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THE SCIENTOMETRIC EVOLUTION OF THE "NETWORK SOCIETY": MAPPING AND TRACING THE INFLUENCE OF A CONCEPT

Catarina Bastos Cardoso

Dissertation presented as partial requirement for obtaining the Master's degree in Statistics and Information Management

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ABSTRACT

The “Network Society” is an analytical concept developed by the sociologist Manuel Castells. The author applies this term to describe a new form of social organisation, global and dynamic, which was emerging in the end of the 20th century. The Network Society is underpinned by microelectronics, driven by software and based on flows of information. Castells explains its influence at many levels, namely in communication and the economy. Since its introduction in the 1990s, it has framed much of academic research and policy-relevant worldviews when it comes to define and understand the contemporary digital ways. By 2021, the world has become more digitally dependent than ever and the connectivity between different societal realms achieves an increasing relevance.

This work inquiries how Castells’ concept of Network Society was received by academic communities. The main goals are to uncover how it has evolved in terms of meaning and appropriation. Considering the multifaceted nature of this concept, we investigate a possible theoretical road which might have led to its emergence. Afterwards, a peer-reviewed paper analysis is applied and bibliometric evidence is used to map the field structure of academic work related to the Network Society. We aim at unpacking a specific concept and pursue its evolution. We embrace a rather different approach from those commonly undertaken in bibliometric research, which refer to the study of authors or disciplines.

We find that two moments can be distinguished in what concerns the use of the string “Network Society” as an indicator. From 2000 to 2009, three communities are identified in terms of intellectual structure: one dedicated to the Social Sciences in general, another one to studies of power, control, and surveillance, and finally one devoted to Geography. From 2010 to 2020, a change in discourse happens, a greater focus on digital and decision-making matters takes shape and a branch dedicated to the online sphere comes into prominence. The 2000s display a stronger impact in terms of citations, whereas the “take-off” in production itself takes place in the 2010s. The Network Society moves in a multidisciplinary panorama but Sociology and Communication disciplines remain at the core research areas. Castells assumes a central position in this body of literature but authorship is heterogeneous and fragmented, i.e., the term is almost exclusively appropriated by researchers without strong links outside their closed circles. The most impactful papers are related to governance and policy-making. The concept seems to be portrayed as a tool for analysing global but also local and specific issues.

KEYWORDS

Scientometrics; Bibliometrics; Science mapping; Network Society; Manuel Castells.

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LIST OF ABBREVIATIONS AND ACRONYMS

ICT	Information and Communication Technology
ISI	Institute for Scientific Information
MCP	Multiple Country Publications
JIF	Journal Impact Factor
SCI	Science Citation Index
SCP	Single Country Publications
SJR	SCImago Journal & Country Rank
WoS	Web of Science

1. INTRODUCTION

Sociologist Manuel Castells introduced the concept of "Network Society" in the mid-1990s, more precisely in 1996, year of his book's *The Rise Of The Network Society* first publication. Since then, this key contribution to social theory has been used and interpreted by scholars and policy-makers. Therefore, it is important to understand how this term emerged and has been applied in different fields of knowledge and time periods.

1.1. BACKGROUND

The Network Society became a well-known label after the publication of the first volume of the book trilogy *The Information Age*, authored by Manuel Castells. In *The Rise Of The Network Society*, first published in 1996, Castells identified, described and explicated a new social structure, mainly characterised by its dynamism, interconnection, and expandability (Castells, 2010). These features are empowered by the microelectronics, the internet, and the digital sphere, which were beginning to achieve relevance by that time. Castells outlines the emergence of a Networked Society and interdependent political economy, whose lifeblood are the flows of information. While the author himself rejects peremptorily any forecasting imprint in his work, it is undeniable that we would witness, in the following years and decades, some forms of socio-technical arrangements that at least pay some resemblance to Castells' core presuppositions. Communication stands out as a crucial element in the Network Society, allowing the connectivity between people, cities, corporations, countries, and many other actors (Castells, 2010). Wireless infrastructures and bandwidth capacity keep growing, and devices keep getting smaller and more portable.

Rather than trying to set forth an analysis of whether the real world matched the key points highlighted by the author, this work attempts an account of the reception of his ideas and worldview. In particular, we trace the academic impact of the "Network Society" concept. We interrogate not his work directly but rather indirectly, through the mirror of the interpretation of others as revealed by bibliometric evidence, namely professional research audiences in their formal research publications, as a way to understand the views stemming from what is arguably Castells' key contribution to social theory. Our research question can thus be articulated in the following way: *what are the varieties in the meaning and the dynamics of appropriation of the "Network Society" concept?*

In order to produce answers, a bibliometric analysis is applied to the journal-based scientific literature using the exact term introduced by Castells in the title, abstract, or keywords of papers published in indexed scientific outlets. Bibliometrics is a branch of scientometrics and goes about the quantitative study of publications so as to uncover the knowledge structure of research production and influence (Broadus, 1987; Pritchard, 1969; van Raan, 2004). Bibliometrics includes different techniques that allow the achievement of insights and the establishment of connections between documents, authors, or specific pieces of content. Our approach is not limited to bibliometric data. By surveying the key points of *The Rise Of The Network Society*, as well as briefly review books of other authors who also made important contributions to social studies, it attempts to provide an integrative review (Breslin & Gatrell, 2020; Cronin & George, 2020; Mendonça, 2017). This type of research synthetises knowledge about a subject by identifying and mapping the different communities of practice which develop work about a specific topic or agenda. An integrative review is a way to create new knowledge but also to

reshape already existing knowledge. It brings together different materials and sources, which may add extra perspectives and go beyond the borders of a traditional review.

1.2. RELEVANCE

A bibliometric analysis of the Network Society is necessarily focused on the new Information and Communication Technologies (ICTs), which are a milestone in todays' society. According to The World Bank (2021), in the year 2000 the proportion of internet users worldwide was 6.7%. In 2017[1], this proportion rose to 49%. The digital divide is still a reality, as half of the world's population does not have access to the internet (World Economic Forum, 2018). However, this just emphasises the importance of connectivity: not belonging to networks is still affected by the networked nature of our society.

The telecommunications infrastructure reflects the relevance, expansion, and robustness of connectivity networks in present time. According to the OECD Statistics (2021), the total number of mobile broadband subscriptions in all the countries that are part of the organisation grew 298% between 2009 and 2020. From the countries with available data for both years, the biggest increases are verified in the Netherlands, Estonia, Chile, Czech Republic, Turkey, and New Zealand. Regarding fixed broadband subscriptions, an increase of 57% is verified in the total OECD countries, between 2009 and 2020. In this statistic, the countries which display the most remarkable growth are Colombia, Turkey, Mexico, Chile, Greece, Slovak Republic, and Portugal.

Considering the EU27 countries (OECD, 2021), the percentage of individuals using the internet (in the last 3 months) in 2009 was 62.9%. In 2020 it was 87.3%, representing an increase of 24.4 percentage points. This growth in usage is accompanied by a growth in frequency, as the percentage of individuals using the internet daily or almost every day (in the last 3 months) in 2020 (79.3%) is superior in 33.4 percentage points to the value in 2009 (45.9%). At the business level, and taking into account all businesses (with 10 persons employed or more), an increase of 44.5 percentage points is verified in the percentage of businesses with a mobile broadband connection between 2010 (25.4%) and 2020 (69.9%). An increment is also noted in the percentage of businesses using social media: 28.8% in 2013 and 50.3% in 2019 (+21.5 percentage points).

This dissertation also attempts to provide insights on the published work using Castells' concept as a referential. 2021 marks the 25 years pass over the first publication of *The Rise Of The Network Society.* This seems an appropriate time to study the life cycle of this concept and its stemming information in a first-quarter century of existence. The conclusions of this work may be compared and complemented by future research, being a part of an ongoing study of the Network Society.

1.3. OBJECTIVES

The Network Society is intimately related to power, communication, globalisation, and the new technologies (Castells, 2010). It is important to deconstruct this concept and verify how it has been used by different professional research audiences and across time.

[1] Latest available data by the time of writing.

The main goal of this study is to trace the impact of the concept of Network Society in journal-based scientific literature. The following specific objectives are defined:

1. Identify research areas, authors, journals, countries, and institutions of affiliation which produce relevant content related to the Network Society;
2. Apply bibliometric techniques (co-citation, bibliographic coupling, and co-word) to discover what are the varieties and dynamics of the Network Society in the literature;
3. Map the structure of the scientific field created by this concept.

This dissertation is organised as follows. Section 2 is dedicated to present and describe the concept of Network Society. Section 3 details the methodological framework. Section 4 offers the main results of this study. It includes descriptive statistics of several units of analysis and a science mapping view sustained by network analysis. Section 5 goes on to offer final remarks and outlines some limitations and opportunities for future research.

2. THE RISE OF A CONCEPT

This chapter reviews the concept of Network Society, as it was described and explicated by Manuel Castells in the first volume of his trilogy *The Information Age*. The goal is to provide a clear definition of the term, understanding how it was built by its own author. As a starting point, we take a step back and try to unveil the intellectual path (the leading authors preceding Castells) which might have favoured the emergence of this concept.

2.1. NAVIGATING THE LABELS: THE ROAD TO THE NETWORK SOCIETY

The development of theory using a concept as a gravitational centre is a common thread followed in economic research. In *The Weightless World – Strategies for Managing the Digital Economy,* Diane Coyle (1997) uses the idea of "weightlessness" to analyse the features and consequences of an economy whose value is dematerialised. The author recognises the impact of information and communication technology in the economic sphere: the growth of the services sector and deeper changes at demographic, social, or political levels, such as unemployment, inequality, crisis of the welfare state, or the globalisation inherent to the existence of financial markets. In this context, the appliance of the concept of "weightlessness" becomes an explanatory factor for the analysis. Coyle defines the world as weightless because the main output of a weightless economy is not physical, it does not own a material existence. Communication, information, knowledge, and a broad range of services are not tangible, while being highly valuable in this type of economy. It is also in this context of an economic value attributed to a non-material resource that Ove Granstrand (2000) introduces the concept of "intellectual capitalism". The author joins the terms "capitalism", the economic system based on private property, and "intellectual", applied to describe assets which are valuable but not physical (such as patents, databases, reputation, human capital, or the general know-how) to create a new meaning. This new type of capitalism maintains its basic characteristics, but is now exchanging knowledge and information. Several indicators are proposed as proofs for the predominance of an intellectual capitalism in society. Information and communication technologies are presented as indispensable in this conjuncture. Through their collectability, interactivity, and controllability, they generate intellectual capital and allow different agents to profit from its appropriation.

In *As Time Goes By: From the Industrial Revolutions to the Information Revolution*, Freeman and Louçã (2001) depart from the concept of long waves of capitalist development to analyse the changes economics, seen as an historical and evolutionary science, was going through. The authors consider that, in the beginning of the 21st century, a third Industrial Revolution was happening: the Information Revolution. Referring to an Information Revolution is in fact a way to demonstrate that this moment of transformation, although coming in the sequence of previous Industrial Revolutions, is better described in its essence by a different terminology (Chandler Jr. & Cortada, 2000). This revolution was propelled by technological innovations such as microelectronics, computers, and the internet. One of the main features of this emergent new techno-economic paradigm, denominated as ICT, is that it is the result of the interaction of three industries: electronics, telecommunications, and computer. This dynamic is a novelty, as these industries have developed previously in an independent manner, and they are now cooperating and competing, in a clear new economic framework. These industries themselves were undergoing major changes, for instance, the improvements in wired, wireless and in the speed of communication. The role played by the internet in this scenario conquered increased relevance. Internet service providers became an important sector of economy. Consequently,

questions related to competition, concentration, and regulation started to raise, triggered by the notion that these new giant global multinational corporations were achieving great power and influence in society (Freeman & Louçã, 2001; Louçã & Mendonça, 2002; Mendonça, 2003).

