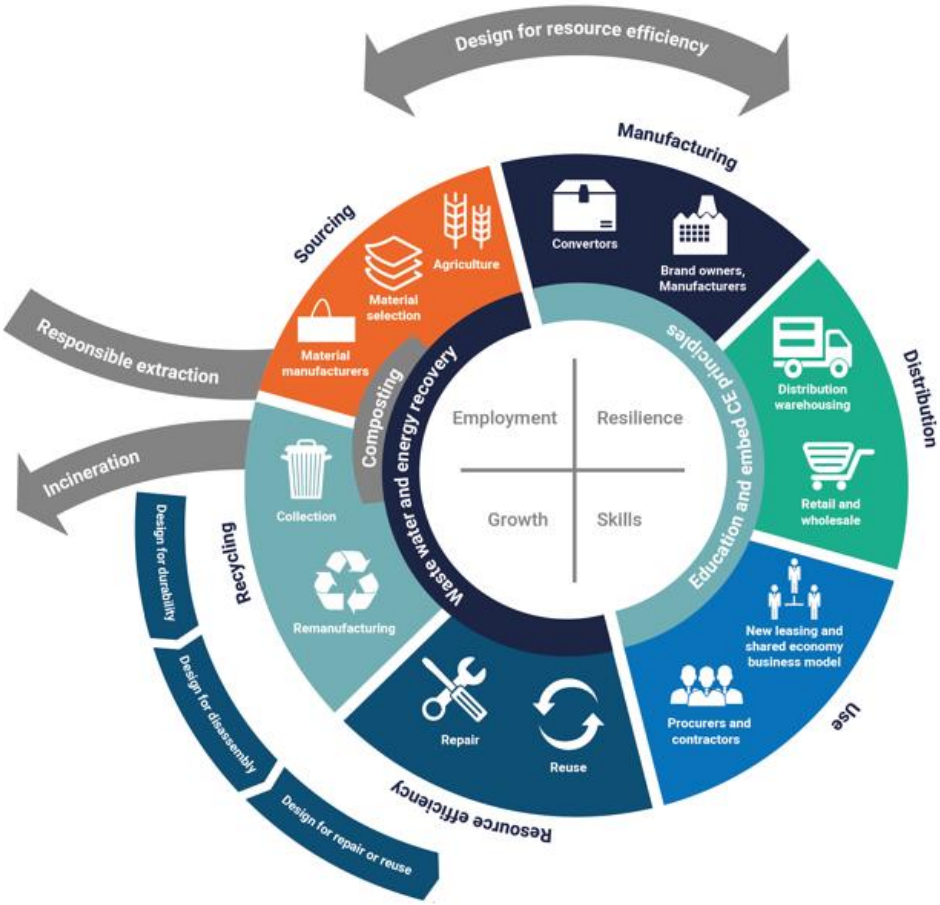
Collaboration in the Circular Economy in the Netherlands: A Proximity Approach



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Abstract

The extraction of raw material is responsible for the majority of the global GHG emissions. Waste management is an important aspect of climate change mitigation. The current economic development model is a linear model, which used too much raw materials. This is unsustainable for the earth. An important solution to this problem is the implementation of a circular economy. In this paper, the hindering factors for a Circular Economy in the Netherlands are identified. For this research, the EUPRO database is used. The proximity dimensions and centrality measures are used to examine the collaborations in the Netherlands. A social network analysis and count regressions are carried out to measure the impact of these variables. In the Netherlands, organizations require collaborate with organizations that have higher geographical proximity, institutional proximity and cognitive proximity than is beneficial for the success of the collaboration. Thus, this paper provides empirical evidence for the proximity paradox. Organizations that are well-connected also have a negative influence on the success of the collaborations in the Netherlands. For these findings, policy recommendations are then considered.

1. Introduction

Climate change is continuously becoming a more pressing issue, as global temperatures continue to rise. This is reflected in the increasing focus on sustainability (Rajeev et al., 2017). Sustainability is considered to be the societal issue of this time (TNO, 2019). Climate change poses increasingly severe risks for the European ecosystems, general health, and economy (European Environment Agency, 2017). Especially in the Netherlands, the change towards a more sustainable society is slow. In 2017, the Netherlands had the second lowest share of energy from renewable sources from the EU member states (Eurostat, 2019).

One important aspect of climate change is waste management. Waste management is important for climate change mitigation for two reasons. First, there are significant non-energy sources of greenhouse gasses (GHGs), including methane emissions from landfills (Ackerman, 2000). Composting bio-waste, for example, greatly reduces the amount of GHGs released compared to landfills (Lou & Nair, 2009). Second, changes in waste management have surprisingly large effects on the way energy is used (Ackerman, 2000). Industries extracting raw materials are the most energy-intensive branches of the manufacturing process. Much less energy is used to shape the materials. Thus, recycling of raw materials or using less, reduces energy use and associated carbon emissions in the most energy-hungry industry branches (Ackerman, 2000).

Currently, the dominant economic development model is a linear economy (Ghisellini et al., 2016). A linear economy is an economy where the general pathway is the extraction of raw materials, followed by a transformation into a product which is then used until it has served its purpose, after which it is discarded as waste, also called "take, make and dispose". Value is created in this economic system by producing and selling as many products as possible (Kenniskaarten, 2016). However, research shows that this method is unsustainable and the negative effects caused by this economic system are threatening the stability of the economies and the integrity of natural ecosystems that are essential for humanity's survival (Yap, 2005; Yuan et al., 2006; Feng & Yan, 2007; Ellen McArthur Foundation, 2012; Geng et al., 2012; Preston, 2012; Stiehl & Hirth, 2012; Su et al., 2013; UNEP, 2013; Waughray, 2013; EC, 2014a; EC, 2014b; Lett, 2014; Mazzatini, 2014; Park & Chertow, 2014). Thus, it is important to change our economic development model into something more sustainable.

An increasingly popular solution is the transformation of the economic development model into a circular economy. Because it is a trending topic, many different definitions have been assigned to it (Kirchherr et al., 2017). The definition used in this paper is the definition from Kirchherr et al. (2017): "an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes". Thus, in a circular economy, raw material extraction and waste generation is highly reduced and ideally even fully diminished. According to Circle Economy (2019), 62% of global GHGs (excluding those from land use and forestry) come from the extraction, processing and production of goods to meet society's needs. Global GHGs may be reduced even further because the transport of these materials will also no longer be necessary in a circular economy. Besides environmental benefits, there are also economic benefits. Since 2000, the price of raw materials has strongly increased (WE Forum, 2014). Switching to a circular economy would mean a decrease in costs by saving the expenses of the raw materials (Kenniskaarten, 2016). Furthermore, by decoupling economic growth from the availability of raw materials, a hindering factor for economic growth is removed. In these ways, the economy may grow into a circular economy.

In 2015, The European Commission published its Circular Economy Package, with the stated objective of "closing the loop" of product lifecycles (Hughes, 2017). According to the Dutch Environmental Assessment Agency (PBL) (Rood & Hanemaaijer, 2017), the Netherlands has a very promising starting position for circular economy. The Netherlands has the highest population density and infrastructure density in Europe and has one of the highest densities of urban area, densities of raw material streams, percentage of recycled household waste, and amount of patents on waste collection and recycling (Rood & Hanemaaijer, 2017). Thus, a transition towards a circular economy would be a good measure for climate change mitigation and waste management in the Netherlands.

Despite the promising starting position, the Netherlands is still far from having a circular economy. The main reason for this is that, for changes to be implemented towards a circular economy, collaboration is required between different actors of the society (Ghisellini et al., 2016). Stakeholders need to work together in new alliances within production chains to achieve a circular economy (Rood & Hanemaaijer, 2017). Stakeholders in a circular economy are also more interdependent than in a linear economy (Ashton, 2008; Ashton, 2009). The reason for this is that in the transition to a Circular Economy, data needs to be collected and shared (Preston, 2012). Furthermore, for a successful implementation of a circular economy, upfront integration of a variety of disciplines in the supply chain, with the co-creation of an ambitious vision, and responsibilities need to be extended to the actors along the entire supply chain (Dora, 2019). The reason for this is that the Circular Economy means the cycle of the chain of several organizations is closed. This means that these organizations are dependent on each other for their raw materials and if one link in the chain fails the rest of the chain suffers (Kenniskaarten, 2016). The collaboration between the different actors thus is not yet sufficient. The reason for this most likely comes from the fact that, the change to a system where the interdependency between the firms is higher comes with a lot of uncertainty.

Collaboration can provide the benefit of resource sharing, allowing firms to combine knowledge, skills, and physical assets. Second, collaborative linkages can provide access to knowledge spill overs, serving as information conduits through which news of technical breakthroughs, new insights to problems, or failed approaches travels from one firm to another (Ahuja, 2000). In order to stimulate the circular economy, collaboration between the stakeholders of the circular economy should be improved. To do that a network analysis should be conducted. From this network analysis, gaps in collaboration between different groups can be detected.

In terms of circular economy, a lot of focus has been put on SMEs, business models, and studying the Technological Innovation Systems (TIS) surrounding the circular economy. The collaboration between the firms, or organizations generally, has not yet been studied in the Netherlands. This research gap could provide new information because the ties that form could predict the way the circular economy will be implemented. This could result in new insights and policy recommendations to stimulate the transition. Because this paper studies the collaboration between companies, this study is carried out on a meso-level.

This leads us to the research questions:

RQ1: What drives collaborations in the circular economy in the Netherlands?

RQ2: What is the impact of the makeup of the collaborations on the chance of a successful outcome of the collaboration?

RQ3: What are the missing links in the Dutch collaboration network, if any?

By focusing on the collaboration within the circular economy, this paper presents a network analysis during a system transformation. The makeup of the collaborations within the systematic transformation can show the focus of the organizations and the type of technologies that can result from these collaborations. Furthermore, the focus is on the policy implications of the results in the network analysis, by trying to identify which extra link can increase the total connectivity most efficiently and which links are crucial by finding out which cause most loss of connectivity when they disappear.

By studying the collaborations that will form in a circular economy, this paper can examine the hindering factors of the organizations within the system. This will help policymakers to understand which efforts are lacking, and thus which efforts will need to be supported. In this way, the more efficient or sustainable type of efforts, projects, and organizations can be discovered, and collaborations focused on them can be supported, which will help the transition towards a circular economy. Furthermore, the methods used in this paper are largely generalizable to other countries, thus allowing policymakers to apply similar measures to improve the collaborative efforts in those countries.

2. Theoretical framework

To study what collaborations are formed in the circular economy, we look into theories on collaboration. We will build largely on network theory, and the key notion of 'proximity'. On this basis, we can perform a network analysis s performed. In a social network analysis, the ties between parties are studied. This allows us to uncover patterns in collaborations within the domain of circular economy. Furthermore, finding places where collaboration is lacking, can show where investment is helpful to further stimulate the circular economy.

2.1 Research question 1

Nieto and Santamaria (2007) identify four main types of collaborations for firms within an industry: 1) collaboration with Research Organizations; 2) collaboration with clients; 3) collaboration with suppliers; and 4) collaboration with competitors. The different types of collaborations tend to be associated with different types of innovations. Collaborations with ROs and educational facilities are very important for the creation of new (mostly scientific) knowledge. Governments are often involved in the regulations and standardisation in upcoming technological systems. Firms who collaborate with suppliers, on the other hand, are stimulating the transition to a new technological system (Luo et al., 2018). For platform technologies especially, collaborations with competitors, also called co-opetition, is a prevalent business model (Ruutu et al., 2017).

In this paper collaboration between all types of organizations is examined. To understand why some organizations collaborate and others do not, the theory of proximity is helpful. Proximity between organizations reduces uncertainty in a collaboration, and stimulates learning, knowledge creation and innovation (Amin & Wilkinson, 1999; Boschma, 2005). Therefore, higher proximities between organizations will increase the chance of a collaboration between the organizations. Thus, one of the independent variables for the presence of a collaboration is the proximity between the organizations. There are five dimensions of proximity (Boschma, 2005; Hardeman et al., 2014): cognitive, organizational, social, institutional and geographical proximity. Cognitive proximity refers to the ease of knowledge transfer and mutual learning between actors. This may depend on the similarity of their knowledge bases. However, regarding cognitive proximity, only a certain level of proximity is needed in order to ensure mutual understanding. Reversely, a certain level of cognitive distance creates opportunities for new combinations of knowledge and technologies to occur, leading to innovation. Hence, one expects organizations to seek partners that are similar, but not too similar. That is, one expects that the association between cognitive proximity and the probability of collaboration follows an inverted U-shape (Broekel & Boschma, 2012).

Organizational proximity refers to the extent to which networks occur within the context of an organizational arrangement, and the extent to which any two actors are under shared hierarchical control. Social proximity refers to the extent that two actors have established a friendly relation in the past. Institutional proximity refers to parties that operate under the same set of norms and values. Both formal and informal institutions structure behaviour by providing particular incentives. Geographical proximity refers to physical distance, viz. transportation costs (Boschma, 2005). In this research, the social proximity is not studied due to lack of time. Boschma (2005) explains how the different dimensions of proximity can promote collaboration. The spreading of tacit knowledge is enhanced through geographical proximity. This effect can even be seen in codified knowledge, because its application may need further information. Furthermore, short distances between of similar activities in transparent clusters ensures successful projects do not go unnoticed. This way, successful projects can be picked up by other organizations without

high costs. This way, geographical proximity stimulates collaboration between organizations. Institutions can be enabling or restricting mechanisms for innovation. Interactive learning and economic coordination are stimulated by a common language, shared habits, a law system securing ownership and intellectual property rights, etc. A culture of shared trust is a capability that enhances learning and innovation. The reason for this is that information can be transmitted more easily when there is cultural proximity and a common language. Thus, proximity in the institutional rules, institutional proximity, can be an enabling factor for interactive learning and innovation. Hierarchical organizations or tight relationships between organizational units can create strong control mechanisms, which can ensure ownership rights and sufficient rewards for investments in new technology. This can reduce the uncertainty and opportunism that is present with the creation of new knowledge. Furthermore, strong ties between units can stimulate the transfer of complex knowledge. Thus, organizational proximity can stimulate new knowledge creation and the transfer of complex knowledge. Finally, the effective transfer of knowledge requires the absorptive capacity to identify, interpret and exploit the new knowledge (Cohen & Levinthal, 1990). Organizations identify new opportunities in close proximity to their existing knowledge base. This also constrains their improvement in other directions, as knowledge and innovation are cumulative. The outcomes of these search processes within firms have a high degree of tacit knowledge and localization. This means cognitive differences will persist as long as the firm-specific competences are difficult to imitate by competitors. Thus, cognitive proximity stimulates similar searches in opportunities. An inverted U-shape relationship is suggested between the probability to collaborate and the cognitive proximity of two organizations (Mowery et al., 1998; Broekel & Boschma, 2012). The reason for this is that organizations are less likely to collaborate with an organization that does not have any different competences from them, as this will not result in new knowledge or skills. This will be further discussed below.

