Exploring network configuration in service ecosystems. Evidence from Southern Italy

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Abstract.

This paper aims to explore the characteristics of network structure in service ecosystems, by adopting a social network analysis approach. More specifically, our paper tries to investigate which network configurations – open, closed or small words- characterize service ecosystems and which type which types of actors hold a central position in service ecosystem network. In order to answer to our research questions, we take empirical evidence from six industry-specific service ecosystems located in the Campania Region (South of Italy) by conducting a social network analysis (SNA), by taking data from the official PONREC platform (Programma Operativo Nazionale "Ricerca e Competitività" 2007-2013) to map relationships between the actors in all systems. Our findings revealed that in service ecosystems, network brokering positions are mostly undertaken by academic institutions, suggesting the efficacy of Regional Government programs in stimulating inter-organizational cooperation among actors of different nature. Secondly, it emerged a tendency toward an open and small world network structure. Our work contributes to the strand of literature focusing on the relational dimension of service ecosystems by proposing an empirical and quantitative approach to the study of their relational dimension.

Keywords: *service ecosystems; R&D relationships; social network analysis; South of Italy; S-D logic.*

1. Introduction

The evolution of Service-Dominant Logic (S-D) logic has recently been marked by the introduction of the *service ecosystem* perspective (Lusch and Vargo 2014) to identify a specific type of critical flow i.e., mutual service provision. Specifically, a service ecosystem is defined as “a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange” (Vargo and Lusch 2016, pp. 10-11). The introduction of a *service ecosystem perspective* (Vargo and Lusch 2004) provides an analytic tool to explore how value co-creation depends upon (and contributes to) the social context through which it is derived in systems of service-for-service exchange—i.e., service systems.

However, differently from the notion of “service systems” (e.g. Maglio et al. 2019) used to describe “a configuration of people, technologies and other resources that interact with other service systems to create mutual value”, the “service ecosystem” stresses the role of institutions, more than technology, in the system development process and in connecting individuals and technology itself (e.g., see Barile and Polese 2010, Vargo and Akaka, 2012). The idea that within service ecosystems value cocreation is coordinated thanks to actor-generated institutions and institutional arrangements suggests that “these dyadic interactions do not take place in isolation, but rather within networks of actors, of which the dyad is just a part” (Vargo and Lusch 2017 p. 49) and emphasizes that the benefit (value) realized by a beneficiary (e.g., a “customer”) occurs through integration of the resources from many sources, understood as holistic experiences. However, differently from typical network conceptualizations (Granovetter (1973), Burt (1992) Achrol & Kotler, 1999), in S-D logic, (i*) network connections represent service-for-service exchange, rather than just connections of resources, people, or product flows; thus, actors are linked by common, dynamic processes (service provision), and (ii) the actors are defined not only in terms of this service provision (resources applied for benefit) but also in terms of the resource-integration activities that the service exchange affords* (Vargo and Lusch 2017). This in turn, suggests that the interdependent relationships among service providers and service beneficiaries within systems of service vary widely in terms of organizations types (Ostrom 2010), strength of relationships (Granovetter 1973), and networks' configuration (Chandler and Wieland 2010). However, despite the recognized importance of the relational dimension in service ecosystems, there is a scant attention within literature in the field to the empirical application of such perspective and the consequent use of social network analysis to the study of service ecosystems. The adoption of a social network approach has demonstrated to be very helpful in order to analyze different types of ecosystems as it allows the identification of the actors involved and their relationships, as it has been empirically demonstrated by literature on the relational dimension of innovation ecosystems (Ahuja 2000, Still et al., 2013; Kajikawa et al. 2015; Russell et al. 2015; Balland et al. 2013; Casanueva et al. 2015; Xie et al, 2014; Salavisa et al. 2015; Li et al. 2013; Eisingerich et al. 2010, 2012; Owen-Smith and Powell, 2004; Broekel and Mueller, 2017). Therefore, we believe that this approach can equally be implemented for the study of service ecosystems by providing the whole picture of the value co-creation networks (Enquist et al., 2015) and allowing to derive evidence-based proposition about the optimal network configuration. In this light, this paper aims to explore the characteristics of network structure in service ecosystems, by adopting a social network approach. More specifically, we explore: RQ1. What are the network structural characteristics of a service ecosystem? RQ2. Which types of actors hold a central position in service ecosystem network? In order to answer to our research questions, we take empirical evidence from six industry-specific service ecosystems located in the Campania Region (South of Italy) by conducting a social network analysis (SNA), by taking data from the official PONREC platform (Programma Operativo Nazionale "Ricerca e Competitività" 2007-2013) to map relationships between the actors in all systems. Our findings revealed that in service ecosystems, network brokering positions are mostly undertaken by academic institutions, suggesting the efficacy of Regional Government programs in stimulating inter-organizational cooperation among actors of different nature. Secondly, it emerged a tendency toward an open network structure. Our work contributes to the debate about network structure within the strand of literature focusing on the relational dimension of service ecosystems by using a SNA to explore their network structure, The remainder of the paper is organized as follows: section two reviews extant contributions adopting a social network approach to explore system's configuration. Section three illustrates the research strategy adopted for addressing the theoretical gap and the research techniques implemented for the empirical case study of service ecosystems in the Region of Campania. Main results are reported and discussed in section four and five, before concluding.