In the late 2000s, a discussion around the notion of digital networks and information environment was taking place, favoured by the progressively enhanced connectivity of the epoch. Overall, these authors had a positive and optimistic view about the topic (Benkler, 2006; Lessig, 2008; Shirky, 2008; Sunstein, 2006; Surowiecki, 2005; Tapscott & Williams, 2006). They stressed the endless opportunities and liberating possibilities that digital openness could offer to society. A new form of decentralised organisation was regarded as a way to improve democracy, autonomy, and to promote justice and equality. Digital connectivity, which happened mainly through the internet, was seen as a means of empowerment and a pathway to enhanced human freedom. This freedom happened at the individual level and on the collective level. Self-organising groups and collaboration were regarded as viable of socioeconomic coordination, hand-shakes in between the visible hand (hierarchies) and the invisible hand (markets).

In the 2010s, a more skeptical overtones stepped in. These authors believe that the hopes brought about by the internet space were converted into a new Gilded Age (Marciano et al., 2020; Mukherjee, 2018; Wu, 2016; Zuboff, 2019;). Instead, a new all-encompassing electronic ecosystem dominated by digital platforms now threatened to harness the sphere of personal privacy, capture human attention, and to control reality itself as it hybridised with cloud-based, AI-driven computing. This intellectual trend encompasses the notion that capitalism happens now in the Big Data era, which may lead to new pressures in terms of social adaptation (Mendonça et al., 2015). However, the emergence of Big Tech companies is purported to have changed the nature of the internet as we knew it. The way these platforms gather and act on information, assuming an intermediation role in different markets, seems to be an example of centralisation and not decentralisation. Making use of the most up-to-date technologies, digital platforms can collect, process, and interpret unprecedent amounts of data about their users. This capability offers an immense potential for commercial value creation, but it also raises questions about possible threats to democracy and public values (Mansell & Steinmueller, 2020). These doubts arise as data gathering often happens without the explicit consent or total awareness of the users, and it is being used by platform owners to predict attention and consequently apply this information in the interest of their business. Thus, the concept of "platform capitalism" is in the centre of a current discussion which considers paths such as policy-making, antitrust and communications regulation (Mansell & Steinmueller, 2020).

This proliferation of jargon in the building and conceptualisation of a theory seems to enrich the analysis undertaken, by clarifying its main terms. The Network Society is almost eponymically related to Castells. As a result, a deeper focus on how this concept was constructed by its author is indispensable. However, others have previously developed theory based on similar principles and ideas. These works evolved around the topic of "Information Society", which shares with the Network Society a common theoretical ground. As an introduction for the study of the Network Society, the works of Marshall McLuhan (*The Global Village*, 1989), Daniel Bell (*The Coming of Post-Industrial Society*, 1973), Alvin Toffler (*The Third Wave*, 1980), Everett M. Rogers (*Communication Technology: The New Media in Society*, 1986), and Peter F. Drucker (*Post-capitalist Society*, 1993) are reviewed. The goal is not to search for the best or most accurate definition of the concept of Information Society, nor is it to compare and contrast the views of different authors about the subject. The objective is to grasp

a wider and diversified perspective about the theme, hoping that this would add relevant information for the conceptual study of the Network Society.

2.2. PAVING THE WAY TO THE "NETWORK SOCIETY"

In the last decades of the 20th century, the perception that information plays a new and determinant role in society is common amongst many authors. Broadly, these authors believe that the quantitative growth of information is leading to qualitative changes in society, which ultimately are constructing a new form of social organisation, known as the Information Society (Webster, 2006). They have analysed this event through different mirrors, which nonetheless present similar characteristics.

We highlight a hallmark book for each decade of the second half of the 20th century, from the 1960s to the 1990s. These works offer insights which may be of use in providing extra theoretical support for the study of the Network Society.

2.2.1. Marshall McLuhan and *The Global Village*, 1960s

In what concerns communication studies, Marshall McLuhan is a reference. The Canadian philosopher gave important contributions to the media theory field. He stressed the relevance of the media themselves, independently from the content they served. McLuhan is the author of the famous statement "the medium is the message", as well as the term "global village".

McLuhan worked on the idea of a global village in the 1960s. The concept was developed in that decade, although the publication of the book entitled *The Global Village* only happens posthumously, in 1989. In this dissertation, the book published in 1989 with the collaboration of Bruce R. Powers is used as the reference, albeit the theory development designed by McLuhan goes back to the 1960s.

In *The Global Village*, McLuhan proposes a conceptual model to analyse the consequences of electronic technologies in society. Electronic media, at the time mainly television and radio, are regarded as extensions of our central nervous system, and defined by simultaneity. According to the author, an analysis of the media framework should be conducted taking as a reference three concepts: the visual space, the acoustic space, and the tetrad (McLuhan, 1963, 1989).

While the visual and the acoustic space can be defined separately, they are inseparable and function in a dynamic equilibrium. McLuhan believes that the transition between the visual space and the acoustic space is happening in modern society, and it is in this non-static framework that the author conceptualises both terms.

The visual space is defined as linear, sequential, quantitative, fragmented, uniform, and tangible, while the acoustic space is described as holistic, circular, qualitative, integrated, resonant, and intangible (McLuhan, 1989). McLuhan applies geographical and biological references to each space. The visual space is connected to the West, being related to the continuity of the phonetic alphabet. On the other hand, the acoustic space emerges as a nature-related space, reflecting the influence of non-alphabetised, pre-alphabetised or even post-alphabetised people, and prioritising non-continuous and non-homogeneous forms of communication. This is typically identified with the East side of the world. Biologically, McLuhan associates each space with a side of the human brain. The visual space appears as a reflection of the left hemisphere, related to analytical activities. The acoustic space is related to the right hemisphere, commonly associated with artistic activities.

The key issue which establishes the connection between this conceptual framework and the new technologies is that these electronic technologies, which were emerging by that time in the West, present for the first time a threat to the hegemony of the left hemisphere of the brain, meaning the type of activities to which it was being associated with. Firstly, they are simultaneous. Electronic media cannot be analysed through linear communication models (McLuhan, 1989). The author states the need for new communication models which would be a better fit for the electronic age. The future communication media would be able to take us from individualism to a collective whole, and this would result in the materialisation of the global village. The economy would also become global and based on market information. Tertiary sector would be predominant, in a decentralised economy. The existence of many fluctuant centres, marked by ubiquity and not rigidly defined, are a key point of the acoustic space. Information is needed for production and distribution, and it is available for everyone, at any time. This information would spread faster and would not be subjected to state-owned control. In fact, McLuhan foresees the rise of what he denominates as a worldwide government, as in this context the national governments would lose power. At work level, this would result in a decrease of office positions, in the progressive impact of computer usage, and in the appearance of a multimedia society. McLuhan seems to apply an approach based on the opposed characteristics of two sides (the West and the East, the left and the right), which in the end function in a simultaneous plan. Curiously, this work is published in 1989, an historical year in terms of end of divisions, marked by the Fall of the Berlin Wall. The following years would also be remembered for important breakdowns of barriers and changes in the world politics: the end of the Cold War and the last days of the Soviet Union.

The tetrad emerges as a scientific tool, able to analyse and foresee the effects on society of any technology (in this specific analysis, video technologies are the object of study). Through a visual representation, the tetrad strives to capture an integral awareness about each invention. In this conceptualisation, it is important to consider the notions of figure and ground. The figure is intrinsically related to the visual space. It defines the medium itself and a specific attention area. On the other hand, the ground is related to the acoustic space, representing the context and a wider area of non-attention (McLuhan, 1989). The tetrad is an empirical instrument which tries to represent simultaneously figure and ground and positive and negative effects of technologies. In *The Global Village*, this exercise is applied to a myriad of technologies (lift, telegraph, electric light, car, plane, electronic media, microphone, telephone, computer, cable TV, or satellite). Due to its multidimensionality, this tool is more easily identified with the acoustic space. In fact, it is a representation of the complementarity and interconnectedness of figure and ground, in an era where the context, enhanced by the media technologies, conquers importance.

2.2.2. Daniel Bell and *The Coming of the Post-Industrial Society*, 1973

In the study of the Information Society, the name of the American sociologist Daniel Bell is unavoidable. Bell addressed issues related to science, technology and capitalism, and their influence in the individuals. His book *The Coming of Post-Industrial Society*, first published in 1973, presents two re-editions (in 1976 and 1999), in which the author revisits his work in the light of more recent years.

In the conceptualisation presented by Bell, society may be divided in three phases denominated by Pre-industrial, Industrial, and Post-industrial (Bell, 1999). A Pre-industrial Society is characterised as extractive. The primary sector in economy is primordial, as agriculture is dominant. In an Industrial Society, the secondary sector emerges as more relevant. Fabricating is the essential mode of

production, which strongly relies on machines. The Post-industrial Society, which may be identified as the Information Society, finds in the processing of information its main mode of production. Services become the most significant economic sector, which the author allocates not only into tertiary (transportation and utilities), but also in quaternary (trade, finance, insurance, real estate) and quinary (health, education, research, government, recreation, entertainment). This white-collar employment sector works mainly with information, which means that an increase in the sector also generates more information (Webster, 2006).

The axial principle of post-industrialism is the codification of theoretical knowledge and the belief that science and technology are not independent (Bell, 1999). The assumption is that all technical innovations are rooted in prior scientific research. These innovations refer mainly to electronic developments, miniaturisation and digitalisation processes, and software improvements. The importance that new technologies conquer in Bell's work have labelled him as technocratic (Webster, 2006). However, the author states that technology is not deterministic. It only provides the necessary instruments for social change, while being capable of acting in society (Bell, 1999).

In Bell's perspective, this new technology should be perceived as an intellectual technology. It is based on telecommunications, computers, programming, algorithms, modelling, simulation, and data-transmission, a type of technology that greatly differs from a merely mechanical system. The strategic resource of post-industrialism is the human capital. Higher education is perceived as a means to achieve success in a society which the author advocates as meritocratic. A conception of society in which the individual is the primary agent is adopted (Bell, 1990).

These technological and economic traits are key to understand how Daniel Bell conceptualises a Post-industrial society. It is also important to acknowledge that the author sees society in an anti-holistic way (Webster, 2006), organised in three independent and separated spheres: social, political, and cultural (Bell, 1990, 1999; Webster, 2006). The effects of post-industrialism emerge from the social level, as this is the sphere which comprises economy, technology, education, and work (Bell, 1999).

From the lenses of a Post-industrial society, Bell regards communication as the main medium for connection, and economy as global and unified. The author endorses the emergence of a new type of society, open to novelty and without social or geographical borders (Bell, 1990, 1999).

2.2.3. Alvin Toffler and *The Third Wave*, 1980

Another relevant name worth mentioning in the theorisation of a Post-industrial society is Alvin Toffler. Toffler was a popular writer and a futurist. In fact, several events and developments that would only happen in the decades to come are foreseen in his writings.

Toffler defines three types of societies, three "waves", related to three specific historical moments. The First Wave is related to the Agricultural Revolution, the Second Wave to the Industrial Revolution and, finally, the Third Wave to the Information Revolution, evolving since the mid-20th century.

