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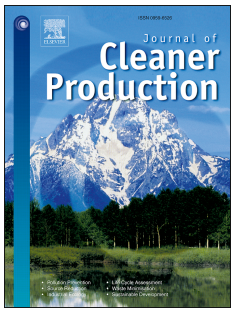

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Dare to make investments in industrial symbiosis? A conceptual framework and research agenda for developing trust

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Abstract

Scholars, policy-makers and industries increasingly express their interest in the development of industrial symbiosis (IS) as a way to transition to cleaner production. Yet, many proposed IS instances never get implemented. In this article, we argue that a lack of clear understanding on how trust develops in the context of IS may prevent the implementation of new IS initiatives. Initiating new IS typically require upfront investments, such as pipelines and waste treatment equipment, and take place in a cross-industry setting. This upfront and cross-industry setting of new IS investments may restrict firms in their ability to develop trust prior to the IS investments. Management literature provides a large body of literature on trust. Based on a multidisciplinary conceptual study, the aim of this paper is to synthesize and combine empirical and theoretical research from the fields of management and IS, and theorize how trust applies to the field of IS, i.e. how firms can deploy certain strategies to develop trust prior to the IS investment in the context of upfront and cross-industry IS investments. As a result, this paper introduces a conceptual IS trust framework and proposes an agenda for future research.

Keywords:

trust, industrial symbiosis, investment, partnership, conceptual framework, research agenda

Abbreviations:

IS – industrial symbiosis
CBT – calculus-based trust
KBT – knowledge-based trust
IBT – identification-based trust
GHG – greenhouse gas
EIP – eco-industrial park
NISP – National Industrial Symbiosis Programme

1. Introduction

Industrial symbiosis (IS) is an inter-organizational relationship that often takes place between otherwise diverse industries, and which aims to economically reduce the environmental impact of firms through the exchange and reuse of waste and byproducts (Chertow, 2000). IS can be considered a form of a buyer-supplier relationship. According to management literature, a buyer-supplier relationship is characterised by different types of interrelationships and levels of interdependence between parties engaged in the exchange of resources (Huo et al., 2019). IS contributes to higher resource efficiency and therefore forms a core part of the agenda towards more sustainable production practices. Trust between firms plays a vital role in establishing new IS relationships (Ashton and Bain, 2012). Indeed, IS scholars argue that trust helps reduce the risks related to the potential long-term commitment, long pay-back time and uncertain business conditions often seen in IS (Hiete et al., 2012). Moreover, insufficient trust levels are considered one of the main barriers for collaboration between companies (Fichtner et al., 2005). In fact, even an anticipated, high economic return from an IS exchange does not necessarily lead to investing in IS (Paquin et al., 2014). Yet, despite the acknowledged need of trust for the establishment of IS relationships, how firms can develop trust in the context of IS is still not fully understood (Yap and Devlin, 2017) and benefits from further research (Velenturf and Jensen, 2016). Management literature, though, offers ample insights into how trust between inter-organizational relationships develops. Hence, management literature can also provide reasonable justification on how and why trust may play a pivotal role in the case of potential IS investments.

The aim of this article is to merge IS literature and management literature to explore the role and development of trust in setting up IS relationships. Insights from management literature are applied and discussed in the context IS investments. In doing so, the authors explore the following research question: *how can firms develop trust in the context of IS investments*? Based on this exploration, a conceptual framework and research agenda for developing trust in the context of IS is presented.

The conceptual framework and research agenda contribute to literature and practice. Currently, the state-of-the-art literature on trust in IS lacks a framework and a research agenda on how to gain further knowledge about trust development in IS. As Pagell and Shevchenko (2014) argue, the integration of multidisciplinary fields is required to advance the field of sustainability, this research contributes to literature by 1) demonstrating how management literature and IS literature are related in terms of trust 2) proposing a conceptual framework for developing trust in the context of IS investments 3) suggesting research agenda for future research. Moreover, the developed framework helps firms, governments and third-party facilitators to advance to the needed trust for upfront and cross-industry IS investments thereby assisting firms in their transition towards cleaner production.

This paper is structured as follows. This section continues by setting the stage and introducing the concept of IS. Section 2 describes the research procedure and the methods applied in this study. Section 3 elaborates on the need for trust in upfront IS investments and shows how IS literature and management literature define trust. Furthermore, section 3 also presents the existing strategies for developing trust according to management literature and approaches for developing different levels of trust in the context of upfront and cross-industry IS investments. The conceptual framework on developing trust in IS is introduced in section 4. Section 5 provides conclusions, discussion and suggestions of how this work can serve as an avenue for future research.

1.1. Introduction to IS

IS is a concept deriving from the field of industrial ecology, related with the flow of resources on an inter-firm level (Chertow and Ehrenfeld, 2012). The usual resources exchanged between firms are wastes, materials, by-products, energy, water, and even know-how (Chertow, 2004). Scholars have studied the emergence of IS since the early 1900s and identified both economic, environmental and social benefits as motivation for setting up IS exchanges (Mirata and Emtairah, 2005). Avoiding waste disposal taxes, ensuring lower costs for input materials (Yap and Devlin, 2016) , lowering greenhouse gas (GHG) emissions (Desrochers and Leppala, 2010), etc. are some of the benefits presented in IS literature. Albino and Fraccascia (2015) have taken a step further and identified two business models related to IS, i.e. for establishing a platform for online waste trading and creating new products based on waste.

Kalundborg in Denmark is perhaps the most cited and well-known case of successful IS (Ashton, 2008). Other well-known instances of IS include Kwinana, Australia (van Beers et al., 2007), Rotterdam, The Netherlands (Baas and Boons, 2004), Styria, Austria (Schwarz and Steininger, 1997), the Guitang Group symbiosis in China (Zhu et al., 2007) and various cases across the United States (Heeres et al., 2004). IS may develop in a variety of ways, ranging from firms which self-organize the IS exchange (Chertow, 2007) to central bodies such as governments, which plan IS using a top-down approach (Domenech, Bleischwitz, Doranova, Panayotopoulos and Roman, 2019). In the middle of this spectrum, third-parties may facilitate certain aspects of the IS exchange such as bringing firms together: the so-called facilitated IS (Paquin and Howard-Grenville, 2012). In this research, the focus is on self-organized and facilitated IS as firms themselves decide whether to partake and invest in IS rather than being forced to by governments in planned IS. IS developed through social networks are considered more capable of expanding their scope of activities and adapting to changing circumstances (Chertow and Ehrenfeld, 2012), while governments imposing IS investments on firms may cancel out the need for trust between the firms (Velenturf and Jensen, 2016).

2. Research procedure

This is a conceptual study, which integrates two research fields: IS literature and management literature. A multidisciplinary conceptual study is a relevant method when research fields do not oppose each other and have not been linked to each other yet.

The above is the case for this study. Management literature offers a large body of literature on how trust develops between firms that take part in an inter-organizational relationship. However, although IS literature argues that trust is important (Velenturf, 2015) given then particular contingencies characterising IS relationships, research on trust in IS literature is in its infancy, especially when compared to management literature. A multidisciplinary conceptual study based on the integration of management and IS literature regarding trust is, therefore, an appropriate method to answer the research question: *how can firms develop trust in the context of IS investments*? The unit of analysis of this research is the party making an initial IS investment and the trust base level between the IS parties. The conceptual/theoretical approach for answering the research question is further justified by the absence of similar studies.

The research procedure, as presented in Fig. 1, is a three-step model. The first step consists of a two literature search rounds in order to identify the relevant background literature (section 3). The first search round includes an extensive search on Scopus, Web of Science and ScienceDirect considering titles, keywords and abstracts with the search strings "*trust*", combined with "*industrial symbiosis*" or "*industrial ecology*" and no restrictions to the fields of knowledge. The scientific papers identified as a result from the search indicate that frameworks and conceptual studies are considered important for advancing the knowledge on topics related to sustainability and IS and are well-received in the scientific community, some examples are Angell and Klassen (1999), Boons et al. (2011), Despeisse et al. (2012) and Seuring and Müller (2008). A second literature search round seeks for scientific papers merging the two literature domains of "*IS*" and "*management*" and their joint link to "*trust*". Studies which combine management literature and IS literature emerged in journals, such as the Journal of Cleaner Production – e.g. Herczeg et al. (2018). Yet, the literature search did not lead to studies that clearly combine management and IS literature to develop knowledge about trust in the context of IS – even though several articles on the topic called for a deeper perspective on trust (Yap and Devlin, 2017).

