Networks and the Transition to Circular Business Models

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Abstract

The shifting to a circular economy (CE) demands the understanding of how companies can introduce circularity into their business models, that is, how companies develop and implement circular business models. In this process networks assume a critical role.
This paper contributes to the theoretical grounding of the role of network forms of organization for Circular Economy, by providing an analysis on how networks have been integrated into the CE literature. For that, it draws on bibliometrics to map and analyze the evolution of the literature on Circular Economy that mentions networks. Moreover, it conducts a systematic literature review (SLR) considering five analytical dimensions: 1) research method used; 2) level of analysis of the study; 3) type of actors in the analysis/network; 4) purpose of the network; 5) network building strategies and challenges.
The results show that the integration of networks in the CE is being accomplished using a diverse set of methodologies, with an underrepresentation of social network analysis and covering several levels of analysis (micro, meso and macro). Studies tend to stress relations inside the value-chain established to manage physical and energy flows. The CE literature also tackles the main challenges in network management, namely coordination, trust and alignment.

Keywords – Network, Circular Economy, Circular Business Model, Bibliometrics, Systematic Literature Review

Paper type – Academic Research Paper

1 Introduction

The main idea behind a Circular Economy (CE) is to develop an economic model in which the production of waste is minimal and resources are used several times to create value (EC, 2014). The shifting to a circular economy demands the understanding of how companies can introduce circularity into their business models, that is, how companies develop and implement Circular Business Models (CBMs)(Lewandowski, 2016).

A CBM can be defined as —a business model in which the conceptual logic for value creation is based on utilizing economic value retained in products after use in the production of new offerings. Thus, a circular business model implies a return flow to the producer from users, though there can be intermediaries between the two parties" (Linder & Williander, 2015: 2).

The literature on CE has already concluded that CBMs have some specific traits since the implementation of CE principles should affect all the BM building blocks, due to the above-mentioned change in the logic behind value creation, delivery, and capture. Some examples found in extant literature are:

- New value propositions, namely based on longer product life cycles, designing for more durable products (Hawken et al. 2000), supporting the end of life strategies and on higher customer service levels (Barquet et al. 2013; Bocken et al. 2016);
- New customer relationships, namely those that promote the shared use of products among users (collaborative consumption) and reward customers that embrace CE behaviors (Bocken et al. 2016);
- New revenue models, namely those based in selling services (instead of selling products), leasing or accessing the products under the pay per use mechanisms (Barquet et al. 2013);
- New key activities, related to closing supply chain loops, like reverse logistics and maintenance (Bocken et al. 2016), enabling components and materials to enter again the production process (Wells & Seitz 2005).

However, scholars have been given less attention to the key partnerships and networks that need to be built in order to implement CBMs. These networks should underlie the relations with all stakeholders and support the new aspects of BM mentioned above, with emphasis on developing new revenue models and closing the supply chain loops.

The paper addresses this gap by contributing to the theoretical grounding of the role of network forms of organization for CE. For that, it draws on bibliometrics to map and analyze the evolution of the literature on Circular Economy that mentions networks. Moreover, it conducts a systematic literature review (SLR) in the two most relevant bibliographic academic databases: SCOPUS and Web of Science.

The paper is structured as follows: section 2 presents the potential of network theory and analysis for the CE literature; section 3 presents the methodology used for the SLR and the results from the bibliometrics analysis; section 4 presents the results from the SLR; and section 5 concludes.

2 Networks as an important form of organization in the Circular Economy

In this section, we resort to some of the main lessons from the literature on network forms of organization from strategy, innovation, and organizational studies. This literature may provide useful insights into the role and configuration of networks for the transition to a CE.

Collaboration with other organizations and actors has long been acknowledged as vital for innovation and value creation (Ahuja, 2000; Lechner & Dowling 2003; Powel et al 1996; Romero & Molina 2011). Through networks companies access a wide variety of resources; perform collaborative R&D, product co-creation, production, and commercial activities; share risks and investments; and get legitimization and counseling.

Network forms of organization are particularly relevant when ambitious, radical and disruptive transformations are at stake, involving risk and experimentation, and where inertia and resistance can hinder the change (Hill & Rothaermel, 2003; Lahti et al, 2018), as is the case of the transition to a CE. It is acknowledged that one single enterprise does not own the entire set of skills and resources required to deliver its value proposition

According to the literature, collaborations can assume diverse formulas. They often materialize in formalized, inter-organizational partnerships/alliances, contractual agreements and joint ventures along the value chain (Ahuja, 2000; Gulati, 1998), or with stakeholders outside the value chain (Geissdoerfer et al, 2018). Collaborations can also be kept in an informal, more personal-based form (Salavisa et al, 2012). These diverse configurations, namely formal and informal relations should also be relevant for the transition to a CE, as suggested by Velenturf & Jensen (2016).

