived from customer and stakeholder requirements.

The present research builds its assumptions on the importance of identifying a well-founded portfolio approach to both information-sharing and collaboration, thus leading to improved sustainability performance for a set of actors rather than for a single actor or a single dyad (Pang et al. 2012).

2.2. Supply-chain triads and TCE perspectives

Transactional factors have important contributions in collaborative portfolio approaches. This is where triadic collaboration requires the analysis of the focal actor's dyads, in practice those underlying the actor – focal-actor – actor groupings as triads. Triads in sustainable supply chains present opportunities for collaboration across actors to improve their social, environmental and economic performance (Park, Sarkis, and Wu 2010; Pagell and Shevchenko 2014; Shi et al. 2014). Managing such transactions may support the focal and associated actors in reducing negative outcomes and increasing positive ones. TCE demonstrates the different costs of transactions between supply-chain actors, including the focal actors (Grover and Malhotra 2003). TCE covers exchanges of products, information and finances; it examines the categories of transaction costs for collaboration, information-sharing and contracting that are associated with these exchanges (Williamson 1987; Busse, Meinschmidt, and Foerstl 2017). This transactional perspective highlights a need for actors to perform governance functions, including contracts whereby a neutral third player coordinates the suppliers' networks (Reardon et al. 2009; Thiele et al. 2011). The term TCE originates from two key elements: (a) forecasting the costs of preparing an economic exchange as well as (b) taking stock of the cost of the economic exchange after said exchange has been executed (Coase 1937). Furthermore, TCE provides a comprehensive understanding of the entire supply chain of an economic organisation by clearly forecasting the scale and scope of each actor in the chain. TCE lucidly explains the decision-making process that takes place within an organisation's supply chain. For example, when a company faces the decision to choose between implementing in-house operations and outsourcing these operations, TCE plays a vital decision-making role – operations can be outsourced to another company if the cost of conducting the transaction is low, however, if the transaction costs would be high for said

operations, this would justify the execution of operations in-house (Ketokivi and Mahoney 2020). This research seeks to explore the importance of the factors of transaction costs for collaboration from the point of view of the dyad-to-triad transformation.

2.3. Triadic supply-chains and research development

The existing literature does not fully analyse direct and indirect dyads for triadic collaborations. It is important to fill these research gaps and hence understand that focal actors do not individually establish the integrated collaboration of dyads, but rather work with the other actors involved in a particular triad. The rationale for triads subsists in the opportunities for the sustainable value that all three actors – the focal actor and associates – can create by collaborating in their transactions across the triadic supply chain (Choi and Wu 2009; Esfahbodi, Zhang, and Watson 2016). This sustainability value is grounded in collaboration with the three actors to add features to products to generate additional benefits (Porter and Kramer 2011; Grimm, Hofstetter, and Sarkis 2014; Pagell and Shevchenko 2014; Tasca, Nessi, and Rigamonti 2017). In evaluating triads, collaboration in buyer-seller dyads is broadly investigated through three-dimensional relationships rather than in linear two-dimensional contexts, and for a totality of upstream and downstream supply-chains (Wu, Choi, and Rungtusanatham 2010). In this research, three types of triad within supply-chain structures are proposed: Open, Closed and Transactional (Mena, Humphries, and Choi 2013). An *Open Triad* is a traditional structure of indirect buyer-seller relationships where both information and product flows are linear between actors. A *Closed Triad* comprises a structure of *contractual* direct buyer-seller relationships between actors. A *Transactional Triad* presents a structure of *potential* direct buyer-seller relationships between actors. The focal actor and associate actors can rely on more than one type of triad. The work of Choi and Wu (2009) identified that triadic structures of business relationships (at horizontal or vertical level) are important for supply-chain performance. This level of analysis offers a logical approach to examining how a sustainable dyad is affected by another in a particular supply chain.

3. Research methodology

3.1. Research design

This is a qualitative methodology that employs a multiple-case study strategy (Miles and Huberman 1994). This strategy generating rich theoretical and

practical insights, especially in the field of sustainable supply-chains (Niall and Rich 2015; Song et al. 2017). This research follows an inductive case-based approach with abductive reasoning to modify the logic of the general theory to reconcile it with contextual factors (Ketokivi and Choi 2014). A triangulation approach is applied to ensure research quality (Eisenhardt 1989). Accordingly, TCE guides exploration in the present enquiry in order to theorise the selection of approaches of supply-chain governance (Williamson 2000, 2008). The research seeks to provide a holistic conceptual framework (see Figure 3) in supply-chain management, involving TCE. This framework will link the triad approaches to the intensity of information-sharing for the focal actor and other actors in sustainable supply chains. TCE is used to explain the triad approaches (direct, indirect and contracting approach-types) in a sustainability context at dyad, chain and market boundaries. The triadic collaboration measures are in terms of triadic actors' strategies around the price, revenue, total cost, flow of information, product and finance, and contracting are antecedent to sustainability performance in economic, environmental and social aspects under the leadership of the focal actor.