In the second step, the relevant state-of-the-art literature are further analysed and integrated. The analysis is based on the existing papers on trust in IS literature and management literature. Firstly, factors affecting the need for trust are depicted in IS literature (section 3.1). The difference between the way IS literature and management literature conceptualise and operationalise trust is introduced in order to define how the two literature domains can contribute with bringing insights to one another (section 3.2). The different strategies for developing trust according to management literature are presented and their relevance in the context of IS is discussed (in section 3.3). Based on the above-described analysis, a conceptual framework for developing trust in the context of IS is proposed (section 4).

Lastly, a discussion of the applications of the proposed model, as well as a proposal for future research agenda are provided (section 5).

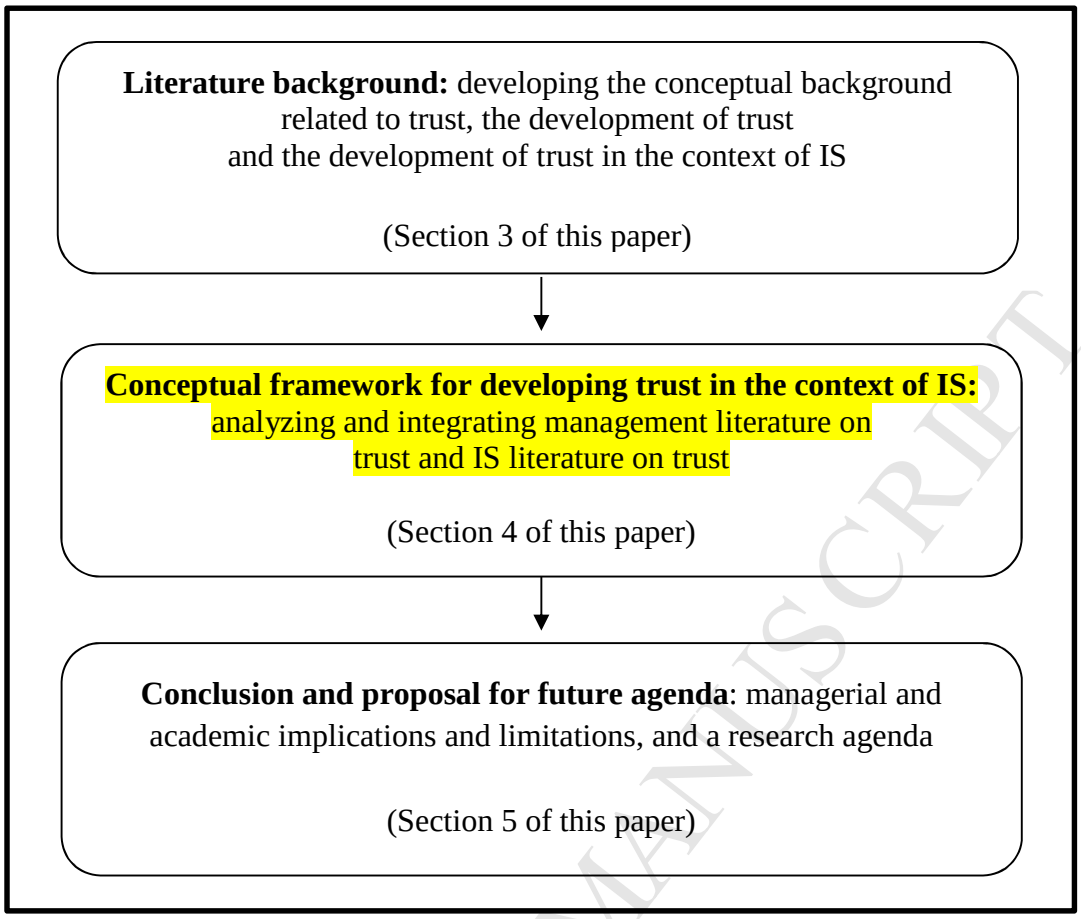


Fig. 1. A description of the three-step research procedure this study is based on.

3. Literature background

3.1 The need for trust in the IS investment from the perspective of the investing party

Vanpoucke et al. (2014) found that investments in buyer-supplier relationships require high levels of trust of the investing party. Likewise, Ehrenfeld and Gertler (1997), Hiete et al. (2012), Velenturf (2015), Fichtner et al. (2005) and Panyathanakun et al. (2013) among others, observe a high need for trust in setting up and investing in IS relationships. The perceived risk of the IS investment affects the required level of trust of the investing party. When the investing party perceives the overall risk of the IS investment as low, lower levels of trust may suffice. On the contrary, the investing party may require higher levels of trust before making riskier upfront IS investments (Nooteboom et al., 1997). There exist strategies and methods to reduce the negative impact of poor supplier performance, such as input-output modelling to prepare the IS network for a crisis (Tan et al., 2016), trust deriving from embedded IS networks (Hewes and Lyons, 2008) and building upon reliable anchor tenants, who provide constant and reliable flows of waste and by-products (Chertow and Ehrenfeld, 2012). The required level of trust in the context of IS might be high because risks for the investing party may arise from the following sources:

1. **Long payback time.** Although literature shows that implemented IS investments can have short payback times – see for example Park and Park (2014) who describe the

short payback times for various investments in IS exchanges in South Korea and Jacobsen (2006) who describes short payback times of IS investments in Kalundborg – IS investments are often characterized by high payback times (Hiete et al., 2012). The longer the payback time, the higher the risk that the investment does not pay itself back.

2. **Economic lock-in.** The economic lock-in effect refers to the risk of being solely dependent on a single supplier and looking for alternatives is expensive due to the asset specificity and high transaction costs typical in the context of IS (Zhu and Ruth, 2013). Case descriptions of amongst others Ashton (2008), Baas and Boons (2004), Ehrenfeld and Gertler (1997) and van Beers et al. (2007) show that most IS exchanges depend on only one supplier and that the asset specificity and transaction costs of the investment are high. Hence, in IS, there is often a high risk of "lock-in", which makes the investment dependable on the supplier.
3. **Incomplete and complex contracts.** IS investments are often accompanied by long-term and complex contracts (Jacobsen, 2006) which enable the IS exchange (Albino et al., 2015). However, firms cannot predict every potential risk because of their bounded rationality. Factors such as changing governmental regulations regarding waste handling can undermine the validity of the contract (Yap and Devlin, 2017). Furthermore, the complex context of IS, the size of the IS investment and the spontaneous and emerging adaptations of IS make it likely to overlook potential risks in the contract (Carpenter et al., 2009).

In addition, when the investing party is the buyer of the waste and byproducts, the required trust levels might be even higher due to the following reasons:

4. **Poor expected supplier performance.** Managing waste and byproducts is often not a core competence and core priority of IS partners (Bansal and Mcknight, 2009). The ability and willingness of the supplier to deliver in accordance with (strict) quality parameters might therefore be uncertain. Furthermore, suppliers might also underperform on other aspects such as on-time delivery in full and guaranteeing sufficient quantities of waste and byproducts in the future (Walker and Jones, 2012).
5. **Inflexibility of the receiving process.** The perceived risk of short falling supplier performance is lower when firms can counteract poor supplier performance. For example, by having a certain degree of flexibility in their own processes in terms of accepting waste and byproducts of varying quality. However, processes become increasingly optimized and become therefore less flexible towards varying waste and byproduct quality. This is especially true in the process industry (King, 2009), which is a major player in IS.
6. **Sharing confidential information.** Even though in most of the IS cases the partnering companies come from different industries or locations and do not recognize each other as competitors, sharing sensitive information about one another is considered a process in progress (Fraccascia and Yazan, 2018). Thus, firms might initiate an IS with limited confidential information about each other and as trust levels increase, so does sharing of internal data.