2. Theory

In general, S-D logic argues that (i) service is the basis of exchange, (ii) value is always co-created, (iii) all social and economic actors are resource integrators, and (iv) value is always phenomenologically determined by a service beneficiary (Vargo, 2008). On this basis, Vargo and Lusch (2011) have recently broadened their perspective on service-for- service exchange by developing the concept of *service ecosystem*. This concept emphasizes on the one hand, *the systemic nature of value cocreation* and on the other, it highlights the importance of institutions (rules, norms, meanings, symbols, practices) and institutional arrangements (interdependent assemblages of institutions), suggesting that these are a key driver of value cocreation interactions (Edvardsson et al., 2014; Vargo and Akaka, 2012). Value cocreation is a core concept of S-D logic (Vargo and Lusch, 2008) and it is defined as "benefit realized from integration of resources through activities and interactions with collaborators in the customer network" (McColl-Kennedy et al., 2012). According to this perspective, resources do not have value *per se*. Indeed, value is co-created by actors when resources are used and combined through different modalities (Chandler and Vargo, 2011). Therefore, institutional or social norms are key in order to create a common environment for value cocreation for the whole community of different actors within the ecosystem, especially at the macro level that is characterized by shared values, norms and rule that, in turn, enable and constrain meso and micro level actors (Lusch and Vargo, 2014). In addition to the focus on institutions, the service ecosystem perspective brings new insights into the idea of value cocreation as a result of the interaction among multiple actors (Lusch and Vargo, 2014), and as part of a process of interdependencies, adaptation, and evolution (Frow et al., 2014). Indeed, service ecosystem perspective contrasts with the traditional focus on dyadic relationships among customers and service providers by emphasizing many-to-many interactions among multiple stakeholders (Gummesson, 2007). In this sense, the "service ecosystems" idea is similar to the "service systems" concept of service science (e.g., Maglio et al., 2009), defined as "a configuration of people, technologies, and other resources that interact with other service systems to create mutual value", which is also grounded in S-D logic. However, the service systems approach evolved into one of service ecosystems, as researchers in the service community began to specialize in specific types of service system entities: not just people and businesses, but also universities and social enterprises (Spohrer et al., 2013; Tracy and Lyons, 2013), things, and people (Ng and Wakenshaw, 2017). As a consequence, an ecosystem perspective is key to understand the holistic dynamics of complex systems, that requires a shift from a firm-centered perspective to one that takes into account of the whole context of a complex world (Gummesson, 2007).Vargo and Lusch (2016) have enhanced this discussion even further, by using the term “actor” for system entities and the word “ecosystem” term to convey the idea of actor– environmental relationship as mutual service provision that is adaptive, self-adjusting and governed by reciprocal value creation and common institutional arrangements. In this sense, actor collaboration is essential (Moeller et al., 2013), in order to increase resource density, improve the set of available resources and enhance the overall value created (Normann, 2001). The idea that within service ecosystems value cocreation is coordinated through actor-generated institutions suggests that “these dyadic interactions do not take place in isolation, but rather within networks of actors, of which the dyad is just a part” (Vargo and Lusch 2017 p. 49). Consequently, the relationships between service providers and service beneficiaries within systems of service vary widely in terms of organizations’ types (Ostrom 2010), strength of relationships (Granovetter 1973), and networks’ configuration (Chandler and Wieland 2010). Our paper tries to investigate this latter aspect - network configuration - of a service ecosystem by adopting the Social Network Analysis (SNA) approach. SNA has been widely implemented for the sociological study of individuals and organizations (Wasserman and Faust, 1994; Welser et al., 2007), as well as for the assessment of nested structures among the actors within the network (Moody and White 2003; Halinen et al. 2012) so we believe that this approach could be equally implemented for the analysis of the relational dimension of service ecosystems. In fact, by using a social network approach it is possible to gain insight about the whole picture of the value co-creation networks (Enquist et al., 2015) and consequently, to derive evidence-based propositions about the optimal network configuration. Network literature is traditionally characterized by two contrasting visions about the desirable structure of networks, namely the Coleman’s Network closure and the Burt’s Structural hole arguments. The debate is about the identification of which configurations of network structures are preferable in order to create social capital. Both visions agree on the definition of social capital as a type of capital that can generate a competitive advantage for specific individuals or groups in pursuing their ends. However, the debate contrasts the closure argument, according to which social capital is more likely to be created by a network where nodes are strongly connected to each other, and the structural hole argument that supports the idea that social capital is generated through a network where nodes can broker connections between otherwise disconnected segments (Burt, 2002).

