

# Changes in the intellectual structure of service innovation and service system in the digital age: an interdisciplinary analysis from 1986 to 2015

SILVA-MORALES Milena J.

Grenoble Alps University

*In the past thirty years, growth in all service sectors and rapid advances in information and communication technologies (ICT) have revealed new challenges for improving service systems through service innovation. Although, these areas of researches are closely related, few studies have investigated the relationship between these areas. This study aims to analyse the changes in the intellectual structure of service innovation and service system research in the digital age in order to a better understand its origins, current state, and future directions. Drawing on bibliometric methods, our proposed methodological approach combines the co-words, co-citation analysis with the qualitative thematic analysis. We perform an extensive co-words and co-citation analysis using multidimensional scaling (MDS), as well as factor analysis and principal component analysis (PCA) to examine 20.950 key terms. These key terms, extracted from 796 articles, published in 277 journals over three decades (1986-2015), indexed in ISI Web of Science and/or Scopus. Subsequently, we examine topics of the recent studies, over the period of the last 5 years, through a thematic analysis. Results provide a 'comprehensive view' of the intellectual structure of service innovation and service system in the digital age, how they both are evolved and their related topics over time; Moreover, it clarifies the main players in bridging conceptual domains of research.*

*Keywords: service innovation, service system, science mapping, bibliometric methods, co-word analysis, co-citation analysis.*

## 1. Introduction

In the new global services economy of the digital age, service innovation and service system have become a central issue for researchers, firms, and governments. However, these areas of researches are closely interrelated, few studies have investigated the evolution, interactions and overlaps between the intellectual structures of them.

Service innovation in the digital age is defined in terms of this paper as the combination of ICT with other resources, so that a service system is able to

process the information received in real-time to offer sensitive and adaptable services in different contexts (Barret et al., 2015; Medina-Borja, 2015).

Furthermore, in this paper the term of the service system will be used in its broadest context to refer to the co-creation of dynamical configurations between human, technological and organisational resources, as well as, internal and external service systems and shared information (such as language processes, metrics, prices, policies and laws). In other words, whatever creates and offers value to providers and users through the service (Maglio & Spohrer, 2008, p. 18).

Service innovation and service system are intimately related from theoretical and practical points of view (Spohrer & Maglio, 2010b; Stoshikj, Kryvinska & Strauss, 2016). An example of this might be an urban service system, which integrated into the Internet of Things (IoT) through service innovation processes. As the result, the city can offer the users the possibility to access innovative services at anytime and anyplace by the use of a digital platform of services and connected objects. It involves the integration and the coordination of new actors with new resources (e.g. skills, knowledge, digital infrastructures and sensors), which are necessary for services to be interoperable, context-sensitive, generative and usable in mobility conditions. Briefly, agility in technology evolution has created several opportunities for the innovation in services as well as service systems in organisational and social levels (Osborne, 2015). In this sense, recent studies combine physical and digital components (Yoo, Henfridsson, & Lyytinen, 2010), in digital platforms (Ghazawneh & Henfridsson, 2013) and digital infrastructure (Tilson et al., 2010) show the evidence of a generative nature in digital technologies (Henfridsson & Byzstad, 2013). Indeed, digital technologies facilitate the combinatory potential of service innovation and service systems (Yoo et al., 2012). However, it allows an overlap of multiple research topics and the birth of multidisciplinary approaches such as the one proposed for Service Science, Management, Engineering, and Design (SSMED) (Spohrer & Kwan, 2010; Spohrer & Maglio, 2010a; Spohrer & Maglio, 2010b). Maglio and Spohrer (2009) define SSMED as the study of innovation in service systems where the concepts of service systems and service innovations are both pillars (Stoshikj, Kryvinska & Strauss, 2016).

Despite the importance of service innovation, previous studies (Miles, 2016; Barret et al., 2015; Carlborg, Kindström & Kowalkowski, 2014) have revealed that service innovation is a commonly used notion which is difficult to define precisely. This is also what it has been mentioned by Snyder et al., (2016, p. 2401) that “the concept [service innovation] remains fuzzy and poorly defined”. Moreover, a key aspect of service innovation in the digital age is the growing digitalisation and embedded technology in IoT objects to enhance service systems (Barret et al., 2015; Medina-Borja, 2015). The evolution towards mobile-based “smart service systems” fed in the real time because of the geographic position of users which brings the topic of digital resources and technologies to the foreground of service innovation research agenda (Maglio & Lim, 2016; Carlborg, Kindström & Kowalkowski, 2014). This technological agility has highlighted a growing concern in the different disciplines such as digital innovation (Sørensen & Landau, 2015) and service innovation (Carlborg,

Kindström & Kowalkowski, 2014). As Sørensen & Landau clarified, for improving academic agility in digital innovation research is necessary that the scientific community progress toward the understanding of emerging research topics at the same time that traditional research topics are studied. Elsewhere, Sørensen & Landau have suggested an “academic ambidexterity”, which means, dealing with traditional research subjects while studying emergent subjects in the same time (Sørensen & Landau, 2015). In this sense, recent researches have suggested a lack of rigorous qualitative/quantitative methods to determine the emergent topics and future research horizons (Small, Boyack, & Klavans, 2014; Small & Upham, 2009). According to Miles (2016, p. 6) bibliometric approaches can be used to explore the development of the literature on “service innovation” and “innovation in services”.

Bibliometric approaches are used to analyse and visualise the “intellectual structure” or “knowledge base” of a research theme or discipline (White and Griffith, 1981). Therefore, the consequence would be one of the following items: detecting the existence of scientific schools and/or academic networks called “Invisible Colleges” (De Solla Price, 1966; Vogel, 2013), identifying potential “research fronts” (Price, 1965; Daim, Chiavetta, Porter, & Saritas, 2016), or to conduct studies on production performance about authors, institutions or countries in relation to a particular discipline or thematic field.

Cobo et al., (2011b) define the bibliometric approaches as a set of methods, which can be used to study and measure texts and information, especially large data sets and through applying two types of procedures: performance analysis and science mapping. The purpose of the performance analysis to evaluate the different groups of scientific actors (e.g. countries, universities, departments, researchers) and to study the impact of their activity based on bibliographic data. Science mapping, in the other hand, allows a longitudinal or temporal analysis to obtain the structural changes perceived from scientific information over a specified period of time (Cobo et al., 2012). According to Small & Upham (2009), this method, also allows us to rigorously determine the most important topics. So this method receives lots of attention from scientific community. Likewise, Zupic & Čater (2015) hold the view that, whereas a traditional qualitative evaluation gives us a good depth with a reduced amount of documents, bibliographic methods allows us to rigorously handle a big amount and even thousands of documents resulting into a graphic description of the structure of knowledge base in a research field.

According to Shafique (2013) the term “knowledge base” makes reference to ideas, perspectives, approaches, theories and methods used to create a new knowledge in a given scientific domain. While the term “intellectual structure, refers to a set of outstanding attributes of the knowledge base that may provide an organised and integral comprehension of a given scientific domain or research topic. In the same way, the intellectual structure of a scientific domain includes the traditions for doing research on that domain, its disciplinary composition, its related research topics and the pattern of their mutual relationships (Shafique, 2013). The pattern of relation provides the evidence of how particular groups emerge, grow or disappear in a period of time (Vogel, 2012). Previously It has been clarified, bibliometric methods are useful to introduce quantitative rigor to traditional literature reviews and outline the

knowledge base research topics in various disciplines (Shafique, 2013) and tracking researchers (Latour, 1987). But despite their importance they received little attention regarding to their combination and complementarity with traditional qualitative methods of extensive reading, synthesis and interpretation of the scientific literature.

Up to now, few studies have had quantitative-qualitative investigation on the association between the intellectual structure of service innovation and service systems to reach a better understanding of its origins, current state, and future directions.

Hence, to fulfil the existing gaps presented so far, this study aims at bringing up a methodological approach, which provides some longitudinal analyses between the interactions and evaluative dynamics of the intellectual structure of research subjects. In addition, this approach leads us to the detection of emerging research topics by the use of quantitative and qualitative methods for literature analysis.

The quantitative phase is based on science mapping by using bibliometric methods (co-citation and co-word analysis), which provides a global view of the evolution of service innovation and service system research. It followed with a qualitative analysis of future research topics, which aims at analysing recent horizons more in-depth and through a thematic analysis.

This paper adopts an interdisciplinary approach. This approach is supported, by the work of Beverungen et al., (2016): "Addressing these challenges requires researchers to extend beyond traditional disciplinary boundaries to reach beyond their disciplinary silos".

Briefly, this study provides an interdisciplinary global view of the intellectual structure of service innovation and service system over a specific period of time (1986-2015), patterns of evolution. This study also reviews the works of the authors that have contributed over the time and future research horizons. We study all of the most relevant publications (in English) that have contributed to the research of service innovation and service system through a quantitative longitudinal analysis.

The following section discusses some related studies and how them have reviewed and analysed the subjects proposed for this paper by the use of qualitative or bibliometric techniques. In section 3, we present the methodological approach that we used to this purpose. Then, in section 4 we show the results of the study. Finally, we present the conclusions and the limitations of this research.

## **2. Related research**

This section discusses several related research, especially, recent reviews and bibliometric studies aiming at answer following questions: Which databases were used for the study? How periods and sub-periods were determined? How many different documents were counted for the analysis? Which bibliometric or

qualitative methods were used? What types of documents have been analysed (e.g. papers, books, proceeding papers)?

## **2.1. Service innovation/Innovation in services/Service innovation in the digital age: imbroglio or misunderstanding?**

In the last 30 years, a huge number of studies concerning service innovation have been published. According to Carlborg, Kindström & Kowalkowski (2014), the first serious discussions and analysis emerged during the 80s with the study of Barras (1986), however, there are still many shortcomings in the service innovation research to date. Service innovation has been studied and characterised through different disciplines and by different authors from different points of view. (Snyder et al., 2016).

As it has been mentioned before, the lack of clarity in the definition of service innovation and the variety of characteristics present in some interrelated perspectives makes it difficult to delimitate this subject. The multiplicity of existing terms in service innovation such as, innovation in services, new service development and service design, is one of the greatest challenge of defining key terms in order to data collection in several previous bibliometric works and literature reviews (cf. Carlborg, Kindström & Kowalkowski, 2014; Snyder et al., 2016). The first group, which perceives these two terms as a single concept and the second group, which distinguishes between these concepts. As mentioned by Menor, Tatikonda, & Sampson in (2002) “in past research the constructs ‘service development’ and ‘service innovation’ have been used interchangeably in the works of Sundbo (1997) and Barras (1986)”. Barret et al. (2015) is another researcher who suggested it is possible to indistinctly use the notion of “innovation in services” and “service innovation”. In contrast, according to Carlborg, Kindström & Kowalkowski (2014 p. 386) states there is difference between these two concepts. “Distinguishing the notion of innovation in service firms from that of service innovation is important”.

Moreover, there are new research fronts by the use of the IT dimension such as “digital innovation” and “IT-enabled service innovation” in the academic discourse related to technology-enabled service (Huang & Rust, 2013). Barret et al. (2015) transposed for the first time relevant works in service innovation in the domain of marketing and operations to the domain of management of information systems. They indistinctly grouped the notions of “service innovation”, “digital innovation” and “IT-enabled service innovation”. Mentioned study, used the service innovation in the digital age as its central focus, highlighted that early or traditional approaches in service innovation and apply ICT as technological tools in the process of service delivery. This study contributes in the productivity and the efficacy of the companies active in service area, resulting new markets and service categories.

Although previous studies distinguish service innovation of innovation in service industries, their differences have been questioned in the last few years. Lusch & Vargo in (2014), Vargo & Lusch in (2004, 2008a, 2008b) and Barret et al. in (2015), suggest that every economic exchange is in essence a service

exchange, where ICT plays a fundamental role of resources that can be combined to facilitate the transport, the transformation and the contextualisation of information in different contexts, creating new opportunities for the exchange of services and for innovation. In this matter, Barret et al. (2015) affirm that the field of digital innovation has emerged as a new speech in the domain of information systems that goes beyond the usual study of technology adoption processes. Digital innovation is defined by Yoo, Henfridsson, & Lyytinen (2010) as the realisation of new combinations of digital and physical components for producing new products [or services]. It differs from other forms of innovation mainly due to digital features such as modularity and generativity of digital technology (Tilson, Lyytinen, & Sørensen, 2010; Yoo, Henfridsson, & Lyytinen, 2010; Yoo, 2010). By the means of digital innovation, a company extends its limits beyond the environment of individual organisations towards network-connected markets (Lyytinen & Yoo, 2002). Hence, digital innovation progressively becomes a centre of focus in service innovation research (Barret et al., 2015).