Among the relevant partners, previous research has highlighted the role of other companies, namely competitors, suppliers and clients, universities and research centers and public entities (Baum et al, 2000). It has shown that the diversity of actors in the network impacts on its performance (Nieto & Santamaría, 2007). Partners bring specialized and complementary resources and capabilities (Dyer & Singh, 1998). In the case of the transition to a CE, it is important to cooperate with a broad range of stakeholders (Geissdoerfer et al, 2018), and therefore multi-actor networks should be present. CE scholars suggest that collaborating with actors inside the supply chain is important in order to close material loops (Bocken et al. 2016; Rizos et al. 2016), collaborations with specialized service providers (e.g logistics and after-service) in order to ensure reverse logistics and customer satisfaction (Lahti et al, 2018; Lewandowski 2016), and collaboration with users and clients in order to redesign products for the CE (Bocken et al. 2016; Tukker 2004). These collaborations involve both large companies and SMEs, namely start-ups exploiting new business opportunities and using CBM from the start (Lahti et al, 2018).

Networks also serve as conduits for accessing resources, with emphasis on intangible ones like technological knowledge, know-how, expertise, information and legitimation (Salavisa et al, 2012). Therefore, networks can be built or mobilized to access several tangible and intangible resources for the transition to a CE. As mention in the introduction, when firms are embracing the CE principles they must perform new activities and use a new set of resources and capabilities. The creation of formal partnerships or informal networking enables to access them without huge in-house investments.

Finally, the literature also stresses that building of networks is a complex process, relying on governance mechanisms based on reciprocity, reputation, and trust that demand long-term and recurrent interactions (Gulati, 1995; Powell, 1990). They involve

complex interdependencies among partners and have a reflex on actors‘ behaviors and strategies (Kim et al, 2006; Powel, 1990). Coordination and alignment between partners are vital to meet benefits, not only at the economic level but also at social and environmental levels that are of utmost importance in CE. The transition to CBMs may demand the reconstruction of the firm‘s network, since traditional partners may be not aligned with the principles of CE. Therefore, partner selection is also an important topic for the development of CBM.

3 Method

3.1 Systematic Literature Review: Advantages and Procedures

In order to detect the knowledge stemming from network literature and how it is being adapted within circular economy studies a Systematic Literature Review (SLR) was conducted. A SLR is a way to summarize existing evidence, identify gaps and suggest some directions for future research and enables to ―comprehensively identify, appraise and synthesize all relevant studies on a given topic" (Petticrew & Roberts 2006: 19). This approach requires scholars to provide explicit and rigorous criteria for searching, including, evaluating and synthesizing the literature. Decisions are noted down, leaving an audit trail, in order to assure its replicability and transparency (Tranfield, et al, 2003).

The search of the literature was made on the two most relevant bibliographic databases: SCOPUS and Web of Science. The steps used for the search and selection of documents are presented in table 1.

Table 1. Systematic literature review procedures

Step	**Decision**	**Comment / Result**
Selection of the database	SCOPUS Web of Science	databases containing journals that are generally highly regarded by the academic community; large number of sources, providing broad coverage of the academic literature
Keyword search SCOPUS	Search query: TITLE-ABS-KEY(network* AND ―circular economy"	N = 256
Keyword search Web of Science (all databases)	TOPIC: (network* AND "circular economy")	N = 246
Inclusion criteria	Document type = Article OR Article in Press Language = English	SCOPUS: N = 127 Web of Science: N = 132
Database integration	Exclusion of duplicates (documents that are in both databases)	N = 183
First scanning through title, abstract and keyword reading	Exclude 41 papers because did not meet the research criteria, as did not contain the words "network" or "circular economy" within the title, abstract and keywords Exclude 37 papers because they were out of scope (e.g papers dealing with the optimization of materials or energy Flows, namely in	 N = 105

	industrial parks, industrial symbiosis or waste collection networks; bibliometric studies using social network analysis)	
Access check	4 articles were excluded because full text was not available	N = 101

Source: Author's own elaboration

Therefore, the database used for the SLR has 101 papers. The SLR was organized in five structural dimensions: 1) research method used; 2) level of analysis of the study; 3) type of actors in the analysis/network; 4) purpose of the network; 5) network building strategies and challenges. For each dimension, several analytical categories were considered. Initially, a deductive approach was used, based on the literature review on networks presented in section 2. After the analysis of the documents, new analytical categories were introduced in an inductive procedure, namely the separation between single and multiple case studies in the research method, and build business models in the network purpose.