In empirical research, the notion of proximity is most used in studies on trade agreements between countries is through the gravity model (Biggiero & Basevi, 2009; Kepaptsoglou et al., 2010). Trade agreements can be seen as collaborations between countries. Similarly, one can use this model to analyse collaboration in the circular economy. In the gravity model, the GDP of a country and the distance between the capitals are typically used to predict trade agreements. As this social network analysis focuses on organizations, the four dimensions of proximity are used to indicate distance instead of only geographical distance. Instead of the GDP, the organization size is used in the social network analysis. The size of organizations is seen as an important factor for having many collaborations, because having more resources available to invest in collaborations makes pursuing those collaborations more likely. The size of organizations is correlated with the use a firm can make of knowledge created by universities (Cohen et al., 2002; Guena et al., 2003). Furthermore, bigger firms have more resources available for R&D. Higher R&D employments are correlated with more open innovation (Cohen et al., 2002).

Hypothesis 1: The size of organizations positively influences the chance for a presence of a collaboration.

Hypothesis 2: The proximity between organizations positively influences the chance of collaboration between the organizations.

Following the proximity framework, Hypothesis 2 will be divided in four sub-hypotheses:

Hypothesis 2a: The Geographical proximity between organizations positively influences the chance of collaboration between the organizations.

Hypothesis 2b: The Institutional proximity between organizations positively influences the chance of collaboration between the organizations.

Hypothesis 2c: The Organizational proximity between organizations positively influences the chance of collaboration between the organizations.

Hypothesis 2d: Cognitive proximity between organizations positively influences the chance of collaboration between the organizations, but only up to a certain level ('inverted-U shape)'.

2.2 Research question 2

While there may be collaboration between organizations, this does not mean that new knowledge is being created. Collaborations may actually be focused more on exchange rather than the production of new knowledge (Bozeman & Youtie, 2016). What is more, collaborations may fail, for example, when conflicts emerge, or unforeseen problems hinder the production of new knowledge. Thus, in order to study whether the collaborations between organizations will promote knowledge production, the outcomes of the collaborations are to be assessed. The output of the collaborations that is examined is the success of the collaborations.

According to Miller (2006), highly diverse partner capabilities may reduce the innovative benefits a collaboration could provide. The reason for this would be that organizations can only adopt practices and capabilities that are similar to their own. On the other hand, innovation cannot be achieved from combining capabilities that are very similar to existing capabilities within the organization. Organizations can gain more knowledge from collaborating with partners with different capabilities. According to van Rijnsoever et al. (2015), having a higher group diversity promotes technological diversity. Sampson (2007) found that R&D alliances with moderate diversity contribute more to firm innovation than alliances with very low or very high levels of capability diversity. Thus, in case of a network analysis, having a diversity of the actors in the project is likely to be important to the chance of a successful project. Diversity can be understood as a lack of one or more of the five dimensions of proximity (van Rijnsoever et al., 2015). Boschma (2005) explained how each dimension of proximity may have a negative impact on the performance.

Too much geographical proximity can hinder interactive learning and innovation. This can happen when regions stop looking outward for opportunities. This way the learning ability of the actors may be thus far reduced that organizations lose their innovative capacity. This prevents them from being able to respond to new developments. This is called spatial lock-in. Spatial lock-in is especially likely in highly specialized regions, because interactive learning will be hindered due to excessive cognitive proximity between local actors in specialized regions. Institutional proximity may also become a hindering factor to innovative performance. Institutional environments consist of interdependencies among the actors in the environment. If all actors adhere to the same institutions, following the same incentives, knowledge production will be less creative. Instead, by bringing together organizations that adhere to different institutions, like in university-industry-government partnerships, complementary knowledge can be brought together creating win-win-win opportunities. Too much organizational proximity can also be hindering innovation and learning. Hierarchical dependencies between organizational units and a parent organization may limit creativity, innovation and interactive learning. New ideas are not rewarded in a bureaucratic system, because hierarchical governance lacks feedback mechanisms that are present in symmetrical relations. This hinders the occurrence of interactive learning. Strong ties also limit access to sources of new knowledge and skills outside of the established channels. Thus, a certain level of autonomy and decentralization is helpful for organizational units. Too much cognitive proximity, finally, can also hinder innovative performance. One reason for this is that creating new knowledge requires heterogeneous, complementary knowledge bases. New sources create new ideas and stimulate creativity.

Moreover, routines within an organization can hinder the search for new technologies and new market possibilities. This can create a cognitive lock-in. Here the cumulative nature of knowledge creates a disadvantage for the organization. This is called the competency trap. Finally, higher cognitive proximity results in higher chance of involuntary knowledge spill-overs. Due to the higher cognitive proximity, the partner organizations have the same absorptive capacity, which increases the chance of spill-overs. According to Boschma (2005), and consistent with Sampson (2007), the relation between cognitive proximity and collaboration success follows an inverted-U shape, indicating that there is an optimal level of cognitive proximity. A certain level of cognitive proximity is needed in order to ensure mutual understanding, but a certain level of cognitive distance is needed to ensure opportunities for new combinations of knowledge and technologies to occur, leading to innovation.

Hypothesis 3a: The geographical proximity between the organizations in a collaboration negatively influences the chance of a successful project.

Hypothesis 3b: The institutional proximity between the organizations in a collaboration negatively influences the chance of a successful project.

Hypothesis 3c: The organizational proximity between the organizations in a collaboration negatively influences the chance of a successful project.

Hypothesis 3d: The cognitive distance between the companies in a collaboration positively influences the chance of a successful project, but only up to a certain level ('inverted-U shape').

As mentioned in the theory for hypotheses 2 and 3, proximity can have different effects on the outcome of a collaboration. Boschma and Frenken (2010) introduced the idea of a proximity paradox. The paradox describes that while proximity provides an important incentive for organizations to collaborate and exchange knowledge, too much proximity may harm the innovative performance of the organizations. The high proximity dimensions reduce the uncertainty of the collaboration. However, this reduces the gain from that collaboration. Broekel and Boschma (2012) argued that the proximity levels at which organizations tend to collaborate may be higher that the proximity levels that would be optimal for a successful collaboration. This would reflect biases by organizations to avoid risks by collaborating with proximate partners, even though more distant partners would yield better results. This would mean organizations are not gaining the most out of the collaborations they participate in. To test this hypothesis, one can combine the various hypotheses as formulated under hypothesis 2 and 3. We thus expect that geographical proximity positively affects the probability of collaboration (hypothesis 2a), but negatively affects the success of the collaboration (hypothesis 3a). Likewise, we expect that institutional and organizational proximity positively affects the probability of collaboration (hypothesis 2b and 2c), but negatively affects the success of the collaboration (hypothesis 3b and 3c). Regarding cognitive proximity, we expect that the optimum of the inverted-U shape curve lies at a higher level of cognitive proximity when explaining collaboration than when explaining success. This would indicate that organizations tend to collaborate with partners with a higher cognitive proximity than what would be optimal for successful collaboration.

As mentioned above, inter-organizational collaborative linkages provide benefits through resource sharing, allowing organizations to combine knowledge, skills, physical assets, and access to knowledge spill overs, serving as information conduits. Three aspects of an organization's network structure are likely to be relevant in connection with the above benefits: the number of direct ties maintained by an or, the number of indirect ties maintained by the organization (the organizations it can reach in the network through its

partners and their partners), and the degree to which an organization's partners are linked to each other (i.e., whether there are structural holes in the organization's ego network) (Ahuja, 2000). One way this can be measured is by studying the centrality measures. Centrality within a network shows how important that vertex is within the network. This can be seen as the equivalent of the size of the organization. However, with network centrality the focus lies on the resources that can be gathered from the network, whereas the size of the organization focuses on the amount of resources present in the organizations. Of course, size and centrality are often linked. Degree centrality refers to the count of the other organizations with which an organization is connected in the network, regardless of the direction. Organizations can benefit from connecting organizations to other organizations that are unconnected to each other. Brokerage centrality is defined as the number of organization pairs that are indirectly connected due to the (one-step) intermediation by the organization in question. Actors that hold a broker position in a network are more likely to express ideas, are less likely to have those ideas dismissed, and are more likely to have those ideas evaluated as useful (Burt , 2004). Betweenness centrality refers to the extent to which an organization lies on indirect knowledge flow paths between other organizations. Betweenness centrality for a given organization is the number of shortest paths between other organizations which pass through the organization in question. Finally, Eigenvalue centrality refers to a node's importance while giving consideration to the importance of its neighbours. The main principle is that links from important nodes (as measured by degree centrality) are worth more than links from unimportant nodes (Golbeck, 2013; Nomaler et al., 2014).

Hypothesis 4: The centrality of the organizations positively influences the chance of a successful project.

Because multiple centrality measures are used, Hypothesis 4 can be divided into four sub hypotheses:

Hypothesis 4a: The degree centrality of the organizations positively influences the chance of a successful project.

Hypothesis 4b: The betweenness centrality of the organizations positively influences the chance of a successful project.

Hypothesis 4c: The brokerage centrality of the organizations positively influences the chance of a successful project.

Hypothesis 4d: The eigenvector centrality of the organizations positively influences the chance of a successful project.

For this research, the type of collaboration is a government funded project. In order to measure the output, performance indicators are needed. There are several ways to measure the success of a project (De Wit, 1988). However, these measures are related to input, client/team satisfaction, or time management. These measures seem to be related to in-firm projects. For this research, these measures are not as relevant to measure success. Instead the impact of the project is more relevant to whether the findings are relevant. As the circular economy is still in the exploration phase, it may be more relevant to use a measure similar to scientific entities. One way that success can be measured, is by counting the amount of documents (articles) that are produced and the number of citations for each article (Acuna et al., 2012). As good data on citations rates are only available for scientific articles, and the project the outputs are reports rather than scientific articles, we do not use citation as a success variable. Instead, we only measure success here by the amount of documents that are produced.

2.3 Research question 3

An important factor for the performance of an industry is the structure of the network. One important aspect of this is the network density. According to one view, densely embedded networks with many connections are facilitative, and social structures are seen as advantageous to the extent that networks are "closed" (Coleman, 1988; Walker, Kogut, and Shan, 1997). According to an alternate view, however, social structural advantages derive from the brokerage opportunities created by an open social structure (Burt, 1992; Ahuja, 2000). Schilling & Phelps (2007) added to this debate that local density and global efficiency can exist simultaneously, and it is this combination that enhances innovation. Based on this information, the way to most efficiently stimulate innovation is to stimulate the connections that create local density and global efficiency. In other words, collaborations that optimally decrease the average path length or increase the centrality in the network need to be stimulated.

Given the network of collaboration that we obtain from our data collection, we are able to look for "missing links". Missing links detection helps to detect highly likely but non-existent links, which can be used as recommendations to collaborate (Luo et al., 2016). Identifying missing links evaluates existing policies in terms of their possible inability to connect important organizations. The analysis can give clues for new policy in terms of what collaboration to target in the future. Such missing links can be identified by checking, for each possible link that can be added to the network, to what extent the average path length in the network decreases. For example, as an extreme case, consider a network with two components (meaning they have an infinite distance). Adding a link between the two components means that the average path length decreases enormously. A less extreme example is a network with one component but two different clusters, each with one central node that are not connected. Connecting the central nodes of each cluster would maximally decrease the average path length. An example of missing link prediction being done based on path length is the Katz similarity. Katz (1953) describes the similarity between nodes based on the global path between the nodes. This is done by counting the number of paths between two nodes and using this to calculate the similarity. The greater the number of paths between to nodes, the greater the similarity. However, longer paths contribute less to the similarity.

3. Method

3.1 Data collection

3.1.1 Dataset composition

For this network analysis, this paper uses projects in which the actors collaborated to establish a network analysis. This data is collected from the EUPRO dataset, which a database from the Research infrastructure for research and innovation policy studies (RISIS, www risis.eu). The EUPRO dataset provides a cleaned dataset on the R&D projects and the participants of these projects. The dataset consists of 96,674 projects and 526,564 participants. This database was created by the Austrian Institute of Technology (AIT) in 2005. It was created to aid in the analysis of participation patterns of organizations in and across different European funding initiatives and the investigation of collaborative network structures, including their evolution over time (Heller-Schuh et al., 2019). The EUPRO dataset consists of four components: The CORDIS projects database, the EUREKA funding network, the Joint Technology Initiatives (JTI) ARTEMIS, ENIAC and ECSEL programmes, and the COST funding organization database. The CORDIS database contains projects and organizations funded by the European Union for the Horizon 2020 Framework Programme (FP) from 2014 until 2020. EUREKA is a public network for international cooperation in R&D and innovation to which the European Union is subscribed. Eureka is an open platform for international cooperation in innovation with a focus on Small and Medium Enterprises (SME). Eureka has provided 3,636 million euros in funding to this day (Eureka, 2020) and JTI 2,560 million euros (JTI, 2020). The quality of the raw data extracted from the different programmes websites is not generally sufficient for policy-relevant analyses. AIT has undertaken substantial efforts to improve quality and the level of standardisation of the data and to retrieve and add missing data. Data cleaning and standardisation includes three major steps: identification of unique organization name, identification of unique organization type, and regionalisation (European NUTS regions)

The EUPRO dataset is used to gather data on which projects received subsidies/grants for investments into circular economy in the Netherlands. In this database, the parties involved in the projects and the results are published. To collect the data about the projects, RISIS was contacted with a set of keywords (Appendix 1A). These keywords were found through the list of CPC codes from Eurostat (see Appendix 1A). These CPC codes are the patent codes CDC associates with circular economy. The main topics from these patents were used as keywords. Furthermore, a literature research was done to find the terms most related to circular economy. For this part of the research theoretical saturation was reached. A link with clean database with the data about all of the projects was sent. Using this, a network analysis is done on the collaborations in the circular economy. From these pages, the project, the parties involved, and the end result are collected. As this paper's main focus is on the Netherlands, projects with organizations in the Netherlands are used. After filtering on the projects in the Netherlands, the projects were screened to ensure that all the projects were related to the circular economy. This was done by checking titles, short descriptions, and abstracts. From the 1011 projects in the Netherlands, 876 projects remained after the screening, from which 305 were unique (sometimes records were present several times in a dataset). From this dataset, projects from the most recent 10 years was used. As the dataset was based data until 2017, the projects from 2007 to 2017 were used. After, 97 unique projects and 632 unique organizations remained. As the non-Dutch organizations are not shown for the links with other non-Dutch organizations (which are most likely most of their links), the network is not complete for the organizations that are not based in the Netherlands. Thus, the binary logit model of the first research question can only be performed for all Dutch firms. As the analysis of research question 2 is dependent on the network centrality, the same problem is present for non-Dutch firms in the second research question. Thus, the non-Dutch organizations need to be filtered out from the dataset. After filtering for organizations based in the Netherland, only 139 unique organizations remained. The number of projects remained the same.