Coleman (1988, 1990) is one of the most prominent authors of the closure argument. His view emphasizes the importance of strong ties as they encourage the emergence of cooperative mechanisms; promote the development of shared social norms and trust and uncertainty reduction. Typically, closed and cohesive networks are characterized by frequent, reciprocal and repeated interactions where the involved parties usually have the possibility to cross-check information resulting from direct ties by the means of indirect paths in the network (Cassi et al., 2012). The combination of these properties is deemed to generate trust mechanisms within partnerships of collaboration (Walker et al., 1997; Buskens, 2002; McEvily et al., 2003) which in turn, strengthen the motivation and level of commitment to share knowledge within the relationship (Reagans and McEvily, 2003), with specific regard to the exchange of complex as well as sensitive knowledge (Zaheer and Bell, 2005). On this subject, Gargiulo and Benassi (2000) and Beckman et al. (2004) show how in situations of high levels of risk, market uncertainty and costs related to opportunistic behavior, actors tend to prefer to embed themselves in dense and close network structures, as in the case of US venture capital networks (Sorenson and Stuart, 2008). The repeated exchange among stable members is deemed to improve coordination and access to social capital. Therefore, the availability of social capital turns out to be function of the closure of the network surrounding them. In Coleman's view, closed networks are the source of social capital as they provide a better access to information and discourage opportunistic behavior (Coleman, 1988; Walker, Kogut, and Shan, 1997; Rowley, Behrens, and Krackhardt 2000) as "closure facilitates sanctions and makes less risky for people in the network to trust one another" (Burt, 2002) due to the threat of reputation loss. Cohesive and dense networks are likely to have similar information and thus provide redundant information benefits. Additionally, this perspective suggests that redundant ties among firms may result in a collective action's resolution of the problems. Conversely, Burt's structural hole theory (1992, 1997, 2002) emphasizes the role of weak ties and the lack of network closure. The argument considers social capital as a function of brokerage opportunities and relies on concepts that originated in sociology during the 1970s, namely the strength of weak ties (Granovetter, 1973) and betweenness centrality (Freeman, 1977). This perspective can be considered as an extension of the Granovetter's argument about the strength of weak ties that suggests that a greater amount of information is more easily obtained through weak rather than strong and long-term relationships. More specifically, the high costs related to the maintenance of close relationships would limit the number of "ties" that an organization can have. Secondly, since weak ties do not generally encompass a regular-basis interaction, they may access to less redundant information compared to strong ties. Network betweenness is an index proposed by Freeman that indicates the extent to which a node brokers indirect connection among all other nodes in the network. The holes in social structure, i.e. Structural holes, provide a competitive advantage for those actors whose connections span the holes, which in turn act as buffers separating non-redundant sources of information. Therefore, structural holes provide the possibility of brokering the flux of information between the nodes and “control the projects that bring together people from opposite sides of the hole” (Burt, 2002). Additionally, firms who are positioned in structural holes may have more opportunity to brokerage activities, by serving as bridges among relatively unconnected parts of the network. In the end, the availability of information is not limited to the function of a firm’s ties only, but also to those retained by third parties, i.e. network configuration. Critical links represent another class of ties that has gained increasing attention in the network literature. These links have the function of connecting poorly or otherwise disconnected sub-networks in a way that when, for some reason, they dissolve, then the entire network collapses, including the process of knowledge transfer among its members. Due to the critical links’ function to connect sparsely linked parts of the network, they have often been referred to as “bottlenecks” (Sytch, Tatarynowicz, and Gulati 2012) or “bridges” (Glückler 2007). However, “while every critical link can be classified as a weak tie, the same is not necessarily true of the reverse. Critical links are crucial for the structure and integration of the complete network, while weak ties may only have local relevance (Broekel and Mueller 2017). Watts and Strogatz (1998) suggest that the structure of networks may present the benefits of both strong and weak ties. For this specific configuration, the authors refer to the Small Worlds (Travers and Milgram, 1967), i.e. particular types of networks characterized by a shorter path length and a higher clustering coefficient. In other words, in these networks the actors are close to almost all other elements through a smaller number of interconnecting paths, despite the large number of nodes. The first property of Small Worlds - shorter path length - sustains network closure and for this reason, it is expected that knowledge and information circulate through the small world network more easily and quickly. Thus, a network with a small path length can be considered as one with fewer structural holes (benefit of weak ties). On the other hand, the second property - higher clustering coefficient - suggests that a larger social capital is accumulated, which leads to collective problem resolution (benefit of strong ties). However, following Ahuja (2000), the optimal structure of inter-firm networks ultimately depends on the objectives of the network members. The high degree of density and redundancy of linkages within local cliques ensures the formation of a common language and communication codes that enhances reciprocal trust and supports the sharing of complex and tacit knowledge among actors (Breschi and Catalini, 2010); the shortcuts linking local cliques to different and weakly connected parts of the network, ensures a rapid diffusion and recombination of new ideas throughout the network and allow to keep a window open to new sources of knowledge, thereby mitigating the risk of lock-in that could arise in the context of densely connected cliques (Cowan and Jonard, 2004). Social Network Analysis