Table 2 summarizes the structural dimensions and the analytical categories used in the analysis of each document.

Table 2. Dimensions and categories used in the systematic literature review

Dimension	**Categories**
Research method	Theoretical, conceptual and literature review Single case study Multiple case studies Social network analysis (SNA) Models and methods for decision making Other quantitative approaches Other qualitative approaches
Level of analysis	Micro - Firm-level network Industrial symbiosis or industrial parks Supply chain Macro
Actors	Companies in the value chain Other companies Universities and research centres Governments Other stakeholders
Purpose	Close material loops Flow management (e.g. materials, energy) Access to complementary services Product/solution design/development Access to knowledge and information Build business models Access to other resources/capabilities
Network building strategies and challenges	Selection/identification of partners Trust Alignment Coordination Other aspects

Source: Author's own elaboration

3.2 Bibliometrics analysis

The bibliometrics consists in a quantitative analysis of the bibliographic references of a body of literature (Hawkins, 1977), enabling to detect patterns of authorship and publication strategies (Lancaster, 1977), as well as the development of scientific fields (Calero-Medina & Noyons, 2008). In the context of this research, bibliometrics enables the characterization of the database extracted before access check (N=105).

The evolution of the number of papers reveals that networks only recently have become a research topic in the CE literature. Prior to 2010, few studies were published as indicated by the low number of annual publications. Moreover, over three-quarters of the documents were published in the last 2 years (2017 – March 2019).

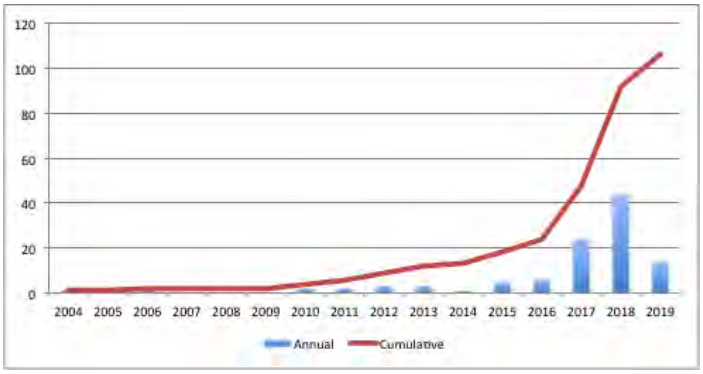

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Figure 1. Evolution of the number of publications (annual and cumulative), until March 2019

Most of these articles were published in journals that have environmental topics (Figure 2), with emphasis to Journal of Cleaner Production (with almost ¼ of the papers) and Resource Conservation and Recycling (with 10% of the papers), which are prominent journals in the area of circular economy (Merli et al, 2018). The 4 most productive journals account for 37.1% of the published articles.

Source: Author‘s own elaboration

Figure 2. Number of articles per journal (journals with at least 2 articles)

The papers involve a total of 352 authors, most of which (91.8%) have only one paper on this topic. The authors with more than 2 articles are listed in table 3, where one can observe a predominance of Chinese and Japanese authors.

Table 3. Authors with more than 2 articles

Author	Number of papers	Country of affiliation
Bocken, N.	4	Sweden
Dong, L.	4	Japan
Fujii, M.	3	Japan
Geng, Y.	3	China
Liu, Y.	3	China
Wang, Y.	3	China

Source: Author's own elaboration

Table 4 lists the six articles with more than 50 citations. From these, three articles have more than 100 citations in both databases, all originally published between 2010 and 2012, being among the first papers in the topic covered in this analysis.

Table 4. Most cited articles (more than 50 citations)

Paper	**Scopus**	**Web of Science**
Shi, H., Chertow, M., & Song, Y. (2010)	**177**	**171**
Chertow, M., & Ehrenfeld, J. (2012)	**155**	**145**
Boons, F., Spekkink, W., & Mouzakitis, Y. (2011)	**127**	**113**
Gregson, N., Crang, M., Fuller, S., & Holmes, H. (2015).	**91**	**75**
Dong, L., Zhang, H., Fujita, T., Ohnishi, S., Li, H., Fujii, M., & Dong, H. (2013)	**77**	**67**
Winkler, H. (2011)	**69**	**-**

Source: Author's own elaboration

4 Results

This section presents the results of the SLR, using the dimensions and categories presented in the Table 2. In this analysis, each document can be simultaneously assigned to more than one analytical category, and therefore, the total count of documents in each dimension may differ.