The dataset consists of 7 documents in total, each containing different variables and information. First, the "projects_export" file was used. This was the file containing the projects and their information. Here, the projects were filtered for relevancy, as mentioned above. Then, the "participations_export" file was used. This file contains information on which participants were present in each project, as well as information on those participants. For organizations with multiple locations, the city name was added to the organizations name (stApplicant). A separate column was made containing all the name of the main organization (MainOrg). For organizations that do not have other locations or overarching structures, the names of the organization was copied into the new column. These files are combined by the project ID (RecCtrNr). This means that if a collaboration happens in in multiple RecCtrNrs, it will appear multiple times. After these are combined, the independent variables need to be created. The dependent variable (Collab), will be created by combining all duplicates of the same collaboration into a count of the collaboration. If there is no collaboration for that combination of organizations, Collab is 0. If there are one or more collaborations for that combination, Collab is 1.

For the independent variables, ten variables from the dataset were used (see table 1): (1) sCity, (2) sCountry (3) stOrgtyp, (4) MainOrg, (5) emp (size of the organization), (6) StartDate, (7) ProjectEUfunding, (8) noParticipants. The categories for stOrgtyp are industry organizations (IND), public and private research organizations (ROR), universities and other educational facilities (EDU), governmental institutions (GOV), non-commercial/non-profit organizations (NCL), Consultancies (CON, and special interest groups, like unions, chambers, inter-trade organizations, etc. (OTH). Furthermore, there were 72 rows with the presence or absence of organizations in the 72 GICS matched. This was used to create the variable (9) CognProx and (10) sqCogn. For the geographical proximity, the county and city of the first organization in the collaboration is compared to the county and city of the second organization. If they were in the same city, Geoprox is TRUE. For the Institutional proximity, if the stOrgtyp of both organizations matched, Insprox is TRUE. The Organizational proximity (Orgprox) is TRUE, if the MainOrg of both organizations is matched. The Cognitive Proximity (CognProx) was measured by counting how many of the 72 rows of GICS industries matched. Then for the second research question, the "documents_export" file was used to count the number of documents per project to assess the impact of that project. Furthermore, the centrality measures were created in R and added to the dataset.

Table 1: the different variables that are used and their descriptions

Variable	Meaning	Range
sCity	The city in which an organization is located	-
sCountry	The country in which the organization is located	-
MainOrg	The main organization. If an organization has multiple locations the main organization is the same. Each location gets a different name and is considered a different organization.	-
stOrgtyp	The type of organization according to the EUPRO dataset	Categorical variable: *IND, ROR, EDU, GOV, NCL, CON, OTH*
Geoprox	Variable for if two organizations are located in the same city.	TRUE/FALSE dummy variable
Orgprox	Variable for if two organizations have the same MainOrg	TRUE/FALSE dummy variable
Insprox	Variable for if two organizations have the same stOrgtyp	TRUE/FALSE dummy variable
CognProx	The amount of similar GICS industries between two organizations.	Count variable. 0-72
sqCogn	The square of this CognProx.	0-5184
emp	The natural logarithm of the product of the number of employees of two organizations	0-11.778
StartDate	The date that the project started	2007-2017
ProjectEUfunding	The amount of funding the EU provided for the project (in million euros)	0.05-10.811
noParticipants	The number of participants in a project	2-37

3.1.2 Dependent Variables

To analyse the network analysis, the dependent variable for RQ1 is the presence of a collaboration between two organizations. In this paper, collaboration is measured by the participation in the same project, which results in the presence of a link between the different organizations. This is measured by creating a network analysis and seeing which actors work together and which do not. This is done by first creating a 2-mode network of all projects in the circular economy in the Netherlands and which actors worked in each project. Then, the 2-mode network is transformed into a 1-mode network of the actors that worked together. For this, an undirected network analysis is used as collaboration is two-sided. As very few organizations collaborated multiple times (only 6 out 303 collaborating pairs had more than 1 collaborations). The network was weighted. Furthermore, for this paper, collaborations with multiple parties are more important than multiple collaborations with the same organizations. presence of a link is a binary variable. Due to the fact that number of unique collaborations is more important than number of total collaborations, repeated collaborations are counted as 1. While some organizations may have multiple collaborations between them, these are counted as a binary variable. For this regression, a Binary logit model will be used.

The dependent variable for RQ2 is the success of the projects from which the network analysis is created. One way to measure this is the amount of achievements on the EUPRO page for each project. The data for this can be found in the EUPRO dataset. This can be done by assessing the quality of the output and

grading this output as a continuous variable. However, such data are not available. Therefore, we proxied the quality of a collaboration by the amount of documents a project delivered, as to indicate the success of the project. If a project contains many documents discussing this project, the impact of this document is considered large. These numbers will also be used as a continuous variable. To normalize the number of documents as outputs for the inputs in a project, we include the amount of funding and the amount of collaborators as control variables. By doing so, the success variable can be understood as an efficiency measure.

3.1.3 Independent Variables

The first independent variable of RQ1 is the size of the organizations. This will be determined with the number of employees. The number of employees are found either on the website of the organizations itself, its LinkedIn introduction page, or on websites which register and monitor other organizations, such as dnb, zoominfo, rocketreach, Apollo, etc. For each collaboration, the natural logarithm of the product of the number of employees of both organizations. The second independent variable of RQ1 is the proximity between the organizations in the Circular Economy. The four dimensions of proximity will be measured according to Hardeman et al. (2014): The geographical proximity will be measured by whether or not they are in the same city/municipality (high proximity), in the same province/county (medium proximity) or not the same county (low proximity). The province/county area is considered based on NUTS2 where applicable (for Luxembourg, the provinces were used and for Ukraine the oblasts were used). The cognitive proximity is measured by the overlap between the amount of industries in which they work. The organizations were sorted into industries according to GICS. In this case, for example an electrical manufacturer which sells to other industries is not counted to the industries in which it sells, only the industry to which the organization itself belongs and has knowledge bases of. This information is also found on the websites of the organization itself. Furthermore, as government institutions (such as municipalities) often do not belong to an industry, an extra sector was created specifically for governmental institutions. Excluded from this are governmental institutions that provide utilities, as these clearly belong to an industry. There was also a subject variable in the EUPRO dataset. This variable divided the projects according to 68 keywords, similar the GICS categorization. The reasons these categories were not used instead were that (1) the keywords were used to describe the project instead of the organizations which was not useful for this analysis; (2) the variable was not present for each datapoint in the dataset and (3) the designation of the keywords was not elaborated upon, which made reproducing it unreliable. The institutional proximity will be a dummy variable, which states whether or not the organizations are in a similar institutional sphere: academia, industry, government or care. This data is present in the EUPRO dataset. Finally, organizational proximity is also measured as a dummy variable. This dummy variable states whether or not two organizations belong to the same overarching hierarchical meta-structure, using the MainOrg column that was created. For example, Arkema Ritthem and Arkema Rotterdam will be considered separate organizations with an overarching hierarchical meta-structure and thus organizationally proximate. The same goes for governmental institutions, as they fall under the federal government of that country.

For RQ2, the first independent variables are four dimensions of proximity. The four dimensions will be scored as they were in RQ1. The other independent variables for RQ2 is the network centrality. Network centrality can be measured by the centrality measures. The centrality indicators from Wasserman and Faust (1994) are used: degree centrality, brokerage centrality, betweenness centrality, and eigenvector centrality. These centrality measures are calculated using functions in R in the package “igraph”. The brokerage is calculated using the functions in the package “statnet”.

3.1.4 Control Variables

For RQ2, multiple control variables are used that may well affect the success of a project. The first control variable is the start date of the project. The reason this variable needs to be controlled for is that a project which has started earlier has had more time to gain articles, which is the success measure of this research. For this variable, the "StartDate" variable from EUPRO will be used. The second control variable that is used is the amount of funding the EU has contributed to the project. The reason for this is that success may simply be attributed to the amount of money spent on the project. For this variable, the "ProjectEUfunding" variable from EUPRO will be used. The reason this variable is used instead of "TotalPojectCosts", which is the total amount of money spent in total on the project, is that TotalProjectCosts is sometimes 0, despite the fact that the ProjectEUfunding is higher than 0. This means that sometimes the variable TotalProjectCosts is not properly measured. Finally, a control variable which is used is the number of participants in the project. This will be used to ensure that the amount of participants in an organization is not the reason for improved performance. For this variable, the "noParticipants" variable from the EUPRO dataset is used.

3.2 Data analysis

To analyze the data, a network graph is created. This will be done using the R language and environment (R Core Team, 2018), because R provides a wide range of quantitative analyses, which are needed for the analysis. The network will contain information on the Dutch organizations that participated in EU funded projects that were coordinated by the Netherlands in 2007-2017. From this network graph, network measures are calculated. Furthermore, the organizations in the network that are most important are also extracted. This is done based on degree and brokerage.

For the first two research questions regressions are carried out. The dataset for these regressions contains every possible collaboration between organizations. This is done by using the R function "combn" to create a list of all possible combinations. Then, a dataset containing the project information and organization information is created by merging the "participations_export" and the "projects_export" files. These files contain information on the organizations and projects, respectively. Here, the data that was collected, regarding the number of employees and the market areas, was added. Then, the dataset with all collaborations was joined with the file containing the information. This dataset was used for the regressions.

For the first research question a regression will be performed to understand the relationship between the independent variables and the dependent variable. As the dependent variable is binary, a binary logistic regression is performed. First, a multivariate binary logistic regression will be applied to test the relationships between the independent variables and binary dependent variable. Second, a correlation matrix is created for the independent variables to observe any nested correlation that might occur. Third, a Variance Inflated Factor (VIF) test is conducted to check for multicollinearity. VIF measures the increase in variance of a regression due to the collinearity between the variables (Baldrich, 2019). For VIF, a cutoff of 5 is often used (Sheather, 2009). If the VIF is higher than 5, the regression coefficients are poorly estimated due to multicollinearity.

For the second research question, a regression will be performed to understand the relationship between the independent variables and the dependent variable. As the dependent variable is a count of the number

of documents released, a count regression can be performed. To do this, the documents in the file "documents_export" were counted for each RecCtrNr. If nothing was counted it was considered a 0. This data was merged with the main dataset. Then, the dataset was filtered for all collaborations that actually occurred, as a collaboration between two organizations that did not occur cannot be successful or unsuccessful. First, a Poisson count model will be applied for each independent variable related to network and the dependent variable. These network measures are too similar to compare together. This would result in correlation between the independent variables, which would make the results less accurate. Thus, the network centrality measures will be ran separately. Second, a Poisson count model will be applied to test the relationships between the proximity independent variables and the dependent variable. After each Poisson model, the overdispersion is tested. If the model is overdispersed, a Quasi Poisson model will be applied. While a negative binomial also works well on overdispersed data, it tends to give more weight to smaller organizations (Ver hoef and Boveng, 2007). This is not significant for this research. The reason the VIF is not tested for the Quasi Poisson is that while for binary logistic regression the use of the VIF has been documented (Midi et al., 2010), this has not been the case for Quasi Poisson regression. However, as the proximity variables are the same for both research questions and the centrality measures are tested with univariate regressions, the multicollinearity of the different proximity measures is considered the same throughout the different regressions.

As the successful links between the organizations are not affected by the zeroes in the network, the non-Dutch organizations can be included in research question 2. However, the centrality measures depend on the full network being present, meaning only the proximity measures can be tested for all organizations. This is done similarly to the regression with the proximity measures for only the Dutch organizations.

Finally, a missing link prediction based on path length is carried out. As this analysis depends on the network and network measures, only Dutch organizations are examined for this research question. To perform this analysis, decrease in average path length for newly added links needed to be measured. First, a function to carry this out for each link in the whole network was attempted. However, due to the fact that the network was unconnected, this was not possible. While trying to remove the unconnected nodes, the network was not representable anymore. Thus, the missing link prediction was carried out manually. This was done by making a list of all the possible combinations between the 25 organizations with the highest degree (see table 12). This is done by adding the two organizations into the dataset and adding a fake RecCtrNr (project number) in. This was done for all 300 combinations. Then, a network was created from the new dataset and the average path length was measured. This is the average of the shortest paths between each node.

4. Results

4.1 Network visualisation

The dataset that was created for all the Dutch organizations that participated in project with a Dutch project coordinator, contained 139*138/2 = 9591 organization pairs. Table 2 shows the descriptive statistics for all variables for research question 1, including the mean, minimum value and maximum value. These rows contained all possible collaborations between the organizations. During data collection, data was not available for all organizations. From these rows, data was available for 9548 organization pairs. From these 9548 possible collaborations, 303 collaborations occurred. Furthermore, in 850 possible collaborations were both organizations from the same city (Geoprox = TRUE), organizations were institutionally proximate in 5329 collaboration (Insprox = TRUE), organizations had organizational proximity in 17 of the collaborations(Orgprox=TRUE), and the sum of the Cognitive Proximity was 9252 with an average cognitive proximity of about 0.965. Finally, the average number of employees of the Dutch organizations was 4171 (rounded down) with a median of 80 employees. The average number of employees of all organizations was 9308 (rounded down) with a median of 252 employees.

As mentioned before, a network analysis was carried out of the organizations that participated in EU funded projects. The projects were ranged from 2007 until 2017 and were coordinated by the Netherlands. The network (see figure 1) contains the collaboration between the Dutch organizations for the projects that have a Dutch coordinator. The vertices are sized according to their degree. The colours of the nodes are based on the type of organization.

Table 2 descriptive statistics for the variables for research question 1

Variable	**Min**	**1st Quarter**	**Median**	**Mean**	**3rd Quarter**	**Max**
emp	0.000	2.813	4.119	4.165	5.431	10.142
CognProx	0.000	0.000	0.000	0.4151	1.000	19.000
sqCogn	0.000	0.000	0.000	1.223	1.000	361.000
Logical	**True**	**False**				
Geoprox	347	9122				
Orgprox	17	9452				
Insprox	3407	6062				

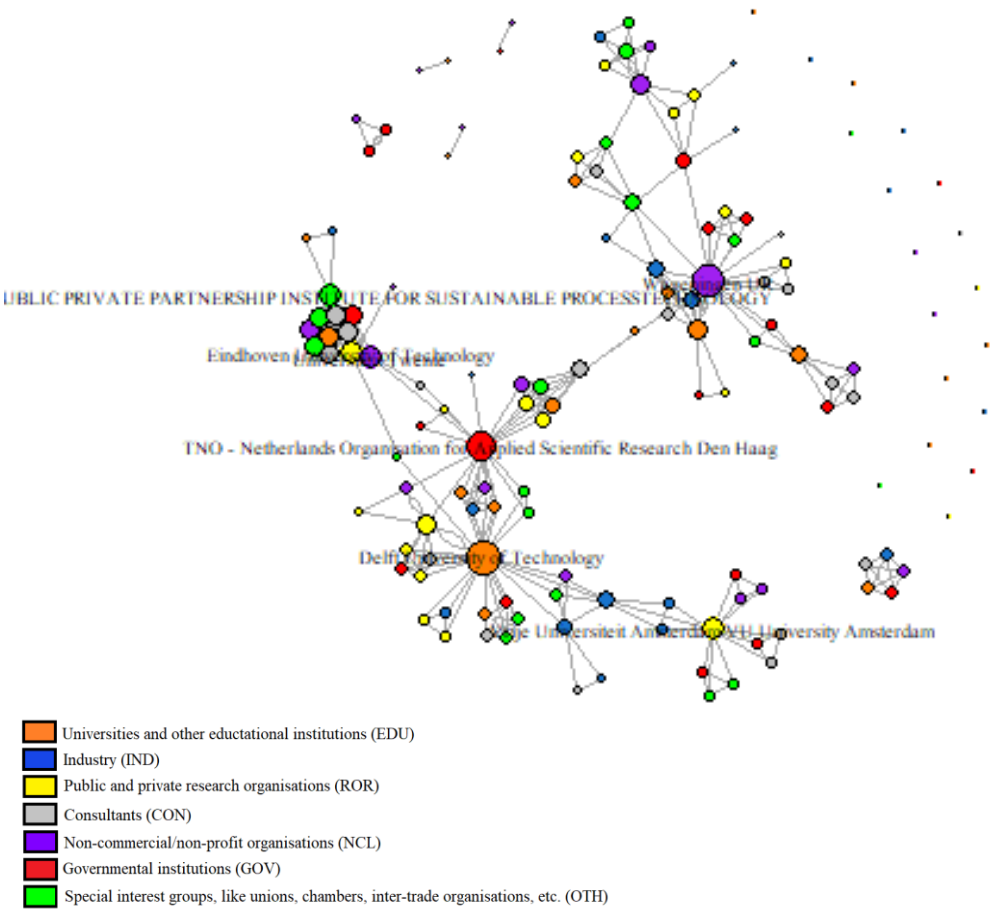

Figure 1: Network analysis of the collaboration between all Dutch organizations in EU funded projects coordinated by the Netherlands. The projects are ranged from 2007 until 2017. The node size is linked to the degree centrality of that node. The colours of the nodes are related to the type of organization.