(SNA) has been widely implemented for the sociological study of individuals and organizations (Wasserman and Faust, 1994; Welser et al., 2007), as well as for the assessment of nested structures among the actors within the network (Moody and White 2003; Halinen et al. 2012). In particular, studies within economic geography have paid increasing attention to relational issues (Dicken et al., 2001; Bathelt and Gluckler, 2003; Yeung, 2005) and provided a rich narrative on spatial dynamics of evolution. Our paper tries to investigate which network configurations – open, closed or small words-characterize the Campania service ecosystems and which type which types of actors hold a central position in service ecosystem network.

3. Methodology

In order to answer our research questions, we develop a SNA in six service ecosystems in the Region of Campania. The main purpose of the SNA is to study entire social structures (complete networks) or local networks (ego-centered networks) by identifying and analyzing the links between the individuals or organizations representing the nodes of the network and it has been widely used for the analysis of ecosystems' relational structure. We find that the region of Campania is an interesting case of study as it has been concerned in the last years with a strong commitment of regional government institutions in promoting initiatives to favor multi-actor networks to promote processes of value cocreation in different industrial domains, in line with the priority European development objectives. In this vein, the Region has implemented the Research and Competitiveness Operative National Plan (PONREC) that is one of the seven Italian programs financed for the 2007-2013 period by the European Union (EU), through the Structural Funds, to promote "convergence", i.e. the growth of regions whose development is lagging behind (regions whose per capita Gross Domestic Product is less than 75% of the EU average): Calabria, Campania, Puglia and Sicily. The PON R&C finances projects in the fields of scientific research, technological development, competitiveness and industrial innovation and has a budget of more than 6 billion euros. The program targets six industrial areas namely Transport & Logistics, Cultural Heritage Agri-Food, Clean Tech, Energy, Life Sciences. To the purpose of our analysis we analyses seven regional networks, corresponding to the above industrial areas.