4.1 Research method

Around 1/5 of the studies have a theoretical, conceptual or review nature. Authors are proposing new frameworks or reviewing the state-of-the-art. This is the case of half of the most cited documents mentioned in the previous section (Boons et al, 2011; Chertow & Ehrenfeld, 2012; Winkler, 2011)

Most empirical studies use a case study methodology, either focusing on a single case or using multiple cases for comparison and generalisation. Some cases studies are combined with models for decision-making (e.g. Accorsi et al, 2015; Dong et al, 2016; Promentilla et al, 2016).

Quantitative methodologies are frequently employed to solve problem of optimization of material flows (waste, energy, by-products) and to help decision-making, either by

firms or network planners, namely in terms network design and location of facilities. Scholars use a diverse set of approaches, including mix integer linear programming (Accorsi et al, 2015; Bangera et al, 2018; Rentizelas et al, 2018), agent-based models (Fraccascia & Yazan, 2018; Lieder et al, 2017), and Life Cycle Assessment (Krystofik et al, 2018; Piezer et al, 2019). Other quantitative approaches, like regressions and cluster analysis, are also used, but less often (e.g. Bag et al, 2019; Barrie et al, 2019; Dubey et al, 2018).

Surprisingly, social network analysis (SNA) is not often employed in this literature. Only six studies use this methodological approach. This is unexpected because SNA is a toll that enables to understand and mapping networks and to analyse the actors/stakeholders in terms of their position in the network, reflecting their power and roles (namely in terms of coordination and brokerage) (Scott, 2000).

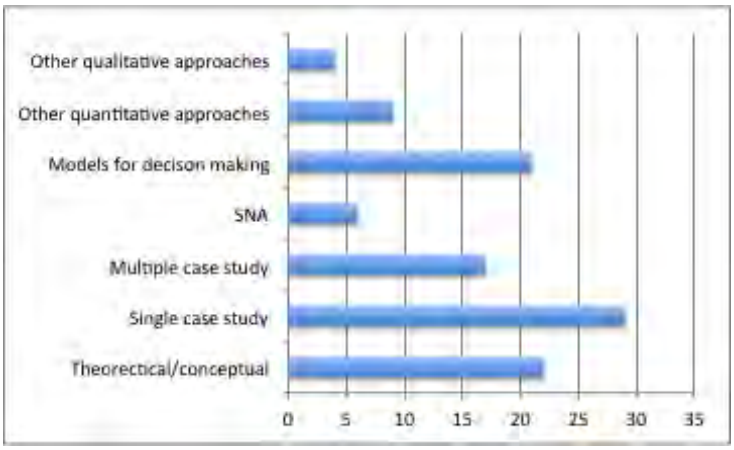

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Figure 3. Research method employed in the studies

4.2 Level of analysis

Most studies have a meso perspective, focusing either on networks related to industrial symbiosis and industrial parks (e.g. Boons et al, 2011; Chertow & Ehrenfeld, 2012; Dong et al, 2013; Shi et al, 2010), or on networks related to specific supply-chains (e.g. Accorsi et al, 2015; Lin et al, 2018; Winkler, 2011).

The macro level includes networks developed at a city, region or national level (e.g. Gregson et al, 2015; Nuss et al, 2019; Tong et al, 2018) and networks related to the promotion of the circular economy principles (e.g. Barrie et al, 2019; Ogondo et al, 2013; Pialot et al, 2017; Spring & Araujo, 2017). Finally, in the micro level, authors are focusing on the networks at the firm level (Dubey et al, 2019; Hsieh et al, 2017; Niero et al, 2017).