Long payback times, economic lock-in, incomplete contracts, poor expected supplier performance, inflexible receiving processes and the need for sharing confidential information increases the perceived risk of the upfront investment. It is therefore not surprising that many IS scholars suggest that trust plays a vital role in establishing new IS relationships, among others (Ashton and Bain (2012), Chertow (2007), Ehrenfeld and Gertler (1997), Hewes and

Lyons (2008); Sterr and Ott (2004); Yap and Devlin (2017). To develop trust, one has to consider the context of initial IS investments.

IS relationships often take place *across different industries* and require *upfront* investments to enable the exchange and reuse of waste (Bansal and Mcknight, 2009). Indeed, case descriptions of amongst others Baas and Boons (2004), Ehrenfeld and Gertler (1997), Schwarz and Steininger (1997), van Beers et al. (2007) and Zhu et al. (2007) show that IS often requires *upfront* investments to process and transport waste and byproducts and to prepare waste and byproducts to meet exacting quality standards. See for example case descriptions of the Kalundborg symbiosis (Jacobsen, 2006) and the Guitang Group symbiosis (Zhu et al., 2007), which mention upfront investments such as pipelines and waste treatment equipment. Furthermore, from the aforementioned case descriptions it is evident that IS often take place in a *cross-industry* environment (Bansal and Mcknight, 2009). Literature describes various waste and byproduct exchanges such as fly ash, waste water, steam, sulphur and various minerals and chemicals between otherwise unrelated industries such as cement production, energy generation, oil and sugar refinery and more (Bansal and Mcknight, 2009). The cross-industry nature further complicates increasing the intensity of the business relationship.

The *upfront* and *cross-industry* nature of IS investments may restrict firms in developing trust due to the lack of previous business transactions (Vanpoucke et al., 2014). Yet, the need for trust increases when the cross-industry nature leads to unfamiliarity with each other's business because the unfamiliarity may complicate the ability to judge the quality of the resources the other brings in or to audit the other's behaviour and performance (Brinkhoff et al., 2015). As such, the upfront and cross-industry nature creates a context in which trust plays a peculiar and not yet fully understood role. Fig. 2 graphically depicts the need for trust and the research context, thereby showing that the strategies to develop trust should take into account the context of upfront investments and the cross-industry nature of IS.

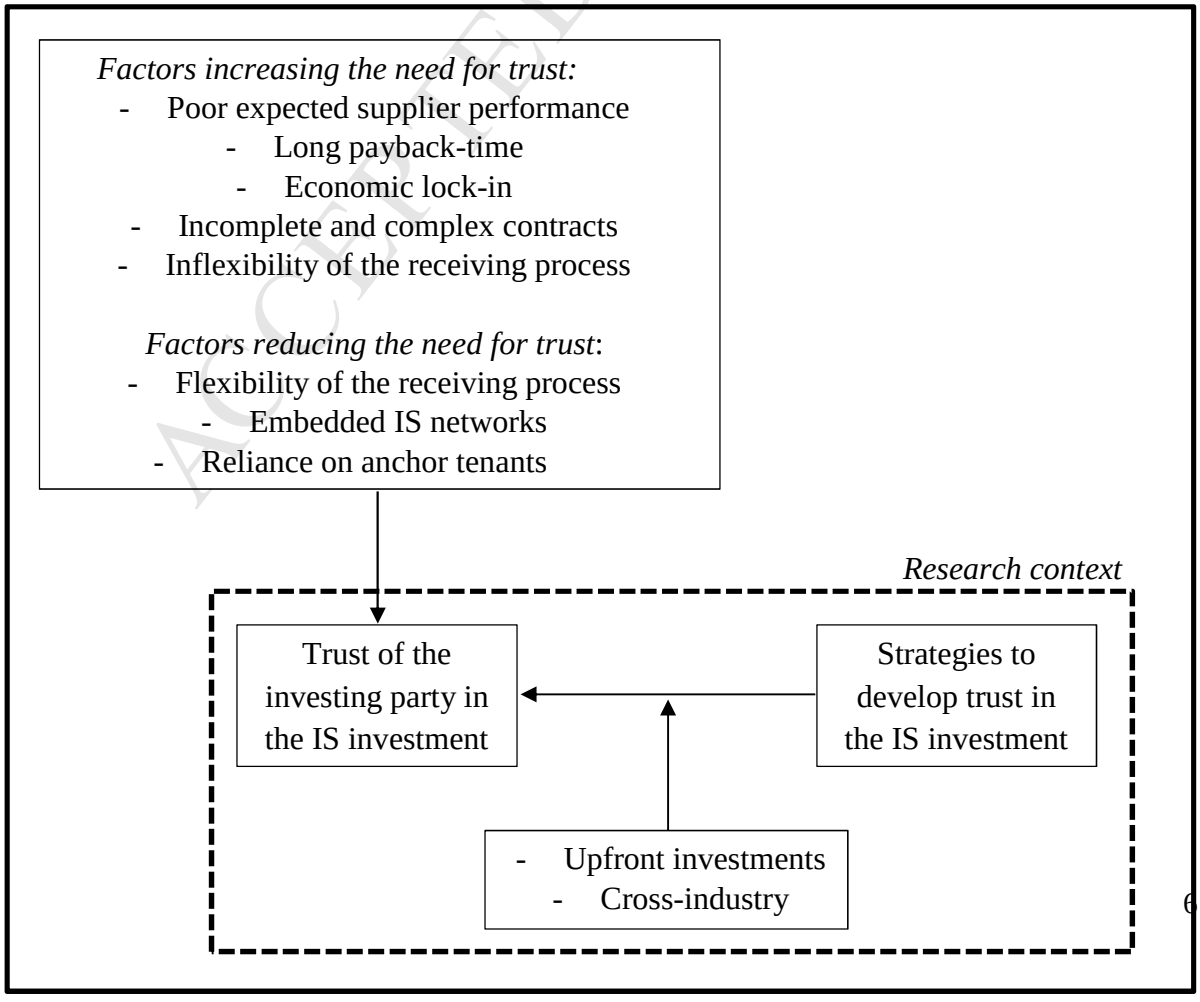


Fig. 2. The need for trust in IS investments and the research context of trust developing strategies (dotted box).

To explore the research question: *how can firms develop trust in the context of IS investments*?, the next section 3.2 elaborates on the definition of trust and how trust develops and section 3.3. provides strategies which firms can deploy to develop trust.

3.2. Conceptual understanding of trust and its operationalisation in the context of IS

Management literature and IS literature often hold a limited perspective on trust. In management literature, the mainstream view holds that trust emerges naturally as a result of exchanges (Li, Eden, Hitt and Ireland, 2008) – e.g. relationship length is often used as a proxy for trust in survey studies. In the field of IS, trust is often described in general terms and lacks sound analysis (Hiete et al., 2012). For example, Ehrenfeld and Gertler, (1997) refer to the role of trust in establishing IS as "*an atmosphere of trust in Kalundborg existed even in the absence of specific experience between firms*" (p. 74); Gibbs (2003) argues that "*many of the key barriers to EIP [eco-industrial park] formation revolve around issues of inter-firm networking, trust and the potential to cooperate*" (p. 230) and Ashton (2008) notes that: "*as a proxy for trust, respondents were asked to indicate which of the other managers [in the IS of Barceloneta, Puerto Rico] they would be willing to do business with personally, regardless of industry affiliation*" (p. 45). Hiete et al. (2012) takes a somewhat more elaborate perspective on trust by mentioning that in the initial stages of IS, IS partners rely on calculus-based trust. However, they do so without arguing why calculus-based trust is important and how calculus-based trust can be developed. Johnston et al. (2004) furthermore presumes without further justification that if trust levels are high that would lead to more collaboration between dyads. Due to the limited perspective on trust in IS literature, how and why trust arises end enables upfront investments in the cross-industry context of IS remains unclear. Management literature has conceptually addressed this issue and can thus, contribute to understanding the formation and role of trust in inter-organisational relationships.

Mayer et al.'s (1995) frequently cited definition of trust offers a useful avenue to explore how firms can develop trust in upfront IS investments. Mayer et al. (1995) refers to trust as "*the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action, irrespective of the ability to monitor or control that other party*" (p. 712). This definition carries notions of the belief in the other's ability, integrity and benevolence. These notions are similar to Sako's (1992) and Nooteboom's (2002) categorizations of competence, contractual and goodwill trust. Competence trust (ability) describes the belief that the other is capable enough to perform a given set of tasks; contractual trust (integrity) refers to the belief that the other will adhere to the agreements and accepted ethical principles; goodwill trust (benevolence) labels the confidence that the other will not show self-interested behaviour when an opportunity occurs (Crane, 2018).