The empirical context is located in Fresh-Fruit-and-Vegetable (FFV) supply chains within a developing country (Jordan) for export markets in European countries. FFV supply chains are selected as they are in need of a better understanding of how actors should work together in a complex network of many triads (Jraisat, Gotsi, and Bourlakis 2013). There were variations in governance across FFV-chain actors, as well as consensual variations in collaborative triads (Jraisat, Gotsi, and Bourlakis 2013). These FFV supply-chains are characterised by certain key features. (1) *Sector structure* of vertical and horizontal collaborations; this feature affords a key focus on the producers as focal actors, as they are usually exporters at the same time. (2) *Product features*, as these are perishable products and sometimes seasonal products; this feature is linked to the regime of full-calendar production, with production in the Jordan Valley occurring from October to April, and in the highlands from April to October. (3) *Actor-type features* are significant as this chain includes a variety of collaborative firms (producers, retailers, etc.) whilst also dealing with international actors (exporters, importers, etc.). Hence a collaborative approach in triads is vital for the FFV supply chain.

3.2. Sampling

The case studies cover two triads selected through theoretical sampling (Eisenhardt 1989). These are triads

of collaborative sustainable direct and indirect dyads, in which each triadic actor should have information-sharing and collaboration functions in the FFV supply chain. This research adopted selection standards derived from the existing literature. A *standard of transitivity* provided a basic structure of harmony for each set of dyads, where the three actors in question had chosen each other as partners in their triad (Wasserman and Faust 1994). Four types of sample were selected based on geographic and market analysis. These types are a dyad in the highland for local markets; a dyad in the Jordan Valley for export markets; a dyad in both highlands and Jordan Valley for export markets; and a dyad in both highlands and Jordan Valley for both local and export markets. This was followed by a study of the other six dyads linked to focal actors in each triad. In this way, it was possible to progressively map existing actor – focal-actor – actor triads and to construct a supply-network view. It resulted in the identification and analysis of nine dyads for each focal actor, thus providing a wider view of the triadic chains. The sample actors comprised a total of two primary triads (Group Type 1 and Group Type 2), including an export gatekeeper as a focal actor, and the focal actor's two supporting triads (associate sub-triads).

A *standard of long-term duration* ensured that the dyads could provide observations related to mutual relational history (Wilson 1995). The two triads were examined based on stability and reduced exposure to the uncertainty of newly-formed dyads or dyads approaching cessation (Bastl, Johnson, and Finne 2019). The sampling used advanced research within the online directory of sustainable firms and exporters, selecting companies that had been working for at least five years with various dyadic firms. A snowballing sampling technique was then used to identify firms, generating a list of 50 firms, which were then shortlisted to 14 firms involved within the two primary triads.

A *standard regarding collaboration mechanisms* based on various collaborations within the triads (Luzzini et al. 2015). Each firm was asked to identify a dyadic collaborative actor for inclusion in the unit of analysis. In each case, a primary triad was chosen as *actor 1 – focal-actor – actor 2* and two supporting triads were chosen as *actor 3 – focal-actor – actor 4* and *actor 5 – focal-actor – actor 6* to involve the 14 firms identified, including direct and indirect dyads. See Table 1 for Primary Triad A (Group Type 1) and Primary Triad B (Group Type 2). Although in each triad all three actors were connected via transactional supply, minimum sustainable value, mutual support and use of the same tendering procedures, they had different responsibilities, operations and experiences regarding the sustainability of economic, environmental

Table 1. Cases overview.

Case type	Triad	Triad age	Triadic industry Actor 1-Focal Actor-Actor 2	Main market	Interviewee type	No. of interviewees
Group 1	A	12	Exporter-Producer-Importer	Export Markets	Focal actor: Sustainability Manager; HR Manager; Contracting Manger Actor 1: Export Manager; Contracting Manager; Sustainability Manager Actor 2: Marketing Manager; Import Manager; Contracting Manager	9
	A1	8	Raw Material Supplier-Producer-Wholesaler	Local Market	Actor 3: Operation Manager; Relationship Manager; IT Manager Actor 4: Marketing Manager; Contracting Manager; Market Manager	6
	A2	12	Exporter-Producer – Post-harvest Centre	Export Market	Actor 5: Export Manager; Relationship Manager; Sustainability Manager Actor 6: Sales Manager; Centre Manager, Contract Manager	6
Group 2	B	6	Importer-Producer/Exporter-Retailer	Export Market & Local Market	Focal actor: Production Manager; Export Manager; Contracting Manger Actor 1: Operation Manager; Relationship Manager; Sustainability Manager Actor 2: Sustainability Manager; Contracting Manger	9
	B1	5	Producer-Producer/Exporter – Wholesaler	Export Market & Local Market	Actor 3: Operation Manager; Relationship Manager; Contracting Manger Actor 4: Marketing Manager. Market Manager; IT Manager	6
	B2	6	Exporter-Producer/Exporter-Importer	Export Markets	Actor 5: Export Manager; Contracting Manager; Sustainability Manager Actor 6: Marketing Manager; Import Manager; Relationship Manager	6
Total						42