The graph of the network of participating organizations in projects contained 139 nodes and 303 edges. The network contains one hub around the nodes of "Universiteit Twente", "Eindhoven University of Technology", and "Public Private Partnership Institute for Sustainable Process Technology". This was confirmed by creating a separate network graph with vertex sizes based on eigenvector (this network is undirected meaning the hubscore and the eigenvector are equal) (see figure 4 in Appendix 1B). This confirmed the group of nodes mentioned as a hub. The average degree of each node is 4.36, meaning each organization collaborated with about four others organizations on average. Meanwhile the median degree is 3. Furthermore, the average of the betweenness centrality was 133, while the median was 0. This shows that the betweenness centrality of this network was very skewed. The average brokerage centrality is 13.94, while the median is 0. This, along with the values in table 4, show that the brokerage centrality in this network is skewed. The average path length of this network is 4.25. This is the average of the shortest paths from each node to all the other nodes in the network. The network has a diameter of 9 and a clustering coefficient of 0.58.

In this network, there are 14 articulation points (see table 3). An articulation point in a network is a node whose removal disconnects the network (Tian et al., 2017). These organizations are important to the connectivity of the network. Upon closer inspection of the 14 articulation points, a pattern can be observed in the 14 organizations. The organizations are often either research or educational facilities (high knowledge production) with over a 1,000 employees, present in many GICS industries or small industry organizations (firms) with a low amount of employees (micro or small organizations) which are present in one or two GICS industries (highly specialized). The industries of the organizations present in 1 or two organizations were examined, but they were not the same nor were they in the same industry group.

Table 3: The organizations which form articulation points in the Network and the type of organization, number of industries it is present in, the number of employees, and its location.

Organizations	Org type	Number of GICS industries	Number of employees	City	County
Biodetection system BV	IND	1	39	Amsterdam	North Holland
ECN – Energy Research Centre of the Netherlands	ROR	3	493	Petten	North Holland
Avantium Chemicals BV	IND	2	220	Amsterdam	North Holland
Wageningen UR	EDU	5	6500	Wageningen	Gelderland
TNO Den Haag	ROR	19	2600	Den Haag	South Holland
Delft University of Technology	EDU	22	3554	Delft	South Holland
Vrije Universiteit Amsterdam	EDU	9	4600	Amsterdam	North Holland
Gemeente Amsterdam	GOV	1	16000	Amsterdam	North Holland
Van Gansewinkel	IND	1	4125	Eindhoven	North Brabant
Stichting Public Private Partnership Institute for sustainable Process	OTH	7	39	Amersfoort	Utrecht
Eindhoven Univeresity of Technology	EDU	13	3239	Eindhoven	North Brabant
Provalor BV	IND	2	1	Ursem	North Holland
Rood Wit Blauw Water Services BV	CON	1	70	Almelo	Overijssel
KWR Water BV	ROR	2	170	Nieuwegein	Utrecht

Furthermore, there are nodes which are brokers in the network. The nodes with the highest brokerage centrality are the nodes that increase the number of organization pairs that are indirectly connected due to presence of the node. The ten nodes with the highest brokerage centrality are shown in table 4. Here the same pattern as with the articulation points was observed.

Table 4: The 10 organizations with the highest brokerage centrality in the Network and the type of organization, number of industries it is present in, the number of employees, its location, and the brokerage centrality.

Organizations	Org type	Number GICS industries	Number of employees	City	County	Broker centrality
Wolthuis Yvonne Barbara	CON	1	1	Utrecht	Utrecht	586
Wageningen UR	EDU	5	6500	Wageningen	Gelderland	450
Vrije Universiteit Amsterdam	EDU	9	4600	Amsterdam	North Holland	340
Vitens N.V. Zwolle	IND	1	1378	Zwolle	Overijssel	314
Vitens N.V. Utrecht	IND	1	1378	Utrecht	Utrecht	272
Vezet BV	IND	4	561	Warmenhuizen	North Holland	224
Boerenverstand Consultancy	CON	2	4	Utrecht	Utrecht	140
Veolia Vroomshoop	IND	1	179000	Vroomshoop	Overijssel	108
Vanderlande Industries BV	IND	1	6500	Veghel	North Brabant	104
Van Remmen UV Techniek BV	CON	1	11	Wijhe	Overijssel	94

4.2 Research question 1

In order to answer the first research question, the binary logit model regression was performed on the organizations in the Netherlands. The independent variables that were tested were (1) size of the organization, (2) the geographical proximity at the city level, (3) the organisational proximity, (4) the Institutional proximity, (5) the cognitive proximity, and (6) the square of the cognitive proximity. The results of the regression are shown in table 5.

The size of the organizations is significantly correlated with the presence of the link. This means that Hypothesis 1 is accepted. The geographical proximity at the city level between two organizations is also significantly associated with a presence of collaboration between these organizations. This means Hypothesis 2a is accepted. The institutional proximity and the organizational proximity are not significantly correlated with the presence of a collaboration. This means hypothesis 2b and 2c are not accepted. The cognitive proximity is significantly correlated with the presence of a collaboration between two organizations. The square of the cognitive proximity is also significant, but with a negative estimate. This means that the effect of cognitive proximity on the chance of collaboration has an inverted u shape. This means that Hypothesis 2d is accepted.

Table 5 Binary Logit Model with the presence of collaboration as the dependent variable and the four dimensions of proximity and the organization size.

	Dependent variable:
	Collab
Geoprox	0.807***
	(0.225)
OrgProx	0.050
	(1.053)
Insprox	0.045
	(0.129)
CognProx	0.473***
	(0.080)
sqCogn	-0.030***
	(0.009)
emp	0.161***
	(0.034)
Constant	-4.473***
	(0.180)
Observations	9,548
Log Likelihood	-1,254.557
Akaike Inf. Crit.	2,523.114
Note:	*p<0.1; **p<0.05; ***p<0.01

From the estimates of the CognProx and the sqCogn, the optimum Cognitive proximity for the presence of collaboration can be calculated. This is done by calculating the point at which the estimates CognProx and sqCogn are equal. The formula for this is:

$Y = -0.030x^2+0.473x$

Where z is the variable "emp". From this formula, the derivative is created. Then, the x is calculated for where the derivative is 0. The value for is 7.88. This means, the optimal Cognitive proximity score is a score of 7.88. Being present in 7-8 of the same industries as another organization will optimally increase the chances of collaborating with that organization.

In order to ensure these results are not caused by multicollinearity between the independent variables, the Variance Inflation Factor test was performed (see table 6). All variables have a value around 1 except the CognProx and the sqCogn. This is to be expected as the sqCogn is derived from the CognProx. However, to ensure that the multicollinearity of CognProx does not extend to the other independent variables, another binary logit model is carried out, this time without the sqCogn (see Appendix 1C). Here all the VIF values are around 1 and thus multicollinearity is not present between the different variables.

Table 6 Variance Inflation Factor test for the independent variables of the Binary logit model of table 5.

	Binary logit model
	VIF
Geoprox	1.014800
Orgprox	1.010227
Insprox	1.028562
CognProx	5.118190***
sqCogn	4.826241
emp	1.164665
Observations	9548
Note:	*** VIF>5

Finally, a correlation matrix was created for the correlation between the independent variables and the dependent variable (see figure 2). From this figure, the independent variables which were significant in the regression are also correlated with the dependent variable in the correlation matrix. The variable CognProx is strongly correlated to the sqCogn. This is to be expected as the sqCogn is derived from the CognProx. Furthermore, we see a correlation between the company size (emp) and CognProx, sqCogn, and institutional proximity. As organizations are larger, they can have broader cognitive abilities, increasing the chance of higher cognitive proximities. Organization size is negatively correlated with institutional proximity. This means that larger organizations tend to work with a greater variety of types of organizations. Most likely this is due to fact that large firms have the resources to collaborate with more organizations and thus more types of organizations. Furthermore, we see a slight correlation between the Geographical proximity at the city level and cognitive proximity.

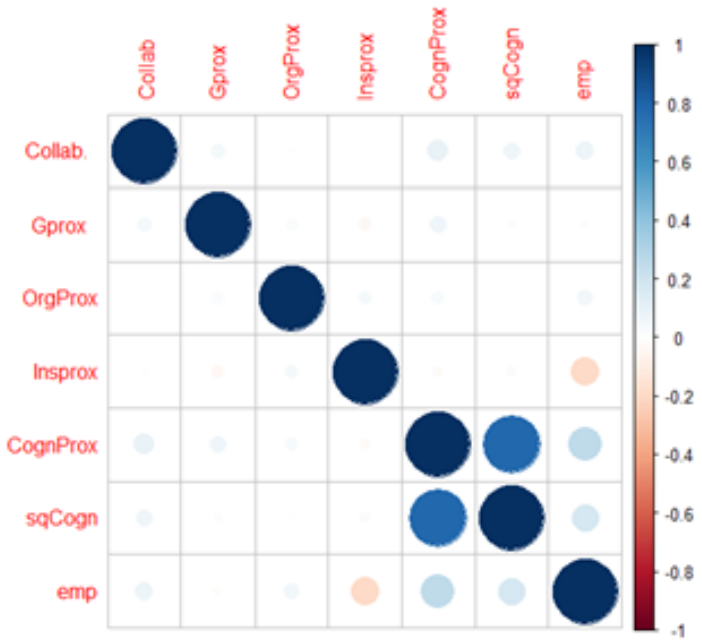

Figure 2 Correlation matrix between the dependent variable and independent variables of research question 1

4.3 Research question 2

The data for this analysis are the 303 present links from the first research question. Here too, some of the organizations did not have data for some of the measures. Thus, 293 observations are used in the regression. Table 7 shows the descriptive statistics for all variables for research question 2.

Table 7 Descriptive statistics for all variables for research question 2

Variable	Min	1st Quarter	Median	Mean	3rd Quarter	Max
Success	*0.000*	0.000	2.000	2.567	2.000	48.000
CognProx	0.000	0.000	1.000	0.9898	1.000	14.000
sqCogn	0.000	0.000	1.000	4.137	1.000	196.000
Eigenvector	0.000	0.001	0.019	0.216	0.119	0.996
Brokerage	0.000	0.000	12.00	60.85	54.00	463.00
Betweenness	0.00	0.00	104.0	466.6	668.0	3026.3
Degree	1.00	5.00	7.00	8.22	11.00	24.00
ProjectEUfunding	0.595	1.310	3.158	3.651	4.716	10.811
StartDate	2008	2012	2013	2013	2015	2017
noParticipants	3.00	14.00	18.00	17.95	23.00	37.00
Logical	**True**	**False**				
Geoprox	24	269				
Orgprox	1	292				
Insprox	97	196				

4.3.1 Proximity measures

The proximity measures are taken as the independent variables. The dependent variable is the success of the project. All models are Quasi Poisson count models. The results of the regression are shown in table 8. Here, the Geoprox has a negative estimate and is significant. This means that the Geographical proximity between two organizations significantly decreases the chance of a successful project. This confirms our Hypothesis 3a, less geographical proximity between organizations increases the chance of a successful project. The Orgprox was not significantly correlated with the dependent variable. Hypothesis 3b cannot be accepted. The Insprox is also significant and has a negative estimate. This means our hypothesis 3c can be accepted, less institutional proximity between organizations increases the chance of a successful project. Finally, CognProx and sqCogn are not significant. This means hypothesis 3d cannot be accepted on a national level.

The estimate of Geoprox for research question 1 was positive and significant. The estimate of Geoprox in this regression is significantly negative. This asserts the presence of a proximity paradox for the geographical proximity. The presence of geographical proximity stimulates organizations to collaborate, while also negatively impacting the success of the project. The estimate of the institutional proximity for research question 1 was positive. The significant negative estimate of Insprox indicates the presence of a proximity paradox for the institutional proximity. However, for a proximity paradox to be accepted, relation between the presence of a collaboration and thee institutional proximity should also have been significant. As it is, however, the proximity paradox for the institutional proximity has not been proven.

Table 8 A Quasi Poisson count model with the dependent variable as the impact and the independent variable as the four measures of proximity in column 1 and the four measures of proximity and the square of the cognitive proximity in column 2.

	Dependent variable:	
	Success	
	(1)	(2)
Geoprox	-1.015**	-1.000**
	(0.403)	(0.405)
Orgprox	-0.150	-0.080
	(2.288)	(2.295)
Insprox	-0.393**	-0.403**
	(0.190)	(0.192)
CognProx	0.034	-0.024
	(0.042)	(0.108)
sqCogn		0.007
		(0.011)
StartDate	-0.418***	-0.422***
	(0.040)	(0.041)
ProjectEUfunding	0.196***	0.195***
	(0.038)	(0.038)
noParticipants	0.021	0.020
	(0.016)	(0.016)
Constant	841.806***	849.517***
	(80.476)	(81.937)
Observations	293	293
Note:	*p<0.1; **p<0.05; ***p<0.01	

4.3.2 Network Centrality measures

In order to answer the second research question, a count model regression was performed on the organizations in the Netherlands. First, the network centrality measures are taken as the independent variables. The centrality measures that are used are the (1) degree centrality, (2) betweenness centrality, (3) brokerage centrality, and (4) the eigenvector centrality. The dependent variable is the Impact of the project. The results of the regression are shown in table 9. The Poisson models of these variables were performed (raw data in Appendix 1D). The dispersion test of all Poisson modes showed that the data was overdispersed (see Appendix 1D). Thus, all models are Quasi Poisson count models.