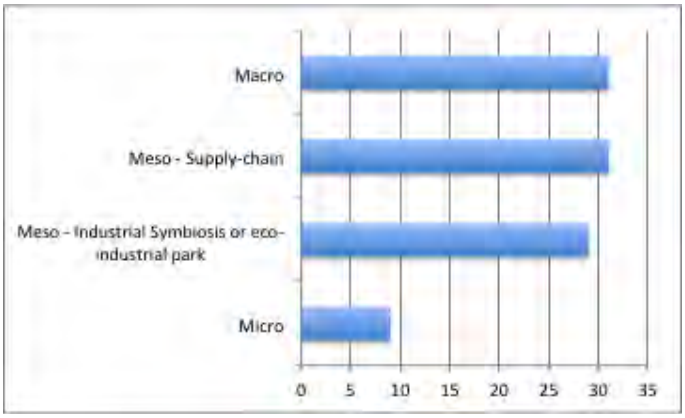

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Figure 4. Level of analysis adopted in the studies

4.3 Actors/Stakeholders

Regarding the network actors/stakeholders considered in the analysis, the majority of studies is concerned with the role of companies in the value chain, namely in terms of material flows. Governments (either central or local) are also included in a large number of studies, stressing its role in policy-making (e.g. Gumley, 2014; Lokesh, 2018), partnership creation (Baldassarre et al, 2019) or public procurement (Abreu et al, 2018). Fewer studies include other actors: universities (e.g. Mengal et al, 2018; Perey et al, 2018), companies outside the value chain (e.g. Shi et al, 2010; Winkler, 2011), NGOs (e.g. Herczeg et al, 2018; Kristensen et al, 2016; Mathews et al, 2018) or stakeholders like citizens (Hsieh et al, 2017; Petrescu et al, 2016), consumers (Korhonen et al; 2018; Pialot et al, 2017) and regulatory bodies (Mulrow et al, 2017). Some scholars stress the need to develop networks with a diverse/heterogeneous set of actors (e.g. Bellantuono et al, 2017; Domenech et al, 2019; Giezen, 2018; Wang et al, 2017), or the need to develop tripartite networks including companies, public organisations and the academia (e.g. Barrie et al, 2019; Dong et al, 2016).

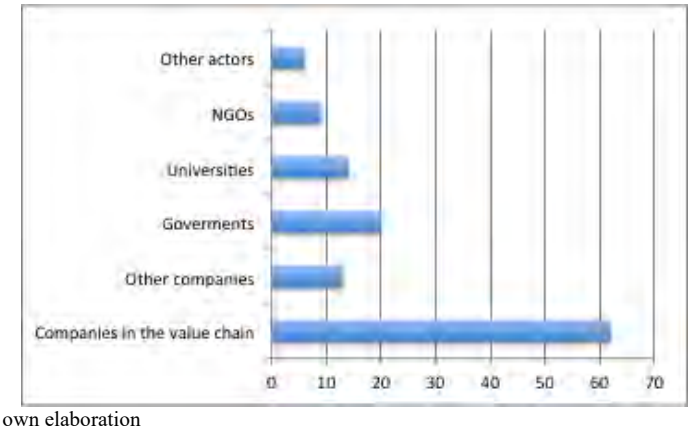

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Figure 5. Network actors/stakeholders included in the analysis

4.4 Purpose of the network

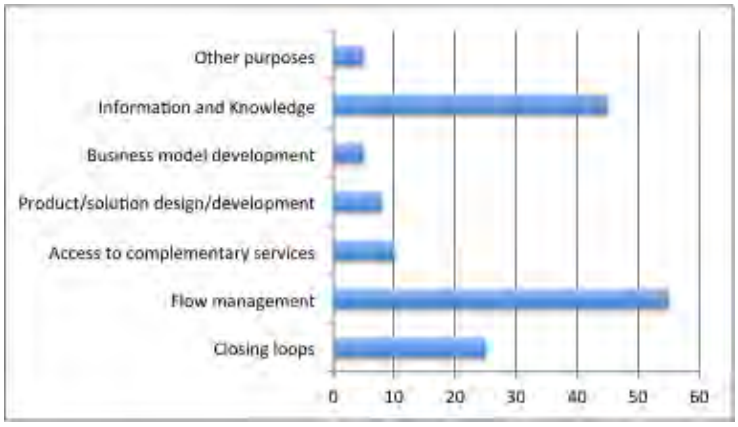
The documents reflect two main reasons for networking behaviour: the management of physical (by-products, materials, waste), energy and monetary flows and the access to knowledge and information.

The management of flows in vital for replacing the linear take-make-disposal/waste model and attaining circularity (Ghisellini et al, 2016), as stressed by the definition of CBE previously presented. Therefore, this is not an unexpected result. The number of studies explicitly addressing the closing of loops is considerably lower, when compared to the number of studies that tackle the issue of flow management.