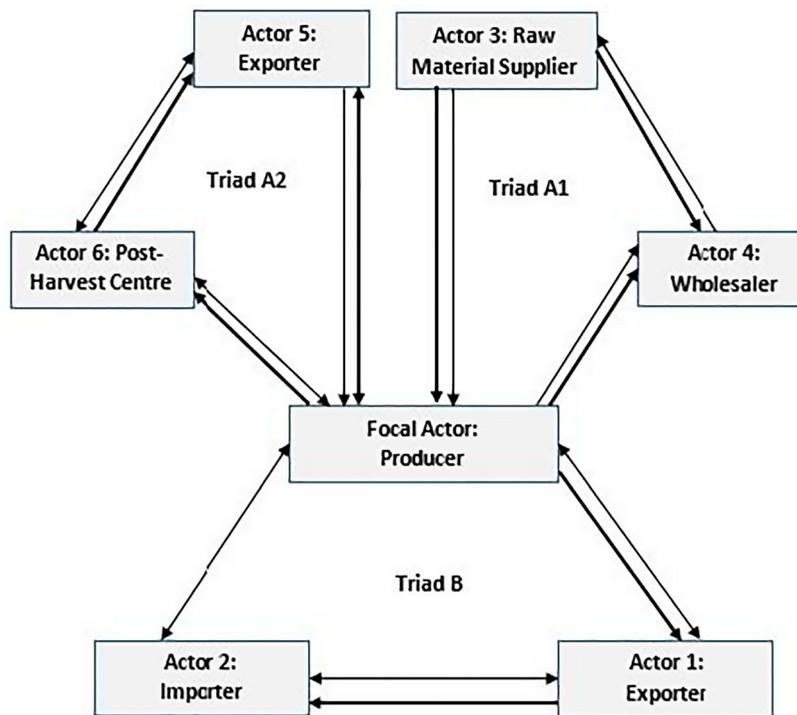
and social aspects. There were variations in governance across FFV-chain actors, as well as consensual variations in collaborative triads (Jraisat, Gotsi, and Bourlakis 2013; Luzzini et al. 2015).

3.3. Data collection

Primary data was collected through semi-structured interviews as a key source, and from two observation days on triadic actor sites (Eisenhardt 1989). A case-study protocol was applied for improved research reliability (Yin 2014). The protocol stipulated triadic rational issues by focusing on identifying collaboration mechanisms, information-sharing schemes, as also their methods and reasons within a triad. In each case, data collection started with a gatekeeper firm (a focal actor) which received an invitation letter, information sheet and consent form, explaining the research purpose and the need for all three actors in their primary triad and supporting triads (sub-triads) to participate. Thereafter, a purposeful sampling approach directed the selection of the interviewees (Lincoln and Guba 1985). The two primary actors identified two supporting actors who were then approached in the

same way. The chief manager of each focal actor was asked to suggest three downstream managers for the interview.

In total, 42 interviews (ranging from 60 to 90 minutes per interview) were obtained from the managers involved in triads during May–July 2018 (see Table 1). The aim was to obtain answers on the extent of collaboration in information-sharing. Practical and theoretical replications were performed by applying multiple cases to the same dyad-type and to different dyad-types; likewise, in respect of multiple levels of managers for the same dyadic actor, and the same manager-type for different dyadic types; and likewise regarding the same FFV supply-chain type for different triad types (Eisenhardt 1989; Voss, Tsikriktsis, and Frohlich 2002). For reflective practitioner inputs, several contacts were made with managers to seek specific clarifications regarding emails, phone calls and document exchanges that had created mutual benefits (Yin 2014). The interviews were also transcribed and reviewed. The scrutinised interviews used for cross-case analysis (Miles and Huberman 1994). A research assistant in the role of silent observer attended one meeting involving each triad. In addition, documentaries from firms' annual reports, sustainability records, websites and



Group 1: Closed triad (Seller (focal actor: producer) has direct dyad with primary buyer 1 (importer from European and Gulf markets) and direct dyad with secondary buyer 2 (Exporter). Information sharing is highly between the three actors in their triad A. This triad is based on formal contract between the actors in each dyad in Triad A. Triad A has a transactional triad with sub-Triad A2 via supportive actor 6 (Post-Harvest Centre) including both formal and informal contracts and open triad with sub-Triad A1 including informal contracts

Figure 1. Illustrates the case of triad A-Group 1.

related data, were collected for triangulation purposes (Eisenhardt 1989).

3.4. Data analysis

Research progresses from observing the phenomena to explaining why the phenomena arise and thence to suggesting how collaborations in triadic supply-chains occur. Several steps were taken in the data analysis.

Firstly, open coding using the interview transcripts and other sources such as observations, followed by assigning initial codes that were generated from themes identified in the literature, for data reduction and display (Corbin and Strauss 2008). Secondly, the application of first-order codes to triad approaches and their strengths, with the refinement of selected key first-themes (contextual factors) to achieve greater focus as non-repetitive themes (Miles and Huberman 1994). Each case was presented based on the key themes, approaches, and related key display (Yin 2014). Thirdly, axial coding was applied via cross-case comparison for data exploration to enhance replication logic amongst the triads, providing

themes focussed on the actor, dyad, triad, and supply-chain levels (Eisenhardt 1989), in order to detect similarities and differences in triad approaches across cases. Fourthly, matching the comparisons, whereby pattern-matching identified contextual factors that explained each actor's sustainability performance and selection of the triad approach. Finally, replicating the key findings in a TCE perspective, where components of TCE and governance modes were used to structure the case findings with second-order quotes. The process was iterative, moving backwards and forwards in time, exploring the condition of each supply-chain prior to sustainable collaboration, and how/why circumstances began to change. By conducting iterations between data coding and theory elaboration (Miles et al. 2014), this analysis method facilitated the development of insights into theoretical associations from the empirical findings.

3.5. Research quality

The entire research was validated according to Yin's (2008) four tests as shown in Table 2.

Table 2. Research quality.