Table 9 Quasi Poisson count models with different centrality measures as independent variables and the impact as the dependent variable

	Dependent variable:			
	Success			
	(1)	(2)	(3)	(4)
eigenvector	-2.614**			
	(1.087)			
betweenness		0.0002		
		(0.0001)		
brokerage			-0.0003	
			(0.001)	
degree				-0.009
				(0.019)
StartDate	-0.344***	-0.400***	-0.408***	-0.407***
	(0.045)	(0.042)	(0.042)	(0.041)
ProjectEUfunding	0.120***	0.178***	0.190***	0.189***
	(0.044)	(0.040)	(0.039)	(0.039)
noParticipants	0.042**	0.028	0.029*	0.029*
	(0.017)	(0.018)	(0.017)	(0.017)
Constant	691.656***	804.272***	821.008***	818.587***
	(90.503)	(84.543)	(84.125)	(83.227)
Observations	293	293	293	293
Note:				*p<0.1; **p<0.05; ***p<0.01

The Quasi Poisson models for the four centrality measures are summarised in table 9. From this table, we can see that the degree centrality of an organization is significantly correlated with the impact of the project. This means hypothesis 4a can be accepted. The betweenness centrality of an organization is not significantly correlated with the impact of the project. This means hypothesis 4b is not accepted. The brokerage centrality of an organization is significantly correlated with the impact of the project. This means hypothesis 4c can be accepted. The eigenvector centrality of an organization is significantly correlated with the impact of the project. However, the estimate is negative. This means hypothesis 3

4d has been falsified. In fact, the opposite of the hypothesis seems to be true. Project with organizations with higher eigenvector centrality are less likely to be successful. The estimates of the brokerage centrality and degree centrality were also negative and while these results were not significant, this does point towards a trend of well-connected organizations hindering the success of projects. From these results, it appears that the projects with participants that are in hubs perform significantly worse than projects without participants in hubs. This is the contrary to the results from Gloor et al. (2011), where innovators that were closer to the main hub, were more successful.

Finally, a correlation matrix was created for the correlation between the independent variables for hypotheses 3 and 4 and the dependent variable (see figure 3). From this figure, instantly a strong correlation is seen between the different network centrality measures. The brokerage centrality, betweenness centrality and degree centrality appear to have a positive correlation with CognProx and sqCogn and a negative correlation with Insprox. This means that organizations that are brokers, have high betweenness or high degree tend to have high cognitive proximity with organizations. One reason for this could be that organizations in our network with high brokerage centralities, degree centralities and betweenness centralities are often Research organizations (ROR) or Educational facilities (EDU), which are large knowledge producers often with broad industrial presence compared to the rest of the network. It also shows the same result as in figure 2, where larger organizations often have lower institutional proximity and higher cognitive proximity than smaller organizations. Furthermore, like in figure 2 a strong correlation between CognProx and sqCogn is present. Furthermore, the independent variables which were significant in the regression are also correlated with the dependent variable in the correlation matrix.

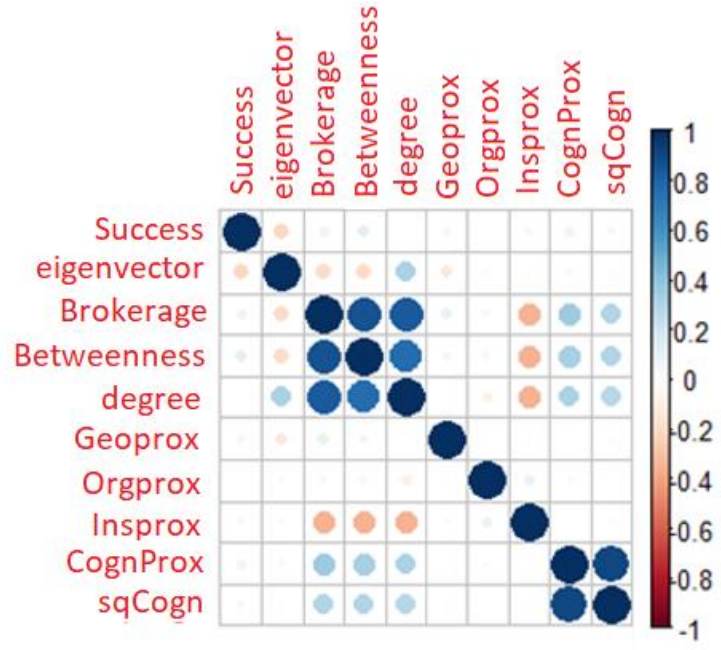

Figure 3 Correlation matrix with the dependent variable and the independent variables for hypotheses 3 and 4 compared.

4.3.3 All organizations

Finally, in order to get a better look at the rest of the organizations participating in the projects, the proximity measures were tested with the impact on all organizations participating in projects with a Dutch coordinator. For this analysis, 5689 collaborations, of the 199,396 possible collaborations, were present for projects for the Netherlands. From these 5689, data was available for 5668 collaborations (see table 10).

Table 10 descriptive statistics for the variables for the international dataset of research question 2

Variable	Min	1st Quarter	Median	Mean	3rd Quarter	Max
Success	0.000	0.000	2.000	3.718	2.000	48.000
CognProx	0.000	0.000	1.000	1.024	1.000	21.000
sqCogn	0.000	0.000	1.000	3.956	1.000	441.000
ProjectEUfunding	0.050	2.762	3.780	4.639	6.994	10.811
StartDate	2008	2010	2013	2013	2015	2017
noParticipants	2.00	14.00	18.00	19.81	26.00	37.00
Logical	**True**	**False**	**NA**			
Geoprox1	694	4995				
Geoprox2	104	5585				
Orgprox	13	5655	21			
Insprox	1712	3977				

Quasi Poisson regressions were run as they were in the previous analyses (see table 11). However, as this data contains international organizations, another geographical proximity measure was used. Geoprox1 is a TRUE/FALSE variable on whether or not two organizations in a collaboration are from the same country. The variable previously known as Geoprox is now Geoprox2. In this regression, collaborations between organizations that have Geographical proximity significantly decrease the chance of a project being successful. This means hypotheses 3a can be accepted. The institutional proximity and the organizational proximity are not significantly correlated with the dependent variable. This means Hypothesis 3b and 3c cannot be accepted. The institutional proximity was significant with a negative estimate for the organizations from the Netherlands, however this effect is not significant for the organizations from all over Europe. Even if the Geographical proximity per country was present, the effect was not significant. One reason this might be the case, is that not all collaborations are taken account for non-Dutch organizations. Most of their collaborations will be in the country in which they are present. Thus, this effect may be better observed if this effect is observed per country.

The sqCogn is significantly correlated with success, but has a negative estimate. This is in line with theory of optimal proximity (hypothesis 3d). From the estimates of the CognProx and the sqCogn, the optimum Cognitive proximity can be calculated. This is done by calculating the point at which the estimates CognProx and sqCogn are equal. The formula for this case would be:

$Y = -0.012x^2+0.163x$

Where x is the cognitive proximity, and a, b, and c are the control variables StartDate, ProjectEUfunding, and noParticipants, respectively. From this formula, the derivative is created. Then, the x is calculated for where the derivative is 0. The value for is 6.79. This means, the optimal Cognitive proximity score is a score of 6.79. Having a collaboration with organizations that are present 6-7 of the same industries will optimally increase the chances of the project being successful.

Table 11 A Quasi Poisson regression with the dependent variable, the independent variables, and the control variables of hypothesis 4 for all firms participating in projects with a Dutch coordinator.

	Dependent variable:	
	Success	
	(1)	(2)
Geoprox1		-0.277***
		(0.067)
Geoprox2	-0.560***	-0.312
	(0.181)	(0.191)
Orgprox	-0.338	-0.263
	(0.567)	(0.566)
Insprox	-0.016	-0.017
	(0.040)	(0.040)
sqCogn	-0.012***	-0.012***
	(0.002)	(0.002)
CognProx	0.164***	0.163***
	(0.021)	(0.021)
StartDate	-0.484***	-0.483***
	(0.009)	(0.009)
ProjectEUfunding	0.176***	0.174***
	(0.010)	(0.010)
noParticipants	-0.053***	-0.054***
	(0.003)	(0.003)
Constant	974.731***	972.362***
	(18.709)	(18.642)
Observations	5,668	5,668
Note:	*p<0.1; **p<0.05; ***p<0.01	

Regarding the proximity paradox, we can observe that the paradox holds for geographical proximity, both in this regression and the regression in chapter 4.3.2. Organizations prefer to collaborate within the same city, but the more successful projects tend to be the ones that collaborate over distance. Regarding organizational and institutional proximity, we did not find this pattern in this regression. Finally, regarding cognitive proximity, we computed to optimal cognitive proximity to collaborate (7-8) and to have the highest probability for success (6-7). The difference in the values of the coefficients suggest that the proximity paradox is also present for the cognitive proximity. A larger cognitive proximity is necessary to stimulate collaboration, than to stimulate success. However, while there is evidence for the proximity paradox in the cognitive dimension when comparing the levels of optimal proximity for the probability of collaboration and for performance, it should be noted that the differences between the optimal levels are quite small.

4.4 Research question 3

The 25 organizations that collaborated the most based on degree are shown in table 12. There is clearly overlap between these firms and the articulation points (Table 3). These 25 organizations were combined to create all possible combinations between the organizations. This resulted in 300 unique collaborations

(See Appendix 2). The best collaboration to add to the network based on the improvement of the average path length is the collaboration between *TNO Den Haag* and *Public Private Partnership Institute.* Through this collaboration, the average path length changed from 4.25 to 4.20. After that, any other collaboration with TNO Den Haag only lowers the average path length to 4.239731. All the other collaborations do not improve the average path length. Thus, generally TNO Den Haag can create important links that improve the average path length.

Table 12 The 25 organizations with the most collaborations (based on degree)

Organizations	degree
Delft University of Technology	27
Wageningen UR	24
TNO - Netherlands Organization for Applied Scientific Research Den Haag	21
Vrije Universiteit Amsterdam/VU University Amsterdam	12
Universiteit Twente	12
Stichting Public Private Partnership Institute for Sustainable Process Technology	12
Eindhoven University of Technology	12
Van Houtum Papier BV	10
Universiteit Leiden/ Leiden University	10
Smurfit Kappa Group	10
SAPPI Netherlands Services	10
Parenco BV	10
Mayr-Melnhof Eerbeek BV	10
KWR Water BV	10
Eska Graphic Board BV	10
ECN – Energy Research Centre of the Netherlands	10
DS SMITH Packaging Netherlands	10
Crown van Gelder Papierfabrieken	10
Rijksuniversiteit Groningen	8
Provalor BV	8
Nederlands Normalisatie-Instituut	8
Gemeente Amsterdam	7
BTG Biomass Technology Group BV	7
Avantium Chemicals BV	7
Vitens N.V. Zwolle	6

5. Conclusion

The aim of this paper was to study the collaboration in the circular economy in the Netherlands. To do that, this paper focuses on the presence of collaborations and the impact of the collaboration. In this paper, a social network was created in order to study the collaboration in the circular economy in the Netherlands. The network was created to gather information about the collaborations within the circular economy in the Netherlands. The resulting network had 139 participants and 303 links. This paper examines the factors that drive collaboration in circular economy in the Netherlands. A binary logit model regression was performed to analyse the factors that increase collaboration. The results show that high Geographical and Cognitive proximity are driving factors to collaboration in the circular economy within the Netherlands. The size of an organization is also a driver of collaboration between two organizations. Moreover, this paper provides empirical evidence for the presence of the inverted U shape of probability between the cognitive proximity and the likelihood to cooperate. The optimal score for the highest likelihood of collaboration is a similarity in 7-8 industries.

The second research question examines the factors that drive the success of projects in the circular economy. Quasi Poisson regressions were run to examine the effect of proximity and centrality measures on the success of the project. The results show that collaborations with lower proximity drive the success of projects, while organizations that are closer to hubs hinder project success. The negative impact of the eigenvector centrality on success indicates that we may need to rethink the way we think about factors such as network position and firm size. The results also show empirical evidence of the inverted U shape of probability between cognitive proximity between two organizations and the success of the project. The optimum for this function is a score of 6-7. Furthermore, within a country the institutional proximity between organizations also negatively impacts the success of the projects. When looking at the international level, this effect seems to disappear. Finally, the results from the first and second research question show that a higher proximity is desired for a higher chance of collaborating, but undesirable for the success of the project. This effect is also shown in the optimal scores for cognitive proximity in both research questions, as the optimal score for collaboration is between 10 and 11 and the optimal score for success is between 6 and 7. A higher cognitive proximity is required for collaboration than for the success of the project. This provides empirical evidence for the proximity paradox. This paradox is also present for the geographical proximity. Here a positive estimate is shown for collaboration between geographically proximate organizations while a negative estimate is shown for the success of geographically proximate organizations.

The final research question examines the missing links and important nodes in the circular economy in the Netherlands. Here, the improvement of the average path length for 300 important collaborations were tested. TNO - Netherlands Organization for Applied Scientific Research Den Haag is an important node in the network. Collaborations between with this organization will result in an improvement of the average path length and thus of the knowledge flow in the network. The most fruitful collaboration would be a collaboration between TNO Den Haag and Stichting Public Private Partnership Institute for Sustainable Process-Technology.

6. Discussion

The conclusions from this research include multiple implications for improving the performance of the circular economy in the Netherlands. In the theoretical framework of this paper, it is theorized that while organizations tend to collaborate with organization with high proximity measures, a lower proximity is beneficial to the result of the collaboration. The theoretical implications of this paper is to confirm the theory for geographical proximity and cognitive proximity. In the first regression (see table 5), it is shown that a higher geographical proximity results in a higher chance of a collaboration, while in the regression for the second research question (Tables 9 and 11), a higher geographical proximity has a negative effect on the success of the project. For cognitive proximity, in research question 1 it is shown that the optimum score for collaboration lies around 7-8, while for the success it lies around the 6-7.

Another theoretical implication of this research, is the rejection of the idea that for nodes with higher resources, such as organizations with a higher eigenvector centrality, the performance of the collaboration improves. The eigenvector significantly decreases the chance of a successful project. When looking at existing theory, articles seem to imply that well-connected organizations are a positive factor for the success of projects (Gloor et al., 2011). A possible reason for the different results in this research is that the success was controlled for the amount of money spent on the project and the amount of participants in this paper. This is not the case in the Gloor et al. (2011) article. This makes the measurement of success also a measure of how *efficiently* success can be achieved in a project. Thus, the organizations with a great network position may be less efficient at achieving success than organizations that are less well-positioned. A possible reason for is are that the well-connected may not feel need to perform well in projects compared to organizations that are only poorly connected. Another reason might be that they are often asked as a collaboration partners regardless of their performance, but due to their reputation, size and/or resources. Thus, this paper proposes that firms that have a higher centrality are less efficient for the success.