In this sense, Sørensen and Landau (2015) developed a bibliometric study to analyse the scientific production in digital innovation, where they found 3189 papers published between 2000 and 2014 in the “basket of eight journals” in information systems management. At the end, 102 papers were particularly selected for “mobile ICT” using 3 periods of 5 years each. Their study discusses about the challenges for the IS field academic agility in the ever-changing landscape of digital innovations research. Sørensen and Landau concludes: “these challenges involve dealing with highly decentralised and distributed phenomena challenging boundaries of employment and non-employment, human versus non-human agency and a wide array of unanticipated consequences.... For any of this to come to fruition, academic agility is at the core of the challenge” (Sørensen and Landau, 2015, p. 168). To understand these challenges, they propose an “academic ambidexterity” to deal with existing topics in parallel with emerging topics. This “academic ambidexterity” is based on the “contextual ambidexterity” (cf. Gibson and Birkinshaw, 2004).

Furthermore, Nardelli showed in (2015) how researchers have conceived and defined the relationship between ICT and innovation in services, by the use of qualitative analysis based on a concept-centric approach. Final data in that work include 41 papers organised in five umbrella themes: 1) management of ICT-based technological innovation; 2) management of organisational innovation resulting from ICT adoption; 3) NSD and innovation in service delivery; 4) business model innovation; and 5) relationship between ICT and innovation in services. The result of that study is a conceptual typology that organises and summarises the relationships between ICT and innovation in services while revealing theoretical gaps and an agenda for future research.

Concerning the research of scientific production in service innovation, the bibliometric study from Carlborg, Kindström & Kowalkowski (2014) point of view, includes the period between 1986 and 2010 taking Barras (1986) as the starting point. Their review includes a study on digital innovation, service innovation and innovation in services in the fields of service management and service marketing. The study defines three different phases to study and analysis existing literature review, with the purpose of giving a clearer vision of how the

field of research in service innovation has evolved. These phases include: 1) formation phase: 1986–2000; 2) maturity phase 2001–2005; 3) multidimensional phase: 2006–2010. This work is in contrast with recent studies such as Lusch & Vargo (2014); Vargo & Lusch, (2004, 2008a, 2008b) and Barret et al. (2015), Carlborg, Kindström & Kowalkowski (2014) who explain it is important to make the distinction between the concepts of “innovation in service firms” and “service innovation”. Besides, they also suggest that it is important to study the interaction between new service development (NSD), new product development (NPD) and their possible combinations from theoretical and practical points of view. In addition, they propose future horizons of research such as the development and conceptualisation of service innovation typologies instead of focusing on the intrinsic differences between services and products. Besides that, they suggest studying the growing number of digitally-enabled innovations including new combinations of digital and physical components, in line with the work of Yoo, Henfridsson, & Lyytinen (2010). Carlborg, Kindström & Kowalkowski in (2014) affirm digital innovations make a call towards a better comprehension of the barriers and the motors of technological service innovations and towards the inclusion of other disciplines such as design, information systems, theory of organisations, operations, public policies and strategy. In their work, they mention the necessity of further work including other countries because the biggest part of the documents reviewed for their study come from Western Europe.

Snyder et al. (2016) argued that the term “service innovation” has become an inaccurate and vague, although it is still important to explain the growing service sector as they hold that “Despite the considerable attention given to studying service innovation, research still struggles to answer the most basic question: What is service innovation?”. They also show that previous works mainly made use of assimilation, demarcation and synthesis perspectives for research in service innovation such as those of Miles (2016); Carlborg, Kindström & Kowalkowski (2014); Coombs & Miles (2000) and Ordanini & Parasuraman, (2010). According to Snyder et al. (2014), it is necessary to establish new perspectives to categorise studies in service innovation. Hence, their work proposed a new categorisation based on changes, which is composed of: 1) degree of change, 2) type of change, 3) newness, and 4) means of provision. In this context, their work provides an analysis from a new perspective on the meaning of “service innovation” through a literature review at the same time that they remark a lack of methodological rigor in previous reviews of literature concerning service innovation.

Miles (2016) presented a bibliometric study including trends and main topics in service innovation literature, which shows the impossibility of reviewing every paper, report, or even every book in the matter. His analysis is based on four approaches, for categorisation of service innovation studies: Techno-assimilation; Techno-demarcation; Servo-demarcation; Servo-assimilation. Miles (2016, p. 4) argues: “Because ‘services’ refers to both industries and their products, it is unclear whether ‘innovation in services’ means new or improved service (products) or new or improved ways of creating these services (processes). ‘Service innovation’, in contrast, might be expected to focus more centrally on new or improved services (products), though there is some inconsistency in the literature here”. Miles concludes that “service activities are

being transformed by the application of new technological opportunities, by organisational change and innovation in a globalising world which changing attitudes and expectations on the part of citizens, consumers and employees. There will be much need to deepen our understanding of particular service activities, their evolution and the ways in which they can be practised more effectively and sustainably (Miles 2016, p.30).

Authors	Objective	Methodological approach	Field	Database	Key terms	Period	Type of document	#
Barret et al., (2015)	Advance theoretical developments on service innovation in a digital age.	Qualitative	Management of information systems, Marketing, Operation	Non specified	Non specified	Non specified	Books; Journal articles	148
Carlborg, Kindström & Kowalkowski (2014)	Analyses the progression of service innovation research according to topicality and perspective	Qualitative content analysis	No specified	ISIWoS	“service/s innovation”, ‘innovation in service/s’, or ‘service/s development’	1986-2010 divided in 3 phases	Journals articles	128
Hsu & Chiang (2015)	Study SSME in information systems research	Bibliometric performance analysis	50 social sciences disciplines.	ISIWoS	“Service science*”, “Information system*”, “Service management*”, and “Service engineering**”	1991-2012	Journals articles	4513
Miles (2016)	Summarise the research fronts and the main trends of literature in service innovation	Bibliometric performance analysis. Co-words analysis	Non specified	Google scholar	“service innovation”, “innovation in services”	1960-2014	Books, official reports and journals articles	No specified
Nardelli (2015)	Study the relationship between ICT and innovation in services	Qualitative analysis based on a concept-centric approach	Non specified	Principally ABI Inform, but too in Scopus&ISIWoS	Combination of “ICT”, “servic*” and “innovat**”	Non specified	Journal articles	41
Oliveira, Mendes & Rozenfeld (2015)	Described the main quantitative characteristics of PSS research field	Bibliometric performance analysis and science mapping	Interdisciplinary	ISIWoS	“product service system” or “servitization”.	2002-2013	Journal articles	118
Sakata et al., (2013)	Determine the structure and geographical distribution of knowledge, and the structure of research collaboration in service innovation	Bibliometric performance analysis and science mapping	Interdisciplinary	ISIWoS	“service* and (science* or management* or engineering*)”	1970- 2008	Journal articles	54928
Snyder et al., (2016)	Propose different categories for service innovation research	Qualitative	Non specified	Scopus	“Service/es innovation” and “Innovation in service/es”	Non specified	Journal articles	1046; Selected:255; Final sample: 43
Sørensen and Landau (2015)	Study the challenges for the IS field academic agility in the ever-changing landscape of digital innovations research	bibliometric	Management of information system	“basket of eight IS journals”	Digital innovation, Mobile ICT	2000–2014 divided in 3 sub-period of 5 years	Journal articles	3189; Final sample: 102

Table 1: Synthesis of several related research presented in section 2.1 and 2.2. Source: Authors

## **2.1. Service System**

There is a very reduced amount of bibliometric studies or reviews about service system in literature. Hsu & Chiang (2015) as well as Sakata et al., (2013) presented bibliometric studies including performance analysis of publications about SSMD. In contrast, Oliveira, Mendes & Rozenfeld (2015) presented a bibliometric analysis limited to the study of scientific production in the field of “product-service system”. Table 1 shows a summary of the different related works presented in sections 2.1 and 2. 2.

## **3. Methodology**

In this section, we will present 9 steps which define the methodological approach used to study the intellectual structure of « innovation service » and « system of service » from 1986 to 2015. The approach is based on 2 stages. The first stage is founded on a quantitative analysis based on science mapping with bibliometric method and data mining. The second stage is based on a qualitative examination through a thematic analysis (Braun & Clarke, 2006; Gioia and al., 2012). The steps of the methodological approach are shown the Figure 1.

### **3.1. Research design**

This first step is divided in three sub-steps: a) Define a research question; b) chose an appropriate bibliometric method to answer the research question; c) chose a suitable data-mining, bibliometric or science mapping tool.

Regarding the research question, taking into account that the goal of this work is to study the interaction between the intellectual structures of “service systems” and “innovation services”, the following question were defined:

*How the intellectual structure of service innovation and service system linked and evolved over time (1986-2015)? What are the dynamics of the conceptual structure evolution and associated topics over time? Which authors play a key role in bridging conceptual domains of research? and what are the future research horizons?*

Appendix 1 shows different bibliometric methods and several research questions associated with each method. Several studies present a detailed review of different bibliometric methods (cf. Zupic & Cater, 2015; Cobo et al., 2011a).

Several bibliometric methods were studied (i.e. citation, bibliographic coupling, co-citation, co-author, co -words analysis). This study selected the co-citation analysis (Small & Upham, 2009) and the co -word analysis (Callon et al., 1983) as appropriate bibliometric methods to answer the research questions.

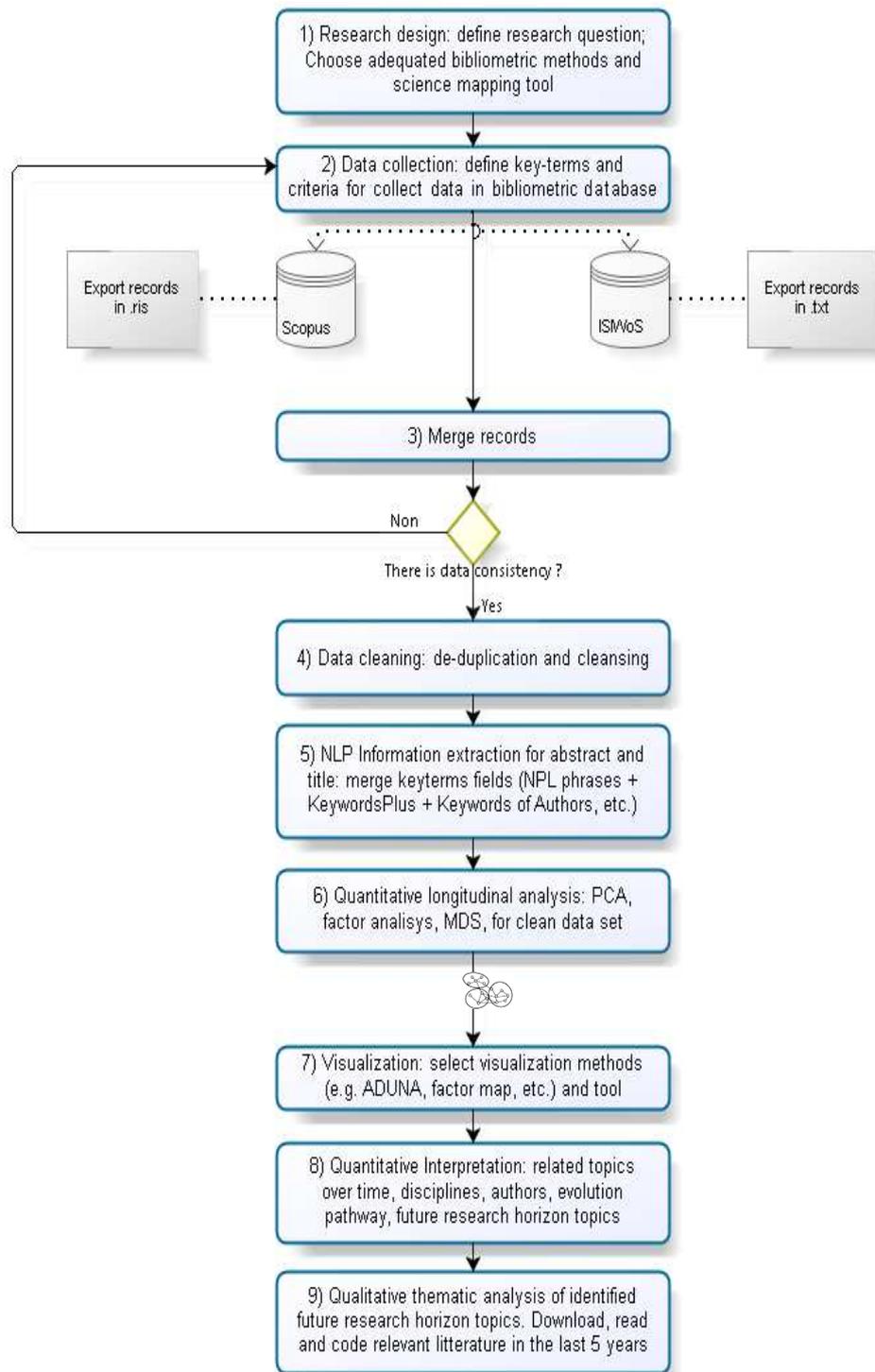


Figure 1: Methodological approach. Source: Authors

The co-citation analysis was chosen because it maps the structure of a research field through pairs of documents that are commonly cited together (Coulter et al., 1998). Additionally, this method has been used in the literature to identify emerging topics (Small, Boyack, & Klavans, 2014; Small & Upham, 2009) and discover the invisible colleges (Vogel, 2012; Noma, 1984). The result

of co - citation analysis returns a set of groups that can be understood as the intellectual basis of the different subfields of a research area.