In his *The Third Wave*, Toffler (1980) states that the way new technologies impact society would lead to a whole new civilisation, which would have information as its material basis. The Third Wave has the capacity not only to accelerate the flows of information, but also to act on them.

Toffler describes the Third Wave by clearly pointing out its opposition to some classic features of the Second Wave. In an Industrial Society, standardisation, synchronisation, centralisation, concentration, and maximisation were key points. It is easy to find similarities between these characteristics and the way machines function, as they refer to a mechanical rhythm. In opposition to this fabricating imprint of the Second Wave, the Third Wave presents a flexible rhythm, as well as a preference for personalisation, segmentation, diversity, and appropriate scale. Throughout the book, it is clear the cut Alvin Toffler establishes between the Industrial Society and this new Post-industrial society. They differ virtually at all levels. Even concerning the techno-sphere, relevant for both waves, Toffler predicts the Third Wave technologies to be smaller, simpler, reusable, and less energy-consuming in comparison with their big, complex, and energy-consuming predecessors of the industrial age. This results in a generalised inadequacy of social and political structures which were designed according to an industrial context. They no longer fit in the Third Wave.

The way work is organised in the Third Wave is a relevant point in this analysis. It goes beyond the appearance of more flexible styles of work, which per se are already worlds apart from the rigid schedule of the Industrial Society. Toffler elaborates on the appearance of the electronic cottage and the electronic office. The electronic cottage represents the notion that, in the forthcoming years, working from home would be a possibility. The author anticipates that some white-collar tasks would be possible to run from home. Working at home would bring people closer to each other at familiar and community levels, in a way that curiously finds more similarities with the First Wave (Agricultural Revolution) than with the Second Wave (Industrial Revolution). The office of the Third Wave would also be substantially different from the office of the Second Wave. It would be more electronically connected, operating in a global economy where transnational corporations are predominant. The economic relations denote a shift of focus to the individual, in a global framework of demassification. The Third Wave is keen on diversity and interaction, instead of the standardisation and passiveness of previous times. Consequently, it is harder to reach consensus. The Third Wave society privileges relationships over specification, and the whole over the half (Toffler, 1980).

Politically speaking, the Third Wave brings with it the obsolescence of the nation-state (Toffler, 1980). This political structure proves to be inefficient in dealing with the issues which develop at a more local and regional level, as well as with the ones that happen internationally. Plus, the compartmentalised way in which the government is organised does not allow for interrelatedness between areas, which is an important component for politics in the Third Wave. This turning point felt at the moment *The Third Wave* was written is explained by Toffler (1980, p. 14):

> "(…) this book flows from the assumption that we are the final generation of an old civilization and the first generation of a new one, and that much of our personal confusion, anguish, and disorientation can be traced directly to the conflict within us, and within our political institutions, between the dying Second Wave civilization and the emergent Third Wave civilization that is thundering in to take its place."

2.2.4. Everett M. Rogers and *Communication Technology: The New Media in Society*, 1986

Everett M. Rogers is an American communication theorist, well-known for his diffusion of innovations theory. This work allocates consumers into different groups, according to their rate of adoption of a

new idea. Due to its special focus on the adoption of new technologies, Rogers' research is particularly impactful in the communication field.

In *Communication Technology: The New Media in Society*, Rogers (1986) observes the Information Society through a clear communicational point of view. The author perceives that the way communication happens in society changed in the 1980s decade. He denominates as new communication technologies this new type of computerised communication channel in which the message flow takes place on a many-to-many basis. Besides the contribution of electronics for the development of the new communication technologies, the author also recognises the important role of governmental policies in this matter.

The new media conceptualisation sharply contrasts with the characteristics of the mass media channels, previously dominating the communicational panorama. They are highly interactive, especially due to their computerised basis. This degree of interactivity is not achievable by mass media channels. Most of the new communication technologies are also highly asynchronous, preserving the message and allowing its time-shift consumption. Apart from some written forms, this capability is not verified in the majority of mass media. The new communication technologies have a high degree of segmentation. On the contrary, as it is expressed in its name, mass media are designed to convey the same message to all the audience.

Rogers notes that these main features of an interactive communication originate a shift in control. This power of control is no longer exclusive for the sources or producers of a message. It is also reachable for its receivers or consumers. This means that even the nomenclature becomes somehow obsolete: all the individuals in this communication systems are participants with a potentially equal power of control. According to Rogers, this is producing a great impact in communication research. The traditional linear model of communication is no longer adequate to study an interactive model of communication. The high degree of interactivity calls for a new approach, more suitable for this new type of communication.

It is in this context of paradigm change that the author introduces an analysis of the Information Society. As with previously presented authors, its conceptualisation is sustained in opposition to the characteristics of the Agricultural and Industrial societies. Rogers locates the seed of the Information Society in the mid-50s, in the US. Apart from key characteristics already mentioned (electronics as the basic technology and interactive nature of media), the author identifies information as the main resource of this kind of society. The author acknowledges the abstraction level inherent to this resource, as it does not exist physically. In what regards employment, information workers take the place of factory workers. The labour force is now predominantly constituted by people who produce, process, or distribute information. Consequently, the factory is substituted by the research university in what regards the key institution of this society. Universities hold an information-producing role in what concerns content, but also individuals. As it is put by Rogers (1986, p. 16):

> "Today, access to the scientific upper class is mainly through formal education (especially at the graduate level), through the use of intelligence, rather than through the control of capital as it was for the robber barons of the Industrial Society. To the scientific-technological elites of the Information Society will come money and political influence, but their stock-in-trade is brainpower."

2.2.5. Peter F. Drucker and *Post-Capitalist Society*, 1993

Just three years before Castells' *The Rise Of The Network Society* is published, Peter F. Drucker, management consultant and author, describes a new society, baptised as Post-capitalist Society. Drucker is frequently introduced as one of the most prominent names in the management field. Paying strong attention to human relations, a human approach is to be noted in this work.

Drucker (1993) places the beginning of the Post-capitalist Society immediately after World War II, and defines it as a transition period which was still being lived by then and would continue in the forthcoming years. Thus, the author introduces the Post-capitalist Society as a society which is already able to be studied in some points, but still difficult to predict in others.

This is particularly notorious in what concerns the understanding of the behaviour of the basic economic resource in this society: knowledge. Drucker believes that an economic theory knowledge-centred is still lacking, but its importance as the primary resource in this new society is unshakeable. Knowledge occupies now the previously central position of capital, natural resources, or labour, acting on the structure of society and affecting it at social, economic, and political levels. The main idea is that productivity and innovation create value, and productivity and innovation happen when knowledge is applied to work. Drucker specifies that a shift from knowledge to knowledges already took place, considering the high degree of specialisation needed. Knowledge is defined by the author as information in action. In a Post-capitalist Society, achieving knowledge productivity is possible through management, by applying time and methodology to this objective. In Drucker's view, this is a function performed by organisations, which assume a major role in a Post-capitalist Society.

An organisation is a group of specialised people. It has a single and determined task, which is the only driver of its action and the only focus of its attention. This guarantees that the institution is effective in achieving its results, which are always obtained externally. An organisation (that may be business or non-business) requires management, a degree of autonomy, and is naturally ready for change, as it seeks innovation for value creation. Its most valuable resource are the people who work in it. Knowledge workers emerge as the "new leading social class" of the Post-capitalist Society. They are employed in organisations, while being the owners of the means of production: their knowledge and expertise. This makes them simultaneously dependent on and independent from the organisation. Some managerial aspects regarding the functioning of an organisation are also mentioned, for instance, the flexible leadership positions depending on the assigned project and not on predetermined hierarchies, and a preliminary conceptualisation of what would evolve to be the outsourcing of some services. According to Drucker, responsibility should be the principle guiding an organisation, instead of power. Yet, organisations are not powerless institutions. This power should be however under the scrutiny of political and regulatory entities in order to prevent abuse situations.

Drucker recognises great importance in the social sphere of society, arguing that it should constitute an independent sector that would transcend the organisation. It would be a place to practice citizenship through volunteering actions, for instance. Regarding politics, Drucker believes that the nation-state is not so important as it was before. Society is now facing issues to which the nation-state is not able to respond, being because they happen at a very small or at a very large scale, such as environmental affairs or terrorism. At the educational level, the spotlight is again on the individual: the educated person, as Drucker conveys. In a Post-capitalist Society, it is not possible to dissociate knowledge from the people who own it. As an important source of knowledge, school assumes a

growing importance in a Post-capitalist Society. More than a place in which different disciplines are studied, it becomes an institution able to provide the tools for individual and life-long learning.

2.3. MANUEL CASTELLS AND *THE RISE OF THE NETWORK SOCIETY*, 1996

2.3.1. Castells, intellectual profile

Sociologist Manuel Castells was born in Catalonia in 1942. His intellectual journey as an academic and researcher was initially marked by the studies of Urban Sociology and social movements. Later emerged the theme of ICTs. Regardless of the specific field of study under the spotlight at a given time (as research areas of interest evolved and overlapped since his career began in the late 1960s), Castells identifies power as the nuclear subject in all his work (Castells, 2016; Rantanen, 2005). Power relationships cross all aspects of society, shaping and influencing it at social, economic, political, technological, and communicational levels. The impact of power in society is found in Castells' work across time, always seen through the lenses of a grounded theory, meaning that all the research is strongly empirical, cross-cultural, and relies on a constant open-theorising mindset towards the discovery of new findings and interthematicity to remain relevant (Castells, 2016; Costa et al., 2019).

2.3.2. The concept has risen: the "Network Society"

This focus on power in society leads us to the main concept introduced and developed in the 1990s by Manuel Castells in the first volume of his most acclaimed trilogy *The Information Age*: the concept of "Network Society". *The Rise Of The Network Society* was first published in 1996 and re-edited in 2000 and 2010. In these pages, Castells (2010) defines a new social structure, a new form of society, identified as the society we live in. Informationalism is designated as the object of analysis, and it is classified as pervasive. This means that the central point under analysis - information - is not fixed in a certain domain of society. It is expandable, it connects a myriad of societal spheres and can be studied in many perspectives. The Network Society is based on flows of information. Following this rationale, it is also important to bear in mind the actual structure attributed to the society under study: a network-based structure. A network is defined as a dynamic, open, flexible, and adaptable set of interconnected nodes, holding and exchanging information which flows in this system (Castells, 2010; Castells & Cardoso, 2005). Networks already existed as a form of organisation. However, the combination of this social structure with the new information technologies and its economical applicability never happened before. This merge has changed the performance of activities (Castells, 2010). Due to this networked system, power is reorganised in society and major transformations occur. Castells aims to study this logic with a wide scope, applying it to different societal aspects. This would ultimately reveal impacts, connections, and disconnections between realms.

2.3.3. A tale of technology, communication, media, and politics

The first aspect to be mentioned, mainly because it served as a motor for everything that happened afterwards, is the Information Technology Revolution which started in the 1970s and continued to develop in the following decades, reaching a milestone in 1995, year to which is attributed the creation of the internet in Silicon Valley, in the US (Castells, 2002, 2016). This Information Technology Revolution is characterised by a series of technical developments and new uses in microelectronics, computing, and telecommunications (Castells, 2010), seen as an intrinsic part of society (Castells, 2016; Castells & Cardoso, 2005). These new technologies refer to the creation of the internet, but also to

improvements in wireless infrastructures and connectivity, bandwidth capacity, and mobile devices, all in permanent convergence (Castells, 2005, 2010; Castells et al., 2009). A new Information Technology template is born, with profound impact in the communication realm (Castells & Cardoso, 2005), as we are referring to communication technologies. In the Network Society, communication is a crucial element for connectivity between people, cities, corporations, countries, and many other agents (Castells, 2010). Besides being the technological basis for the network, the internet is also an open, global, horizontal means of communication, meaning that it is a medium which allows for the first time an autonomous communication, without space or time barriers (Castells, 2002, 2005, 2007). It provides a new public space for citizens, with a potentially global reach.