In order to build our six networks, we considered the co-participation to the same regional project as a proxy for a service-for-service relationship and consider as a tie within our network. To build our relational data, we used the official PONREC platform which provides information about all projects that have been funded within the region by FESR (European Regional Development Fund) funds, classified by area of specialization for the period 2007-2013. Each of the projects has been assigned a numeric code and a reference name. Secondly, for each network, we selected only those projects falling in the corresponding domain. Then, for each project we selected only those beneficiaries located in Campania Region. Finally, we were able to select 85 regional projects in which are involved 141 organizations for the Transport and Logistics (T&L), while we selected 24 Projects with 73 organizations for the Cultural Heritage IE (CH), for Life Sciences (LS) we selected 38 projects with 59 actors, also for Agri-food (AGR) we collected all the projects (13) in which are involved 37 organizations, the Energy sector (EN) counts 24 projects with 72 actors, finally, 62 actors are involved in the Clean Tech sector (CT) projects that are 23. Each organization constitutes a node in our network and we considered whether these organizations co- participate in one of the projects to build the edges of the networks. To present data in a visual form and compute structural network metrics we used *NodeXL*, an interactive network analysis software that implements a set of key functionalities for visual network analytics. We employed a force-driven algorithm where nodes repel each other and edges pull the connected nodes together to gain a better understanding of the spatial structure of relationships (Russell et al., 2015). In graph theory, force-driven layout reveals the macro-level structure of the network including the key clusters and brokers in the network, and potential structural holes (Burt, 1992).

Table n.1 – Regional Service Ecosystems

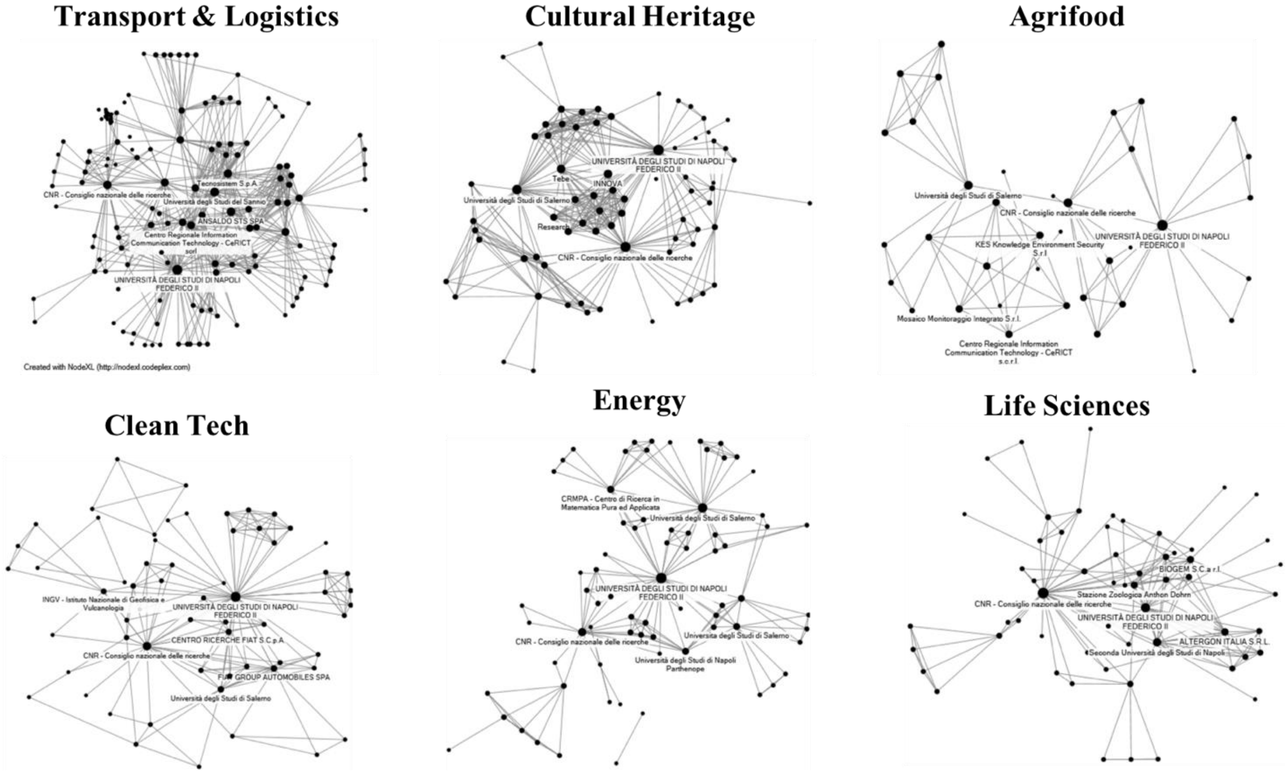
	N. of Actors	**N. of Relationships**	**N. of projects**
Transport & Logistics (T&L)	141	559	85
Cultural Heritage (CH)	73	358	24
Agrifood (AGR)	37	79	13
Clean Tech (CT)	62	189	23
Energy (EN)	72	194	24
Life Sciences (LS)	59	155	38