From the results, some policy recommendations can be derived. From the results of the second research question, a negative correlation between the organizations closest to the hub and the success of the project. If the government of a country wanted to stimulate the circular economy, it could stimulate collaborations between organizations that are not close to the hubs in the network. Collaborations between organizations that are not at the centre of the network stimulate the success of a project. From tables 3 and 4, it is shown that mostly enterprises and micro firms are brokers and highly connected organizations. Thus, choosing non-central organizations could be done by stimulating SMEs to participates in projects more than enterprises or micro organizations. This way the success of projects can be achieved more efficiently. This is especially the case for SMEs with a broad presence in different industries. Furthermore, according to the results, organizations from different cities are less likely to collaborate. However, when they collaborate the success of the project is more likely. In an international setting, collaboration between different countries seems to improve the project performance best. Thus, increasing collaborations between organizations from different countries is an important stimulant of project success and would improve the performance of the circular economy in that country. Finally, cognitive proximity is shown to be subject to the proximity paradox, where collaboration requires a higher proximity than success. Reducing this effect could increase performance of the actors in the Circular Economy. One way to do this is to stimulate collaborations between organizations from different sectors in upcoming government-funded projects. This way, cognitive lock-in is less likely to occur.

For the Netherlands and Dutch organizations specifically, there are additional recommendations. First, given the fact that geographical proximity negatively affects the chance for success but positively affects the chance of collaboration, it would be beneficial for the success of the project for those collaborations to be

between organizations in different cities for the collaborations that happen between the Dutch organizations. Furthermore, institutional proximity negatively affects the chance of success for organizations within the Netherlands. Thus, it is recommended to stimulate collaborations between different types of organizations, so with a high institutional distance. Having a higher diversity will stimulate the success of the projects and according to (van Rijnsoever et al., 2015) will stimulate the technological diversity, which is important for a technological system. Finally, in order to drive the circular economy in the Netherlands, it is recommended for the flow of information to stimulate TNO Den Haag to collaborate with different organizations. This organization is both an articulation point and the only organization with which the average path length seems to decrease when other large nodes collaborate with it. A good collaboration would be with Stichting Public Private Partnership Institute, as this showed a great network improvement.

As this study is a deductive one, the research method uses a positivist approach. A positivist approach holds that society operates according to general laws and that these can be detected by the researcher. Thus, to check the validity of the research in this paper, the validity measures for positivist research will be used (Herrmann & Vaskelainen, 2018). The first validity measure is the construct validity. This measure is to check that the correct operational measures are used to study the concepts in this paper. The way of measuring the concepts in this paper was taken from other peer-reviewed articles. This way the validity of the operationalization was ensured. The second validity measure is the internal validity is the internal validity. Internal validity is gained when a causal relationship is established between the variables. The causal relationship between the independent variables and the dependent variable have been backed up by other papers in the theory. Third is the external validity. External validity is used to define the domain to which this paper can be generalized. The external validity of this research is quite high because the variables used in this paper are not specific to a country. Furthermore, in the second research question the proximity analysis was performed over international organizations, meaning these results are indicative of the circular economy in other countries as well. This means that while some of the recommendations (especially from research question 3) were specific to the Netherlands, the rest were general to other countries as well. Finally, the reliability of the paper, which refers to the fact that the operations of a study—such as the data collection procedures—can be repeated, with the same results. The method has been clearly explained, all new data that has been added has been retrieved from a public source, and the source for each datapoint is present in the dataset. Thus, the replicability of this paper is high as well.

The main limitation of this research is the impact measure from the second research question. This is based on the number of articles of each project in the project database. As it is unclear how representative these data are of the impact of the project, adding another performance indicator would have made the research more reliable. However, in the EUPRO dataset there did not seem to be another performance indicator that could be used on all or even most projects. This, due to the difference in the project output. Some projects had scientific article(s) as output, while others had multiple documents, and others again had pilots, etc. This made it difficult to create another performance indicator. Another limitation is the fact that the link prediction could not be carried out according to e.g. the Katz algorithm, due to the disconnectedness of the network. If more time had been present, the unconnected nodes could have been removed manually and a link prediction could have been carried out. This could have made the results from the link prediction, more reliable and complete. Finally, a limitation of this paper is that the data for all of Europe could not be examined instead of only in the Netherlands. This would have given a more reliable insight of the effects of proximity on an international level. For this paper, this insight remains limited.

In the results, it shows that working with international organizations improves performance in the circular economy for the Netherlands. This is interesting due to the fact that circular economy is mostly looked at as a local system. The influence of organizations in a circular economy interacting on an international level would be an interesting direction for future research. Another interesting direction to study would be the effect of network position and size on the efficiency to produce impactful outcomes. Current research correlates networks position and size of an organization to higher success. Thus, more research into why the network position of the organizations can lead to lower performance would be interesting. In the light of proximity theory, it would also be interesting to extent this research by distinguishing between different innovation stages (Research, Development and Marketing). It has been argued that different stages in the innovation process require different types of proximity (Davids & Frenken, 2018). Based on the type of proximity that are present in a case study, the innovation stage can be identified and a transition to the next stage can be stimulated. Therefore, it would be interesting for future research if the proximities can be used to identify the stage or change of innovation stage of the circular economy (or any system).

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References

Achterberg, E., Hinfelaar, J., & Bocken, N. (2016). Master Circular Business with the Value Hill, 1–16.

Ackerman, F. (2000). Waste Management and Climate Change. *Local Environment, 5(2)*, 223-229.

Acuna, D. E., Allesina, S., & Kording, K. P. (2012). Predicting scientific success. *Nature*, *489*(7415), 201-202.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative science quarterly, 45(3)*, 425-455.

Amin, A., & Wilkinson, F. (1999). Learning, proximity and industrial performance: an introduction . *Cambridge Journal of Economics*, 121-125.

Ashton, W. (2008). Understanding the organization of industrial ecosystems. *Journal of Industrial Ecology, 12(1)*, 34-51.

Ashton, W. (2009). The structure, function, and evolution of a regional industrial ecosystem. *Journal of Industrial Ecology, 13(2)*, 228-246.

Baldrich, J. F. (2019). Regression Diagnostics.

Biggiero, L., & Basevi, M. (2009). Testing the gravity model through network analysis. *In European Trade Study Group Conference', Rome* , 10-12.

Boeing, G. (2016). Visual Analysis of Nonlinear Dynamical Systems: Chaos, Fractals, Self-Similarity and the limits of Predicition. *systems, 4(4)*, 37.

Boschma, R. (2005). Proximity and Innovation: A Critical Assessment. *Regional Studies, 39(1)*, 61-74.

Boschma, R. A., Frenken, K. (2010) The spatial evolution of innovation networks. A proximity perspective. In R. A. Boschma, R. Martin (eds), The Handbook of Evolutionary Economic Geography, pp. 120–135. Cheltenham: Edward Elgar

Bozeman, B., & Youtie, J. (2016). Trouble in paradise: Problems in academic research co-authoring. . *Science and engineering ethics, 22(6),* , 1717-1743.

Broekel, T., & Boschma, R. (2012). Knowledge networks in the Dutch aviation industry: the proximity paradox. *Journal of Economic Geography*, *12*(2), 409-433.

Burt, R. (1992). *Structural Holes: The Social Structure of Competition.* Cambridge, MA: Harvard University Press.

Burt, S. (2004). Structural Holes and Good Ideas. *American Journal of Sociology, 110(2)*, 349-399.

Camisón-Zornoza, C., Lapiedra-Alcamí, R., Segarra-Ciprés, M., & Boronat-Navarro, M. (2004). A meta-analysis of innovation and organizational size. *Organization studies, 25(3)*, 331-361.

Circle Economy. (2019). *The Circularity Gap report.* Retrieved from Circle Economy: https://bfc732f7-80e9-4ba1-b429-7f76cf51627b.filesusr.com/ugd/ad6e59_ba1e4d16c64f44fa94fbd8708eae8e34.pdf

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative science quarterly*, 128-152.

Cohen, W.M., R.R. Nelson and J. Walsh. 2002. Links and Impacts: The Influence of Public Research on Industrial R&D. Management Science. Vol. 48: 1-23.

Coleman, J. (1988). "Social capital in the creation of human capital.". *American Journal of Sociology, 94*, 95-120.

Davids, M., & Frenken, K. (2018). Proximity, knowledge base and the innovation process: towards an integrated framework. *Regional Studies, 52(1)*, 23-34.

De Wit, A. (1988). Measurement of project success. *International journal of project management*, *6*(3), 164-170.

Dhanaraj, C., & Beamish, P. (2003). A resource-based approach to the study of export performance. *Journal of Small Business Management, 41*, 242-261.

Don, R. (2019). *Game theory.* Retrieved from The Stanford Encyclopedia of Philosophy (Winter 2019 Edition), Edward N. Zalta (ed.): https://plato.stanford.edu/archives/win2019/entries/game-theory/

Dora, M. (2019). Collaboration in a circular economy: Learning from the farmers to reduce food waste.

EC. (2014). MEMO, Questions and Answers on the Commission Communication "Towards a Circular Economy" and the Waste Targets Review. European Commission.

EC. (2014). Towards a Circular Economy: a Zero Waste Programme for Europe. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.* (p. 398). European Commission.

Ellen McArthur Foundation. (2012). *Towards the Circular Economy.* Retrieved from Ellen McArthur Foundation: http://www.ellenmacarthurfoundation.org/business/reports

European Environment Agency. (2017, Jan 25). *Climate change poses increasingly severe risks for ecosystems, human health and the economy in Europe.* Retrieved from European Environment Agency: https://www.eea.europa.eu/highlights/climate-change-poses-increasingly-severe

Eurostat. (2018). *Patents related to recycling and secondary raw materials (cei_cie020).* Retrieved from Eurostat: https://ec.europa.eu/eurostat/cache/metadata/en/cei_cie020_esmsip2.htm

Eurostat. (2019). *Renewable energy statistics.* Retrieved from Eurostat statistics explained: https://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics

Faber, J., & Frenken, K. (2009). Models in evolutionary economics and environmental policy: towards an evolutionary environmental economics. *Technological Forecasting and Social Change, 76*, 462-470.

Feng, Z., & Yan, N. (2007). Putting a circular economy into practice in China. *Sustainable Science, 2*, 95-101.

Fleming, L., King, C. III, Juda, A. I. (2007) Small worlds and regional innovation. Organization Science, 18: 938–954.

Frenken, K., Hardeman, S., & Hoekman, J. (2009). Spatial scientometrics: Towards a cumulative research program. *Jouranl of Infometrics, 3*, 222-232.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. Journal of cleaner production, 143, 757-768.

Geng, Y., Fu, J., Sarkis, J., & Xue, B. (2012). Towards a circular economy indicator system in China: an evaluation and critical analysis. *Journal Cleaner Production, 23*, 216-224.

Geuna, A., Fontana, R., & Matt, M. (2003). Firm size and openness: the driving forces of university-industry collaboration.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production, 114*, 11-32.

Gloor, P., Dorsaz, P., & Fuehres, H. (2011). Analyzing success of startup entrepreneurs by measuring their social network distance to a business networking hub. In *Proceedings 3rd international* conference on collaborative innovation networks coins, Basel. Sept (pp. 8-10).

Golbeck, J. (2013). *Network structures and measures.* Newnes.

Hardeman, S., Frenken, K., Nomaler, Z., & ter Wal, A. (2014). Characterizing and comparing innovation systems by different 'modes' of knowledge production : a proximity approach. *Science and Public Policy, 42(4)*, 530-548.

Herrmann, A., & Vaskelainen, T. (2018). *Session 1: Introduction and Fundamentals of Research design.* Retrieved from Blackboard: https://uu.blackboard.com/webapps/blackboard/execute/content/file?cmd=view&content_id=_3063240_1&course_id=_116610_1

Heller-Schuh, B., Barber, M., Züger, M., & Scherngell, T. (2019) Report on the content and technical structure of the EUPRO infrastructure. Vienna: Australian Institute of Technology. Retrieved from: RISIS

Homrich, A. S., Galvao, G., Abadia, L. G., & Carvalho, M. M. (2018). The circular economy umbrella: Trends and gaps on integrating pathways. Journal of Cleaner Production, 175, 525-543.

Hughes, R. (2017). The EU Circular Economy package – life cycle thinking to life cycle law? *Procedia CIRP, 61*, 10-16.

Ji, L., Liu, C., Huang, L., & Huang, G. (2018). The evolution of resources conservation and recycling over the past 30 years: a bibliometric overview. Resources, Conservation and Recycling, 134, 34-43.

Katz, L. (1953). A new status index derived from sociometric analysis. *Psychometrika*, *18*(1), 39-43.

Kenniskaarten. (2016). *Circular economy.* Retrieved from Het groene brein: https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/how-is-a-circular-economy-different-from-a-linear-economy/

Kepaptsoglou, K., Karlaftis, M., & Tsamboulas, D. (2010). The Gravity Model Specification for Modeling International Trade Flows and Free Trade Agreement Effects: A 10-Year Review of Empirical Studies. *The Open Economics Journal, 3*, 1-13.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 221-232.

Lett, L. (2014). Las amenazas globales, el reciclaje de residuos y el concepto de economia circular. *Riv. Argent. Microbiol., 46(1)*, 1-2.

Lou, X., & Nair, J. (2009). The impact of landfilling and composting on greenhouse gas emissions – A review. *Bioresource Technology, 100(16)*, 3792-3798.

Luo, P., Li, Y., Wu, C., & Chen, K. (2016). Detecting the missing links in social networks based on utility analysis. Journal of computational science, 16, 51-58.

Mazzatini, U. (2014). *Green report.* Retrieved from Rivoluzione a Davos, il big business mondiale vuole l'economia circolare: http://www.greenreport.it/news/consumi/rivoluzione-a-davos-il-big-business-mondiale-vuole-leconomia-circolare/

Mesa, J. A., Esparragoza, I., & Maury, H. (2019). Trends and Perspectives of Sustainable Product Design for Open Architecture Products: Facing the Circular Economy Model. International Journal of Precision Engineering and Manufacturing-Green Technology, 6(2), 377-391.

Midi, H., Sarkar, S. K., & Rana, S. (2010). Collinearity diagnostics of binary logistic regression model. Journal of Interdisciplinary Mathematics, 13(3), 253-267.

Mowery, D. C., Oxley, J. E., Silverman, B. S. (1998) Technological overlap and interfirm cooperation: implications for the resource-based view of the firm. Research Policy, 27: 507–523

Nieto, M. J., & Santamaría, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, *27*(6-7), 367-377.

Nomaler, Ö., Frenken, K., Giuliani, E., & Arora, S. (2014, September 23). "In The Loop": On cycles in knowledge networks.

Park, J., & Chertow, M. (2014). Establishing and testing the "reuse potential" indicator for managing waste as resources. *J. Environ. Manag., 137*, 45-53.

Pla-Barber, J., & Alegre, J. (2007). Analysing the link between export intensity, innovation and firm size in a science-based industry. *International Business Review, 16(3)*, 275-293.