This feature has a profound impact in media and politics. A new type of communication emerges: the mass-self communication (Castells, 2007, 2016). Enhanced by the internet, this form of communication is able to establish connections from the local to the global, from "many selves to many selves". Communication systems become increasingly digital, operating through electronic hypertext and reconfigured multimedia business networks (Castells, 2002, 2016). The Network Society witnesses the emergence of new spaces of mediation, characterised by a higher interaction between audience and organisations, whilst this intertwining still occurs in an institutionalised framework of power (Reese & Shoemaker, 2016). Castells (2007) defines the mass media system as a channel used by the political system to obtain power over people's minds (Castells, 2016). Therefore, media become a space of power (Castells, 2007). However, there is a twist in the Network Society: the political system faces a crisis, with a continuous and generalised discredit of the citizens towards governance (Castells, 2005), but that does not result in a depoliticisation of society. On the contrary, it empowers citizens with their own counterpower, potentiating global networked social movements able to influence decision-making processes. Either symbolising domination or resistance to domination, power struggles act on a networking-logic, once again reinforcing the interdependence of this structure (Castells, 2016).

2.3.4. The informational economy and the widespread global

The Information Age also gives rise to a new techno-economic paradigm (Costa et al., 2019): the informational economy. Castells (2010) summarises this new economy in three adjectives: informational, global, and networked. Information is the material basis upon which all the economy elements operate. Production, consumption, and management processes take place at a global scale, and productivity and competitiveness are now understood in the logic of global networks.

Globalisation is a nuclear point in the analysis of the Network Society, especially in the economical realm, as it describes the fundamental idea of interconnection and interdependency (Castells, 2016). This new economy is global in the sense that all the economies worldwide are dependent on the performance of their globalised core, due to the linkages that unite them, creating a single unit (Castells, 2010). This economic system is constituted by global financial markets, which have become wider and more internationalised, a process in which the new electronic technologies played a relevant part (Castells, 2005, 2010). The informational economy necessarily reshaped capital flows. Technology became paramount for competitiveness. For Castells, the social world is simultaneously empowered by and dependent on information technologies (Costa et al., 2019).

This market globalisation also affected the way corporations are organised (Castells, 2010). In an informational economy, the network enterprise emerges in opposition to the hierarchical forms of institutional organisation. It functions around business projects, which may call for the participation of

different elements that do not need to be organised in a formal structure, as the important matter is to perform a project (Castells, 2002, 2010). This results in horizontal corporations and global business networks, which are by nature able to reconfigure themselves. Castells (2002) also refers to the terms e-commerce and e-business, given the extreme importance of the internet and other computer networks in establishing the connections needed in order to perform these business activities. East Asian business networks (mainly in Japan, Korea, and China) are presented as an example of this form of management and organisation (Castells, 2010). These changes in business practice conducted to a gradual decentralisation and individualisation of work.

2.3.5. Space, time, and the flows between

Castells (2002, 2010) also details the appearance of a new culture, the culture of real virtuality, which is simultaneously real and virtual. The online communities became a good example of it. They exist in an electronic domain, while being undoubtedly part of a concrete reality, as they are not abstract. The culture of real virtuality is marked by the space of flows and timeless time. The first one refers to a new kind of spatiality, defined by processes of information flows, ultimately leading to the creation of metropolitan regions, from which the best examples are again located in the Asian continent (Castells, 2010). The metropolitan regions are constituted by mega-nodes (important areas in the network) and the connections built between networks, always empowered by communication technologies. Timeless time refers essentially to a more flexible view of time experienced in the Network Society.

2.3.6. Castells and the "Network Society": the other sides

While overall Castells demonstrates an optimistic view of the Network Society, he still acknowledges a potentially dark side of this new social structure (Castells, 2002, 2010). The permeability of the networks' infrastructures to be controlled, and without clear regulation, offers those in control the possibility of a stronger power over many more domains. Castells notes that there are questions of sovereignty and privacy to be discussed, being now difficult to state that the internet is totally free. A high degree of connectivity between economies can be dangerous during crisis, somehow accelerating the spreading of its negative effects. The digital divide is referred, being clear that connectivity coexists hand-in-hand with dysconnectivity, and that there are spaces of exclusion, outside the networks. Not everyone nor every place has access or has the same conditions of access to the internet and to other communication networks, fact that draws an undeniable inequality in the Network Society.

Besides being considered one of the most remarkable works in social theory, *The Information Age* has triggered the criticism of some authors. Webster (1997), Webster and Robins (1998) and Garnham (2000) critique falls around the definition of the concept of Information Society, arguing that it is unclear and incoherent. In fact, this is a critique commonly pointed to the wide range of authors working on the topic of the Information Society (Webster, 2006): an underdeveloped and vague definition of the term. The authors argue that this construct refers to the consequences of economic processes that were already happening in the past, not representing a novelty. Stalder (1998) mentions an uncritical political analysis of mass media, as well as a lack of important references.

2.4. PRELIMINARY CONCLUSIONS

The authors referred in this chapter chronologically place their analysis in the end of the 20th century. This is identified as a transition period (Drucker, 1993; McLuhan, 1989) and as a third evolutionary

phase of society (Bell, 1973; Toffler, 1980; Rogers, 1986), which differs greatly from the previous ones. Information is essential in this new type of society.

The new technologies are also at the core of this framework. Progressively electronic (McLuhan, 1989), while benefiting from an intellectual creation background (Bell, 1973), their strong impact at communicational level is widely perceived by the authors (Bell, 1973; McLuhan, 1989; Rogers, 1986; Toffler, 1980). A connection may be established between these new communication technologies and the way work is organised in society. The services sector, the one which operates on information, assumes a prominent position (Bell, 1973). So do the people who work with information (Rogers, 1986), as well as the institutions whose performance relies substantially on information management (Drucker, 1993).

Besides being distinctly marked in society, this technological relevance does not slip into macro-mechanical improvements. In fact, in this technological landscape, the importance attributed to each individual is reinforced (Drucker, 1993; Toffler, 1980). Bell (1973) defines human capital as the main strategic resource in society. Drucker (1993) highlights the importance of human relations in a managerial approach. Rogers (1986) states that the power lies not only in producers, but also in consumers. Accordingly, attention is given to education and the knowledge resulting from intellectual studies (Bell, 1973; Drucker, 1993; Rogers, 1986).

Castells' Network Society emerges after the development of these theories, necessarily finding in them some common points. The Network Society is based on flows of information and runs on an informational economy (Castells, 2010). Therefore, information is no less important than in previous theories. Another common line of thought is the emphasis put on the new technologies and their influence on the way communication happens in society. Castells takes perhaps a step further, consolidating his analysis of communication with specific inputs about the internet, which was just concretely materialised in the end of the 1990s decade.

Castells applies the concept of "network" to his wide study of society and by this way stresses a notion that, while mentioned and foreseen by previous authors, obtains in this analysis a clear sense: globalisation. Castells includes terms such as global financial markets and global business networks. While created by individual nodes, this networked-based structure and networking-logic of society also operates on edges, assuming effectively a global dimension. The individuality of different nodes coexists with a globalisation phenomenon, and its particularities lie perhaps in this constant terminological paradox, which Castells himself often describes: the local and the global, the power and the counterpower, the inclusion and the exclusion in networks (Castells, 2010).

3. METHODOLOGY

In this chapter, the methodological framework applied in this study is presented. The choice of bibliometrics as the method for this work is justified. A brief introduction of available bibliographic databases and bibliometric indicators is offered. The workflow for bibliometric mapping is provided, detailing the specific actions taken in each step of data collection, data cleaning and pre-processing, and data analysis. An overview of the materials used for this study is provided. The main bibliometric techniques are theoretically described.

3.1. THE BIBLIOMETRIC APPROACH

Bibliometrics is a set of techniques used to measure academic output and impact (Broadus, 1987; Pritchard, 1969; van Raan, 2004). It counts the number of publications and citations, and strives to understand their configuration in terms of relevant scholars, institutions, research areas, and content. It is a quantitative approach that applies a batch of statistical analysis to the study of scientific literature. By extracting and analysing information retrieved from academic documents, it is a useful tool in unveiling hidden patterns and trends in a topic of study. Bibliometrics is a branch of scientometrics, part of the information science sphere (Hood & Wilson, 2001). In a field where methodologies frequently overlap, bibliometrics finds its distinctive feature by being clearly focused on the literature. In the end, bibliometrics is a method to measure science through research performance, contributing to its advancement and enhancing knowledge growth.

Bordons et al. (2004) claim that scientific disciplines are becoming more intricated and sometimes difficult to distinguish from each other. This interdisciplinarity, which can be tracked by bibliometrics, provides insights about the interaction between different fields of knowledge (Bordons et al., 2004). Considering that Castells' work belongs to the field of Sociology, it might hold some citation and publication patterns common in the Social Sciences. The extensive work published in other written forms apart from scientific articles, such as books or non-scholarly press (Hicks, 1999, 2004) is one of the most important to be considered. The heterogeneity of Social Sciences is reflected frequently in citations coming from different areas of knowledge (Barnett et al., 2011; Nederhof, 2006). Knowing that different subjects would present different idiosyncrasies which must be taken into consideration, bibliometrics is a method able to shed light in different areas of expertise.

3.2. RESEARCH DESIGN

This broad applicability of bibliometrics justifies why it seems an adequate approach to address the main objective of this study: trace the impact of the concept of Network Society in journal-based scientific literature. We are referring to a sociological concept, undoubtedly connected to the name of Manuel Castells. However, due to its dynamic nature, some meanings could be lost if a strict categorisation into a specific knowledge field was attempted. This term carries an inherent multidimensionality, whose influence can be tracked by a research method such as bibliometrics.

3.2.1. Databases

The idea of creating a citation index for science is due to Eugene Garfield (Garfield, 1955). This unified index would be useful for information retrieval and to assess the impact of a specific work (Small, 2017). In 1960, Garfield founded the Institute for Scientific Information (ISI), whose main product is

the Science Citation Index (SCI). This is considered to be the beginning of the bibliographic databases which aggregate scientific publications related to a wide range of fields. Today, ISI is Web of Science (WoS) and it is one of the most commonly used and recommended databases for bibliometric studies, together with Elsevier's Scopus and Google Scholar (Archambault et al., 2009; Harzing & Alakangas, 2016; Mongeon & Paul-Hus, 2016; Zupic & Čater, 2015). These online databases allow the access of students, academics, and researchers to a great number of scientific literature, which permits reliable statistical treatment. Many kinds of metadata can be extracted from publications. Not only basic information such as names of authors or titles of documents, but also geographical or institutional details. Furthermore, it is possible to analyse the references made by each paper, which is a crucial feature when trying to conduct an interdisciplinary research. After being contextualised, information of such type would likely be useful in unveiling patterns and relevant insights about the subject under study (Narin, 1976; Sugimoto & Larivière, 2018; van Raan, 2004).