Like all business relationships, the three notions of trust also apply in the context of IS investments. For example, the supplier might misrepresent their ability to control the overall quality or the quality variances in order to get rid of their waste and byproducts and avoid landfill taxes (Mirata, 2004). IS partners might not act integer or benevolent for various reasons (Park et al., 2008). Low levels of trust in the ability, integrity or benevolence of the business partner might ultimately put the upfront IS investment at stake.

3.2.1. The development of trust

Management literature argues that the development of trust moves through three different, yet complementary, trust bases (Lewicki et al., 2006). The first trust base – calculus-based trust (CBT) – is defined as trust based on an economic calculation of the costs and benefits of the business partner for overstating their ability, (not) adhering to the agreements or (not) acting opportunistically in ambiguous situations. Based the calculated economic impact for the other firm when not fulfilling their part of the obligation, firms can estimate the likelihood that the other will act (un)trustworthy (Lewicki and Bunker, 1995). Therefore, CBT is established when the costs for sustaining the relationship prove to be lower than the potential generated benefits (Chen, Lin and Yen, 2014). When business partners get to know each other better, trust development moves from CBT to knowledge-based trust (KBT). KBT relies on the ability to understand and predict the other's behaviour through knowledge, hence forming another basis of (dis)trust (Shapiro et al., 1992; Lewicki et al., 2006). Finally, when business partners start to identify themselves with each other and internalize each other's preferences, identification-based trust (IBT) develops (Lewicki et al., 2006). IBT relies upon the knowledge that the other is motivated to pursue joint outcomes rather than maximizing its own self-interest (Lewicki and Bunker, 1995). IBT only develops in a small subset of business relations, as it requires parties to respect and consider each other's standpoint (Pinto, Slevin, & English, 2009). Developing the next trust base can already start in the preceding trust base. KBT can already develop from the beginning and IBT can develop even though KBT hasn't reached its peak yet (Lewicki et al., 2006). In addition, it is possible to have different levels of trust for the different notions of trust (i.e. ability, integrity, benevolence) (Lewicki and Bunker, 1995). The trust model proposed by Lewicki and Bunker is based on the notion of a progressive development of trust, meaning that parties move from one stage of trust to the other over time (Pinto et al., 2009). Shifting to the next trust base typically happens at specific points in the relationship, with trust levels quickly increasing in short time spans. This sudden shift in trust levels is explained by the increased intensity of the business relationship at a given point in time (Lewicki et al., 2006).

3.3. Strategies for developing trust

Based on management literature, Ireland and Webb (2007) identify four strategies that firms can use to create trust between business partners (without specifying which notion of trust and which trust base), namely:

- boundary spanners
- common identity
- authority
- justice

The latter two strategies – authority and justice – are excluded from further analysis. Authority enables the exertion of power and provides a source legitimate influence over the other firm while sustaining the current trust levels. Therefore, authority is not directly linked to creating trust between parties entering in an IS, as it is based on their own will. Justice requires previous business transactions to build up norms of reciprocity and is therefore out

of the scope of this study due to the context of upfront investments (Ireland and Webb, 2007). Boundary spanners and common identity, on the other hand, can be applied in virtually every buyer-supplier relationship and firms can proactively apply these strategies to create trust without the need for business transactions prior to the IS investment. In fact, the strategies of boundary spanners and common identity also occur in IS literature.

3.3.1. Boundary spanners

The strategy of boundary spanners refers to gathering and sharing information about firms' strategic intentions (Perrone, Zaheer and McEvily, 2003). As such, boundary spanners can provide transparency of the objectives and capabilities of potential IS partners (Ireland and Webb, 2007). According to IS literature, boundary spanning agents (e.g. board-of-director interlocks, purchasing agents and IS champions) and third-party facilitators (e.g. Kalundborg Symbiosis Centre and the National Industrial Symbiosis Programme (NISP) can utilize their boundary spanning role to create trust. Hewes and Lyons (2008), for example, show that so-called 'champions' play an important role in establishing trust. Champions are advocates of the IS exchange and can be persons from inside or outside the firm. Furthermore, IS literature suggests that boundary spanning activities informal meetings at business clubs or at the golf court (Jacobsen, 2006), making participants partake in participatory modelling (Batten, 2009). Likewise, Paquin and Howard-Grenville (2009) claim that boundary spanners such as third-party facilitators (e.g. Kalundborg Symbiosis Centre and the NISP) can create trust. However, at which stage of the trust creating process the above described boundary spanning activities are useful for the investing party remains unclear. In addition, although mentioned as enablers for IS, the role of other boundary spanners, such as public knowledge (e.g., company websites, certifications, reputation, etc.) and a shared network (e.g. common relationships) in terms of creating trust, is not yet discussed in literature. Hence, questions such as how and when to apply boundary spanners benefit from further exploration.

3.3.2. Common identity

The strategy of a common identity refers to establishing shared goals and norms that in turn become antecedents for developing trust within a relationship (Mayer et al., 1995). According to management literature, when firms identify themselves with a certain group, they act in a way that benefits those within that group (Ireland and Webb, 2007). A common identity can derive from cultural and geographical proximity (Lewicki et al., 2006). In the context of IS, a common identity often arrives from a shared 'green profile' and social proximity (often enabled through geographical proximity) (Zhu et al., 2015). Furthermore, common identity can derive from allocating and maximizing the benefits of IS through methods, as presented by Andiappan et al. (2016) when such methods lead to shared goals.

However, developing a common identity may require significant time and the upfront nature of initial IS investments might not allow for this time. Nevertheless, when a common identity already exists, the investing firm can capitalize on this. The question therefore is how and when to capitalize on a common identity in the context of IS.

4. Conceptual framework for developing trust in the context of IS

In the next paragraphs, it is explored how the investing party can deploy the strategies of boundary spanners and common identity to increase the level of trust by progressing to the

next trust base: from CBT to KBT and, eventually, to IBT. In this trust progression, the context of upfront and cross-industry investment as well as the three notions of trust, i.e. ability, integrity and benevolence. The discussion is summarized in the conceptual framework presented at the end of this section.

4.1. Establishing calculus-based trust (CBT)

As already mentioned, CBT ensues from an economic estimation of the costs and benefits of the IS partner for overstating their ability and (not) adhering to the agreements or (not) acting opportunistically in ambiguous situations (Lewicki et al., 2006). Therefore, strategies to develop CBT should gain insights into the costs and benefits of the business partner.

Boundary spanners can contribute to the development of CBT. Boundary spanning agents, such as purchase and operations managers, finance experts and lawyers, may arrange meetings with the potential IS partner to derive impressions and clues on which to base their estimation of the costs and benefits of the other for overstating their ability and not acting integer (Ireland and Webb, 2007). Likewise, boundary spanning agents can collect insights into the cost for the other when acting opportunistically. High costs for acting opportunistically reduces the likelihood for opportunistic behaviour, thereby increasing the CBT in benevolence.

However, boundary spanners can go beyond plain observations and estimations of costs and benefits by providing financial benefits. Literature offers several approaches, which boundary spanners can use to increase CBT. Some examples are a fuzzy optimization model (Leong, Tan, Aviso, Mei, & Chew, 2016; Ng & Ng, 2013), an optimization-based negotiation framework suggested by Andiappan et al. (2016), a cooperative game model (Tan et al., 2016), a multi-objective optimization approach (Leong et al., 2017); all applied as tools to support decision-making in estimating an optimal outcome from an IS.

Furthermore, Paquin and Howard-Grenville (2009) claim that boundary spanners such as third-party facilitators (e.g. Kalundborg Symbiosis Centre) and a shared network can provide impressions and clues about the costs and benefits for the other based on their earlier experiences with the potential IS partner, thereby increasing CBT in the ability, integrity and benevolence. Finally, publicly available knowledge, about disposal costs for example, may also contribute to the economic estimations.