Validity and reliability	Research design	Related stage
Construct Validity	<ul style="list-style-type: none"> - Building trust with interviewees. - Multiple sources of evidence at data collection: interviews; observation (meetings); documents. - Chain of evidence at data collection: three relationships (dyads) for each case (triad) and use the same case protocol. - Transcripts are refined by the interviewees 	<ul style="list-style-type: none"> Research design Data collection
Internal Validity	<ul style="list-style-type: none"> - Explanatory approach: develop a theoretical association. [at both Case level/ Cross case level] - Chain of evidence at data analysis: key theme-matching and coding via support of key literature and key interview quotations. [at Case level] - Chain of evidence at data analysis: key proposition development. [at Cross Case level] - Data triangulation: comparing quotes from interviews with observations and document material. [at Cross Case level] 	Data analysis
External Validity	<ul style="list-style-type: none"> - Multiple cases: replication logic among the cases. - Analytical generalisation: building a new holistic framework. 	Research design
Reliability	<ul style="list-style-type: none"> - Case study protocol is the same for all cases - Case database: interview quotes, meetings, and documents. - Key themes guided propositions and discussions - External review: final case report was validated by uninvolved experts (Policymakers). 	Data collection

4. Findings and discussion

4.1. Case-study level

A detailed report for each case was written based on triangulated data gathered from interviews, observations and documentary data. Each within-case description was presented in a case summary with a complex triad display (Miles et al. 2014). Summarisation of the role of each actor, types of products, types of collaboration, dyad age, contracting, types of information-sharing and strategic solutions related to sustainable dyads along their chain.

4.1.1. Case-study group 1

Primary Triad A covers a producer in the focal-actor role as a seller of FFV; an exporter as FFV buyer and seller to importers; and an importer as FFV buyer for Gulf and European markets. Sub-Triad A1 has a supplier as a seller of untreated farming crops; a producer in the focal-actor mode as a buyer of raw produce and seller of FFV products; and a wholesaler group of trading firms that buy FFV products. Sub-Triad A2 includes an exporter as a buyer of FFV products; a producer in a focal-actor mode as a seller of FFV products; and a post-harvest centre as a service provider for both other actors (see Figure 1). All three actors are committed to a 12-year-long triad by formal contracts with each other, based on arrangements agreed at several collaborative stages. Highly collaborative strategies (including daily, weekly and yearly meetings, and training) are applied at different management levels, with Sub-Triads A1 and A2 showing particularly effective collaboration. Primary Triad A reflects concentrated collaboration, where the three actors cooperate efficiently through fixed contracts.

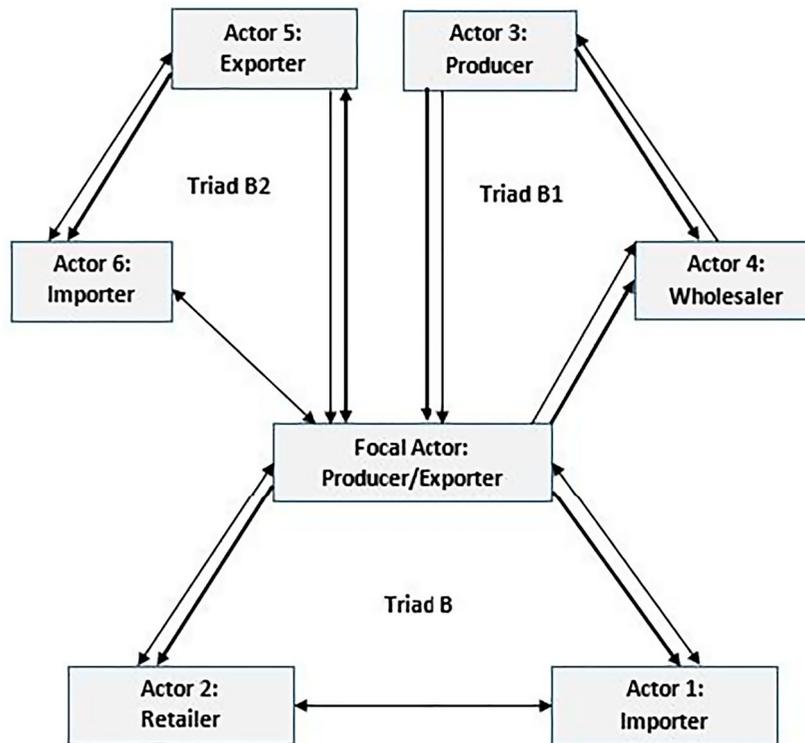
4.1.2. Case-study group 2

In Primary Triad B, the focal actor is a dual-functional producer/exporter firm. This focal seller/buyer actor supplies FFV products year-round to a retailer as a buyer for the local market and an importer as a buyer for European markets, both inside and outside the European Union. Figure 2 shows the configuration of Triad B. This triad exhibits both concentrated and cultivated collaboration established formal and informal contracts as a key governance mode for their six-year business triad. All three actors have strategic roles owing to their pre-agreed pricing strategy and equal profit-sharing.

4.2. Cross-case-study level

A wider body of knowledge regarding sustainable dyads and their triads is needed to disaggregate overlapping concepts in order to generate consistent findings (Esfahbodi, Zhang, and Watson 2016). Accordingly, each case was examined and compared to discover common patterns (Miles et al. 2014). The purpose was to ascertain the collaborations at triads based on information-sharing activities between the dyadic actors.