4. Results and discussions

Visualization of the network of all service ecosystems under analysis are provided in Figure n.1.

Our networks present a varying size, in terms of total number of nodes (T&L showed the maximum value with 141 nodes, while Agrifood ecosystems is the smallest network with 37 nodes); total number of edges (ranging from 79 to 551) and diameter (values range from 4 to 5). In order to explore the configuration of the networks we computed structural and positional network metrics for each of the six clusters under analysis (Table n.2).

Figure n.1 Network visualizations



At the structural level, we calculated metrics of *density* and *small worlds properties* to gain insights about the overall configuration of the network. The *density* of a network at time *t* represents the relationship between the relationships existing at time *t* and the potentially achievable relationships at the same time. This ratio is between 0 and 1, and for values close to 0 we interpret the network as being weakly connected, while for values close to 1 we interpret the network as strongly connected. Based on the density values resulting from the SNA, all clusters present a network with a relatively sparse structure (values ranging from 0,06 for T&L network and 0,13 for CH network) (Balland et al., 2012), suggesting the presence of structural holes in both networks (Ahuja, 2000). However, the weakly connected nature of the network is counterbalanced by the low number of connected components, i.e. a maximal set of nodes, in a way that a path connects each pair of nodes. With the exception of the T&L cluster, where the number of connected components (21) is relatively high (due to the higher number of actors), the other networks present a low number of connected components (between 6 and 3). From a small world perspective, we calculated metrics of *average path length* and the *average clustering coefficient* (Watts and Strogatz, 1998). The *average path length*, represents the average graph-distance between all pairs of nodes, and it is fundamental for the evaluation of the network performance as it informs whether a node can have an easier and quicker access to other actors with less efforts, thus accessing to a larger amount of knowledge or information (Kajikawata, 2010). Generally speaking, a small value of average path length indicates a small diameter of the network, which in turns suggests that organizations in the network can pool resources through a smaller number of paths and structural holes are buried. On the other hand, *clustering coefficient* represents the extent to which nodes connected to *i* are also linked to each other and the *average cluster coefficient* shows the system's overall connectivity based on local relationships. It is argued that small world configuration allows to benefit from both closed and open networks' advantages. In fact, while, a network with a small path length sustains network closure (as it allows information to circulate more easily and quickly through a less number of paths and structural holes), a network with high clustering coefficient suggests that a larger social capital is accumulated, which is a benefit of open and sparser networks. All our networks present relatively low values of average path length (between 2,12 and 2,49) and high values of clustering coefficient (ranging from 0,71 and 0,85). These results suggest that both networks present the structural characteristics of small worlds, thereby allowing the actors to benefit from the advantages of both closed and open networks.