A common identity, such as a shared ‘green’ profile or social proximity is unlikely to be a source of initial impressions and clues about the costs and benefits of the other for overstating their ability, not acting integer or not acting in a benevolent way (Lewicki et al., 2006).

4.2. Progressing to knowledge-based trust (KBT)

As discussed earlier, KBT relies on the ability to understand and predict the other’s behaviour through knowledge, hence forming another base of (dis)trust atop of CBT (Shapiro et al., 1992; Lewicki et al., 2006). The strategy of boundary spanners and common identity may be useful for gathering knowledge, thereby creating KBT.

Boundary spanning agents, such as purchase and operations managers, may arrange meetings with potential IS partners to better understand and predict the other’s behaviour (Ireland and Webb, 2007). Quality checks of the material and process checks at the other’s facilities can lead to insights into the other’s ability. Furthermore, boundary spanning agents,

such as purchasing and operations managers and board-of-director interlocks, can build up relationships with the other company prior to the investment. The relationships enable open communication and knowledge sharing and potentially lead to insights into the other's integrity and benevolence (Ireland and Webb, 2007). The empirical study of Paquin et al. (2014) on NISP suggests that IS are more likely to be established between companies that are well acquainted with each other's past participation in an successful IS. Gulati (1995) furthermore suggests that building such close relationships can lead to the use of more informal contracts instead of comprehensive ones, which can also bring lower transaction costs for both parties.

Furthermore, third-party facilitators such as the Kalundborg Symbiosis Center may contribute to the development of KBT. Paquin and Howard-Grenville (2012), for example, show that the NISP in the United Kingdom gains insights into the ability of potential IS partners prior to the initial IS investment. These insights are then shared between the involved IS partners. In addition, third-party facilitators like Kalundborg Symbiosis Center and the NISP can introduce firms to each other. As such, third party facilitators enable firms to use their own boundary spanning agents to gather knowledge about the potential IS partner (Paquin and Howard-Grenville, 2009). In addition, public knowledge (e.g. reputation and clearly stated business ambitions) exhibits capabilities and goals of the other party and can therefore create KBT in the ability, integrity and benevolence (Ireland and Webb, 2007).

The strategy of a common identity may contribute to KBT in terms of predicting the integrity and benevolence: when goals, norms and values are similar, the other is more likely to act integer and show benevolence. Kalundborg symbiosis is a great example on how companies can establish shared engagement and commitment in the IS, thus avoid experiencing usual issues with quality or material flow and instead exploring opportunities for further collaboration (Valentine, 2016).

4.3. Progressing to identification-based trust (IBT)

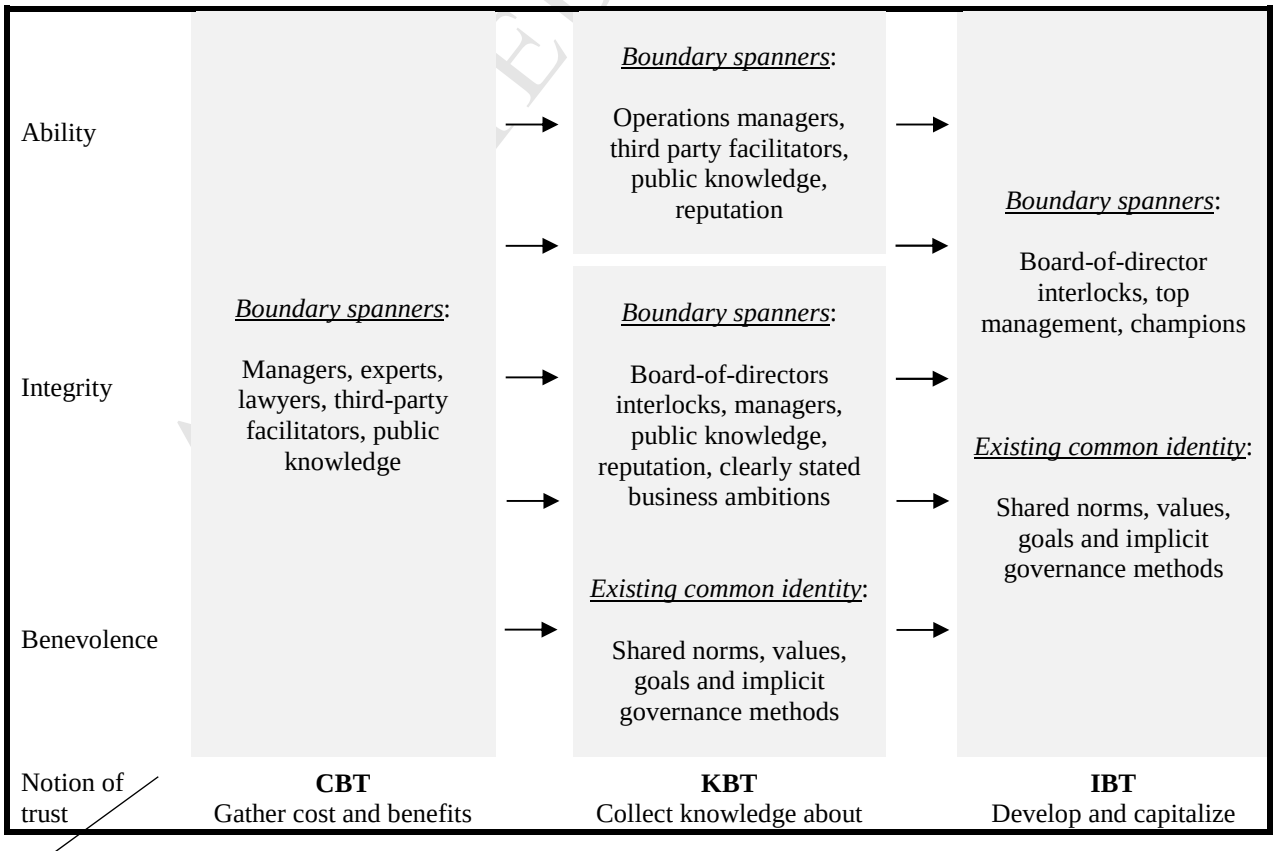
As noted, IBT develops when IS partners internalize each other's desires and intentions which leads to higher trust in the other's integrity and benevolence (Lewicki et al., 2006). To develop IBT, boundary spanners and a common identity should lead to shared desires and intentions.

Boundary spanning agents can play a role in developing IBT by integrating firms on a strategic level and identify and establish shared goals, and as such create trust in the other's integrity and benevolence (Ireland and Webb, 2007). Doménech and Davies (2011) suggest that trust in IS networks grows faster when there are common rules and implicit governance methods. Due to the strategic nature of the IS, developing shared goals, common rules and implicit governance methods probably requires the involvement and support of top-management and board-of-directors who should act as champions. However, time limitations may constrain the role of boundary spanning agents as developing a common identity may be time consuming and frequent contact between key stakeholders is needed (Doménech and Davies, 2011). Nevertheless, practices which lead to shared goals such as allocating and maximizing the benefits of IS – e.g. the optimization based negotiation framework of Andiappan et al. (2016) – can be conducted prior to the IS investment, thereby helping to develop IBT.

According to Chen et al. (2014) IBT is considered to demand minimal explicit governance methods for both parties and lead to the development of common coals and even exchange of

knowledge. Hence, existing common identity with common goals and implicit governance methods makes it unlikely that the other firm does not to adhere to agreements because it is against its own goals. Moreover, a common identity explicitly defines what is valued in reciprocity and the outcome of a reciprocal exchange that is being sought – i.e. if a firm is facing an issue, partners will aim to join forces in overcoming it (Ireland and Webb, 2007). That is the case with water shortage problems in Kalundborg, where through collective action of local businesses, IS was established to ensure the effective recirculation of water between companies (Herczeg et al., 2018). Similarly, in the EIP in Tianjin, China, in order to avoid further farmland degradation, companies worked together and through IS exchanges of waste resources managed to find an innovative method to produce new soil (Shi, Chertow, & Song, 2010). This means that a common identity can contribute to the development of IBT in terms of integrity and benevolence. Moreover, when firms identify themselves with a common identity in terms of IS, this common identity gives insights into the other's priorities. When IS receives high priority by the other firm, the other firm is more likely to develop the necessary IS capabilities, thereby increasing their ability. Hence, a common identity can provide trust in the other's ability.