Eight triad approaches emerged during the data analysis; these are grouped into three aggregated levels according to the intensity of information-sharing between focal and associate actors in each triad (Table 3). The research has identified six contextual factors that are linked to the TCE dimensions of asset specificity, uncertainty and frequency, and offers key propositions (Table 4). The research gained insights into how focal actors in dyadic triads choose between the available approaches based on different intensity levels of information-sharing (Table 5).



Group 2: Closed triad (Seller (focal actor: producer/exporter) has direct dyad with primary buyer 1 (importer from European markets) and direct dyad with secondary buyer 2 (retailer in local markets). The action of information sharing is high between the three actors in their triad B. This triad is based on formal and informal contracts between the actors in each dyad. Triad B has a transactional triad with sub-Triad B2 via supportive actor 6 (Importer) including both formal and informal contracts and open triad with sub-Triad B1 including informal contracts.

Figure 2. Illustrates the case of Triad B-Group 2.

This presents a conceptual framework informing sustainability performance, choice of triad approaches reflecting collaboration mechanism strategies, and thus the intensity of information-sharing (Figure 3).

4.2.1. Triad approaches for collaboration mechanism

At the cross-case level, the eight triad approaches are described according to direct, indirect and contracting portfolios: *direct-dyadic triad boundaries* (total cost, pricing and revenue strategies); *indirect-dyadic chain boundaries* (information, product and finance flows); and *contracting-market boundaries* (formal, mixed and informal contracts) (see Table 3). These portfolios are organised according to the collaboration mechanism(s) in force and indexed by intensity (high to low) of information-sharing. The information-sharing strategies having the highest intensity have been confirmed as the most important in enhancing sustainability performance and improving the sustainability value of FFV features and benefits for the sustainable dyadic triad.

Direct approaches refer to how focal actors directly choose and interact with their associate actors in applying collaborative strategies at the symmetric-dyad level in mutual triads, through three strategies: total cost, pricing, and revenue strategies.

Indirect approaches exhibit information flows that can promote collaboration and effective interaction at a dyad-triad level that may be used to develop a cohesive strategy for the benefit of other actors.

Contracting approaches, the eight approaches are identified at three levels in the supply chain. A key finding highlights that the triad focal actors employ a combination of the approaches at the three levels with varying degrees of application.

4.2.2. Contextual factors

The three TCE dimensions (assets specificity, uncertainty and frequency) serve to group the contextual factors. Six types of contextual factors are identified as having

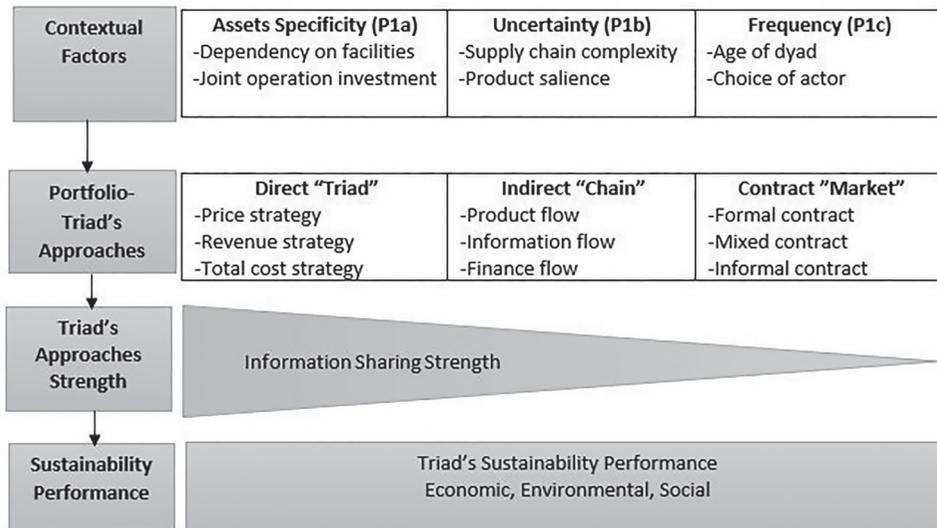


Figure 3. Research framework.

Table 3. Triad approaches of collaboration mechanisms in supply-chains.

Portfolio of triad approach	Types of triad approach (collaboration mechanism)	Description
Direct approach: Dyadic triad boundaries	Total cost strategy	Focal-actor triads manage their transactions based on SBSRs with the triads including minimisation of chain cost of key functions selected in one or more actors; and <i>not</i> all costs for all three triads.
	Pricing strategy	Focal-actor triads analyse total chain costs including the triad pricing for all three triads as a single firm in the chain.
	Revenue strategy	Focal-actor triads work with the triadic actors to ensure an equal percentage of profit due to be distributed for all three triads.
Indirect approach: Dyadic-chain boundaries	Information flow	Focal-actor triads manage information flow as an effective interaction to develop a cohesive strategy at SBSR triads to share benefits with other triads in the chain.
	Product flow	Focal-actor triads manage product flow as a traceability method to facilitate other flows, such as information and financial flows to share benefits with other triads in the chain.
	Finance flow	Focal actor triads manage financial flow as a cost-benefit method to share benefits with other triads in the chain.
Contracting approach: Contracting-market boundaries	Formal contract	Focal-actor triads apply direct and indirect approaches at high levels based on formal agreements as the most important governance approach, which are all linked to high intensities of information-sharing based on concentrated collaboration.
	Informal contract	Focal-actor triads apply direct approaches at high levels and indirect approaches at low levels based on informal agreements as the only governance approach, which are all linked to low intensities of information-sharing based on cultivated or directed collaboration.

impacts on sustainability performance (*economic, environmental and social domains*) linked to collaboration mechanisms as indicated in Table 3 and information-sharing activity in dyadic triads in agri-supply-chains. Table 4 presents these contextual factors which contribute to dyads to emerge and develop within triadic portfolios, whilst Table 5 shows their relative strengths across the case studies. Hence a key proposition is highlighted:

P1: focal actors apply collaboration (*cultivated; concentrated; directed*) at dyad level to form reasonable triad level (*closed; transactional; open*) by applying different transaction dimensions and seeking different levels of information-sharing strength, leading to *enhancing their sustainability performance at the agri-supply-chain level*.