3.2.2. Indicators

van Raan (2004) defines an indicator as a mathematical result that addresses a specific assumption and reveals trends. Indicators are relevant in measuring research, as they attribute a numeric weight to academic performance.

Developed in the first half of the 20th century, power laws such as those developed by Bradford (1934) and Lotka (1926) showed how bibliometric data diverged from other kinds of data, essentially because of its regularly observed high skewness. Acknowledging this was an important step in accomplishing one of the main goals in bibliometrics: understanding the structure of science (Sugimoto & Larivière, 2018).

In research measurement, indicators can also be regarded as a way to quantify concepts (Sugimoto & Larivière, 2018). Through this perspective, an indicator is connected to an unobservable concept (research production, for instance) and it is capable of measuring it through observable variables (number of publications, for instance). Indicators can be placed in three different groups: input, such as funding for scientific activity; output, such as papers; and impact, from which citations are a good example.

The use of bibliometric indicators is widely discussed and criticised in the scientific field, mainly when they are used for research evaluation. The inherent quantitative rigour of a mathematical indicator can suffer the influence of many factors. It is important to be aware of these particularities and apply these indicators within their specific context (Sugimoto & Larivière, 2018).

Table 1 presents a summary of bibliometric indicators in this study.

Indicator	Description	Reference
Bradford's Law	Pattern that estimates the exponentially diminishing returns of searching for references in science journals.	Bradford (1934)
Collaboration Index	Co-authors per article index calculated only using the multi-authored article set.	Elango & Rajendran (2012); Koseoglu (2016)
Dominance Factor	Proportion of number of multi-authored papers of an author as first author to total number of multi-authored papers of the author.	Kumar & Kumar (2008)
h-index	A scientist has index *h* if *h* of his or her N_p papers have at least *h* citations each and the other (N_p-*h*) papers have ≤*h* citations each.	Hirsch (2005)
Lotka's Law	Frequency of publication by authors in any given field as an inverse-square law, where the number of authors publishing a certain number of articles is a fixed ratio to the number of authors publishing a single article.	Lotka (1926)

Table 1 – Description and references of main bibliometric indicators in the study

3.3. DATA COLLECTION

For this study, the data was retrieved from the online bibliographic database WoS, a multidisciplinary source with extended coverage and whose findings are highly correlated with other databases (Archambault et al., 2009; Harzing & Alakangas, 2016; Mongeon & Paul-Hus, 2016; Zupic & Čater, 2015). WoS is also considered to be preferable in terms of historical depth, data quality resulting from initial high-level indexing practices, and availability of metadata (Sugimoto & Larivière, 2018).

The search was made for the exact term "Network Society" in the fields title, abstract, authors' keywords and keywords Plus[2] in Web of Science Core Collection[3] and, in a first phase, without any exclusion concerning document types. Later, this retrieval was refined to include only articles and reviews in peer-reviewed academic journals. These formal publications in scientific peer-reviewed outlets were chosen for reasons of consistency and control of the database. We believe that these two types of documents already provide the necessary information to conduct a bibliometric analysis focused on contributions coming from academia. No date restrictions were applied, to ensure thoroughness.

The term "Network Society" was chosen for the query as it covers all the meaning of this work. The Network Society is already a vast and intertwined concept, which encompasses different fields of

[2] Authors' keywords are the keywords chosen by the authors of the publication. Keywords Plus are keywords automatically attributed by the bibliographic databases.

[3] Web of Science Core Collection includes Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index - Science (CPCI-S), Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH), and Emerging Sources Citation Index (ESCI).

study. We decided to focus on this sole concept in order to reach its sense in the most accurate possible way. For this reason, no other similar topic, term, or synonym was included in the search criteria.

As, by retrieval time, the year 2021 was incomplete, the decision was to exclude from the analysis the documents belonging to that year. As a result, the analysis timespan ranges from 1994 to 2020. 1994 is the publication year of the first document corresponding to the query. 2020 is the most recent complete year. Apart from these refinements, no other filtering in terms of search fields was applied. The main justification for that decision is that any exclusion could possibly and inadvertently eliminate relevant results for our work and compromise one of our main goals: determine in which areas the Network Society had impact. No exclusions in terms of language were made, although the search was conducted in English. Data retrieval took place on the 2nd of March 2021.

Figure 1 details the data collection procedures, number of records excluded and reasons for exclusion, and the final number of items used in the analysis.

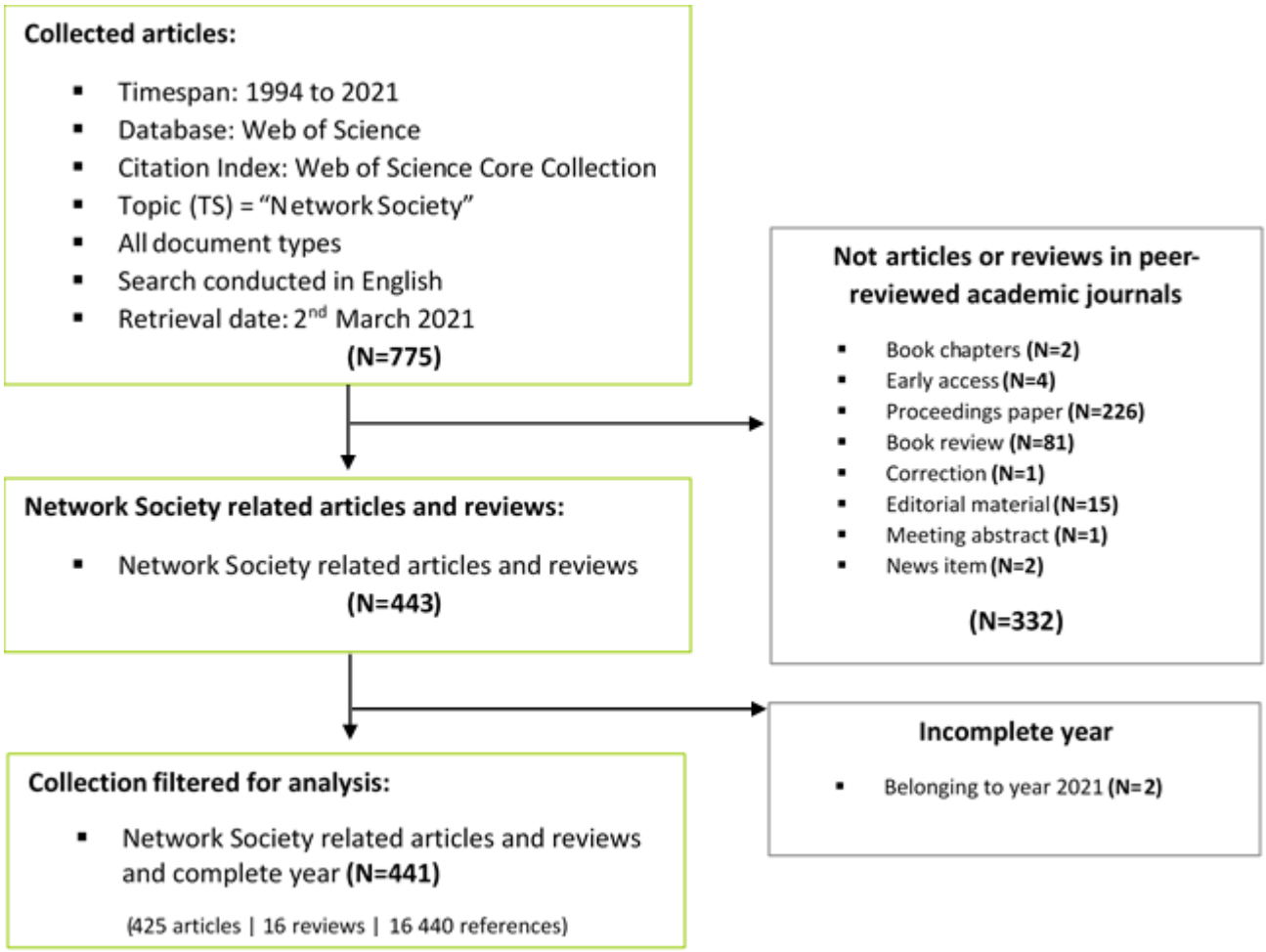

Figure 1 – Diagram of data collection process

3.3.1. Materials

The complete set of articles and reviews in peer-reviewed outlets mentioning the term "Network Society" in the title, abstract, authors' keywords, or keywords Plus up to 2020 were retrieved from the online bibliographic database WoS. Table 2 details the main information about the materials used in this analysis.

Description	Results
Main information	
Timespan	1994 to 2020 (27 years)
Sources	323
Documents	441
Average citations per documents	14.41
Average citations per year per doc	1.14
References	16 440
Publications per year	16.33
Annual Percentage Growth Rate	15.35
Documents	
Articles	425
Reviews	16
Keywords Plus	394
Authors' Keywords	1 526
Authors	
Authors	738
Authors of single-authored documents	216
Authors of multi-authored documents	522
Single-authored documents	233
Documents per author	0.60
Authors per document	1.67
Co-authors per documents	1.82
Collaboration Index	2.51

Table 2 – Main information about the dataset

The dataset analysed ranges from 1994 to 2020, covering a timespan of 27 years. The final corpus is constituted by 441 documents (425 articles and 16 reviews) from 323 different peer-reviewed academic journals indexed in WoS. The collection presents a predominance of articles (96% of the total manuscripts) and a total of 16 440 references. The number of keywords attributed by the authors (1

526) is greater than the number of keywords attributed by the bibliographic database (394). The average citations per documents is 14.41. On average each publication receives slightly more than 1 citation per year (1.14).

There is a total of 738 authors, from which 71% (522) are authors of multi-authored documents, while 29% (216) are authors of single-authored documents. Most of the items (53%, 233) are single-authored documents. The number of single-authored and multi-authored documents is approximately the same, although the authors typically tend to collaborate. The index of authors per document (which considers each author only once, even if that author has more than one publication) is 1.67 and the average number of co-authors per article (which considers author appearances) is 1.82. The Collaboration Index of 2.51 shows that, considering the multi-authored documents set, the number of co-authors per article surpasses two.

3.3.2. Data cleaning and pre-processing

In a preliminary analysis of the raw data, it was noted that in some cases one author was being identified under two different names, or different authors were being identified under the same name. Name ambiguity is a common issue in bibliometric analysis (Tang & Walsh, 2010), which needs to be addressed in order to guarantee that it does not have implications in the final results. It was necessary to conduct a name disambiguation at the authors' level. A list of all the names of the authors was manually checked in search of possible name ambiguity problems, such as the same name spelling for different people, different name spellings for the same person, or misspelling errors (Tang & Walsh, 2010). Word ambiguity problems were also detected in other variables in the data frame, namely affiliations, authors' keywords, keywords Plus, and cited references. Apart from ambiguity issues, it was also noted the existence of blank spaces and wrongly identified information in different variables. Plus, the presence of authors identified as "Anonymous" in the cited references was prominent. The Pattern Replacement Function *gsub* in R was applied to address these questions. It was used to standardise words referring to the names of authors and institutions, as well as keyword terms. Regarding the keywords, the plural forms (for instance, "networks") were edited to the singular forms ("network", in this case), for accuracy reasons. The *gsub* function seemed also adequate for the cleaning actions needed. It was applied to clean the blank spaces, wrongly categorised information, and delete the "Anonymous" in the cited references, with the purpose of obtaining a cleaner dataset. The metadata was double-checked in order to verify the existence of duplicate entries[4].