On the other hand, the co-word analysis was chosen because it allows mapping the strength of association between information elements in textual data via keywords. The results of a co-words analysis can be understood as semantic or conceptual groups of different topics covered in the research field (Callon et al., 1983).

According to Munoz et al., (2016) although analyses by co-citation and co-words allow to analyse the evolution of a field of research by a longitudinal study, each of them allows us to study a different and complementary evolution. As Munoz et al., reminds us while a longitudinal study using co-words analysis allows us to analyse the evolution of research topics, a longitudinal study based on co-citation allows us to analyse the continuity in the intellectual structure.

Different units of analysis can be used as the bibliometric method to build the analytical network (Zupic & Cater, 2015; Cobo et al., 2011a). For example: document, author, journal (in the case of citation, bibliographic coupling, co-citation analysis); words, keywords, or terms retrieved from title, abstract or document 's body (in the case of co-words analysis); authors (in the case of co-author analysis). In this study we use analysis units for co-words and co-citation.

Finally, regarding to the selection of the analysis tool, different bibliometric tools presented by Cobo et al., (2011a) and Zupic & Cater (2015) were reviewed. In this sense, VantagePoint© was selected as text-mining and science mapping tool in order to discover knowledge in titles, abstracts and keywords. This selection involved the acquisition of associated license.

### **3.2. Data collection using research terms**

The table 1 shows several approach to choose the key terms for data collection in past related research. Considering the work of Carlborg, Kindström, & Kowalkowski (2014); Miles (2016) and Snyder et al., (2016) we used the terms "Service(s) innovation", "Innovation in service(s)", "digital innovation", and "service system" as key search terms. Barret et al., (2015) have used the notion "Service innovation in the digital age" to split the set of terms used in this study. In this sense, Huang and Rust (2013) have used a multidisciplinary perspective. Appendix 1 shows the search terms used in this study. Moreover, Barras's research (1986) consider as one of the first research in service innovation. In this study, as in the case of Carlborg, Kindström & Kowalkowski (2014), we took the year 1986 as the starting date for the present study. Therefore, the study period was from 1986 to 2015. Our chosen keywords are searched in titles, abstracts and keywords of articles. Data were collected from ISI Web of Science (ISIWoS) (Science Citation Index Expanded SCI-EXPANDED; Social Sciences Citation Index SSCI; Arts & Humanities Citation Index A&HCI; Emerging Sources Citation Index ESCI) and Scopus because they are the most important and consistent bibliometric databases. They included eight cycles of data collection between 16 April and 15 May 2016. The final data was limited to

only scientific articles in English, peer reviewed. In this sense, the total data collected were 2439 records, of which 1004 derived from ISIWoS and 1435 Scopus. For each record was exported all available information in formats .RIS and CSV for Scopus and, formats .TXT and .CSW for ISIWoS.

### **3.3. Merge of records**

After connecting consistent data, all records collected in ISIWoS and Scopus were imported and combined into the text- mining tool VantagePoint. The import of records was performed using appropriate filters (" Scopus Filter" and " ISIWoS Filter").

### **3.4. Data cleaning**

Data cleaning is very important to ensure the quality of the results. In this step, several cleaning procedures were performed to eliminate duplicate or irrelevant records, consolidate similar terms and combine similar entities. A proprietary algorithm to clean the data was used with VantagePoint, however, manually review was necessary for the abstracts, author 's names, titles, sources (i.e. review or journal name) and affiliations of each record. This function is important when combining data from multiple databases (Kongthon, 2004). For example, it allowed detecting cases where the same article appears in Scopus and ISIWoS, due for example to differences in writing the names of the authors. After cleaning the number of records was reduced from 2439 to 796 published in 255 different journals. The Figure 2 illustrates the final 796 records (articles or reviews) by year. For analysis from 1986 to 2015, 3 periods of 10 years P1 (1986-1995), P2 (1996-2005) and P3 (2006-2015) were defined. P1 is composed of 12 articles, P2 of 57 and P3 of 727 records.

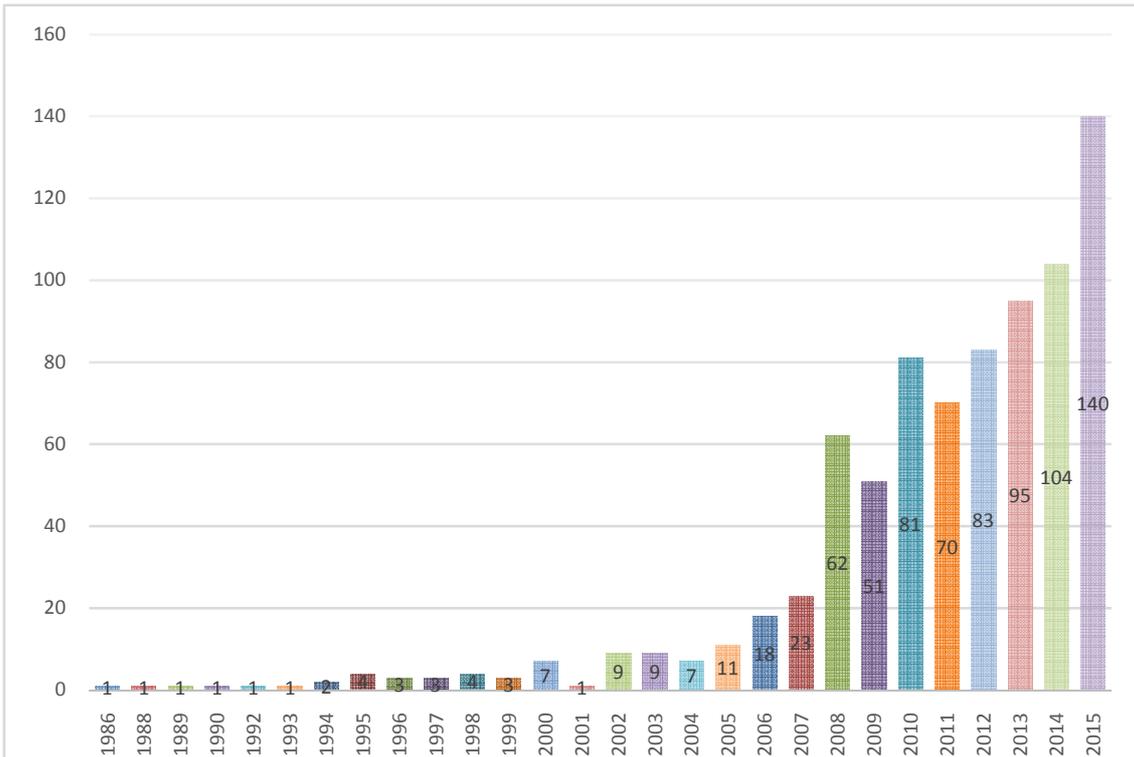


Figure 2. The sample of articles included in this study concerning service innovation and service system in the digital age research from 1986 to 2015.

### 3.5. NLP Information extraction

In order to mining key information titles and abstracts, a procedure of text mining was performed through Natural Language Processing (NLP) for extract information of articles. This function is especially useful for analysing all abstract or all text of an article. NLP allows to decompose the abstract or all the text in an article, beyond the keywords proposed by the authors or keywords indexed by a database provider. A new field was created to group items resulting from the combination of all categories of key terms of 796 articles: Abstract (NLP) (Phrases) (18655 items) + Title (NLP) (Phrases) (1991 items) + Keywords (author 's) (1277 items) Keywords Plus + (942 items) + Scopus Keywords (3026). A cleaning procedure has reduced the total items to 20950. These final items were used for co-words and co-citation analysis. Before, a first thesaurus for records was performed to related topics over time, authors' names and sources. A thesaurus is defined for Kongthon (2004) as a grouping of terms or key phrases, into certain concepts. This is important for ensure the quality of cluster analysis, factor analysis or principal component results.

### 3.6. Quantitative longitudinal analysis

In order to map the changes and interactions in the intellectual structure, it is necessary to define several periods. The total period (1986-2015) was divided into three equal periods of ten years 1986-1995 (P1) 1996-2005 (P2) and 2006-

2015 (P3) (cf. Vogel, 2012). After we perform a multivariate analysis to reduce the dimension of the resulting network of co-words or co-citation data analysis, so that it is easily understood (Shafique, 2013). According to Cobo et al, (2012) the most frequently used methods of reduction are: principal component analysis (PCA); multi-dimensional scaling (MDS); exploratory factor analysis and cluster analysis. These methods help to find relationships among topics and concepts and to reduce the dimensionality of the original large set of variables. In order to ensure the robustness of the results, researchers generally use various grouping methods simultaneously, for example, similar studies have used these MDS and PCA techniques complementary (i.e., Shafique, 2013; Nerur et al, 2008). These techniques grouped a set of items in various subsets, which must have a high similarity to each other and must be quite different from other items in the other groups. Such techniques were used during different periods studied (P1, P2 and P3) to determine the relationships, the mapping of patterns and trends in bibliometric networks service innovation and service system. It was also possible to establish various relationships between the units of analysis such as co-occurrence, coupling, cross-correlation, auto-correlation (Cobo et al., 2011b). We perform a supplementary quantitative analysis on P3 for identifying the emergent topics.

### **3.7. Visualisation**

Each type of analysis produces a different view, therefore, there are several visualization techniques of the results: MDS (Shafique, 2013), auto-correlation map (Leone et al, 2012), Pajek (Wallin, 2012). After generating the map, we perform some analysis to extract knowledge of the map. For example, the "networks analysis" (Vogel & Güttel, 2013) allows different statistical analysis on the generated maps, determine the total number of nodes, the number of isolated nodes, the average degree of the network, the number of loosely connected components, the network density, etc. On the other hand, if a clustering algorithm is applied to build the map, the density and centrality of the various clusters can be measured or even other measures could be established considering the relationships between clusters.

### **3.8. Quantitative interpretation**

At this step, the obtaining results during the quantitative analysis were interpreted based on the experience and knowledge of the authors. In order to obtain appropriate conclusions about the evolution of the interaction between service innovation, the results were contrasted with recent studies as the one which was done by Barret et al. and 2015 Huang & Rust, 2013.

### **3.9. Qualitative in-depth themes analysis/interpretation**

By considering the study of Zupic & Cater (2015), we perform a qualitative thematic analysis which is useful to complement and extend quantitative analyses, based on science mapping and bibliometrics methods. By considering

Sørensen & Landau (2015) proposed “academic ambidexterity”, the qualitative analysis focus on future research horizons topics for a review of emerging issues identified in the step 3.7. This thematic analysis was focused in the last 5 years (2011-2015). A co-occurrence matrix between future research horizons and existing publication was constructed to identify the articles to download. Consequently, 184 articles of last 5 years of emerging topics were identified. A total number of 182 studies were downloaded and the 2 articles were not accessible. All articles were imported in a qualitative data analysis computer software (NVIVO 11.3) and emerging topic were coded. After reviewing all article, 59 of them were chosen for a complete reading. The NVivo software was used for thematic content analysis through an adaptation of the methodology Gioia (Gioia et al., 2012). We began by generating first-order concepts derived from quantitative phase. Second, we looked for relationships between first-order concepts. By grouping convergent categories at a higher level of abstraction, we identified theoretical categories or second-order themes. For instance, we grouped the aforementioned first-order emergent topics into the second-order theme. Third, we looked for aggregate analytical theoretical dimensions. These were organized through a "data structure". Finally, we constructed a model by identifying relationships between second-order themes and aggregate analytical/theoretical dimensions.

## **4. Results**

The objective of this paper is to analyse the intellectual structure of service innovation and service system literature, interactions, related topics and changes over time. The results obtained after completing the different stages included in the analysis developed for P1, P2 and P3 are shown below.