Table n.2 -Metrics of network structure

	T&L	**CH**	**AGR**	**CT**	**EN**	**LS**
Vertices	141	73	37	62	72	59
Unique Edges	551	354	79	169	194	153
Edges with Duplicates	8	4	0	20	0	2
Total Edges	559	358	79	189	194	155
Diameter	5	5	4	4	4	4
Graph Density	0,06	0,13	0,12	0,09	0,07	0,09
Connected Components	21	6	5	4	3	3
Average Geodesic Distance	2,49	2,12	2,15	2,12	2,71	2,38
Average Clustering Coefficient	0,71	0,79	0,75	0,85	0,83	0,74
Average Degree	8,92	9,75	4,27	5,77	5,39	5,22

In order to identify the nature of the key actors in both network calculated metrics of network Degree centrality. Table n.3 shows the top ten actors in terms of degree centrality scores for each network.

Degree Centrality is typically an indicator of engagement (Barabasi and Albert, 1999) and indicates the number of connections that each actor has with the other nodes of the network. In all networks the most popular and influential nodes are universities and research centres, with particular regard to CNR, Federico II University; University of Salerno and to a lesser extent top positions are occupied by large firms (e.g. FIAT Group; Biogem). The prominent role of academic institutions suggests their key function as service provider within service ecosystems. In particular, their centrality confirms one of the key ideas of the service ecosystem perspective, that is the shift from a firm-centered perspective to one that takes into account among service system entities not only people and businesses, but also universities (Spohrer et al., 2013; Tracy and Lyons, 2013), and more generally, the whole context of a complex world (Gummesson, 2007). Interestingly, oftentimes most central positions are occupied by research public-private aggregations (i.e. Consorzi) among academic and research institutions and private companies, suggesting the important role of these associations in promoting mutual service relationships in the sector.

Table n. 3 -Top ten actors in terms of degree centrality, by network

Transport&Logistics		**Cultural Heritage**	
Vertex	Degree		Degree
Università Degli Studi Di Napoli Federico II	48	Università Degli Studi Di Napoli Federico II	42
Università degli Studi del Sannio	36	CNR - Consiglio nazionale delle ricerche	38
ANSALDO STS SPA	33	Università degli Studi di Salerno	32
CNR - Consiglio nazionale delle ricerche	33	Tebe	25
Tecnosistem S.p.A.	31	INNOVA	25
Centro Regionale Information Communication Technology - CeRICT scrl	28	CUSSMAC Consorzio Universitario Salernitano su Sistemi e Metodi per Aziende Competitive	15
Università degli Studi di Salerno	28	Consorzio Interuniversitario Nazionale per lInformatica (C.I.N.I.)	15
TEST S.c.a r.l.	27	CRMPA - Centro di Ricerca in Matematica Pura ed Applicata	15
Seconda Università degli Studi di Napoli	25	Research	15
Università degli Studi di Napoli Parthenope	25	CARSO - Consorzio del Centro di Ricerca Avanzata per l'Ottica Spaziale, la Sensoristica e l'Ottimizz	15
Agrifood		**Clean Tech**	
Vertex	Degree	Vertex	Degree
Università Degli Studi Di Napoli Federico II	14	Università Degli Studi Di Napoli Federico II	37
Università degli Studi di Salerno	9	CNR - Consiglio nazionale delle ricerche	25
CNR - Consiglio nazionale delle ricerche	9	Università degli Studi di Salerno	13
Mosaico Monitoraggio Integrato S.r.l.	6	Fiat Group Automobiles Spa	13
KES Knowledge Environment Security S.r.l	6	Centro Ricerche Fiat S.C.P.A.	11
Centro Regionale Information Communication Technology - CeRICT s.c.r.l.	6	INGV - Istituto Nazionale di Geofisica e Vulcanologia	9
Consorzio Nazionale Interuniversitario per le Telecomunicazioni	6	Seconda Università degli Studi di Napoli	8
ProdAl S.c.ar.l	6	L&R Laboratori e Ricerche S.r.l.	7