3.4. DATA ANALYSIS

3.4.1. Techniques

Citation analysis, co-citation analysis, bibliographic coupling, co-author analysis, and co-word analysis are the main bibliometric techniques (Zupic & Čater, 2015).

Citations are considered a measure of influence, similarity, and objectivity, able to estimate the impact of different units of analysis, especially in a cumulative perspective (Aria & Cuccurullo, 2017; Garfield,

[4] The only one identified is an article by Manuel Castells, "Materials for an exploratory theory of the Network Society", published in two different outlets: *Berliner Journal Fur Soziologie* and *British Journal Of Sociology*. We believe that this sole article by Castells would not introduce bias in the analysis; on the contrary, it might add interpretational value. The choice was to maintain this article in the corpus.

1979; Sugimoto & Larivière, 2018; Zupic & Čater, 2015). Moreover, citations are regarded as relational data, capable of providing insights of a different nature (not just purely quantitative). While the reasons behind a citation can be vast, it necessarily implies an interaction of some kind between different pieces of research (Sugimoto & Larivière, 2018). In a bibliometric study, citations can be classified as global or local. Global citations are the citations that a document which is part of the collection receives from any document indexed in the bibliographic database. Local citations happen when a document in the collection is cited by documents which are also part of the analysed set. In relational terms, co-citation and bibliographic coupling are two specific techniques of citation analysis (Aria & Cuccurullo, 2017; Narin, 1976).

As defined by Small (1973), co-citation happens when two documents are cited together, therefore analysing the cited documents themselves. This means that a co-citation connection is established when one or more documents in the dataset cite two articles in the references, being the weight of the connection dependent on the number of articles which produce this co-citation. This bibliometric technique is also typically applied to authors and sources. On the other hand, bibliographic coupling links units of analysis that share the same bibliographic references, which results in a connection between the citing documents, authors, or sources. The difference between these two techniques lies precisely in the nature of the units of analysis: reference lists are fixed, while citations are dynamic. As a result, co-citation analysis is commonly agreed to be more suitable to detect evolutions in knowledge structures across time (Aria & Cuccurullo, 2017; Sugimoto & Larivière, 2018; Zupic & Čater, 2015). Fig.2 (adapted from Vogel & Güttel, 2013; Zupic & Čater, 2015) offers a visual representation of both techniques.

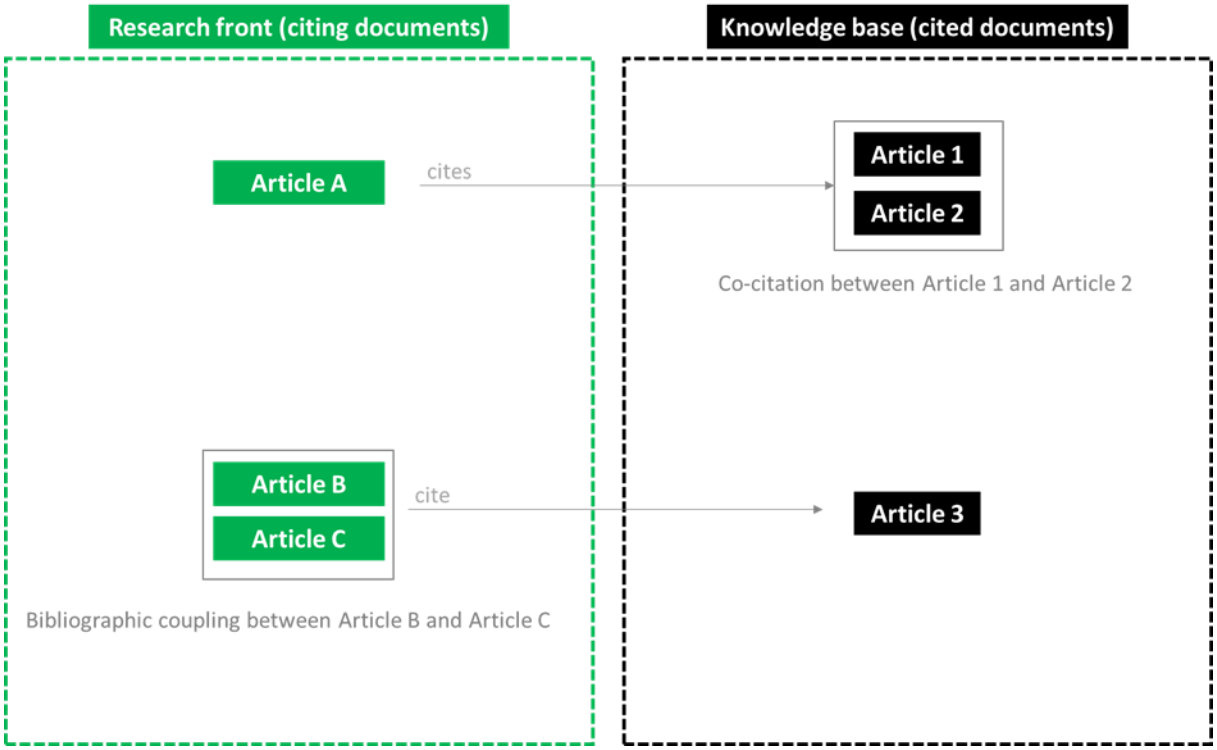

Figure 2 – Visual representation of co-citation and bibliographic coupling techniques

The notion of authorship varies across disciplines, as some tend to recognise as authors not only the individuals who perform the task of writing, but also others who make their contribution to the scientific output through different forms (Sugimoto & Larivière, 2018). Co-authorship refers to the shared authorship of a paper between two or more individuals, implying collaboration between academics. Consequently, co-authorship highlights the importance of social relations, and tends to be elucidative about a social structure surrounding a particular theme (Noyons, 2004). In bibliometrics, scientific collaboration is seen as an important factor, as it means recognition of quality work (Beaver & Rosen, 1978; Uddin et al., 2012). An interesting facet of co-authorship is that it puts in evidence the links between authors, but also between journals, institutions, and organisations. It is largely empowered by the digital technologies, allied with an increasing mobility and a growth in international funding programs (Sugimoto & Larivière, 2018). Scientific production is evolving as a hybrid network. Collaborations are happening in many forms: amongst different research institutions, different sectors (academic, industrial or governmental, for instance), and different countries (Glänzel & Schubert, 2004; Heimericks et al., 2003). This form of collaboration, which is expanding internationally but still restricted within the scientific community, shows a networked-nature (Zitt & Bassecoulard, 2004).

Co-word studies the co-occurrence of words and their strength of association in the titles, abstracts, or keywords of manuscripts. It is a content analysis. Co-word is the only technique which uses the words of the documents as units of analysis, aiming to understand the cognitive structure and thematic evolution of a research field through the concepts used in scientific texts (Callon et al., 1991; Cobo et al., 2011; Noyons, 2004; Zupic & Čater, 2015). The method relies on the background creation of a co-occurrence network of keywords. Each cluster in this network, interpreted as a conceptual group, corresponds to a research theme (Cobo et al., 2011), and a set of research themes is a research field. The themes appear based on the interactions between the terms, and do not depend on previous definitions (Callon et al., 1991). These themes are visualised by being plotted in a strategic diagram (see Appendix A), according to two measures: centrality and density (Callon et al., 1991; Cobo et al., 2011). Centrality refers to the strength of external ties of the theme to other themes, therefore measuring its relevance for all the research field. Density is related to the strength of internal ties within the research theme itself, being a metric of its own development. Depending on their position in the diagram, they are categorised as highly developed and isolated themes, motor themes, emerging or declining themes, and basic and transversal themes (Cobo et al., 2011). Motor themes and basic and transversal themes are both important for the research field, but while the first group is internally very well developed, the second is undeveloped. On the other hand, highly developed and isolated themes and emerging or declining themes are both peripheral to the research field, but while the first group is internally well developed, the latter is undeveloped. If these themes are tracked over time, they may reveal thematic areas, which are an evolution of themes in different sub-periods. This is a way to understand the conceptual structure of a research field, by identifying thematic trajectories.

3.4.2. Mapping a scientific field

Methodologically, bibliometrics goes beyond the individual weighting of scientific production. It enables descriptive statistics, but it is also a way to implement science mapping, an approach focused on unfolding the structure and dynamics of scientific fields (Aria & Cuccurullo, 2017; Zupic & Čater, 2015). The purpose of mapping a scientific field is to obtain a wider and consistent perspective about a topic of research. The interest lies in the relations between the different units of analysis (authors, references, sources, countries, institutions of affiliation, titles, abstracts, keywords), hoping that the

connections established between these elements would reveal a bigger picture about a research area. The relevance of this type of analysis dwells in the evolution of a particular theme across time, in the changes its structure may have faced, and in the trends it followed or even created.

A science mapping analysis relies greatly on a network matrix creation for a visual representation of results (Aria & Cuccurullo, 2017). Network analysis is therefore interpreted through graphs and a group of statistics that can be applied at the network level and at the vertex level. The main measures are degree centrality, closeness centrality, and betweenness centrality (Aria & Cuccurullo, 2017; Barnett et al., 2011; Uddin et al., 2012). At the network level, degree centrality represents the average number of nodes to which each node of a given network is linked. At the vertex level, this index is applied to a particular node. Closeness centrality describes, at the network level, the average shortest-path distance among the nodes in a network. At the vertex level, it represents the number of steps needed to reach every other vertex in the network, departing from the vertex analysed. In what concerns betweenness centrality, it is used at the network level to determine the average capacity to control the stream of information in the network for each node. For an individual vertex, betweenness centrality measures its gatekeeping potential, representing approximately the number of shortest-paths in which it is found between any pair of nodes in the network. In a network interpretation, it is also worth mentioning the statistics of size (number of nodes in the network), density (proportion of present edges from all possible edges), diameter (length of the shortest-path between two nodes), and average path-length (mean of the shortest distance between each pair of nodes).

3.4.3. Data analysis process

The data was analysed in R, using the package *bibliometrix,* as well as the biblioshiny app and the package *ggplot2*, for complementary analysis and visualisation. This open-source tool allows a wide range of bibliometric analysis (Aria & Cuccurullo, 2017).

The data was extracted from WoS in BibTeX format. Afterwards, it was imported to R and converted into a bibliographic data frame. In a first phase, an exploratory analysis of the corpus is performed. It consists of descriptive statistics to obtain an overview of the records. Data analysis was performed for authors, countries, affiliations, journals, subject categories, documents, and keywords, considering the time window of 1994 to 2020. The analysis conducted in this section are the following:

- Annual scientific production from 1994 to 2020
- Total citations per year
- Number of publications and total citations for each period
- Most productive authors on the topic of the “Network Society”
- Top-cited authors on the topic of the “Network Society”
- Top-authors’ production over the time
- Most productive countries (First authors): Single Country Publications (SCP) and Multiple Country Publications (MCP)
- Top-cited countries on the topic of the “Network Society”
- Most frequent affiliations
- Top-journals in terms of publication on the “Network Society”
- Top-cited journals on the topic of the “Network Society”
- Yearly evolution of the average of SJR Quartiles of the most relevant sources
- Most frequent subject categories
- Evolution of subject categories per year, in absolute number of articles
- Top-cited documents on the topic of the “Network Society”

- Word cloud of authors' keywords
- Authors' keywords growth

After this introductory information, the scientific field of the Network Society is mapped. In what regards science mapping, the timespan from 1994 to 2020 is divided in three time slices: 1994 to 1999, 2000 to 2009, and 2010 to 2020. The goal is to better capture the trajectory, evolution, and influence of the string "Network Society" over time. These time slices are related to the publishing years of the three editions of *The Rise Of The Network Society*. The first volume of *The Information Age* was published for the first time in 1996. It was re-edited twice: in 2000, right at the verge of a new century, and in 2010, at the end of the first decade of that new century.