### **4.1. Changes of the intellectual structure**

#### **4.1.1. Intellectual structure of P1 (1986-1995)**

The resulting thesaurus of P1 allow us to reduce to 496 terms in 20 groups for the factor analysis. In the period 1986-1995, the service innovation and service system research revolved around 20 main topics: 1) Innovation in services, 2) Adoption and diffusion, 3) Consumer/customer/user, 4) Service sector/Service industries, 5) Information Technology, 6) Reverse product cycle theory, 7) Service innovation, 8) Service system, 9) Absorptive capacity/ACAP, 10) Complex service systems, 11) Generation of new types of services, 12) Institutional, 13) National government, 14) National systems of innovation, 15) Product-service innovation, 16) Quality of service, 17) Schumpeterian, 18) Service logic, 19) Technological innovation, 20) Technology policy.

Innovation, services and technology and reverse product cycle theory, were the most important motors themes.

The application of multivariate analysis technique to the co-words analysis developed allows us to check the existence of up to 4 different groups or clusters (see, Figure 3 and 4), some of which are closely linked.

The visualisation through a MDS allows us to delineate the first 10 years of relation between service innovation, service system and technology research. The study of Barras (1986), Miles (1993), Kingmanbrundage George & Bowen (1995) and Buzzacchi, Colombo & Mariotti (1995) are at the top of the ranking in most cited papers with a total of 274, 74, 34 and 28 citations received, respectively.

The works of Smith (1994), Latour & Roberts (1992), Kerkhof (1994), Evangelista & Sirilli (1995), Beltramini (1988), Metcalfe (1995) and Barras (1990) complete the total of documents that includes 12 research paper. In this period there are a differentiation between innovation in service and service innovation, but both perspectives are theoretically influenced by the reverse product cycle theory and the Schumpeterian approach.

In the late 1980s and early 1990, the literature started showing an inclination of companies moving towards adoption and diffusion of technology and technology policy. Regarding Service system, the works of Smith (1994) about complex service system and the work of Kingman-Brundage, George & Bowen (1995) about service logic and service system are theoretically influenced by the marketing and operations theory. A large proportion of these papers published in marketing and innovation journals (Table 3). Each article in the Thomson Reuters Web of Knowledge database is assigned to one or more subject categories<sup>1</sup>, according to the journal in which it was published. In this period, the remaining works are related to the web of science categories of Management, planning & development and Economics. Figure 4 depicts several associated authors for P1 topics.

---

<sup>1</sup> [http://incites.isiknowledge.com/common/help/h\\_field\\_category\\_wos.html](http://incites.isiknowledge.com/common/help/h_field_category_wos.html)

	Journals/Reviews	Number of articles (1986-1995)
1	RESEARCH POLICY	3
2	CAMBRIDGE JOURNAL OF ECONOMICS	1
3	FUTURES	
4	INTERNATIONAL JOURNAL OF COMPUTER APPLICATIONS IN TECHNOLOGY	1
5	INTERNATIONAL JOURNAL OF SERVICE INDUSTRY MANAGEMENT	1
6	JOURNAL OF BUSINESS VENTURING	1
7	JOURNAL OF PERSONAL SELLING AND SALES MANAGEMENT	1
8	JOURNAL OF SERVICES MARKETING	1
9	RESEARCH EVALUATION	1
10	SERVICE INDUSTRIES JOURNAL	1
	Total	12

Table

Journals ordered by number of articles concerning P1.

3.

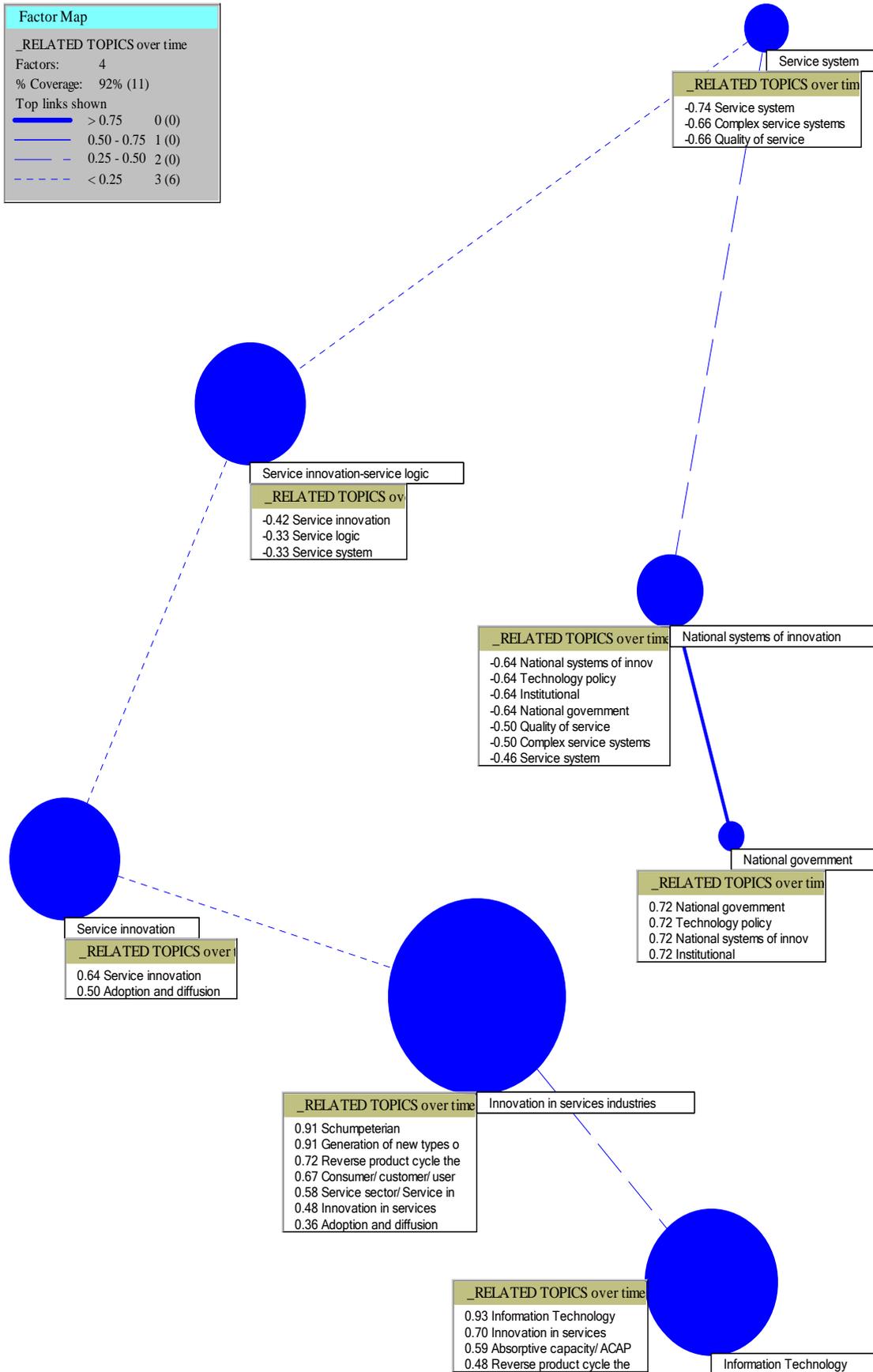


Figure 3: Identification of P1 period factors.

Factor Map		
_RELATED TOPICS over time		
Factors:	4	
% Coverage:	92% (11)	
Top links shown		
	> 0.75	0 (0)
	0.50 - 0.75	1 (0)
	0.25 - 0.50	2 (0)
	< 0.25	3 (6)

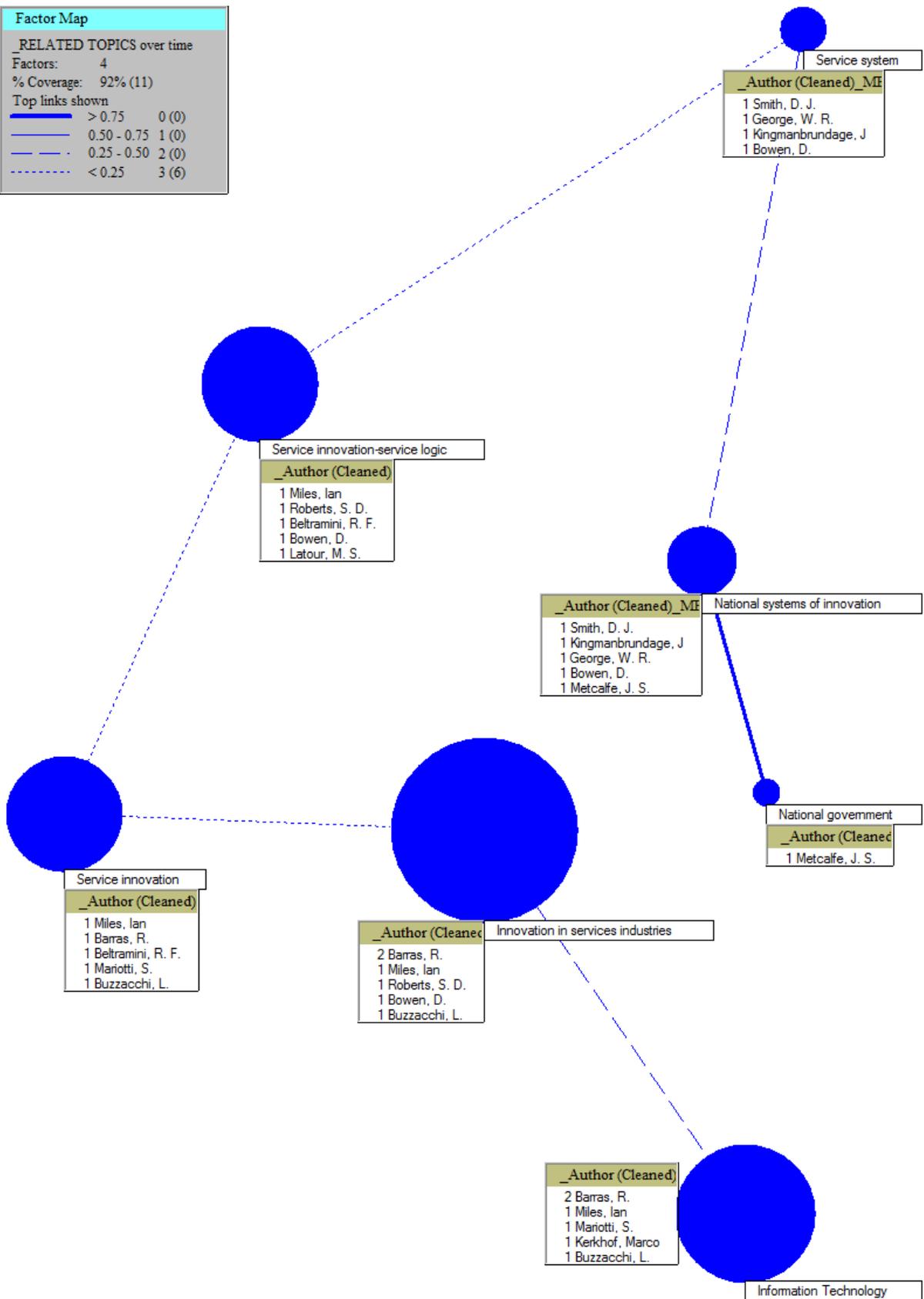


Figure 4: Factor map with some several authors concerning P1 period.

#### **4.1.2. Intellectual structure of Period 2 (1996-2005)**

In this period, the resulting thesaurus allow us to reduce to 1950 terms in 41 groups for a factor analysis. We generated a factor map via VantagePoint's Factor analysis. We obtained twelve factors in figure 5.

The theories predominant in the P2 centres on Structuration theory, Actor network theory (ANT), Consumer Theory, Diffusion of innovation theory, neo-Schumpeterian theory, Organization theory and Resource-based theory

In 1997 Gallouj propose a neo-Schumpeterian appropriate theory of innovation. The same year Gallouj and Weinstein (1997) proposes an approach Lancasterian to interpret innovation processes in the service sector.

Lee (2003) is the only study on service system in this period. Lee discusses how to design smart products and service systems using web-based intelligence technologies and about the trends of product and service innovation in industry.

Around 2004, the concept of value co-creation came into importance from the pivotal work of Vargo and Lush (2004) about new perspectives to a new dominant logic for marketing, the service-dominant logic.

Johnson and Walker (2004), discusses technology-enabled service innovations. Johnson and Walker states that diffusion of innovation theory warrants review in order to accommodate better the case provided by technology-enabled service innovations.

Lyytinen, Yang and Yoo (2005) discusses the evolution of the mobile infrastructure in South Korea through the lens of actor network theory. These authors analysed the roles of standards in promoting, enabling and constraining innovation in broadband mobile services over a 10-year period. According of Lyytinen, Yang and Yoo, successful innovation and diffusion of broadband mobile services are collective achievements and firms need to deploy strategies that enable them to mobilize broad socio-technical networks that include technological, institutional, political, financial resources and standards.

Barney, Muhanna and Ray (2005) presents an empirical study that examines the extent to which IT impacts customer service through a resource-based analysis.