The conceptual framework, depicted in Fig. 3, suggests strategies for developing trust in the context of upfront cross-industry IS investments. The conceptual framework illustrates how the notions of trust (ability, integrity and benevolence) in the potential IS partner can be enabled by various trust strategies, thus developing different bases of trust (CBT, KBT, IBT). To summarize, boundary spanners are considered capable of getting insights in the other's ability, integrity and benevolence and contributing to the development of CBT. Boundary spanners may also contribute to creating KBT in terms of ability, integrity and benevolence, while an existing common identity can possibly contribute to KBT in predicting the presence of integrity and benevolence of the other party. For trust to progress to IBT, boundary spanners and existing common identity can create trust in the other's ability, integrity and benevolence.



Trust base	of the other for not being trustworthy	the other's trustworthiness	shared desires and intentions

Fig. 3. Conceptual framework for developing trust in the context of upfront cross-industry IS investments. The figure should be read from left to right and from top to bottom. Each of the three trust bases that the development of trust moves through, i.e. CBT, IBT, KBT, are cross-linked with the notions of belief in the other's ability, integrity and benevolence through the trust strategies of boundary spanners and common identity.

5. Conclusion and proposal for future agenda

The objective of this research is to merge IS literature and management literature to explore the role and development of trust in setting up IS relationships. This is done by addressing the following research question: *how can firms develop trust in the context of IS investments?* Based on literature from the fields of management and IS, a conceptual framework for developing trust in the context of IS is developed and presented. The conceptual framework describes which strategies firms can apply to increase trust and at which stage the strategies should be applied.

However, despite introducing new aspects of the way in which trust is developed, the authors acknowledge the need for further research on the topic. More specifically, several papers from management literature suggest the absence of empirical studies on the role of trust in inter-company relations, some examples are Johnston et al. (2004) and Pinto et al. (2009). Therefore, the authors also see the need for an empirical study verifying how and to what extent the presented conceptual framework holds in practice. The following four questions could be examined in more details in order to further develop and operationalize the framework:

1. *Which trust base (CBT, KBT, IBT) is needed for the upfront and cross-industry IS investment to take place?*
    a. *For which of the three notions of trust (i.e. ability, integrity, benevolence)?*
2. *How can firms accelerate the trust developing process?*
    a. *For each of the three notions of trust*
    b. *For each of the three trust bases (i.e. CBT, KBT, IBT)*
3. *How effective is each strategy in developing trust, and what are the barriers?*
    a. *For each of the three notions of trust*
    b. *For each of the three trust bases*
4. *Which contingency factors need to be considered and how, when and why do they affect the trust development?*
    a. *E.g., How and to what extent does the openness of the firms have an impact on the development of trust in the context of IS?*
    b. *E.g., How and to what extent does geographic proximity influence the development of trust in the context of IS?*
    c. *E.g., Required level of trust*
    d. *E.g., How does power impact the effectiveness of creating trust through the strategies of boundary spanners and a common identity?*

Lewicki (2006) illustrates the relevance of the second question by means of an example. Saying hello to the child-care attendant every morning might eventually lead to getting to

know this person. However, being stuck with someone in an elevator for two hours accelerates this process and might lead to high levels of knowledge and trust in the other only after two hours. In the context of up-front investments, accelerating the trust developing process can be essential for the implementation of the IS investment.

In relation to question 4a and 4b, Mirata (2004) reports that the openness of the firms involved in the IS affects the degree in which they trust each other. Whereas the petro-chemical firms and chemical firms in the Humber region in the United Kingdom did not trust each other due to a closed attitude towards other businesses, firms in the West Midlands trusted each other more easily due to a history of communication. Boundary spanning agents, such as purchasers and board-of-director interlocks, might thus, be obstructed by a history of limited communication. Geographical proximity – although recently mostly hailed for technically allowing the exchanges of quickly degrading waste and byproducts or to economically enable the IS exchange (Lombardi and Laybourn, 2012) – can also ease the job of the boundary spanning agents as they can more easily meet in person. Moreover, geographical proximity makes it more likely that a common identity is already existing prior to the IS investment. However, the importance of geographic proximity remains rather unclear.

The proposed agenda could address the possible shortcoming of this study in the following way. First, as already mentioned, future research could use empirical data, either surveys or case studies, to test the usefulness of each strategy for developing a certain trust level (i.e. CBT, KBT or IBT) as well as the link to the notions of trust (i.e. ability, integrity or benevolence). Second, factors such as company size, industry, type of exchange, the uncertainty in the supplier's ability, size of the investment, competitive relationship between firms (albeit IS occurs typically on a cross-industry level and the involved firms are often not competing (Hiete et al., 2012)) most likely influences the usefulness of the proposed strategies in different ways (Lewicki et al., 2006). As such, further exploratory case studies as well as survey studies are needed to fully understand the role of trust in establishing upfront cross-industry IS investments.

Nevertheless, this research contributes to the field of cleaner production is several ways. The novelty of this study lies in providing an improved understanding of the development and role of trust in upfront cross-industry IS investments based on insights from the fields of management and IS. In doing so, this research contributes by providing:

1. An improved understanding on <u>when</u> to apply different trust developing strategies
2. An improved understanding on <u>how</u> to apply different trust developing strategies
    a. The role of boundary spanning agents, such as IS champions, changes when moving from CBT to KBT to IBT. In fact, an IS champion could be a different person depending on the stage of the trust development process
3. A conceptual IS trust framework and agenda for future research

As such, this exploratory work may act as an umbrella framework and research agenda for further studies towards developing trust in the context of IS.

References

Albino, V., Fraccascia, L., Giannoccaro, I., 2015. Exploring the role of contracts to support the emergence of self-organized industrial symbiosis networks: an agent-based simulation study. J. Clean. Prod. 112, 4353–4366. Available at: http://www.procedia-

esem.eu

Albino, V., Fraccascia, L., 2015. The industrial symbiosis approach: a classification of business models. Procedia Environmental Science, Engineering and Management 3, 217-223

Andiappan, V., Tan, R. R., and Ng, D. K. S., 2016. An optimization-based negotiation framework for energy systems in an eco-industrial park. J. Clean. Prod. 129, 496-507

Angell, L. C., Klassen, R. D., 1999. Integrating environmental issues into the mainstream: an agenda for research in operations management. J. Oper. Manag. 17, 575–598

Ashton, W., 2008. Understanding the organization of industrial ecosystems: a social network approach. J. Ind. Ecol. 12, 34–51. https://doi.org/10.1111/j.1530-9290.2008.00002.x

Ashton, W. S., Bain, A. C., 2012. Assessing the "short mental distance" in eco-industrial networks. J. Ind. Ecol. 16, 70–82. https://doi.org/10.1111/j.1530-9290.2011.00453.x

Baas, L., Boons, F., 2004. An industrial ecology project in practice: exploring the boundaries of decision-making levels in regional industrial systems. J. Clean. Prod. 12, 1073–1085. https://doi.org/10.1016/j.jclepro.2004.02.005

Bansal, P., Mcknight, B., 2009. Looking forward, pushing back and peering sideways: analyzing the sustainability of industrial symbiosis. J. Supply Chain Manag. 45, 26–37. https://doi.org/10.1111/j.1745-493X.2009.03174.x

Batten, D. F., 2009. Fostering industrial symbiosis with agent-based simulation and participatory modeling. J. Ind. Ecol. 13, 197–213. https://doi.org/10.1111/j.1530-9290.2009.00115.x

Boons, F., Spekkink, W., Mouzakitis, Y., 2011. The dynamics of industrial symbiosis: a proposal for a conceptual framework based upon a comprehensive literature review. J. Clean. Prod. 19, 905–911. https://doi.org/10.1016/j.jclepro.2011.01.003

Brinkhoff, A., Özer, Ö., Sargut, G., 2015. All you need is trust? An examination of inter-organizational supply chain projects. Prod. Oper. Manag. 24, 181–200. https://doi.org/10.1111/poms.12234

Carpenter, S. R., Folke, C., Scheffer, M., Westley, F., 2009. Resilience: accounting for the noncomputable. Ecol. Soc. 14, 13-18. Available at: http://library.wur.nl/WebQuery/wurpubs/fulltext/148334