The first period, from 1994 to 1999, aggregates the years of first edition only. The next periods are partitioned using the year of each edition as a cut-off point. This yields the following data arrangement: from 1994 to 1999 (4 documents, 62 references), from 2000 to 2009 (104 documents, 3 311 references), and from 2010 to 2020 (333 documents, 13 286 references).

The period from 1994 to 1999 is substantially different from the remaining ones, as it only contains four published documents (see Appendix B). This has statistical implications while performing a bibliometric analysis. The choice was to maintain it as an individual period, for accuracy reasons when analysing the evolution of the Network Society. It corresponds to a time when the concept was still emerging, meaning that its appropriation by scientific literature was necessarily residual.

The main bibliometric techniques of co-citation and bibliographic coupling are applied to map the intellectual structure of the field. The networks created are three co-citation networks of authors (1994 to 2020, 2000 to 2009, and 2010 to 2020), and three bibliographic coupling networks of authors (1994 to 2020, 2000 to 2009, and 2010 to 2020). For each network, the top-25 nodes with the highest values for the centrality measures of degree centrality and betweenness centrality are detailed (see Appendix C to H).

The conceptual structure is analysed through two thematic maps (from 2000 to 2009, and from 2010 to 2020). To close the science mapping analysis, a thematic evolution is displayed, in the form of a Sankey plot. Figure 3 provides the workflow for science mapping analysis used in this work (Aria & Cuccurullo, 2017; Zupic & Čater, 2015), summarising the actions taken in each step of analysis.

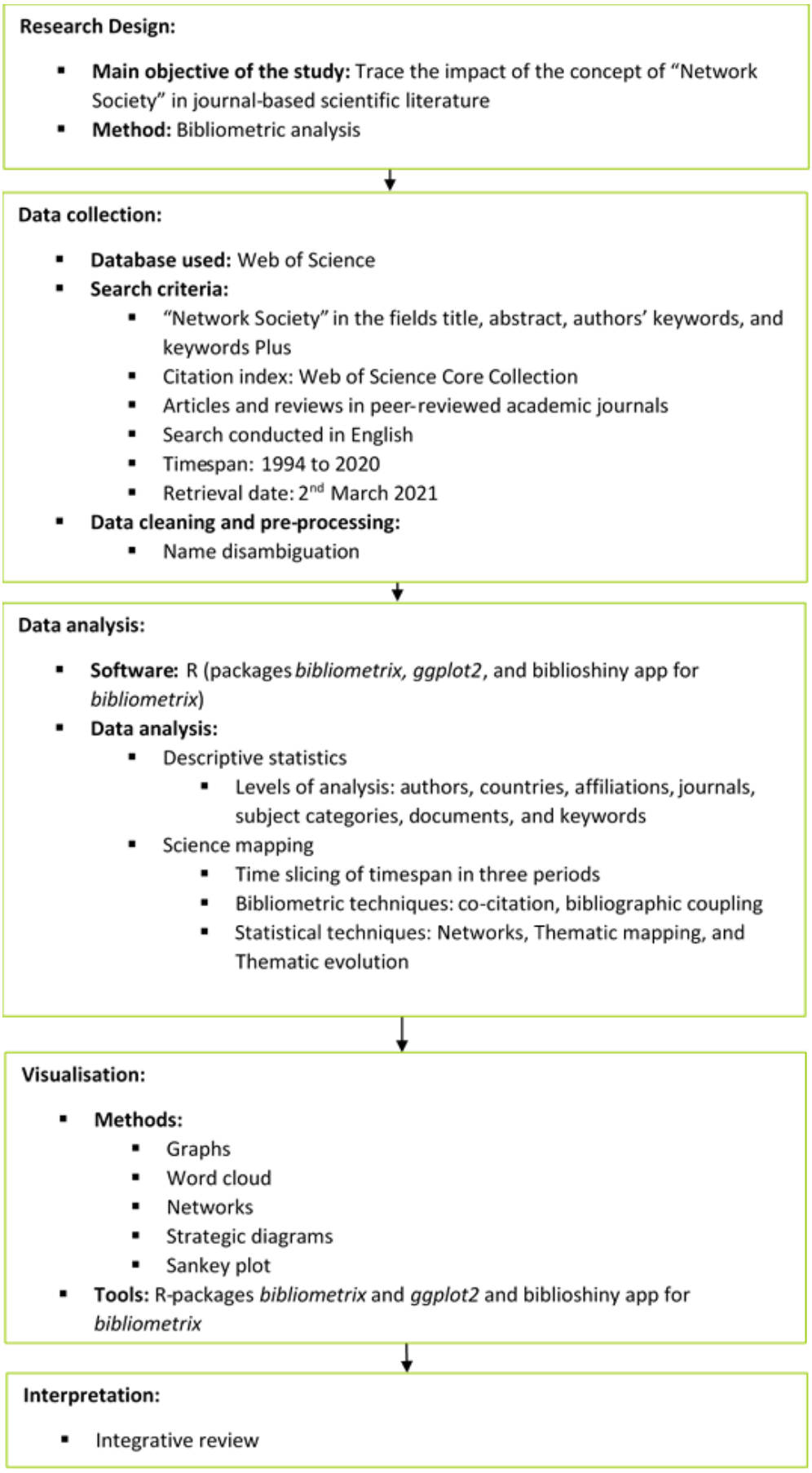

Figure 3 – Applied workflow for science mapping with bibliometric methods

4. RESULTS AND DISCUSSION

4.1. EXPLORATORY ANALYSIS

4.1.1. Annual scientific production

Regarding annual scientific production, from 1994 to 1999, the term "Network Society" has somewhat of a slow start. As we may observe in Fig. 4, there is no production in 1995 and 1996, and only one article was published in each of the years 1994, 1997, 1998, and 1999. The average of publications per year in this period is 0.67. It is therefore possible to affirm that the first edition of *The Rise Of The Network Society* in 1996 did not promote an immediate usage of the term.

By the year 2000, the concept was picked up in the literature and in the ensuing decade the number of relevant publications will average 10.4 per year. However, it is from 2010 to 2020 that scientific production has a marked step jump. The average yearly publication triple (30.27). The number of published items is for the first time superior to 20 in 2012 and 2013. This is followed by a decrease, as the number of published documents in 2014 (6) is the lowest since 2005 (5). From 2015 on, we may consider that a peak of production is reached. Annual scientific production obtains the highest values in the last six years of the timespan. 2015 (47 articles) presents more 41 documents than the previous year. 2017 (49 articles) is the year with the highest number of published papers in this collection. We may therefore consider that since 2015 the topic "Network Society" achieves a new relevance in the scientific field. The annual percentage growth rate of scientific production in this dataset is 15.35.

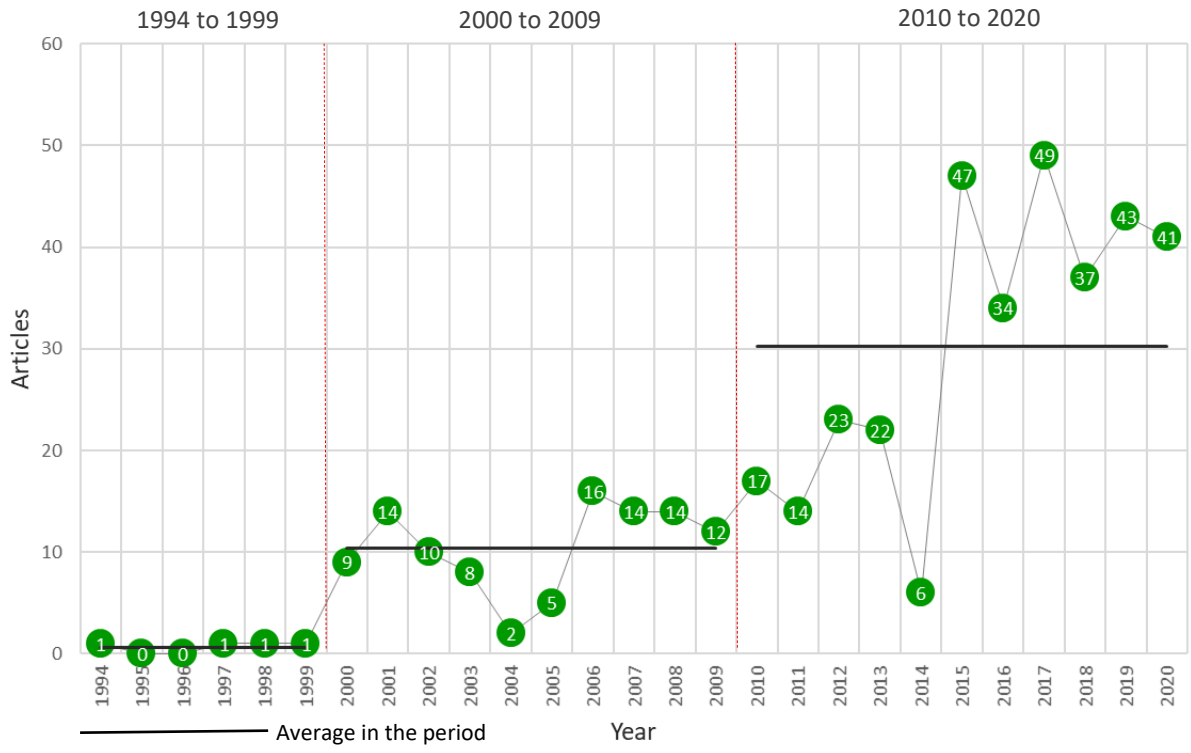

Figure 4 – Annual scientific production from 1994 to 2020

4.1.2. Citations

This dataset gathers a total of 6 353 citations from the 441 documents. Fig. 5 shows the yearly evolution of total citations. From 1994 to 1999, the average of citations is 2.5. From 2000 to 2009, this average value augments to 463.6. The total citations peak is reached in 2003 (939 citations), and a close value is obtained in 2000 (903 citations). After this peak of citations in the first years of the 2000s, a clear decreasing trend might be noted in the following years. From 2010 to 2020, the average of citations (154.73) is inferior when compared to the previous period. While being common in bibliometric analysis for the most recent years to obtain lower citation numbers (as they have less time to be cited), in this collection it could be seen as a particularity. In fact, the total number of citations registered in 2000 and 2003 (1 842 citations) represents 29% of the total citations count. It is important to note that *The Rise Of The Network Society*'s second edition was published in 2000, which can be a justification for the boost on the usage of the term.