The relevance of networking to access knowledge and information, strongly acknowledged in innovation studies, is also recognised in these documents. Scholars not only stress the relevance of partnerships to access and sharing knowledge and information, but also to generate new knowledge (e.g. Barrie et al, 2017; Mathews et al, 2018). Some authors distinguish between types of knowledge (for instance explicit vs tacit) (e.g. Aid et al, 2017; Barrie et al, 2019). Several studies (15) stress the role of digital technologies in facilitating information sharing between the network members (e.g. Dino et al, 2017; Dounavis et al, 2019; Fraccascia & Yazan, 2018). This information sharing is related to the path of material flows and to the quality of materials and partners and enables to reduce transaction costs along the value chain.

Access to complementary services through partnerships with third-party service providers for logistics, waste management, IT and remanufacturing is also highlighted in some studies (e.g. Bernon et al, 2018; Perey et al, 2018).

The authors also address the use of networks for co-creation and development of products/solutions (e.g. Brown et al, 2019; Leising et al, 2018; Niero et al, 2017) and business models (e.g. Mengal et al, 2018; Perey et al, 2018). Other purposes include credibility (Gavertsson et al, 2018) and vision (Mengal et al, 2018; Parida & Wincent, 2019) building.



Source: Author‘s own elaboration

Figure 6. Network purpose

4.5 Network building strategies and challenges

The last dimension of the SLR is related to the network building strategies and challenges in network management. All categories traditionally acknowledge in the network literature are present in this set of studies, chiefly those related to the governance of the network: coordination, trust and alignment.

The coordination challenge is usually raised in the debate between decentralised, bottom-up networks versus planed top-down initiatives (e.g. Giezen, 2018; Guo et al, 2016; Mengal et al, 2018) and to some specific roles that some actors may perform in structuring the network (e.g. Prosman et al, 2017; Zucchella & Previtali, 2019). Some scholars also stress the need to deal with conflict management (Baldassarre et al, 2019; Gupta et al, 2018; Petrescu et al, 2016).

Alignment issues cover a wide range of challenges, namely interest and vision alignment (e.g. Sellitto & Murakami, 2018; Strebel & Posch, 2004), collective goal setting (Aid et al, 2017), expectation management (Baldassare et at, 2019; Barrie et al, 2019) and culture (Walls & Paquin, 2015).

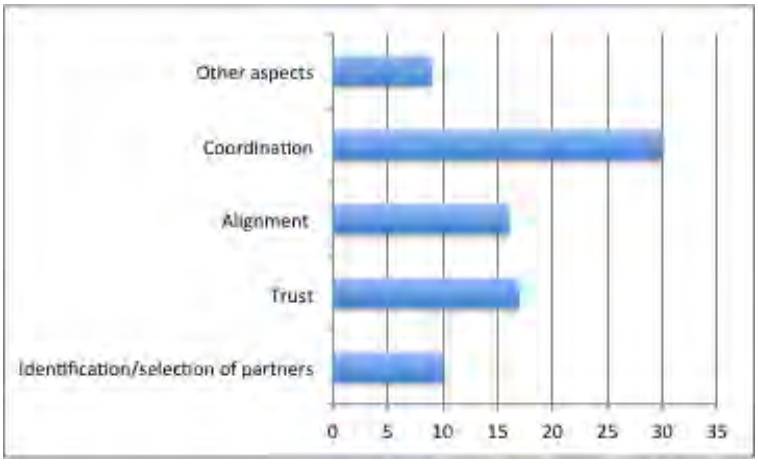


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Figure 7. Network building strategies and challenges

5 Conclusions

This paper provides an analysis on how networks have been integrated into the CE literature. For that, it draws on bibliometrics to map the evolution of the literature on Circular Economy that mentions networks, showing that only very recently the CE scholars started to pay attention to the role of networks, since the majority of the studies has 2 years or less.

Moreover, the paper conducts a SLR considering five analytical dimensions: 1) research method 2) level of analysis; 3) type of actors; 4) purpose of the network; 5) network building strategies and challenges.

The results show that the integration of networks in the CE is being accomplished using a diverse set of methodologies, with an underrepresentation of social network analysis and an emphasis on case studies and decision making models (optimization of material flows and facility location). Studies cover all levels of analysis (micro, meso and macro) and tend to stress relations inside the value-chain established to manage physical and energy flows. Despite this fact, there is also the acknowledgement of the role of other stakeholders (e.g. government and universities) and network purposes, like access to information and knowledge. Moreover, the CE literature tackles the main challenges in network management, namely coordination, trust and alignment.

Further research is needed in order to perform a more fine-grain analysis of the contributions of the network theory to the design and implementation of circular business models.

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