The five most cited studies in this period are Vargo and Lush (2004) with 2132 citations, Gallouj and Weinstein (1997) with 389 citations, Atuahene-Gima (1996) with 216 citations, Sundbo (1997) with 191 citations, Evangelista and Sirilli (1998) with 125 citations.

In P2 articles composed 9 web of science categories: Management, Business, Engineering, Industrial, Operations Research & Management Science, Planning & Development, Engineering, Multidisciplinary, Information Science & Library Science, Political Science, Public Administration.

Factor Map		
_RELATED TOPICS over time		
Factors:	12	
% Coverage:	100% (57)	
Top links shown		
	> 0.75	0 (0)
	0.50 - 0.75	0 (0)
	0.25 - 0.50	4 (0)
	< 0.25	9 (58)

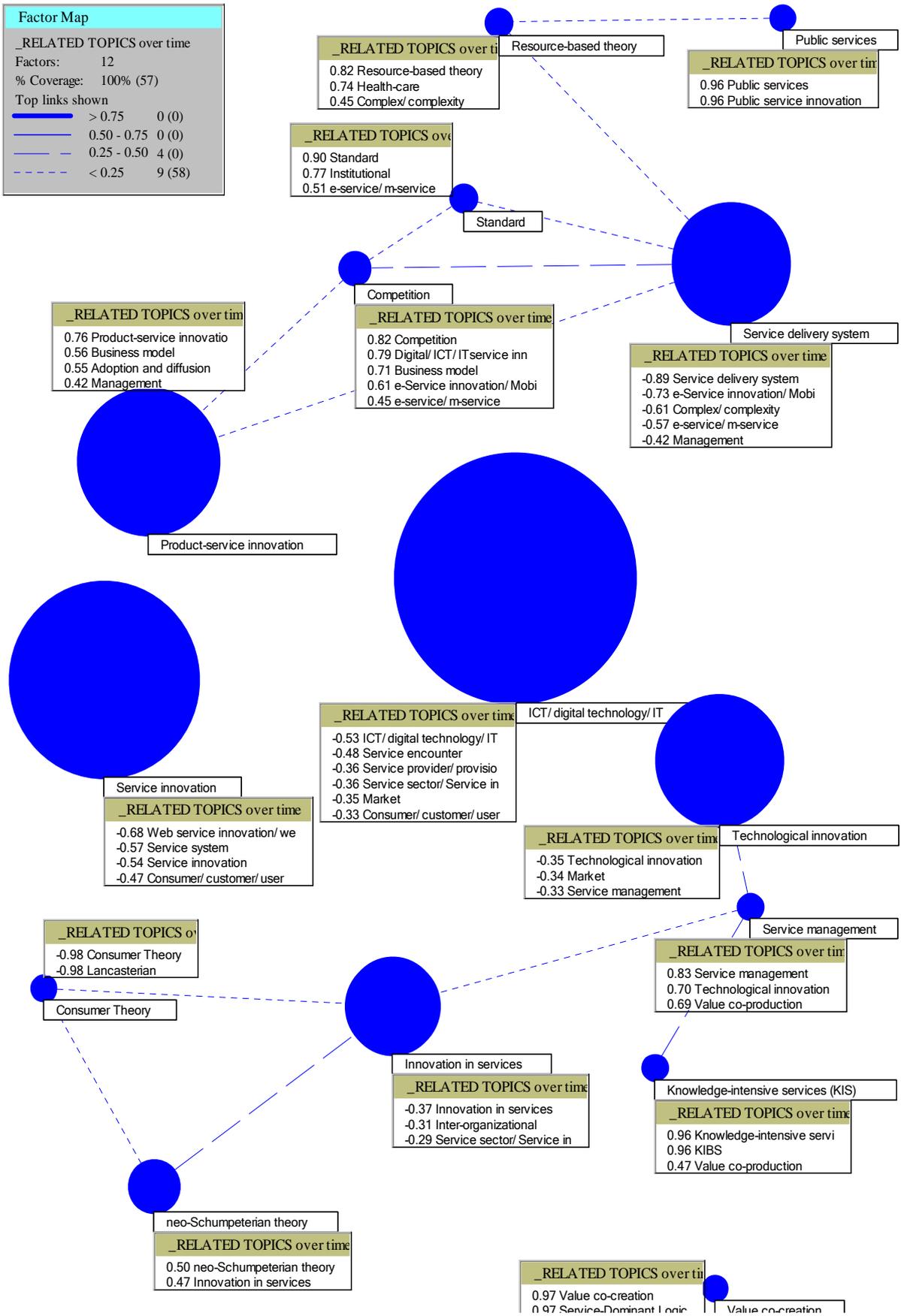


Figure 5: Identification of P2 period factors.

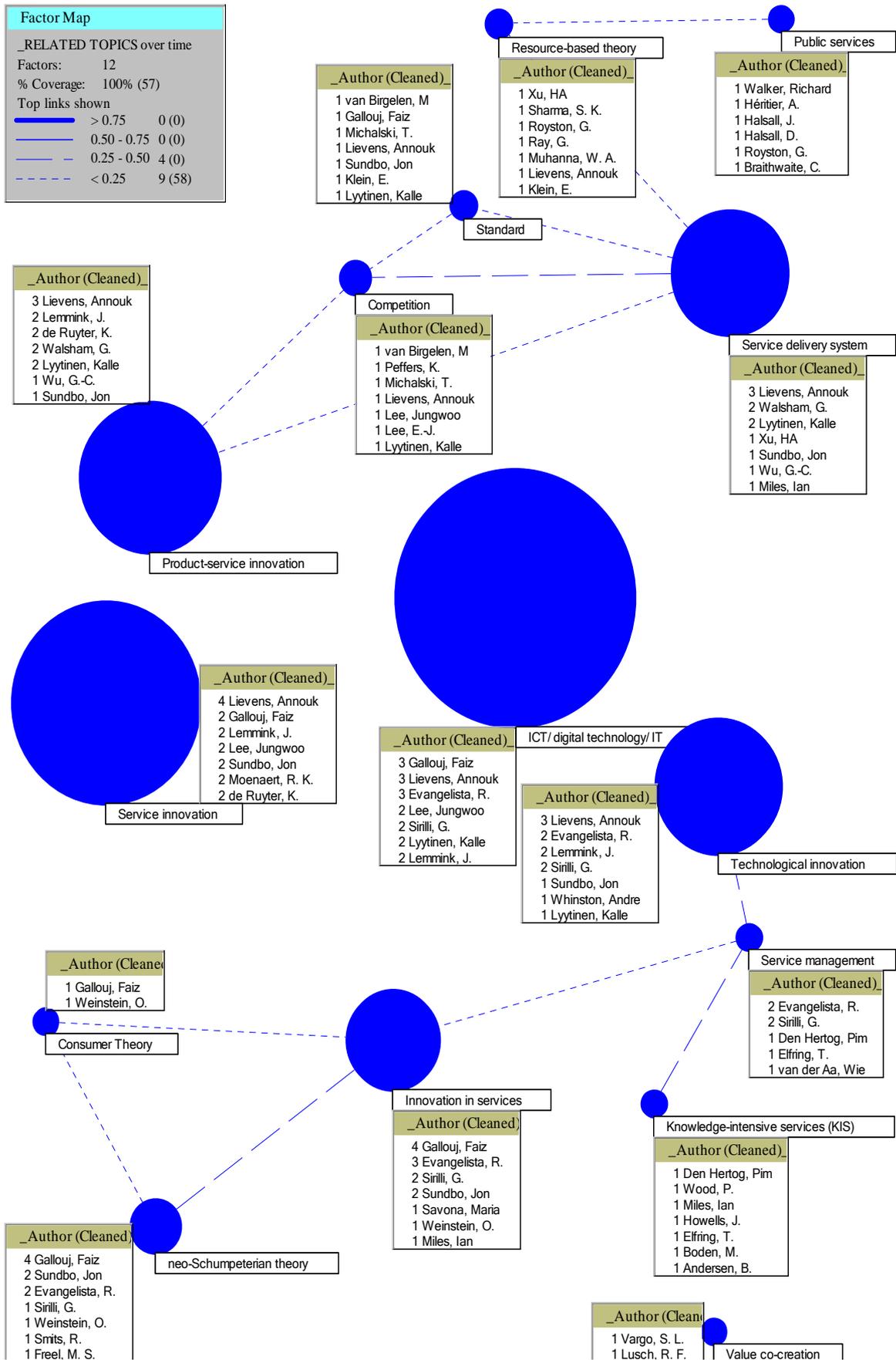


Figure 6: several authors concerning Factor of P2 period.

Table 4 lists the journal of P2 period.

	Journals/Reviews	Number of articles (1996-2005)
1	MIS QUARTERLY: MANAGEMENT INFORMATION SYSTEMS	5
2	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	3
3	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	3
4	IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	2
5	INTERNATIONAL JOURNAL OF SERVICE INDUSTRY MANAGEMENT	2
6	INTERNATIONAL JOURNAL OF SERVICES, TECHNOLOGY AND MANAGEMENT	2
7	JOURNAL OF BUSINESS RESEARCH	2
8	JOURNAL OF SERVICE RESEARCH	2
9	RESEARCH POLICY	2
10	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2
	Others 32 journals	32
	Total	57

Table 4. Some journals ordered by number of articles concerning P2.

### 4.1.3. Intellectual structure of Period 3 (2006-2015)

The resulting thesaurus allows us reducing 19607 terms in 164 groups in order to per the factor analysis. We generated a factor map via VantagePoint's Factor analysis. We obtained 23 factors in figure 7. Emerging topics identified in this P3 through a VantagePoint's emergent topic analysis will be presented in section 4.2.

P1 and P2 researchers of discipline of information systems focused on the adoption of information technology in organizations (Lyytinen and Yoo, 2002; Swanson, 1994). In P3, it has arisen digital innovation and digital service innovation as a research topic. In this period, researchers from various disciplines have contributed to the study of innovation services, for example, Management of Information system (Lusch et Nambisan, 2015; Eaton et al., 2015; Barrett et al., 2015; Srivastava & Shainesh, 2015; Um, Yoo, & Wattal, 2015); Marketing (Echeverri & Skålén, 2011; Skalen, Aal & Edvardsson, 2015;) and public management (Osborne et al., 2015). Figure 7 show new related topics in P3 as Smart City, Open Data, Big Data, Internet of Things, smart service systems.

The top 5 of most cited articles are: Rai, Patnayakuni & Seth (2006) with 360 citations; Ostrom et al., (2010) with 296 citations, Maglio, Bailey & Gruhl (2007) with 264 citations, Maglio & Sphorer (2008) and Zammuto, Griffith, Majchrzak, Dougherty, & Faraj (2007). Figure 8 list several authors concerning the P3 period.

The top 5 of most cited articles are: Rai, Patnayakuni & Seth (2006) with 360 citations; Ostrom et al., (2010) with 296 citations, Maglio, Bailey & Gruhl (2007) with 264 citations, Maglio & Sphorer (2008) and Zammuto, Griffith, Majchrzak, Dougherty, & Faraj (2007). Figure 8 list several authors concerning the P3 period.

For example, in March 2015, a special edition of the journal, Management Information Systems Quarterly entitled "Service Innovation in the Digital Age" presented a first Literature transposition of Marketing and Operations in the field

of Information Systems Management. The aim of this special issue was to light the latest contributions on innovation services in the digital age and service systems (Barret et al., 2015). Three of five articles of this special edition were treated to both innovation services in the digital age and service systems (Lusch & Nambisan, 2015; Eaton et al, 2015. Shainesh & Srivastava, 2015).

In this period IT-related service is customer-centric as technology advances over time and multidisciplinary. As Huang and Rust (2013) concludes: *“IT transforms and renovates service into two seemingly polarized directions; making service more goods-like (more tangible, separable, homogeneous, and storable) or even more service-like (less tangible and separable, but more personalize and perishable) that provide two paths of evolution for service and manufacturing firms to follow that eventually blurs the distinction between goods and service... researchers from diversified disciplines participate in service research that broadens and enriches our understanding about IT-related service. It makes a clear statement that IT-related service is everywhere and the study of it requires interdisciplinary collaboration. (Huang and Rust, 2013, p. 257)”*.

Theories used in P3 are: Innovation diffusion theory (IDT), Institutional Theory, Action theory, Contingency theory, Design theory, Dynamic capability, Structuration theory, Dynamic capability theory, Practice theory, Activity Theory, Agency theory, Characteristics-based approach/theory, Complex adaptive systems theory, Modularity theory, Service logic, Abrahamson 's management fashion theory, Absorptive capacity ACAP theory, Actor network theory (ANT), Behavioral reasoning theory, Collective action theory, Competence-based theory, Conservation of resources theory, Consumer culture theory, Consumer resistance theory, Disruptive innovation theory, Knowledge-based theory, Lancaster's theory, Miller's theory of living systems and systemic thinking, Modular systems theory, neo-Institutional Theory, Queueing theory, Reasoned Action Theory, Resource-based theory, Service-oriented theory, Social Capital Theory, Systemic innovation theory, User innovation theory.