Preston, F. (2012). *A Global Redesign? Shaping the Circular Economy.* Retrieved from Chatham House: https://www.chathamhouse.org/sites/default/files/public/Research/Energy%2C%20Environment%20and%20Development/bp0312_preston.pdf

R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rajeev, A., Rupesh, P. K., Padhia, S. S., & Govindan, K. (2017). Evolution of sustainability in supply chain management: A literature review. *Journal of Cleaner Production, 162*, 299-314.

Ripanti, E. F., & Tjahjono, B. (2019). Unveiling the potentials of circular economy values in logistics and supply chain management. The International Journal of Logistics Management.

Rood, T., & Hanemaaijer, A. (2017). *Waarom een circulaire economie?* Retrieved from Planbureau voor de leefomgeving: https://themasites.pbl.nl/circulaire-economie/

Ruutu, S., Casey, T., & Kotovirta, V. (2017). Development and competition of digital service platforms: A system dynamics approach. Technological Forecasting and Social Change, 117, 119-130.

Schilling, M., & Phelps, C. (2007). Interfirm Collaboration Networks: The Impact of Large-Scale Network Structure on Firm Innovation. *Management Science, 53(7)*, 1113–1126.

Sheather, S. (2009). *A modern approach to regression with R*. Springer Science & Business Media.

Silva, A., Stocker, L., Mercieca, P., & Rosano, M. (2016). The role of policy labels, keywords and framing in transitioning waste policy. Journal of cleaner production, 115, 224-237.

Stiehl, C., & Hirth, T. (2012). Vom additiven Umweltschutz zur nachhaltigen Produktion. *Chemie Ingenieur Technik, 84*, 963-968.

Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China: moving from rethoric to implementation. *Journal of Cleaner Production, 42*, 215-227.

Tian, L., Bashan, A., Shi, D. N., & Liu, Y. Y. (2017). Articulation points in complex networks. *Nature* communications, 8(1), 1-9.

TNO. (2019, December 13). *THE CIRCULAR ECONOMY AND THE ENVIRONMENT: 'DIRECTING AND ACCELERATING SUSTAINABILITY'*. Retrieved from TNO: https://www.tno.nl/en/focus-areas/circular-economy-environment/

UNEP. (2013). *Resource Efficiency: Economics and Outlook for China.* Retrieved from United Nations Environment Programme: http://www.unep.org/pdf/China_Resource_Efficiency_in_English_2013.pdf

van Rijnsoever, F. J., van den Berg, J., Koch, J., & Hekkert, M. P. (2015). Smart innovation policy: How network position and project composition affect the diversity of an emerging technology. *Research Policy, 44(5)*, 1094-1107.

Ver Hoef, J. M., & Boveng, P. L. (2007). Quasi-Poisson vs. negative binomial regression: how should we model overdispersed count data?. *Ecology*, *88*(11), 2766-2772.

Walker, G., Kogut, B., & Shan, W. (1997). "Social capital, structural holes and the formation of an industry network." . *Organization Science, 8*, 109-125.

Waughray, D. (2013). *Davos 2013: Circular Economy Offers Opportunities for Latin America.* Retrieved from The Guardian: http://www.theguardian.com/sustainable-business/davos-2013-circular-economy-opportunities-latin-america

WE Forum. (2014). *Towards the Circular Economy: Accelerating the scale-up across global supply chains.* Geneva, Switzerland: World Economic Forum.

Yap, N. (2005). Towards a circular economy: progress and challenges. *Greener Managment International, 50*, 11-24.

Yuan, Z., Bi, J., & Moriguichi, X. (2006). The circular economy; a new development strategy in China. *Journal of Industrial Ecology, 10*, 4-8.

Appendix 1

Appendix A

The keywords used to select the projects related to circular economy and their source:

patent codes cpc, Eurostat 2018

circular economy
recycling
waste collection
waste transportation
waste separation
waste processing
waste management
recovery of materials
reuse technologies
waste reduction
fuel reprocessing
wastewater treatment

Achterberg, E., Hinfelaar, J., & Bocken, N. (2016). Master Circular Business with the Value Hill, 1–16.

“circular product design”
“circular materials”
“classic long life”
“product as a service”
“product life extension”
“sharing platforms”
“sharing economy”
“sell and buy back”
“repair and maintenance”
“recaptured material”

Homrich, A. S., Galvao, G., Abadia, L. G., & Carvalho, M. M. (2018). The circular economy umbrella: Trends and gaps on integrating pathways. Journal of Cleaner Production, 175, 525-543.

“cradle-to-cradle”
“industrial ecology”
“biomimicry”
“performance economy”
“regenerative design”

Ripanti, E. F., & Tjahjono, B. (2019). Unveiling the potentials of circular economy values in logistics and supply chain management. The International Journal of Logistics Management.

“waste elimination”
“leakage minimisation”

Ji, L., Liu, C., Huang, L., & Huang, G. (2018). The evolution of resources conservation and recycling over the past 30 years: a bibliometric overview. Resources, Conservation and Recycling, 134, 34-43.

“life cycle assessment”
“material flow analysis”
“municipal solid waste”
“waste of electric and electronic equipment”
“wastewater”

Mesa, J. A., Esparragoza, I., & Maury, H. (2019). Trends and Perspectives of Sustainable Product Design for Open Architecture Products: Facing the Circular Economy Model. International Journal of Precision Engineering and Manufacturing-Green Technology, 6(2), 377-391.

“optimization of end-of-life”
“resource efficiency”
“multiple lifecycle generation”
“reduction of unwanted emissions”
“extension of operational life”
“use of low impact materials”

Silva, A., Stocker, L., Mercieca, P., & Rosano, M. (2016). The role of policy labels, keywords and framing in transitioning waste policy. Journal of cleaner production, 115, 224-237.

“zero waste”
“sustainable material management”

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. Journal of cleaner production, 143, 757-768.

“Industrial symbiosis”
“industrial ecology”
“eco-industrial park”

Table 13: CPC codes related to Circular Economy (according to Eurostat, 2018)

Y02W 10/00 - Technologies for wastewater treatment

- Y02W 10/10 - Biological treatment of water, wastewater, or sewage
  - Y02W 10/12 - Anaerobic processes with biogas recycling, capture or flaring
  - Y02W 10/15 - Aerobic processes
  - Y02W 10/18 - Constructed wetlands
- Y02W 10/20 - Sludge processing
  - Y02W 10/23 - Anaerobic processes with biogas recycling, capture or flaring
  - Y02W 10/27 - Aerobic processes
- Y02W 10/40 - Valorisation of by-products of wastewater, sewage or sludge processing
  - Y02W 10/45 - Obtention of biopolymers

Y02W 30/00 - Technologies for solid waste management

- Y02W 30/10 - Related to waste collection, transportation, transferor storage, e.g. segregated refuse collecting, electric or hybrid propulsion
- Y02W 30/20 - Related to waste processing or separation
- Y02W 30/40 - Bio-organic fraction processing; Production of fertilisers from the organic fraction of waste or refuse
  - Y02W 30/43 - Aerobic fermentation, e.g. composting
  - Y02W 30/47 - Anaerobic fermentation, e.g. methanation combined with capture, recycling or flaring
- Y02W 30/50 - Reuse, recycling or recovery technologies
  - Y02W 30/52 - Dismantling or mechanical processing of waste for the recovery of materials during separation, disassembly, pre-processing or upgrading
  - Y02W 30/54 - Metal recycling
  - Y02W 30/56 - Disassembly of vehicles for recovery of salvageable parts
  - Y02W 30/58 - Construction or demolition waste
  - Y02W 30/60 - Glass recycling
  - Y02W 30/62 - Plastics recycling
  - Y02W 30/64 - Paper recycling
  - Y02W 30/66 - Disintegrating fibre-containing textile articles to obtain fibres for re-use
  - Y02W 30/68 - Rubber waste recycling
  - Y02W 30/70 - Recovery of polymers other than plastics or rubbers
  - Y02W 30/72 - Recovery of luminescent materials
  - Y02W 30/74 - Recovery of fats, fatty oils, fatty acids or other fatty substances, e.g. lanolin or waxes
  - Y02W 30/76 - Recovery of tanning agents from leather
  - Y02W 30/78 - Recycling of wood or furniture waste
  - Y02W 30/80 - Packaging reuse or recycling
  - Y02W 30/82 - Recycling of waste of electrical or electronic equipment
  - Y02W 30/84 - Recycling of batteries
  - Y02W 30/86 - Recycling of fuel cells
  - Y02W 30/88 - Nuclear fuel reprocessing
  - Y02W 30/90 - Reuse, recycling or recovery technologies crosscutting to different types of waste

Y02W 90/00 - Enabling technologies or technologies with a potential or indirect contribution to greenhouse gas emissions mitigation

- Y02W 90/20 - Computer systems or methods specially adapted for waste reduction or recycling of materials or goods

Appendix B

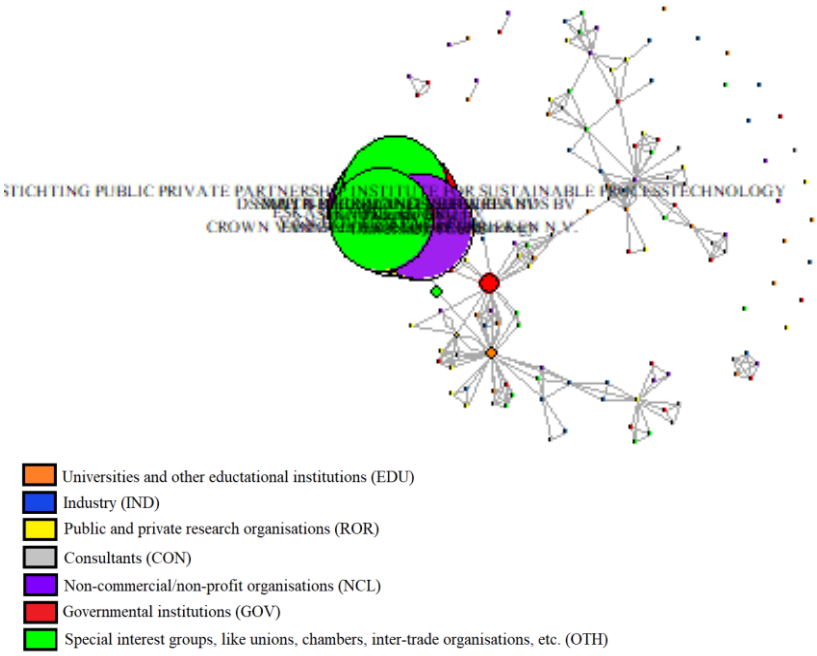

Figure 4: Network analysis of the collaboration between all Dutch organisations in EU funded projects coordinated by the Netherlands. The projects are ranged from 2007 until 2017. The node size is linked to the hubscore of that node. The colors of the nodes are related to the type of organisation.

Appendix C

Table 14: Binary logit model with the dimensions of proximity and the size of the organisations as independent variable and the presence of a link as the dependent variable

	Dependent variable:
	Collab
Gprox3	0.870***
	(0.224)
OrgProx	-1.573
	(1.232)
Insprox	0.011
	(0.128)
CognProx	0.200***
	(0.034)
emp	0.181***
	(0.034)
Constant	-4.440***
	(0.179)
Observations	9,548
Log Likelihood	-1,262.760
Akaike Inf. Crit.	2,537.519
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 15: The Variance Inflation Factor (VIF) of the binary logit model of table 1

	Binary logit model
	VIF
Gprox3	1.008222
Orgprox	1.168658
Insprox	1.021704
CognProx	1.282655
emp	1.122845
Observations	9548
Note:	*** VIF>5

Appendix D

All poisson regressions for the success of a project.
Control Variables:
Start date of the project (StartDate)
The amount of funding the EU provided (ProjectEUfunding)
The number of participants (noParticipants)

Independent variable: Eigenvector centrality

```
ptest1<- glm(n.x~eigenvec+ StartDate.x + noParticipants.x + ProjectEUfundin
g.x, family = "poisson", data = df_Succes)
> summary(ptest1)

Call:
glm(formula = n.x ~ eigenvec + StartDate.x + noParticipants.x +
    ProjectEUfunding.x, family = "poisson", data = df_Succes)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.2630  -1.4132  -0.8786  -0.3495  10.2463

Coefficients:
                   Estimate Std. Error z value Pr(>|z|)
(Intercept)       9.075e+00  6.836e-01  13.275  < 2e-16 ***
eigenvec         -1.691e+00  2.713e-01  -6.231 4.64e-10 ***
StartDate.x      -6.712e-09  5.600e-10 -11.987  < 2e-16 ***
noParticipants.x  4.054e-02  5.255e-03   7.714 1.22e-14 ***
ProjectEUfunding.x  9.066e-08  1.908e-08   4.752 2.01e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 1879.8  on 292  degrees of freedom
Residual deviance: 1414.6  on 288  degrees of freedom
AIC: 2029.6

Number of Fisher Scoring iterations: 7

> dispersiontest(ptest1)

        Overdispersion test

data:  ptest1
z = 3.4688, p-value = 0.0002614
alternative hypothesis: true dispersion is greater than 1
sample estimates:
dispersion
   9.38744
```

Independent variable: betweenness centrality

```
ptesty2<- glm(n.x~between+ StartDate.x + noParticipants.x + ProjectEUfundin
g.x, family = "poisson", data = df_Succes)
> summary(ptesty2)

Call:
glm(formula = n.x ~ between + StartDate.x + noParticipants.x +
    ProjectEUfunding.x, family = "poisson", data = df_Succes)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.4833  -1.3650  -1.2684   0.0179  10.5672
```

```
Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)         1.228e+01  6.590e-01  18.640  < 2e-16 ***
between            -2.080e-04  6.038e-05  -3.445 0.000571 ***
StartDate.x        -9.274e-09  5.189e-10 -17.873  < 2e-16 ***
noParticipants.x    3.033e-02  5.101e-03   5.945 2.77e-09 ***
ProjectEUfunding.x  1.597e-07  1.647e-08   9.695  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 1879.8  on 292  degrees of freedom
Residual deviance: 1453.2  on 288  degrees of freedom
AIC: 2068.3

Number of Fisher Scoring iterations: 7

> dispersiontest(ptesty2)

        Overdispersion test

data:  ptesty2
z = 3.6509, p-value = 0.0001306
alternative hypothesis: true dispersion is greater than 1
sample estimates:
dispersion
  9.105404
```

Independent variable: brokerage centrality

```
ptest3<- glm(n.x~brok+ StartDate.x + noParticipants.x + ProjectEUfunding.x,
family = "poisson", data = df_Succes)
> summary(ptest3)

Call:
glm(formula = n.x ~ brok + StartDate.x + noParticipants.x + ProjectEUfundin
g.x,
    family = "poisson", data = df_Succes)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.6098  -1.3448  -1.0749   0.0607  10.8714

Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)         1.365e+01  6.666e-01  20.472  < 2e-16 ***
brok               -3.048e-03  4.019e-04  -7.584 3.34e-14 ***
StartDate.x        -1.022e-08  5.267e-10 -19.397  < 2e-16 ***
noParticipants.x    2.711e-02  5.012e-03   5.408 6.38e-08 ***
ProjectEUfunding.x  1.590e-07  1.659e-08   9.584  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 1879.8  on 292  degrees of freedom
Residual deviance: 1400.9  on 288  degrees of freedom
AIC: 2016

Number of Fisher Scoring iterations: 7

> dispersiontest(ptest3)

        Overdispersion test
```

```
data:  ptest3
z = 3.5781, p-value = 0.000173
alternative hypothesis: true dispersion is greater than 1
sample estimates:
dispersion
  8.507991
```