Assets specificity: There are two transactional factors (dependence on facilities and joint-operational investment) that were found variable and effective between the

Table 4. Contextual factors influencing dyads to emerge and develop within triadic portfolios.

TCE dimensions	Contextual factors	Key quotations
Assets specificity	Facility-Dependence	<i>Our dyadic actor is fully aware about our pricing strategy on raw material, packaging, customer service and even our damaged inventories [. . .]. (Focal actor A—Contracting Manager). Our relationship with importers is for getting together and putting joint planning together for our costs and then profits [. . .] It is a way of sharing information for gaining better sustainability performance with our actors in the chain [. . .]. (Actor 3/B1 – Relationship Manager)</i>
	Joint-operational investment	<i>Yes, we do want to support exporters to develop their logistics (e.g. transportation and equipment) in future transactions and there is a number of sharing strategies for frequent meetings, plans, cost, profits and training for sustainable purposes. (Actor 6/A2 – Sales Manager).</i>
Uncertainty	Supply-chain complexity	<i>We also support jointly our various chain suppliers for tax flexibility, sharing our market facilities, providing membership for market information, but still this is not effective along the supply-chain [. . .]. (Focal actor B – Production Manager)</i>
	Product salience	<i>Our sustainable importers always ask about how we can help in managing their product flow with other transactional actors [. . .] we do that in different ways such as providing holistic support for quality systems at the chain level, negotiating with the government to solve their leading approach along the supply-chain [. . .]. (Focal actor A – Production Manager)</i>
Frequency	Age of dyad	<i>Our contracts are for sharing many things [. . .] actually we share activities, resources and uncertainty for the success of our long-term relationships, leading to sharing information regarding costs, price setting and also positive financial benefits [. . .] (Actor 5/A1 – HR Manager).</i>
	Choice of actor	<i>We select our actors on a win-win basis, where we can work cooperatively with our importer or exporter [. . .] to develop a sustainable triad of collaboration, good communication, and trust, and to agree on beneficial options for competitive resource agenda and training programs [. . .]. (Actor 4/B2 – Export Manager).</i>

actors within their triads. Both Groups show high levels of facility-dependence and joint-operational investment as *concentrated collaboration* in Triad A, and as *cultivated and concentrated collaboration* in Triad B between the focal actor and associate actors within closed triads. Cases in Groups 1 and 2 display low to medium levels of facility-dependence and joint-operational investment as a *directed collaboration* between the focal actor and each actor in the supporting triads in their *open* (Sub-Triads A1, B1) and *transactional* (Sub-Triads A2, B2) forms.

Previous research found pricing strategy as a way for dyadic actors within their triadic collaborations to analyse costs and pricing processes along with their functions, leading to sharing information (Jraisat, Gotsi, and Bourlakis 2013; Formentini and Romano 2016). This mutual strategy focuses on pricing between buyers and sellers inside the supply chain (Formentini and Romano 2016), affecting the price-lists offered to end-customers (Van Der Rhee et al. 2010). This economic approach is an aspect of sustainable development to be integrated with mainstream information and management systems. Gathering and sharing data from various valuable sources provides rich information availability, leading to improved social interactions and environmental outcomes (Williams and Moore 2007; Pang et al. 2012). In both Case-Groups, all managers stated that they fully applied the concept of pricing in their actions with the dyadic actors and that most of their partners are aware of the importance of efficient collaborative cost analysis for reintegrating the business functions to achieve improved

benefits for economic and social purposes. These factors have focal actors bond with their focal and supporting triads in order to gain support in managing internal and external problems (Flynn, Huo, and Zhao 2010). Hence, an efficient price strategy plays an important role in supporting actors against such chain-related ambiguities. Focal actors apply revenue strategy to sharing costs and profits between dyadic actors in their operational strategies and technologies in order to achieve the supply-chain paradigm and information management (Formentini and Romano 2016). Revenue strategy is now viewed as a powerful driver for moving towards collaboration and for expediting sustainable results (Wikström 1996). This provides equal benefits, including revenue enhancements, cost reductions, and flexibility in coping with high demand uncertainties (Simatupang and Sridharan 2005). Literature and case studies indicate that revenue strategy is important for establishing triads based on information-sharing, and provides a synergy for collaboration in agri-supply-chains in developing countries. It is proposed that:

P1a: Focal actors with different collaboration at dyad level are important to form reasonable triad types by applying sharing information for different specific-asset investments that affect collaboration mechanisms at the Triad level to enhancing their sustainability performance at the agri-supply-chain level.

Uncertainty: Group 1 (Sub-Triad A1) shows actors having an open triad, which provides very limited support for information-sharing between them. There is a

Table 5. Overview across Cases: Available approaches on the basis of different intensity-levels of information-sharing.