Journals of the period P3 are listed in the table 5. This period is characterised by multidisciplinary and increasing publications

	Journals/Reviews	Number of articles (2006-2015)
1	MIS QUARTERLY: MANAGEMENT INFORMATION SYSTEMS	31
2	INTERNATIONAL JOURNAL OF SERVICES, TECHNOLOGY AND MANAGEMENT	27
3	SERVICE INDUSTRIES JOURNAL	26
4	JOURNAL OF SERVICE MANAGEMENT	23
5	INFORMATION SYSTEMS RESEARCH	16
6	JOURNAL OF SERVICE RESEARCH	14
7	RESEARCH POLICY	14
8	INDUSTRIAL MARKETING MANAGEMENT	13
9	JOURNAL OF BUSINESS RESEARCH	12
10	JOURNAL OF BUSINESS & INDUSTRIAL MARKETING	11
11	JOURNAL OF MANAGEMENT INFORMATION SYSTEMS	11
12	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	11
13	JOURNAL OF SERVICES MARKETING	10
14	TECHNOVATION	10
15	MANAGING SERVICE QUALITY	9
16	JOURNAL OF INFORMATION TECHNOLOGY	8
17	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	8
18	JOURNAL OF THE ACADEMY OF MARKETING SCIENCE	8
19	SERVICE SCIENCE	8
20	EUROPEAN MANAGEMENT JOURNAL	7
21	INFORMATION SYSTEMS AND E-BUSINESS MANAGEMENT	7
22	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT	6
23	MARKETING THEORY	6

24	ORGANIZATION SCIENCE	6
25	EUROPEAN JOURNAL OF INFORMATION SYSTEMS	5
26	EUROPEAN JOURNAL OF MARKETING	5
27	EXPERT SYSTEMS WITH APPLICATIONS	5
28	INDUSTRIAL MANAGEMENT & DATA SYSTEMS	5
29	Info	5
30	INTERNATIONAL JOURNAL OF INNOVATION AND TECHNOLOGY MANAGEMENT	5
	Others 225 journals	395
	Total	727

Table 5. Journals ordered by number of articles concerning P3.

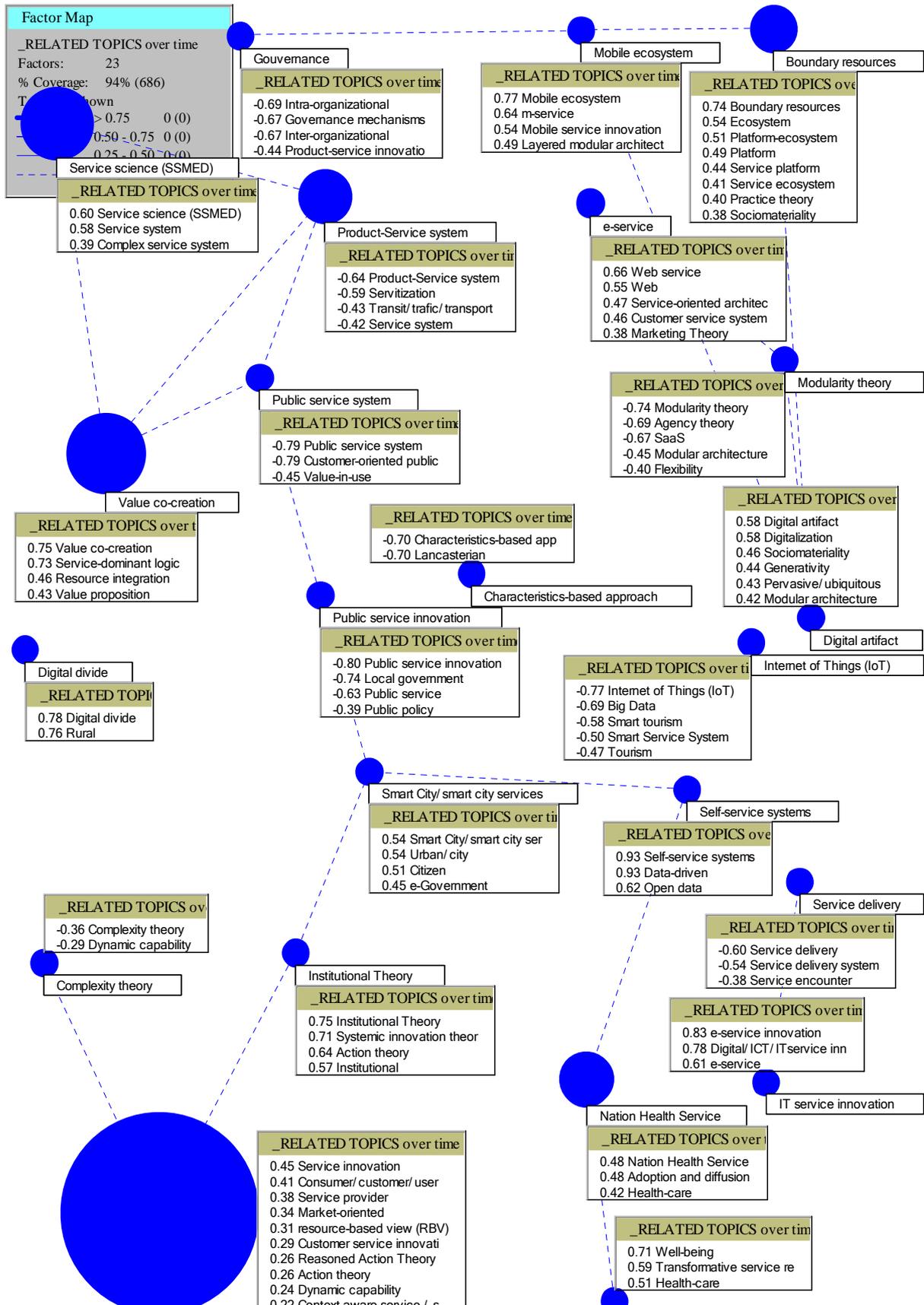


figure 7. Identification of P1 period factors.

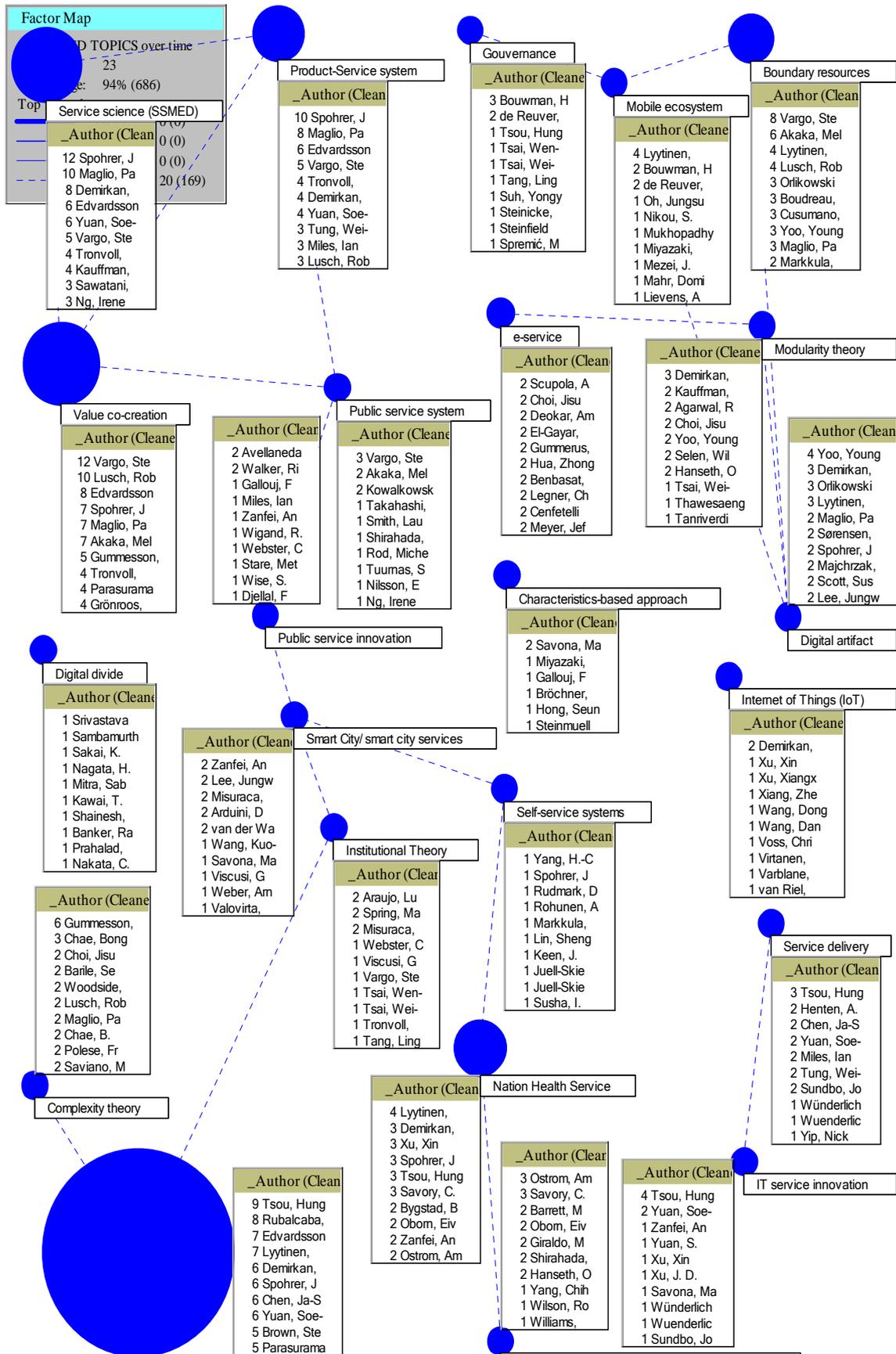


Figure 8: several authors concerning Factor of P3 period.

Figure 9 shows a broadened view of thematic evolution service innovation and service system over time.

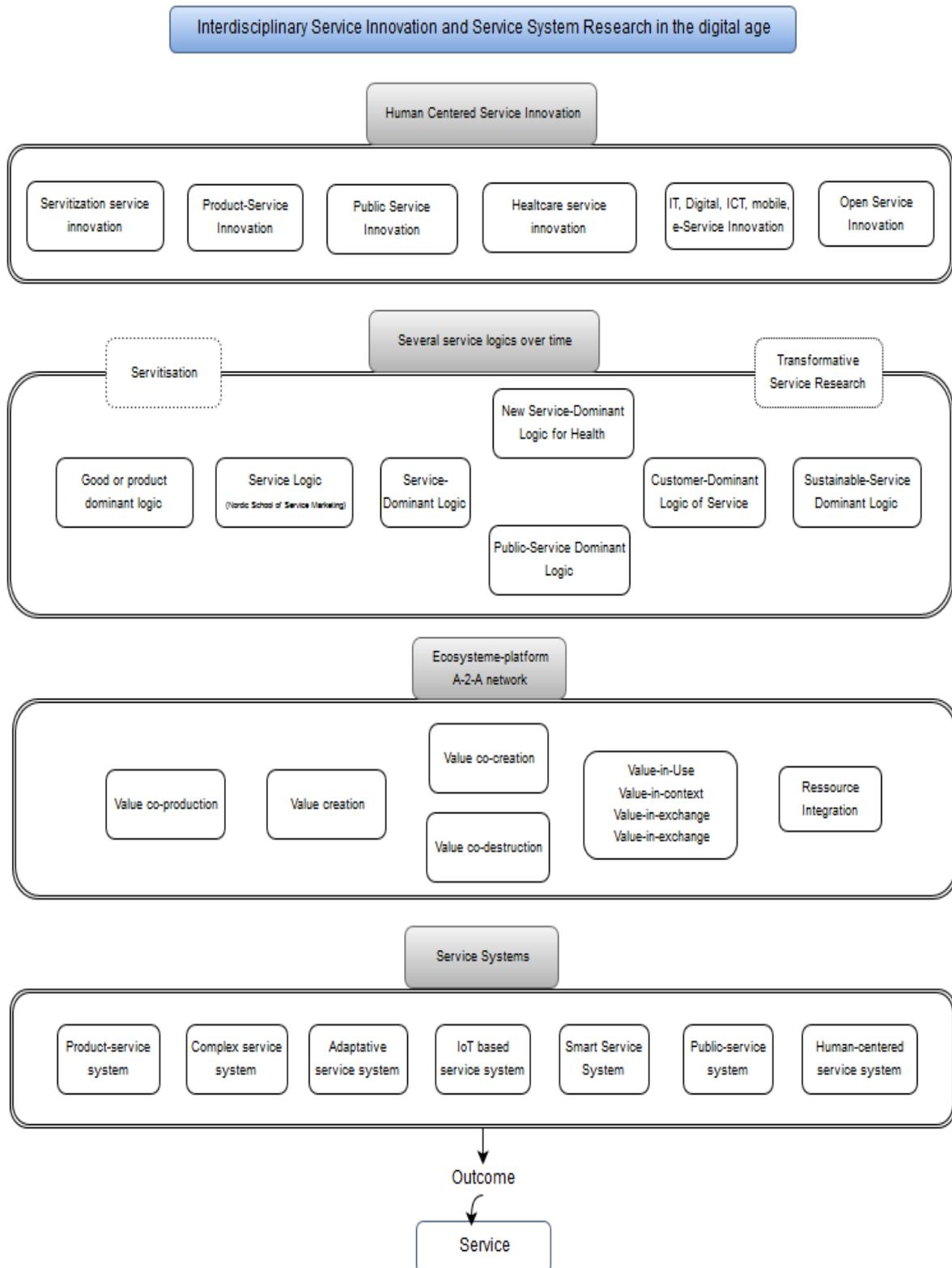


Figure 9: Interdisciplinary service innovation and service system research in the digital age



## 5. Conclusions and limitations

The goal of this study is to delineate the structure conceptual of service innovation and service system in the digital age from 1986 to 2015 to examine empirically how they evolve in the course of time. We apply the structure intellectual of service innovation and service system research, identification of related topics, pivot authors, journals and their interactions over three decades to advance knowledge in the field and support future interdisciplinary research. Dividing service innovation and service system research into three distinct phases helps to clarify its evolution, which in turn provides a clearer view of how the field has developed, in terms of both volume and related topics.