Chen, Y.-H., Lin, T.-P., Yen, D. C. (2014). How to facilitate inter-organizational knowledge sharing: The impact of trust. Inform Manag, 51, 568–578. https://doi.org/10.1016/j.im.2014.03.007

Chertow, M.R., Ehrenfeld, J., 2012. Organizing self-organizing systems: toward a theory of industrial symbiosis. J. Ind. Ecol. 16, 13–27. https://doi.org/10.1111/j.1530-9290.2011.00450.x

Chertow, M. R., 2000. Industrial ecology: literature and taxonomy. Annu.Rev. Energy Env. 25, 313–337. https://doi.org/10.1146/annurev.energy.25.1.313

Chertow, M. R., 2004. Industrial symbiosis. Encycl. Energy. 3, 407–415. https://doi.org/10.1080/00343400701874123

Chertow, M. R., 2007. "Uncovering" industrial symbiosis. J. Ind. Ecol. 11, 11–30. https://doi.org/10.1162/jiec.2007.1110

Crane, B., 2018. Revisiting who, when, and why stakeholders matter: trust and stakeholder connectedness. Bus. Soc. 1–24. https://doi.org/10.1177/0007650318756983

Despeisse, M., Ball, P. D., Evans, S., Levers, A. (2012). Industrial ecology at factory level – a conceptual model. Journal of Cleaner Production, 31, 30–39. https://doi.org/10.1016/j.jclepro.2012.02.027

Desrochers, P., Leppala, S., 2010. Industrial symbiosis: old wine in recycled bottles? some perspective from the history of economic and geographical thought. Int. Reg. Sci. Rev. 33, 338–361. https://doi.org/10.1177/0160017610375441

Domenech, T., Bleischwitz, R., Doranova, A., Panayotopoulos, D., Roman, L., 2019. Mapping Industrial Symbiosis Development in Europe_ typologies of networks, characteristics, performance and contribution to the Circular Economy. Resour. conserv. recy., 141, 76–98. https://doi.org/10.1016/j.resconrec.2018.09.016

Dwyer, F. R., Schurr, P. H., Oh, S., 1987. Developing buyer-seller relationships. J. Mark. 51, 11–27. https://doi.org/10.1017/CBO9781107415324.004

Ehrenfeld, J., Gertler, N., 1997. Industrial ecology in practice. J. of Ind. Ecol. 1, 67–79. https://doi.org/10.1162/jiec.1997.1.1.67

Fichtner, W., Tietze-Stöckinger, I., Frank, M., Rentz, O., 2005. Barriers of interorganisational environmental management: two case studies on industrial symbiosis. Progress in Industrial Ecology, An International Journal, 2(1), 73. https://doi.org/10.1504/PIE.2005.006778

Fraccascia, L., Yazan, D. M. (2018). The role of online information-sharing platforms on the performance of industrial symbiosis networks. Resour. conserv. recy., 136, 473–485. https://doi.org/10.1016/J.RESCONREC.2018.03.009

Gibbs, D., 2003. Trust and networking in inter-firm relations: the case of eco-industrial development. Local Econ. 18, 222–236. https://doi.org/10.1080/0269094032000114595

Gulati, R. (1995). Does Familiarity Breed Trust ? The Implications of Repeated Ties for Contractual Choice in Alliances. Acad Manage J, 38(1), 85–112.

Heeres, R. R., Vermeulen, W. J. V., de Walle, F. B., 2004. Eco-industrial park initiatives in the USA and the Netherlands: first lessons. J. of Clean. Prod. 12, 985–995. https://doi.org/10.1016/j.jclepro.2004.02.014

Herczeg, G., Akkerman, R., Hauschild, M. Z., 2018. Supply chain collaboration in industrial symbiosis networks. J. Clean. Prod. 171, 1058–1067. https://doi.org/10.1016/j.jclepro.2017.10.046

Hewes, A. K., Lyons, D. I., 2008. The humanistic side of eco-industrial parks: champions and the role of trust. Reg. Stud. 42, 1329–1342. https://doi.org/10.1080/00343400701654079

Hiete, M., Ludwig, J., Schultmann, F., 2012. Intercompany energy integration adaptation of thermal pinch analysis and allocation of savings. J. Ind. Ecol. 16, 689–698. https://doi.org/10.1111/j.1530-9290.2012.00462.x

Huo, B., Tian, M., Tian, Y., & Zhang, Q., 2019. The dilemma of inter-organizational relationships: Dependence, use of power and their impacts on opportunism. Int J Oper Prod Man, 39(1), 94–115. https://doi.org/10.1108/IJOPM-07-2017-0383

Ireland, R. D., Webb, J. W., 2007. A multi-theoretic perspective on trust and power in strategic supply chains. J. Oper. Manag. 25, 482–497. https://doi.org/10.1016/j.jom.2006.05.004

Jacobsen, N. B., 2006. Industrial symbiosis in Kalundborg, Denmark. J. Ind. Ecol. 10, 239–255. https://doi.org/10.1162/108819806775545411

Johnston, D. A., McCutcheon, D. M., Stuart, F. I., Kerwood, H. (2004). Effects of supplier trust on performance of cooperative supplier relationships. J Oper Manag, 22(1), 23–38. https://doi.org/10.1016/j.jom.2003.12.001

King, P. L., 2009. Lean for the process industry. Dealing with complexity. Taylor & Francis, New York.

Kwon, I. W. G., Suh, T., 2004. Factors affecting the level of trust and commitment in supply chain relationships. J. Supply Chain Manag. 40, 4–14. https://doi.org/10.1108/13598540510578351

Kwon, I. W. G., Suh, T., 2004. Factors affecting the level of trust and commitment in supply chain relationships. J. Supply Chain Manag. 40, 4–14. https://doi.org/10.1111/j.1745-493X.2004.tb00165.x

Leong, Y. T., Lee, J.-Y., Tan, R. R., Foo, J. J., Mei, I., Chew, L. (2017). Multi-objective optimization for resource network synthesis in eco-industrial parks using an integrated analytic hierarchy process. J. Clean. Prod. 143, 1268-1283. https://doi.org/10.1016/j.jclepro.2016.11.147

Leong, Y. T., Tan, R. R., Aviso, K. B., Mei, I., Chew, L. (2016). Fuzzy analytic hierarchy process and targeting for inter-plant chilled and cooling water network synthesis. . J. Clean. Prod. 110, 40–53. https://doi.org/10.1016/j.jclepro.2015.02.036

Lewicki, R. J., Bunker, B. B., 1995. Trust in relationships: A model of development and decline. In Conflict, cooperation and justice: Essays inspired by the work of Morton Deutsch (pp. 133–173). Jossey-Bass, San Francisco.

Lewicki, R. J., Tomlinson, E. C., Gillespie, N., 2006. Models of interpersonal trust development: theoretical approaches, empirical evidence, and future directions. J. Manag. 32, 991–1022. https://doi.org/10.1177/0149206306294405

Li, D., Eden, L., Hitt, M., Ireland, D., 2008. Friends, acquaintances or strangers? Partner selection in R&D alliances. Acad. Manag. J. 51, 315–334. https://doi.org/10.1002/smj

Lombardi, D. R., Laybourn, P., 2012. Redefining industrial symbiosis: crossing academic-practitioner boundaries. J. of Ind. Ecol. 16, 28–37. https://doi.org/10.1111/j.1530-9290.2011.00444.x

Mayer, R. C., Davis, J. H., Schoorman, F. D., 1995. An integrative model of organizational trust. Acad. Manag. Rev. 20, 709–734. https://doi.org/10.5465/AMR.1995.9508080335

Mirata, M., 2004. Experiences from early stages of a national industrial symbiosis programme in the UK: determinants and coordination challenges. J. Clean. Prod. 12, 967–983. https://doi.org/10.1016/j.jclepro.2004.02.031

Mirata, M., Emtairah, T., 2005. Industrial symbiosis networks and the contribution to environmental innovation: The case of the Landskrona industrial symbiosis programme. J. Clean. Prod., *13*, 993–1002. https://doi.org/10.1016/j.jclepro.2004.12.010