TCE	Contextual Factors	Portfolio of Triad Approaches	Types of Triad Approaches (Collaboration Mechanism)	Collaboration contributing to Actions of Information-Sharing						Collaboration contributing to the Sustainability focus
				Case 1 'A'			Case 2 'B'			
				Triad A	Triad A1	Triad A2	Triad B	Triad B1	Triad B2	
Assets specificity	Facility-dependence Joint-operational investment	Direct approach: dyadic triad boundaries	Total cost strategy	High	Med	Med	High	Med	Med	Economic: High
				High	High	High	High	High	High	Social: High
Uncertainty	Supply-chain complexity	Revenue strategy Indirect approach: Dyadic-chain boundaries	Information flow	High	High	High	High	High	High	Environmental: Med
				Med	Low	Med	Med	Low	Low	Economic: High
Frequency	Product salience	Finance flow	Product flow	Med	low	Med	Med	low	low	Social: Med
				Med	low	Med	Med	low	low	Environmental: Med
	Age of dyad	Contracting approach: Contracting-market boundaries	Formal contracts	High	Low	Low	Low	Low	Low	Economic: High
				Low	High	High	High	High	High	Social: High
Choice of actors	Informal contracts	Informal contracts	Mixed Contracts	Low	Low	High	High	Low	High	Environmental: Med
				Low	High	Low	Low	Med	Med	

membership body for traders at the wholesaler site in Group 2 (Sub-Triad B1), although this is not effective and provides only very limited activities to help producers in their sustainability performance. There exists a limited number of coordinated training sessions and workshops within specific projects in Sub-Triads A2 and B2. Very few triads conduct quality-control programmes for joint planning affecting their social and environmental domains, whilst certification bodies as cooperative activities are available for only short periods. Both Groups show only low-medium levels of cost-sharing activity for exhibitions, tour visits to various markets, and waste management. These findings present a similar picture to those described by Jraisat and Sawalha (2013).

The key findings have highlighted how supply-chain complexity and product salience are key factors, which are variable and important between the three actors in each triad. Cooperation has become the starting point for information flows as a necessity (Busse, Meinschmidt, and Foerstl 2017). Collaboration between actors takes various forms, such as the use of information technology and/or traditional approaches such as current-plan sharing and the exchange of resources and experts, applying these activities also for social and environmental purposes between actors and service providers (Mikkola 2008; Pang et al. 2012). In both Groups, most managers recognised the importance of developing information flows in their communication strategy, including the development of an interesting base for information-sharing. *Product flow* was added to the key themes of this study, with the expectation that it would show a positive impact on collaboration. Lambert and Cooper (2000) have indicated that all chain actors with whom the focal actor interacts directly or indirectly through its service providers, suppliers or customers, from production to consumption. Actors participate in the various value-chain flows, including product, payment, information, agency-support and promotion flows (Flynn, Huo, and Zhao 2010). According to Lambert and Cooper (2000), information and financial flows at the chain level are to build knowledge-sharing and dissemination mechanisms at triad levels. Hence, a collaboration between actors regarding value-creation and information-sharing are already apparent owing to increased collaborative quality control and systems (e.g. HACCP, Global GAP certificates) to manage waste, recyclable materials, transactional frameworks and regulatory policies (local authorities or international authorities for economic, social and environmental activities) (Jraisat, Gotsi, and Bourlakis 2013). Most of the case studies found that their dyads in triads focus on product flow in order to share product-related activities in

the FFV supply-chain, leading to information-sharing by both dyadic actors within their triad. It is proposed that:

P1b: Focal actors with different collaboration types at the dyad level are important to form reasonable triad types by applying information sharing for different uncertainty analysis that affects collaboration mechanisms at the Triad level to enhance their sustainability performance at the agri-supply-chain level.

Frequency: Two factors, age of dyad and choice of actors, was found effective between the actors within their triads. It is evident in both Groups that high frequencies of interaction in long-term relationships and the presence of criteria-sets guiding actor choices indicate cultivated and concentrated collaboration between the three actors within closed triads. The Groups show low to medium levels of these interactions and criteria as directed collaboration in open and transactional triads. In most of these cases, collaboration was based on formal contracts which formed the framework for information-sharing activities in dyads related to specific transaction frequencies, shared traceability-system investment, and extensive contacts on a weekly and annual basis.

Contract strategy is an approach using formal and/or informal agreements as collaboration mechanisms to set up dyadic relationships with the highest level of mutual information-sharing and the lowest possible costs (Williamson 2008; Tate, Ellram, and Dooley 2014). This is an economic approach to enhancing transactions between buyers and sellers based on maintaining incomplete contracts (Grover and Malhotra 2003). This strategy encourages various activities and resource-allocation activities to help actors share information to improve strategies for optimal costs, prices and profits (Wilkinson and Young 2002; Pingali 2006). Furthermore, dyadic relationships lie at the core of investment in waste management, labour wages and community service; they are the means by which information and uncertainties in actions and performance are merged (Jraisat, Gotsi, and Bourlakis 2013). Aggarwal and Srivastava (2016) indicate that frequent meetings to discuss joint involvement and to increase information-sharing assisted the establishment of dyadic collaboration and dyadic triads. The case studies found that all triads focussed on the contracting strategy in a formal as medium-high in focal triads and sub-triads A1 or informal as low in sub-triads 2 ways for sharing activities, allocating resources and managing uncertainty, leading to information-sharing for both dyadic actors within their triad. It is proposed that:

P1c: Focal actors with different collaboration types at the dyad level are important to form reasonable triad types by applying information sharing for different frequency methods that affect collaboration mechanisms at the

Triad level to enhancing their sustainability performance at the agri-supply-chain level.