The research answers the raised questions, “How have the intellectual structure of service innovation and service system linked and evolved over time (1986-2015)? What are the dynamics of the conceptual structure evolution and associated topics overs time? Which authors play a key role in bridging conceptual domains of research? and What are the emergent research topics for service innovation and service system in the digital age? were answered by a co-word, co-citation and thematic qualitative analysis. The outcome of the analysis is an approach of the intellectual structure of service innovation and service system that delineate the relationship between service innovation and service system in the digital age. The present intellectual structure of research domains may therefore be used as a support to plan and execute future research and future research pathway.

However, the analyses show important changes within these fields, e.g., the gradual integration of the Service Dominant Logic field and Service science the emergence of data-drive service innovation or human-centered service innovation.

We recognize some limitations of this study. Futures research will develop time-sliced analyses with others longitudinal science mapping tools as SCIMAT® or CiteSpace®. For future research, it would be of interest to employ other bibliometric techniques (e.g., bibliographic coupling or co-author analysis c.f. appendix 1) that complement this study.

Other studies may fix 5-year periods for analysing changes in the service innovation and service system research fronts over the last 30 years and include proceeding papers and books.

This paper focuses on intellectual structure to examine the evolution of service innovation and service system over time. Other studies may focus on the analyse of the **conceptual structure** to study similarities, differences and boundaries between Service Innovation, Innovation in Services, Service Design, New Service Development. Moreover, others studies may analyse the patrons evolutive of Invisible Colleges (Vogel, 2012) of Service innovation and Service System research in the digital age as appearance, differentiation, transformation, drift, fusion of sub-disciplines in the last 30 years

This study opens up new possibilities to uncover important research areas a approach for identify potential areas for future research horizons.

## Acknowledgments

This research was funded by RESER Ph.D. Mobility Grant 2015. The author wishes to express his gratitude to RESER. The author is indebted to the professors Lars Fuglsang, Jon Sundbo, Ada Scupola at Roskilde University for their valuable comments and suggestions that have led to the significant improvement of this article and for providing an invaluable research environment at Roskilde University. I am deeply thankful to the Emeritus professor Marie-Christine Monnoyer for their help and for their insightful. The authors thank the two anonymous reviewers for their constructive comments on this paper. The authors express their gratitude Sandra Carolina Rivera Torres for assistance on earlier versions of the work. The authors wish to thank the Ph.D. candidates at Roskilde University for their fruitful co-operation. The authors express their gratitude to Saeedeh Vessal for review of this manuscript. Responsibility for any errors rests, of course, with the author.

## References

- Atuahene-Gima, K. (1996): Differential potency of factors affecting innovation performance in manufacturing and services firms in Australia. *Journal of Product Innovation Management*, 13(1), 35-52.
- Banoun, A., Dufour, L., & Andiappan, M. (2016): Evolution of a service ecosystem: Longitudinal evidence from multiple shared services canters based on the economies of worth framework. *Journal of Business Research*, 69(8), 2990-2998.
- Barras, R. (1986): Towards a theory of innovation in services. *Research Policy*, 15, 161–173.
- Barras, R. (1990): Interactive innovation in financial and business services: the vanguard of the service revolution. *Research policy*, 19(3), 215-237.
- Barrett, M.; Davidson, E.; Prabhu, J.; Vargo, S. L. (2015): Service innovation in the digital age: key contributions and future directions. *MIS Quarterly*, 39(1), 135-154.
- Beltrami, R. F. (1988): High Technology Salespeople's Information Acquisition Strategies. *Journal of Personal Selling & Sales Management*, 8(1), 37-44.
- Beverungen, D., Breidbach, C. F., & Poeppelbuss, J., Tuunainen, V. K. (2016): CfP ISJ: Smart Service Systems: An Interdisciplinary Perspective. *Information Systems Journal*.
- Braun, V., & Clarke, V. (2006): Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.
- Buzzacchi, L., Colombo, M. G., & Mariotti, S. (1995): Technological regimes and innovation in services: the case of the Italian banking industry. *Research Policy*, 24(1), 151-168.
- Callon, M., Courtial, J. P., Turner, W. A., & Bauin, S. (1983): From translations to problematic networks: An introduction to co-word analysis. *Social science information*, 22(2), 191-235.
- Carlborg, P., Kindström, D., & Kowalkowski, C. (2014): The evolution of service innovation research: a critical review and synthesis. *The Service Industries Journal*, 34(5), 373-398.
- Cobo, M. J., Lopez-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011a): Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology*, 62, 1382-1402.
- Cobo, M. J., Lopez-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011b): An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the fuzzy sets theory field. *Journal of Informetrics*, 5(1), 146-166.
- Cobo, M., Lopez-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2012): SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science*, 3(8), 1609-1630.
- Coombs, R., & Miles, I. (2000): Innovation, measurement and services. In Metcalfe J. S. & Miles I. (Eds.): *Innovation systems in the service economy. Measurement and case study analysis. Kluwer Academic: Boston*, pp. 85–103.
- Coulter, N., Monarch, I., & Konda, S. (1998): Software Engineering as seen through its Research Literature: A Study in co-word Analysis. *Journal of the American Society for Information Science*, 49(13), 1206-1223.
- Daim, T. U., Chiavetta, D., Porter, A. L., & Saritas, O. (2016): Anticipating Future Innovation Pathways Through Large Data Analysis.
- Eaton, B., Elaluf-Calderwood, S., Sørensen, C., and Yoo, Y. (2015): "Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System," *MIS Quarterly* (39:1), pp. 217-243.
- Echeverri, P., & Skålén, P. (2011): Co-creation and co-destruction: A practice-theory based study of interactive value formation. *Marketing theory*, 11(3), 351-373.

- Evangelista, R., & Sirilli, G. (1995): Measuring innovation in services. *Research evaluation*, 5(3), 207-215.
- Gallouj, F. (1997): Towards a neo-Schumpeterian theory of innovation in services? *Science and Public Policy*, 24(6), 405-420.
- Gallouj, F., & Weinstein, O. (1997): Innovation in services. *Research policy*, 26(4), 537-556.
- Ghazawneh, A., & Henfridsson, O. (2013): "Balancing Platform Control and External Contribution in Third Party Development: The Boundary Resources Model". *Information Systems Journal* (23:2), pp. 173-192.
- Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013): Seeking qualitative rigor in inductive research notes on the Gioia methodology. *Organizational Research Methods*, 16(1), 15-31.
- Gibson, C. B., & Birkinshaw, J. (2004): The antecedents, consequences, and mediating role of organizational ambidexterity. *Academy of management Journal*, 47(2), 209-226.
- Henfridsson, O., & Bygstad, B. (2013): "The Generative Mechanisms of Digital Infrastructure Evolution," *MIS Quarterly* (37:3), pp. 907-931.
- Hsu, C. L., & Chiang, C. H. (2015): A bibliometric study of SSME in information systems research. *Scientometrics*, 102(3), 1835-1865.
- Huang, M. H., & Rust, R. T. (2013): IT-related service a multidisciplinary perspective. *Journal of Service Research*, 16(3), 251-258.
- Kerkhof, M. (1994): Improved customer service using new information technology as an enabling tool: the case of Electronic Data Interchange in the transportation industry. *International Journal of Computer Applications in Technology*, 7(1-2), 47-52.
- Kingman-Brundage, J., George, W. R., & Bowen, D. E. (1995): "Service logic": achieving service system integration. *International Journal of service industry management*, 6(4), 20-39.
- Kongthon, A. (2004): A text mining framework for discovering technological intelligence to support science and technology management (Doctoral dissertation, Georgia Institute of Technology).
- Latour, B. (1987): *Science in action: How to follow scientists and engineers through society*. Harvard university press.
- LaTour, M. S., & Roberts, S. D. (1992): Cultural Anchoring in the Service Sector. *Journal of Services Marketing*, 6(4), 29-34.
- Lee, J. (2003): Smart products and service systems for e-business transformation. *International Journal of Technology Management*, 26(1), 45-52.
- Leone, R. P., Robinson, L. M., Bragge, J., & Somervuori, O. (2012): A citation and profiling analysis of pricing research from 1980 to 2010. *Journal of Business Research*, 65(7), 1010-1024.
- Lusch, R. F.; Nambisan, S. (2015): Service innovation: A service-dominant logic perspective. *MIS Quarterly*, 39(1), 155-175.
- Lyytinen, K., and King, J. L. (2006): "Standard Making: A Critical Research Frontier for Information Systems Research," *MIS Quarterly*, (30:5), pp. 405-411.
- Lyytinen, K., and Rose, G. (2003): "The Disruptive Nature of Information Technology Innovations: The Case of Internet Computing in Systems Development Organizations," *MIS Quarterly* (27:4), pp. 557-595.
- Lyytinen, K., & Yoo, Y. (2002): Research commentary: the next wave of nomadic computing. *Information systems research*, 13(4), 377-388.
- Maglio, P., Bailey, J., & Gruhl, D. (2007): Steps toward a science of service systems. *Computer*, 40(3), 71-77.
- Maglio, P.P. and Spohrer, J. (2008): 'Fundamentals of Service Science', *Journal of the Academy of Marketing Science* 36: 18–20.
- Maglio, P. P., & Lim, C. H. (2016): Innovation and Big Data in Smart Service Systems. *Journal of Innovation Management*, 4(1), 11-21.
- Medina-Borja, A. (2015): Editorial Column—Smart Things as Service Providers: A Call for Convergence of Disciplines to Build a Research Agenda for the Service Systems of the Future. *Service Science*, 7(1), ii-v.
- Metcalfe, J. S. (1995). Technology systems and technology policy in an evolutionary framework. *Cambridge Journal of Economics*, 19(1), 25-46.
- Menor, L. J., Tatikonda, M. V., & Sampson, S. E. (2002): New service development: areas for exploitation and exploration. *Journal of Operations Management*, 20(2), 135-157.
- Miles, I. (1993). Services in the new industrial economy. *Futures*, 25(6), 653-672.
- Miles, I. (2016): Twenty Years of Service Innovation Research. In Toivonen, M. (Ed.): *Service Innovation: Novel Ways of Creating Value in Actor Systems* (Vol. 6). Springer: Japan, pp. 3-34.