Ng, R. T. L., Ng, D. K. S., 2013. Systematic Approach for Synthesis of Integrated Palm Oil Processing Complex. Part 1: Single Owner. Ind. Eng. Chem. Res., 52, 10206–1022. https://doi.org/10.1021/ie302926q

Nooteboom, B., 2002. Trust: Forms, Foundation, Functions, Failures and Figures. Edward Elgar Publishing Limited, Cheltenham. Available at: https://doi.org/Book Review

Nooteboom, B., Berger, H., Noorderhaven, N. G., 1997. Effects of trust and goverance on relational risk. Acad. Manag. J. 42, 308–338. https://doi.org/10.2307/256885

Pagell, M., Shevchenko, A., 2014. Why research in sustainable supply chain management should have no future. J. Supply Chain Manag. 50, 44–55. https://doi.org/10.1111/jscm.12037

Panyathanakun, V., Tantayanon, S., Tingsabhat, C., Charmondusit, K., 2013. Development of eco-industrial estates in Thailand: initiatives in the northern region community-based eco-industrial estate. J. Clean. Prod. 51, 71–79. https://doi.org/10.1016/j.jclepro.2012.09.033

Paquin, R. L., Howard-Grenville, J., 2009. Facilitating Regional Industrial Symbiosis: Network Growth in the UK's National Industrial Symbiosis Programme. The Social Embeddedness of Industrial Ecology, 103–127. Edward Elgar Publishing Limited, Cheltenham. https://doi.org/10.1111/j.1530-9290.2011.00437.x

Paquin, R. L., Howard-Grenville, J., 2012. The evolution of facilitated industrial symbiosis. J. Ind. Ecol. 16, 83–93. https://doi.org/10.1111/j.1530-9290.2011.00437.x

Paquin, R. L., Tilleman, S. G., Howard-Grenville, J., 2014. Is there cash in that trash? J. Ind. Ecol. 18, 268–279. https://doi.org/10.1111/jiec.12120

Park, H. S., Rene, E. R., Choi, S. M., Chiu, A. S. F., 2008. Strategies for sustainable development of industrial park in Ulsan, South Korea - From spontaneous evolution to systematic expansion of industrial symbiosis. J. Environ. Manag. 87, 1–13. https://doi.org/10.1016/j.jenvman.2006.12.045

Park, J. Y., Park, H. S., 2014. Securing a competitive advantage through industrial symbiosis development: the case of steam networking practices in Ulsan park and park competitive advantage and industrial symbiosis. J. Ind. Ecol. 18, 677–683. https://doi.org/10.1111/jiec.12158

Perrone, V., Zaheer, A., McEvily, B., 2003. Free to be trusted? Organizational constraints on trust in boundary spanners. Org. Sci. 14, 422–439. https://doi.org/10.1287/orsc.14.4.422.17487

Pinto, J. K., Slevin, D. P., English, B., 2009. Trust in projects: An empirical assessment of owner/contractor relationships. Inter J Proj Manage, 27(27), 638–648. https://doi.org/10.1016/j.ijproman.2008.09.010

Prosman, E. J., Waehrens, B. V., Liotta, G., 2017. Closing Global Material Loops: Initial Insights into Firm-Level Challenges. J. Ind. Ecol, 21, 641–650. https://doi.org/10.1111/jiec.12535

Sako, M., 1992. Prices, Quality, and Trust: Inter-firm Relations in Britain and Japan. Cambridge University Press, Cambridge.

Schwarz, E. J., Steininger, K. W., 1997. Implementing nature's lesson: the industrial recycling network enhancing regional development. J. Clean. Prod. 5, 47–56. https://doi.org/10.1016/S0959-6526(97)00009-7

Seuring, S., Müller, M., 2008. From a literature review to a conceptual framework for sustainable supply chain management. J. Clean. Prod. 16, 1699–1710. https://doi.org/10.1016/j.jclepro.2008.04.020

Shapiro, D. L., Sheppard, B. H., Cheraskin, L., 1992. Business on a handshake. Negot. J. 8, 365–377.

Shi, H., Chertow, M., Song, Y., 2010. Developing country experience with eco-industrial parks: a case study of the Tianjin Economic-Technological Development Area in China. J. Clean. Prod. 18, 191–199. https://doi.org/10.1016/j.jclepro.2009.10.002

Sterr, T., Ott, T., 2004. The industrial region as a promising unit for eco-industrial development—reflections, practical experience and establishment of innovative instruments to support industrial ecology. J. Clean. Prod. 12, 947–965. https://doi.org/10.1016/j.jclepro.2004.02.029

Tan, R. R., Aviso, K. B., Cayamanda, C. D., Chiu, A. S. F., Promentilla, M. A. B., Ubando, A. T., Yu, K. D. S., 2016. A fuzzy linear programming enterprise input-output model for optimal crisis operations in industrial complexes. Int. J. Production Economics 181, 410–418. http://dx.doi.org/10.1016/j.jclepro.2015.02.036

Tan, R. R., Andiappan, V., Kin Wan, Y., Ng, R. T., Ng, D. K., 2016. An optimization-based cooperative game approach for systematic allocation of costs and benefits in interplant process integration. Chem. Eng. Res. Des. 106, 43–58. https://doi.org/10.1016/j.cherd.2015.11.009

Uzzi, B., 1997. Social structure and competition in interfirm networks: the paradox of embeddedness. Adm. Sci. Q. 42, 417–418.

Valentine, S. V. (2016). Kalundborg Symbiosis: Fostering progressive innovation in environmental networks. J. Clean. Prod. 118, 65-77. https://doi.org/10.1016/j.jclepro.2016.01.061

van Beers, D., Corder, G., Bossilkov, A., van Berkel, R., 2007. Industrial symbiosis in the Australian minerals industry: the cases of Kwinana and Gladstone. J. Ind. Ecol. 11, 55–72.https://doi.org/10.1162/jiec.2007.1161

Vanpoucke, E., Vereecke, A., Boyer, K. K., 2014. Triggers and patterns of integration initiatives in successful buyer-supplier relationships. J. Oper. Manag. 32, 15–33.

https://doi.org/10.1016/j.jom.2013.11.002

Velenturf, A. P. M., 2015. Promoting industrial symbiosis: empirical observations of low-carbon innovations in the Humber region, UK. J. Clean. Prod. 128, 116-130. https://doi.org/10.1016/j.jclepro.2015.06.027

Velenturf, A. P. M., Jensen, P. D., 2016. Promoting industrial symbiosis: using the concept of proximity to explore social network development. J. Ind. Ecol. 20, 700–709. https://doi.org/10.1111/jiec.12315

Walker, H., Jones, N., 2012. Sustainable supply chain management across the UK private sector. Supply Chain Manag.: Int. J. 17, 15–28. https://doi.org/10.1108/13598541211212177

Yap, N. T., Devlin, J. F., 2017. Explaining industrial symbiosis emergence, development, and disruption: a multilevel analytical framework. J. Ind. Ecol. 21, 6–15. https://doi.org/10.1111/jiec.12398

Zaheer, A., McEvily, B., Perrone, V., 1998. Does trust matter? Exploring the effects of inter-organizational and inter-personal trust on performance. Org. Sci. 9, 141–159. https://doi.org/10.1287/orsc.9.2.141

Zhu, J., Ruth, M., 2013. Exploring the resilience of industrial ecosystems. J. Environ. Manag. 122, 65–75. https://doi.org/10.1016/j.jenvman.2013.02.052

Zhu, Q., Geng, Y., Sarkis, J., Lai, K.-H., 2015. Barriers to promoting eco-industrial parks

development in China. J. Ind. Ecol. 19, 457–467. https://doi.org/10.1111/jiec.12176

Zhu, Q., Lowe, E. A, Wei, Y., 2007. Industrial symbiosis in China - a case study of the Guitang Group. J. Ind. Ecol. 11, 31–42. https://doi.org/10.1162/jiec.2007.929

Highlights:

- Merging the literature in the fields of industrial symbiosis (IS) and management in order to explore the role and development of trust in IS
- A conceptual framework for developing trust and strategies for progressing from calculus-based trust (CBT) to knowledge-based trust (KBT) to identification-based trust (IBT)
- A proposal for a future research agenda on development of trust in the context of IS