DE CLEMENTE CONSERVE SPA	5	EUCENTRE	7
SALVATI MARIO & C. SPA	5	Dismat S.r.l.	7
Energy		**Life Sciences**	
Vertex	Degree	Vertex	Degree
Università Degli Studi Di Napoli Federico II	32	CNR - Consiglio nazionale delle ricerche	31
Università degli Studi di Salerno	25	Università Degli Studi Di Napoli Federico II	21
CNR - Consiglio nazionale delle ricerche	18	Seconda Università degli Studi di Napoli	17
CRMPA - Centro di Ricerca in Matematica Pura ed Applicata	13	Altergon Italia S.R.L.	13
Universita degli Studi di Salerno	12	Biogem S.C.A R.L.	12
Università degli Studi di Napoli Parthenope	12	Stazione Zoologica Anthon Dohrn	11
Seconda Universita degli studi di Napoli	11	Bioricerche 2010 Scarl	10
Neatec SpA	7	CEINGE Biotecnologie Avanzate SCARL	9
Consorzio S.C.I.R.E.	7	Università degli Studi di Salerno	8
CO.EL.MO. S.p.A.	7	Primm Srl	8

From the observation of the network analysis results, the analysed service ecosystems appear to be characterized by an open and sparse network, where brokering positions are mostly undertaken by academic and research institutions. These results are in line with the strand of studies supporting the idea that a sparse network with structural holes is preferable in order to build social capital and carry out innovation activities successfully (Burt, 2002; Saxenian, 1994; Bresnahan, 2001; Ahuja, 2000; Xie et al., 2014). However, the high values of cluster coefficient and relatively small values for average path length in all service ecosystems under analysis, suggest that all networks' structure tend toward small world configurations, indicating that despite keeping an open structure these are still able to provide the actors with a few benefits typical of closed networks (Kajikawa et al. 2010). In particular, the high values of clustering coefficient suggest that a larger social capital is accumulated, which is a benefit of strong ties. These network structural characteristics can be partly explained by the efficacy of Regional Government initiative in stimulating routines of collaborations through various initiatives as High-Tech Districts, Public-Private Aggregations and Labs that turn into actual, consolidated and independent partnerships through which partners establish repeated relationships overtime. On the other hand, our study confirms the centrality of the academic institutions in networks. These last results can be explained by the wave of regional interventions to promote public-private partnerships in the Region to promote systemic and multi-actor processes of value co-creation. This in turn, confirms the idea that in service ecosystems value cocreation is a systemic process that is coordinated through actor-generated institutions (Vargo and Lusch 2017) and more in general, the key role of institutions in value co-creation processes (Vargo and Akaka, 2012).

6. Conclusions

The aim of this work was that of exploring the network configuration of service ecosystems by taking empirical evidence from six service ecosystems' networks in the Campania Region (South of Italy). The social network analysis conducted on mutual service relationships among a heterogeneous sample of organizations revealed that service ecosystems are characterized by an open network, where brokering positions are mostly undertaken by academic institutions, which is in line with the studies arguing that an open structure better sustains the conduct of collaboration and valuable activities. Also, these results suggest the efficacy of Regional Government institutions in stimulating permanent inter-organizational forms of cooperation that convey to the network a small world configuration. Overall, the work contributes to the strand of literature focusing on the relational dimension of service ecosystems by proposing an empirical and quantitative approach to the study of their relational dimension. However, this work is not free from limitations. First, the sample could include a greater number of organizations within the Region in order to achieve a greater extent of validation of the results. Second, other types of inter-organizational relationships could be included in the analysis to better explore service ecosystems' network variety. Finally, a comparative study with other service ecosystems localized in different regions would contribute to the identification of industrial patterns in service ecosystems' network architecture. Future research is invited to overcome above limitations.

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