- Muñoz, L. A., Bolívar, M. P. R., Cobo, M. J., & Herrera-Viedma, E. (2016, June): Science Mapping Tools: their application to e-Government field. In *Proceedings of the 17th International Digital Government Research Conference on Digital Government Research* (pp. 194-201). ACM.
- Nardelli, G. (2015): The Interactions between Information and Communication Technologies and Innovation in Services: A Conceptual Typology. *International Journal of Information Systems in the Service Sector (IJISS)*, 7(3), 15-39.
- Nerur, S. P., Rasheed, A. A., & Natarajan, V. (2008): The intellectual structure of the strategic management field: An author co-citation analysis. *Strategic Management Journal*, 29(3), 319-336.
- Noma, E. (1984): Co-citation analysis and the invisible college. *Journal of the American Society for Information Science*, 35(1), 29-33.
- Oliveira, M. G., Mendes, G. H., & Rozenfeld, H. (2015): Bibliometric Analysis of the Product-Service System Research Field. *Procedia CIRP*, 30, 114-119.
- Ordanini, A., & Parasuraman, A. (2010): Service innovation viewed through a service dominant logic lens: A conceptual framework and empirical analysis. *Journal of Service Research*, 14(1), 3-23.
- Osborne, S. P., Radnor, Z., Kinder, T., & Vidal, I. (2015). The SERVICE Framework: A Public-service-dominant Approach to Sustainable Public Services. *British Journal of Management*, 26(3), 424-438.
- Ostrom, A. L., Bitner, M. J., Brown, S. W., Burkhard, K. A., Goul, M., Smith-Daniels, V., ... & Rabinovich, E. (2010). Moving Forward and Making a Difference: Research Priorities for the Science of Service. *Journal of Service Research*, 13(1), 4-36.
- Price, D. J. de Solla (1965): Little science, big science. New York: Columbia University Press.
- Ray, G., Muhanna, W. A., & Barney, J. B. (2005): Information technology and the performance of the customer service process: A resource-based analysis. *MIS quarterly*, 625-652.
- Rai, A., Patnayakuni, R., & Seth, N. (2006): Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS quarterly*, 225-246.
- Sakata, I., Sasaki, H., Akiyama, M., Sawatani, Y., Shibata, N., & Kajikawa, Y. (2013): Bibliometric analysis of service innovation research: Identifying knowledge domain and global network of knowledge. *Technological Forecasting and Social Change*, 80(6), 1085-1093.
- Skålén, P., Aal, K. A., & Edvardsson, B. (2015): Cocreating the Arab Spring Understanding Transformation of Service Systems in Contention. *Journal of Service Research*, 18(3), 250-264.
- Skålén, P., & Edvardsson, B. (2016): Transforming from the goods to the service-dominant logic. *Marketing Theory*, 16(1), 101-121.
- Shafique, M. (2013): Thinking inside the box? Intellectual structure of the knowledge base of innovation research (1988-2008). *Strategic Management Journal*, 34(1), 62-93.
- Sirilli, G., & Evangelista, R. (1998): Technological innovation in services and manufacturing: results from Italian surveys. *Research policy*, 27(9), 881-899.
- Small, H., Boyack, K. W., & Klavans, R. (2014): Identifying emerging topics in science and technology. *Research Policy*, 43(8), 1450-1467.
- Small, H., & Upham, P. (2009): Citation structure of an emerging research area on the verge of application. *Scientometrics*, 79(2), 365-375.
- Smith, D. J. (1994): Computer simulation applications in service operations: a case study from the leisure industry. *Service Industries Journal*, 14(3), 395-408.
- Sørensen, C., & Landau, J. S. (2015): Academic agility in digital innovation research: The case of mobile ICT publications within information systems 2000-2014. *The Journal of Strategic Information Systems*, 24(3), 158-170.
- Spohrer, J., & Kwan, S. K. (2010): Service science, management, engineering, and design (SSMED): an emerging discipline. In: Wang, J. (Ed.): *Information Systems and New Applications in the Service Sector: Models and Methods*. New York: IGI Global, pp. 194-226.
- Spohrer, J., & Maglio, P. P. (2010a): Service science: Toward a smarter planet. In W. Karwowski, & G. Salvendy (Eds.): *Introduction to service engineering*. New York: Wiley & Sons, pp. 3-30.
- Spohrer, J., & Maglio, P. P. (2010b): Toward a science of service systems: Value and symbols. In P. P. Maglio, C. A. Kieliszewski, & J. C. Spohrer (Eds.), *Handbook of service science*. New York: Springer; pp. 157-194.
- Sriviastava, S. C., and Shainesh, G. (2015): "Bridging the Service Divide Through Digitally Enabled Service Innovations: Evidence from Indian Healthcare Service Providers," *MIS Quarterly* (39:1), pp. 245-267.
- Stoshikj, M., Kryvinska, N., & Strauss, C. (2016): Service Systems and Service Innovation: Two Pillars of Service Science. *Procedia Computer Science*, 83, 212-220.

- Strauss, A.; Corbin, J.M. (1990): Basics of Qualitative Research: Grounded Theory Procedures and Techniques. Thousand Oaks: Sage.
- Sundbo, J. (1997): Management of innovation in services. *Service Industries Journal*, 17(3), 432-455.
- Snyder, H., Witell, L., Gustafsson, A., Fombelle, P., & Kristensson, P. (2016): Identifying categories of service innovation: A review and synthesis of the literature. *Journal of Business Research*, 69(7), 2401-2408.
- Tiwana, A., Konsynski, B., & Bush, A. A. (2010): Research Commentary-Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. *Information Systems Research*, 21(4), 675-687.
- Tilson, D., Lyytinen, K., and Sørensen, C. (2010): "Research Commentary—Digital Infrastructures: The Missing IS Research Agenda", *Information Systems Research* (21:4), pp. 748-759.
- Um, S., Yoo, Y., & Wattal, S. (2015): The Evolution of Digital Ecosystems: A Case of WordPress from 2004 to 2014.
- Vargo, S. L., & Lusch, R. F. (2004): Evolving to a new dominant logic for marketing. *Journal of marketing*, 68(1), 1-17.
- Vogel, R. (2012): The visible colleges of management and organization studies: A bibliometric analysis of academic journals. *Organization Studies*, 33(8), 1015-1043.
- Vogel, R., & Güttel, W. H. (2013): The dynamic capability view in strategic management: a bibliometric review. *International Journal of Management Reviews*, 15(4), 426-446.
- Walker, R. H., & Johnson, L. W. (2004): Managing technology-enabled service innovations. *International Journal of Entrepreneurship and Innovation Management*, 4(6), 561-574.
- Wallin, M. W. (2012): The bibliometric structure of spin-off literature. *Innovation*, 14(2), 162-177.
- White, H. D., & Griffith, B. C. (1981): Author cocitation: A literature measure of intellectual structure. *Journal of the American Society for information Science*, 32(3), 163-171.
- Yoo, Y. (2010): «Computing in Everyday Life: A Call for Research on Experiential Computing». *MIS Quarterly* (34:2), pp. 213-231.
- Yoo, Y. (2013): The Tables Have Turned: How Can the Information Systems Field Contribute to Technology and Innovation Management Research? *Journal of the Association for Information Systems*, 14(5), 227-236.
- Yoo, Y., Boland Jr., R. J., Lyytinen, K., and Majchrzak, A. (2012): "Organizing for Innovation in the Digitized World," *Organization Science* (23:5), pp. 1398-1408.
- Yoo, Y., Henfridsson, O., and Lyytinen, K. (2010): "Research Commentary—The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research", *Information Systems Research* (21:4), pp. 724-735.
- Yoo, Y., Lyytinen, K., & Yang, H. (2005): The role of standards in innovation and diffusion of broadband mobile services: The case of South Korea. *The Journal of Strategic Information Systems*, 14(3), 323-353.
- Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J., & Faraj, S. (2007): Information technology and the changing fabric of organization. *Organization Science*, 18(5), 749-762.
- Zhu, D., & Porter, A. L. (2002): Automated extraction and visualization of information for technological intelligence and forecasting. *Technological forecasting and social change*, 69(5), 495-506.
- Zupic, I., & Čater, T. (2015): Bibliometric methods in management and organization. *Organizational Research Methods*, 18(3), 429-472.

## Author:

First name, surname, title(s): Milena-Jael SILVA-MORALES. Ph.D. candidate.

Institution: Grenoble-Alps University

Department: CERAG

E-mail: [milena.jael@gmail.com](mailto:milena.jael@gmail.com)

**Appendix 1: Bibliometric methods.** Source: Cobo et al., (2011a p. 1384) and Zupic & Čater (2015 pp. 4; 11).

Bibliometric method Description	Units of analysis	Research questions answered by different bibliometric methods
<b>Citation:</b> Estimates influence of documents, authors, or journals through citation rates.	Document Author Journal	<ul style="list-style-type: none"> <li>- Which authors most influenced the research in a journal?</li> <li>- Which journals and disciplines had the most impact on a research stream?</li> <li>- What is the “balance of trade” between journals/disciplines?</li> <li>- Who are the experts in a given research field?</li> <li>- What is the recommended “reading list” for a specific area?</li> </ul>
<b>Co-citation:</b> connects documents, authors, or journals on the basis of joint appearances in reference lists. Kind of relation: co-cited document, author or journal.	Document Author Journal	<ul style="list-style-type: none"> <li>- What is the intellectual structure of literature X?</li> <li>- Who are the central, peripheral, or bridging researchers in this field?</li> <li>- How has the diffusion of the concept through research literature taken place?</li> <li>- What is the structure of the scientific community in a particular field?</li> <li>- How has the structure of this field developed over time?</li> </ul>
<b>Bibliographic coupling:</b> connects documents, authors, or journals on the basis of the number of shared references. Kind of relation: common references among document, author or journal.	Document Author Journal	<ul style="list-style-type: none"> <li>- What is the intellectual structure of recent/emerging literature?</li> <li>- How does the intellectual structure of the research stream reflect the richness of the theoretical approaches?</li> <li>- How has the intellectual structure of small niche X developed through time?</li> </ul>
<b>Co-author:</b> connects authors when they co-author the paper. Kind of relation: co-occurrence of: authors, countries or institution.	Author's name. Country from affiliation. Institution from affiliation	<ul style="list-style-type: none"> <li>- Are authors from different disciplinary backgrounds working together on a new research field, or do they remain within disciplinary boundaries?</li> <li>- Which factors determine co-authorship?</li> <li>- What is the effect of collaboration on the impact?</li> <li>- Are co-authored articles more cited?</li> <li>- Do more prolific authors collaborate more frequently?</li> <li>- Are internationally co-authored papers more cited?</li> <li>- What is the social structure of the field?</li> </ul>
<b>Co-word:</b> connects keywords when they appear in the same title, abstract, or keyword list. Its permit to study the thematic evolution of a research field. Kind of relation: terms' co-occurrence.	Words, keywords, or terms extracted from title, abstract or document's body	<ul style="list-style-type: none"> <li>- What are the dynamics of the conceptual structure of a field over time?</li> <li>- Uncover the conceptual building blocks of a literature.</li> <li>- What are the topics associated with a particular line of research?</li> <li>- Track the evolution of concept X.</li> </ul>

**Appendix 2: Research terms**

Scopus	
Service system ( TITLE-ABS-KEY ( "service science" ) OR TITLE-ABS-KEY ( "Service science, management, and engineering" ) AND TITLE-ABS-KEY ( "service system" ) OR TITLE-ABS-KEY ( "science of service systems" ) AND TITLE-ABS-KEY ( "complex service system" ) OR TITLE-ABS-KEY ( "smart service system" ) TITLE-ABS-KEY ( "urban service system" ) ) AND DOCTYPE ( ar OR re ) AND SUBJAREA ( mult OR ceng OR CHEM OR comp OR eart OR ener OR engi OR envi OR math OR phys OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 1986 AND PUBYEAR < 2015 AND ( LIMIT-TO ( LANGUAGE , "English" ) )	57 records
Service innovation / Innovation in services (TITLE-ABS-KEY ("service innovation" ) OR TITLE-ABS-KEY ( "innovation in services" ) OR TITLE-ABS-KEY ( "innovation in service systems" ) OR TITLE-ABS-KEY ( "digital innovation" ) OR TITLE-ABS-KEY ( "smart service system" ) AND TITLE-ABS-KEY ( service ) OR TITLE-ABS-KEY ( "digital innovation" ) OR TITLE-ABS-KEY ( "service system" ) ) AND PUBYEAR > 1986 AND PUBYEAR < 2015 AND ( LIMIT-TO ( LANGUAGE , "English" ) )	1,378 records
<b>Web of Science</b>	
Service system TOPIC: ("service science") OR TOPIC: ("Service science, management, and engineering") AND TOPIC: ("service system") OR TOPIC: ("urban service system") OR TOPIC: ("science of service systems") OR TOPIC: ("complex service system") OR TOPIC: ("Smart Service System") Refined by: LANGUAGES: (ENGLISH) Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=1986-2015	319 records
Service innovation / Innovation in services TOPIC: ("service innovation") OR TOPIC: ("innovation in services") OR TOPIC: ("innovation in service systems") OR TOPIC: ("digital innovation") OR TOPIC: ("smart service system") AND TOPIC: (service) AND TOPIC: ("digital innovation") AND TOPIC: ("service system")  Refined by: DOCUMENT TYPES: (ARTICLE OR EDITORIAL MATERIAL OR REVIEW OR PROCEEDINGS PAPER) AND LANGUAGES: (ENGLISH) AND DOCUMENT TYPES: (ARTICLE OR REVIEW) Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=1986-2015	685 records