5. Conclusions

This research has conducted a multiple-case study on two triads in FFV supply chains. By examining triadic supply chains, the research has shed light on the implementation of collaboration mechanisms in triads. Previous research highlighted how focal actors work with their dyadic partners to extend sustainability. However, the literature shows that few focal actors apply effective dyad-triad approaches because these are ignored by management at the triadic supply-chain level (Wu, Choi, and Rungtusanatham 2010; Pagell and Shevchenko 2014; Wilhelm et al. 2016). Here, the research questions have elicited answers by identifying triadic approaches for collaboration and by posing three propositions. As this is an abductive approach, TCE is employed to provide answers regarding the contextual factors that have impacts on the associations between collaboration mechanisms, information-sharing activities and sustainability performance.

5.1. Theoretical contribution

The key findings provide a holistic conceptual framework (see Figure 3) in FFV supply-chain, where TCE has significantly extended thinking towards a theory of collaboration for triads. This framework can be a possible theory in the field of the triadic supply chain. TCE was used to explain the findings on selected triad approaches (direct, indirect and contracting approach-types) in a sustainability context at dyad, chain and market boundaries. It could be concluded that triadic collaboration measures in terms of triadic actors' strategies around the price, revenue, total cost, flow of information, product and finance, and contracting are antecedent to sustainability performance in economic, environmental and social aspects under the leadership of the focal actor. While many studies (e.g. Yigitbasioglu 2010; Jraisat, Gotsi, and Bourlakis 2013; Busse, Meinschmidt, and Foerstl 2017) have applied the TCE perspective to dyads, the present research has attempted to extend the application of this perspective to both dyadic and triadic contexts, linking dyadic dyads (of cultivated, concentrated and directed collaboration-types) within triadic supply-chains (of closed, transactional and open triad-types).

The existing literature on collaboration in supply-chains focuses on a single actor (Martinez and Poole 2004) or business relationships (Pagell and Shevchenko 2014; Tasca, Nessi, and Rigamonti 2017). By broadening the empirical focus in the present research to all

three actors (focal actor and associate actors) and their dyads within a triad, we discovered that collaboration is a shared activity of all three actors.

The research confirms also their links to information symmetry and cost reduction. Certain authors (e.g. McAdam, Hazlett, and Anderson-Gillespie 2008; Acquaye et al. 2014) have identified a positive link between collaboration and improved sustainable performance. Weak collaboration between dyadic actors may have a detrimental effect on business performance, whilst effective collaboration should improve it. Each actor was asked about performance in terms of profit and access to markets, social factors (e.g. job creation, family work) and environmental factors (e.g. water pollution, chemical use, health hazards). The dyadic actors most clearly exhibiting sustainable performance were also those achieving the highest indicators in terms of their industry norm, and having a healthy market share, positive social impact and effective environmental activities, whereas those exhibiting the least collaboration also had the lowest profits, a weak market share, minimum social interaction and limited environmental results. According to Duffy, Shaw, and Schaubroeck (2008) and Jraisat, Gotsi, and Bourlakis (2013), actors should pay attention to both financial (profitability) and non-financial (quality) criteria of business performance. Sustainability management includes considerations regarding social aspects and environmental issues, as well as their interaction with economic performance (Seuring and Müller 2008; Beer and Micheli 2017). The organisation's alignment regarding the environmental issues influences the stakeholders. The two aspects of engaging with new partners and funders with respect to the social and environmental issues relating to the performance goals and alignment support. These help to understand the institutional logistics and the front-line workers which alleviate the achievement of social and welfare objectives. To enhance the effect of the social and environmental aspects external stakeholders and funders consider the institutional logics of measure and its compliance. The interaction amongst the beneficiaries should be an important aspect that can help the achievement of primary social aims

5.2. Implications for practice

This research has key managerial implications. It provides focal and triad actors with key recommendations for effective collaboration. Focal firms could apply the direct approach at the dyad level to understand collaboration types linking asset investment and symmetric information between the three actors within each triad. Focal firms could then develop collaboration between the triadic actors and the chain-supportive actors at the chain

level to share information symmetrically and asymmetrically in various situations of uncertainty along the triadic supply chains.

5.3. Limitation and future directions

This research raises interesting areas of study. First, the conceptual framework indicates significant opportunities for future research. A key opportunity exists at the collaboration levels that are developed within the dyads in the context of triadic supply chains. Prior research has indicated that information-sharing (Porter and Millar 1985; Bailey and Francis 2008; Jraisat, Gotsi, and Bourlakis 2013) is needed at various levels of collaboration development and improvement, raising questions about the criteria for each level of development and improvement to help dyadic actors conduct sustainable activities at dyad, triad and chain levels. Second, this research mainly followed a theory-building approach which led to limited generalisability. This study is qualitative in nature and the conceptual framework needs to be tested through further qualitative studies and even quantitative studies involving large-scale surveys. Third, the selected cases were triads where all three actors were connected through business relationships and where important collaborative strategies attached to information-sharing activities took place.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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