Independent variable: degree centrality

```
ptesty5<- glm(n.x~degree+ StartDate.x + noParticipants.x + ProjectEUfunding
.x, family = "poisson", data = df_Succes)
> summary(ptesty5)

Call:
glm(formula = n.x ~ degree + StartDate.x + noParticipants.x +
    ProjectEUfunding.x, family = "poisson", data = df_Succes)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.5897  -1.3426  -1.0396  -0.0512  11.1700

Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)         1.315e+01  6.679e-01  19.686  < 2e-16 ***
degree             -6.119e-02  8.998e-03  -6.801 1.04e-11 ***
StartDate.x        -9.593e-09  5.187e-10 -18.494  < 2e-16 ***
noParticipants.x    2.933e-02  5.051e-03   5.807 6.35e-09 ***
ProjectEUfunding.x  1.425e-07  1.692e-08   8.420  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 1879.8  on 292  degrees of freedom
Residual deviance: 1416.5  on 288  degrees of freedom
AIC: 2031.6

Number of Fisher Scoring iterations: 7

> dispersiontest(ptesty5)

        Overdispersion test

data:  ptesty5
z = 3.4426, p-value = 0.0002881
alternative hypothesis: true dispersion is greater than 1
sample estimates:
dispersion
  8.997904
```

Independent variables:
Square of the cognitive proximity
Cognitive proximity
Institutional proximity
Organisational proximity
Geographical proximity

```
ptesty7<- glm(n.x~sqCogn+ CognProx+ Insprox +Orgprox+ Gprox3+ StartDate.x+
ProjectEUfunding.x+ noParticipants.x, family = "poisson", data = df_Succes)
> summary(ptesty7)

Call:
glm(formula = n.x ~ sqCogn + CognProx + Insprox + Orgprox + Gprox3 +
```

```
    StartDate.x + ProjectEUfunding.x + noParticipants.x, family = "poisson"
,
    data = df_Succes)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.8786  -1.4778  -1.0783   0.1493   9.6929

Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)         1.105e+01  6.476e-01  17.064  < 2e-16 ***
sqCogn             -6.826e-03  3.702e-03  -1.844 0.065227 .
CognProx            1.248e-01  3.921e-02   3.183 0.001456 **
InsproxTRUE        -2.818e-01  8.345e-02  -3.377 0.000732 ***
OrgproxTRUE        -5.632e-01  1.003e+00  -0.561 0.574576
Gprox3TRUE         -1.050e+00  1.738e-01  -6.041 1.53e-09 ***
StartDate.x        -8.497e-09  5.201e-10 -16.338  < 2e-16 ***
ProjectEUfunding.x  1.719e-07  1.728e-08   9.946  < 2e-16 ***
noParticipants.x    3.797e-02  5.170e-03   7.343 2.08e-13 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 1879.8  on 292  degrees of freedom
Residual deviance: 1390.1  on 284  degrees of freedom
AIC: 2013.1

Number of Fisher Scoring iterations: 7

> dispersiontest(ptesty7)

        Overdispersion test

data:  ptesty7
z = 3.6844, p-value = 0.0001146
alternative hypothesis: true dispersion is greater than 1
sample estimates:
dispersion
  8.123143
```

Independent variables (international organisations included):
Square of the cognitive proximity
Cognitive proximity
Institutional proximity
Organisational proximity
Geographical proximity

```
ptest7<- glm(n.x~sqCogn+ CognProx+ Insprox +Orgprox+ Gprox3+ StartDate.x+ P
rojectEUfunding.x+ noParticipants.x, family = "poisson", data = df_Succes)
> summary(ptest7)

Call:
glm(formula = n.x ~ sqCogn + CognProx + Insprox + Orgprox + Gprox3 +
    StartDate.x + ProjectEUfunding.x + noParticipants.x, family = "poisson"
,
    data = df_Succes)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-8.6588  -1.3889  -1.0556   0.2139   9.3545

Coefficients:
                     Estimate Std. Error  z value Pr(>|z|)
```

```
(Intercept)         2.112e+01  1.470e-01  143.743  < 2e-16 ***
sqCogn             -8.454e-03  8.582e-04   -9.851  < 2e-16 ***
CognProx            1.301e-01  8.536e-03   15.247  < 2e-16 ***
InsproxTRUE        -6.751e-02  1.779e-02   -3.794 0.000148 ***
OrgproxTRUE        -2.547e-01  2.455e-01   -1.038 0.299465
Gprox3TRUE         -5.352e-01  7.120e-02   -7.517  5.6e-14 ***
StartDate.x        -1.477e-08  1.135e-10 -130.183  < 2e-16 ***
ProjectEUfunding.x  1.594e-07  3.903e-09   40.842  < 2e-16 ***
noParticipants.x   -5.660e-02  1.044e-03  -54.191  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 49187  on 5332  degrees of freedom
Residual deviance: 27521  on 5324  degrees of freedom
  (20 observations deleted due to missingness)
AIC: 38824

Number of Fisher Scoring iterations: 6

> dispersiontest(ptest7)

        Overdispersion test

data:  ptest7
z = 25, p-value < 2.2e-16
alternative hypothesis: true dispersion is greater than 1
sample estimates:
dispersion
  6.700497
```

Appendix 2

Table 16 The table with the combinations that are added for the missing link prediction.

index	V1	V2
1	AVANTIUM CHEMICALS BV	BTG Biomass Technology Group BV
2	AVANTIUM CHEMICALS BV	CROWN VAN GELDER PAPIERFABRIEKEN N.V.
3	AVANTIUM CHEMICALS BV	Delft University of Technology
4	AVANTIUM CHEMICALS BV	DS SMITH PACKAGING NETHERLANDS BV
5	AVANTIUM CHEMICALS BV	ECN - Energy Research Centre of the Netherlands
6	AVANTIUM CHEMICALS BV	Eindhoven University of Technology
7	AVANTIUM CHEMICALS BV	ESKA GRAPHIC BOARD BV
8	AVANTIUM CHEMICALS BV	GEMEENTE AMSTERDAM
9	AVANTIUM CHEMICALS BV	KWR WATER BV
10	AVANTIUM CHEMICALS BV	MAYR-MELNHOF EERBEEK BV
11	AVANTIUM CHEMICALS BV	Nederlands Normalisatie-Instituut
12	AVANTIUM CHEMICALS BV	Parenco BV
13	AVANTIUM CHEMICALS BV	PROVALOR B.V.
14	AVANTIUM CHEMICALS BV	Rijksuniversiteit Groningen
15	AVANTIUM CHEMICALS BV	SAPPI NETHERLANDS SERVICES BV
16	AVANTIUM CHEMICALS BV	Smurfit Kappa Group
17	AVANTIUM CHEMICALS BV	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY
18	AVANTIUM CHEMICALS BV	TNO - Netherlands Organisation for Applied Scientific Research Den Haag
19	AVANTIUM CHEMICALS BV	Universiteit Leiden /Leiden University
20	AVANTIUM CHEMICALS BV	Universiteit Twente
21	AVANTIUM CHEMICALS BV	VAN HOUTUM PAPIER BV
22	AVANTIUM CHEMICALS BV	VITENS N.V. Zwolle
23	AVANTIUM CHEMICALS BV	Vrije Universiteit Amsterdam/VU University Amsterdam
24	AVANTIUM CHEMICALS BV	Wageningen UR
25	BTG Biomass Technology Group BV	CROWN VAN GELDER PAPIERFABRIEKEN N.V.
26	BTG Biomass Technology Group BV	Delft University of Technology
27	BTG Biomass Technology Group BV	DS SMITH PACKAGING NETHERLANDS BV
28	BTG Biomass Technology Group BV	ECN - Energy Research Centre of the Netherlands
29	BTG Biomass Technology Group BV	Eindhoven University of Technology
30	BTG Biomass Technology Group BV	ESKA GRAPHIC BOARD BV
31	BTG Biomass Technology Group BV	GEMEENTE AMSTERDAM
32	BTG Biomass Technology Group BV	KWR WATER BV

33	BTG Biomass Technology Group BV	MAYR-MELNHOF EERBEEK BV
34	BTG Biomass Technology Group BV	Nederlands Normalisatie-Instituut
35	BTG Biomass Technology Group BV	Parenco BV
36	BTG Biomass Technology Group BV	PROVALOR B.V.
37	BTG Biomass Technology Group BV	Rijksuniversiteit Groningen
38	BTG Biomass Technology Group BV	SAPPI NETHERLANDS SERVICES BV
39	BTG Biomass Technology Group BV	Smurfit Kappa Group
40	BTG Biomass Technology Group BV	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY
41	BTG Biomass Technology Group BV	TNO - Netherlands Organisation for Applied Scientific Research Den Haag
42	BTG Biomass Technology Group BV	Universiteit Leiden /Leiden University
43	BTG Biomass Technology Group BV	Universiteit Twente
44	BTG Biomass Technology Group BV	VAN HOUTUM PAPIER BV
45	BTG Biomass Technology Group BV	VITENS N.V. Zwolle
46	BTG Biomass Technology Group BV	Vrije Universiteit Amsterdam/VU University Amsterdam
47	BTG Biomass Technology Group BV	Wageningen UR
48	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Delft University of Technology
49	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	DS SMITH PACKAGING NETHERLANDS BV
50	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	ECN - Energy Research Centre of the Netherlands
51	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Eindhoven University of Technology
52	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	ESKA GRAPHIC BOARD BV
53	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	GEMEENTE AMSTERDAM
54	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	KWR WATER BV
55	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	MAYR-MELNHOF EERBEEK BV
56	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Nederlands Normalisatie-Instituut
57	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Parenco BV
58	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	PROVALOR B.V.
59	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Rijksuniversiteit Groningen
60	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	SAPPI NETHERLANDS SERVICES BV
61	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Smurfit Kappa Group

62	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY
63	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	TNO - Netherlands Organisation for Applied Scientific Research Den Haag
64	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Universiteit Leiden /Leiden University
65	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Universiteit Twente
66	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	VAN HOUTUM PAPIER BV
67	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	VITENS N.V. Zwolle
68	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Vrije Universiteit Amsterdam/VU University Amsterdam
69	CROWN VAN GELDER PAPIERFABRIEKEN N.V.	Wageningen UR
70	Delft University of Technology	DS SMITH PACKAGING NETHERLANDS BV
71	Delft University of Technology	ECN - Energy Research Centre of the Netherlands
72	Delft University of Technology	Eindhoven University of Technology
73	Delft University of Technology	ESKA GRAPHIC BOARD BV
74	Delft University of Technology	GEMEENTE AMSTERDAM
75	Delft University of Technology	KWR WATER BV
76	Delft University of Technology	MAYR-MELNHOF EERBEEK BV
77	Delft University of Technology	Nederlands Normalisatie-Instituut
78	Delft University of Technology	Parenco BV
79	Delft University of Technology	PROVALOR B.V.
80	Delft University of Technology	Rijksuniversiteit Groningen
81	Delft University of Technology	SAPPI NETHERLANDS SERVICES BV
82	Delft University of Technology	Smurfit Kappa Group
83	Delft University of Technology	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY
84	Delft University of Technology	TNO - Netherlands Organisation for Applied Scientific Research Den Haag
85	Delft University of Technology	Universiteit Leiden /Leiden University
86	Delft University of Technology	Universiteit Twente
87	Delft University of Technology	VAN HOUTUM PAPIER BV
88	Delft University of Technology	VITENS N.V. Zwolle
89	Delft University of Technology	Vrije Universiteit Amsterdam/VU University Amsterdam
90	Delft University of Technology	Wageningen UR
91	DS SMITH PACKAGING NETHERLANDS BV	ECN - Energy Research Centre of the Netherlands

92	DS SMITH PACKAGING NETHERLANDS BV	Eindhoven University of Technology
93	DS SMITH PACKAGING NETHERLANDS BV	ESKA GRAPHIC BOARD BV
94	DS SMITH PACKAGING NETHERLANDS BV	GEMEENTE AMSTERDAM
95	DS SMITH PACKAGING NETHERLANDS BV	KWR WATER BV
96	DS SMITH PACKAGING NETHERLANDS BV	MAYR-MELNHOF EERBEEK BV
97	DS SMITH PACKAGING NETHERLANDS BV	Nederlands Normalisatie-Instituut
98	DS SMITH PACKAGING NETHERLANDS BV	Parenco BV
99	DS SMITH PACKAGING NETHERLANDS BV	PROVALOR B.V.
100	DS SMITH PACKAGING NETHERLANDS BV	Rijksuniversiteit Groningen
101	DS SMITH PACKAGING NETHERLANDS BV	SAPPI NETHERLANDS SERVICES BV
102	DS SMITH PACKAGING NETHERLANDS BV	Smurfit Kappa Group
103	DS SMITH PACKAGING NETHERLANDS BV	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY
104	DS SMITH PACKAGING NETHERLANDS BV	TNO - Netherlands Organisation for Applied Scientific Research Den Haag
105	DS SMITH PACKAGING NETHERLANDS BV	Universiteit Leiden /Leiden University
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111	ECN - Energy Research Centre of the Netherlands	Eindhoven University of Technology
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242	PROVALOR B.V.	VAN HOUTUM PAPIER BV
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245	PROVALOR B.V.	Wageningen UR
246	Rijksuniversiteit Groningen	SAPPI NETHERLANDS SERVICES BV
247	Rijksuniversiteit Groningen	Smurfit Kappa Group
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252	Rijksuniversiteit Groningen	VAN HOUTUM PAPIER BV
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256	SAPPI NETHERLANDS SERVICES BV	Smurfit Kappa Group
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259	SAPPI NETHERLANDS SERVICES BV	Universiteit Leiden /Leiden University
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261	SAPPI NETHERLANDS SERVICES BV	VAN HOUTUM PAPIER BV
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263	SAPPI NETHERLANDS SERVICES BV	Vrije Universiteit Amsterdam/VU University Amsterdam
264	SAPPI NETHERLANDS SERVICES BV	Wageningen UR
265	Smurfit Kappa Group	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY
266	Smurfit Kappa Group	TNO - Netherlands Organisation for Applied Scientific Research Den Haag
267	Smurfit Kappa Group	Universiteit Leiden /Leiden University
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272	Smurfit Kappa Group	Wageningen UR
273	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY	TNO - Netherlands Organisation for Applied Scientific Research Den Haag
274	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY	Universiteit Leiden /Leiden University
275	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY	Universiteit Twente

276	STICHTING PUBLIC PRIVATE PARTNERSHIP INSTITUTE FOR SUSTAINABLE PROCESSTECHNOLOGY	VAN HOUTUM PAPIER BV
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300	University Amsterdam	Wageningen UR