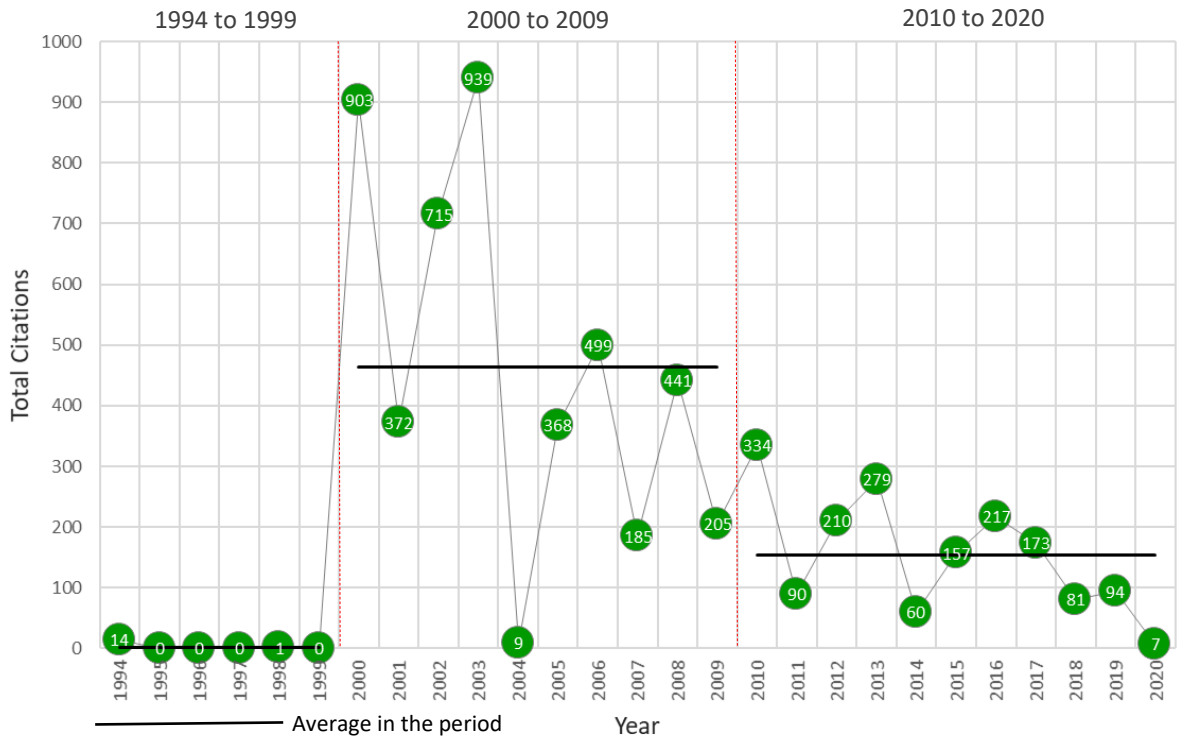

Figure 5 – Total citations per year

Therefore, the annual scientific production and the total citations display opposite patterns. While the annual scientific production presents an increasing trend, reaching its peak in the last years analysed, the higher values of total citations are obtained in the first half of the timespan. Table 3 shows the absolute number of publications and total citations in the timespan and in each one of the periods considered for analysis, as well as their weight for the entire collection.

Period	Number of publications	% of the total dataset	Total Citations	% of the total dataset
1994 to 1999	4	0.9%	15	0.2%
2000 to 2009	104	23.6%	4 636	73%
2010 to 2020	333	75.5%	1 702	26.8%
1994 to 2020	**441**	**100%**	**6 353**	**100%**

Table 3 – Number of publications and total citations for each period

The period from 1994 to 1999 presents residual results for both variables. From 2000 to 2009 happen 73% of the total citations in this collection. This points to a notoriety of the topic of the "Network Society" in this time window. The period comprised between 2010 and 2020 does not hold this impact in terms of citations, but clearly displays a "take-off" in production (75.5% of the total collection).

4.1.3. Authorship

At the authors' level, an individual clearly stands out: Manuel Castells. Castells, the "father" of the Network Society, is the most productive author, both at individual (6) and fractionalised[5] (5.50) levels. The sociologist is as well the most impactful author in this collection, with the highest *h-index* (5) and the highest number of citations (841).

Considering the remaining authors in the productivity ranking in Table 4, only one has four published articles related to the Network Society. Seven share the 3rd position in the top, with three publications each. Two authors have three publications at individual and fractionalised levels, which means that they have not collaborated with other authors. One achieves an *h-index* of 4 and three an *h-index* of 3. This is a heterogeneous group, composed by scholars with different research areas and affiliations.

[5] Fractional counting is an indicator of proportional contribution. Each individual author receives the corresponding share of authorship in a document (Sugimoto & Larivière, 2018). It assumes a uniform contribution by each individual in a co-authored paper.

Position in ranking	Author	Number of publications	*h-index*	Total Citations
Individual				
1	Manuel Castells	6	5	841
2	Peter Millward	4	4	83
3	Aimei Yang	3	3	19
	Iain Munro	3	3	67
	Irina Kuzheleva-Sagan	3	1	3
	Brett Hutchins	3	3	142
	Robert Hassan	3	1	2
	José Antonio Caride Gómez	3	1	2
	Gregg Bordowitz	3	0	0
Fractionalised				
1	Manuel Castells	5.50	5	841
2	Gregg Bordowitz	3	0	0
	Robert Hassan	3	1	2
3	Peter Millward	2.67	4	83
4	José Antonio Caride Gómez	2.50	1	2
	Iain Munro	2.50	3	67
5	Jonathan Beaverstock	2.00	2	536
	Marco Bruno	2.00	1	1
	Michael Corbett	2.00	2	53
	Brett Hutchins	2.00	3	142
	Irina Kuzheleva-Sagan	2.00	1	3
	A.V. Nazarchuk	2.00	2	10
	Erna Oliver	2.00	1	3
	Alexei Shcherbinin	2.00	1	2

Table 4 – Most productive authors on the topic of the "Network Society"

In this collection, 13 authors have a Dominance Factor of 1, but just two also integrate the ranking of the most productive authors: Caride Gómez and Kuzheleva-Sagan. Both have published three articles. The Spanish author single-authored two manuscripts, and multi-authored and first-authored one. The Russian researcher single-authored one manuscript, and multi-authored and first-authored two.

Regarding author productivity, Lotka's Law states that, as the number of published documents increases, the number of authors producing them decreases, and vice versa. This describes an inverse relation between the number of documents and the number of authors. The observed distribution in this dataset follows the theoretical Lotka's Law distribution (see Appendix I). 92.8% of authors (685) have written only one article.

In terms of volume of total citations received by this collection (Table 5), Castells is the most cited author: 841. Next, we may find the names of Kenneth Hacker and Jan van Dijk, both with 541 citations due to the co-authorship of a single paper, and Jonathan Beaverstock, holding 536 citations. The 15 authors who compose the ranking are above the threshold of 150 citations. Three ranking positions are shared between two or more individuals. All refer to collaborations between those authors.

Position in ranking	Author	Country of affiliation	Total citations	Number of publications	*h-index*	Publication year start
1	Manuel Castells	US	841	6	5	2000
2	Kenneth Hacker	US	541	1	1	2003
	Jan van Dijk	Netherlands	541	1	1	2003
3	Jonathan Beaverstock	England	536	2	2	2002
4	Erik-Hans Klijn	Netherlands	414	2	2	2002
5	Joop F. M. Koppenjan	Netherlands	243	1	1	2003
	Ellen M. van Bueren	Netherlands	243	1	1	2003
6	Mark Deuze	US	223	1	1	2006
7	Michael Dillon	England	204	2	2	2001
8	Geert R. Teisman	Netherlands	171	1	1	2002
9	Keith Hampton	US	169	2	2	2001
10	Julian Reid	England	165	1	1	2001
11	Itziar Castelló	Spain	161	2	2	2013
	Mette Morsing	Denmark	161	2	2	2013
	Friederike Schultz	Denmark	161	2	2	2013

Table 5 – Top-cited authors on the topic of the "Network Society"

The most productive authors are not the most cited authors. In fact, four of the most productive authors at the individual level have a number of total citations below five. Apart from Castells, any other author reaches the threshold of 150 citations. At fractionalised level, only Beaverstock accompanies Castells in conquering more than 150 citations. The majority of the most cited authors achieves these top positions in the ranking with a scientific production of one or two articles, being again Castells the only exception.

The top-authors' production over the time (Fig. 6)[6] displays that Castells' track begins in 2000, with two documents and a total of 636 citations. This was a hit year for the author: the highest number of published documents and citations are achieved. Four more articles are published in the analysed period, but without a comparable number of citations. Castells' last publication is in 2010, before the increase in production verified in the 2010s.

[6] The graph shows the authors with three or more published documents in this dataset, ordered by number of publications. The size of the bubble represents the number of articles in each year and the intensity of colour indicates the total citations per year.

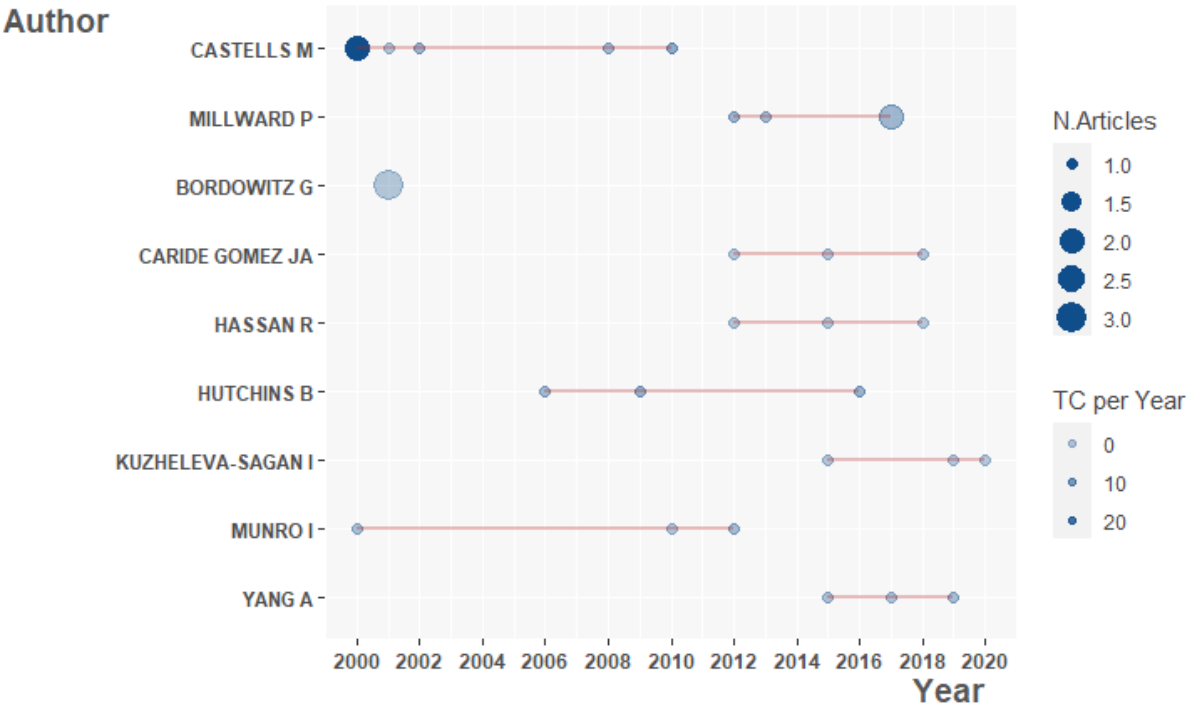

Figure 6 – Top-authors' production over the time

The remaining authors present a somehow fragmented and discontinuous pattern. A clear pattern is displayed amongst the most productive authors in this collection: production is concentrated in the second half of the timespan. The majority started publishing from 2012 on.

4.1.4. Countries

The most productive countries are the US (51 articles, 11.6% of the total documents), Spain (46 articles, 10.4%), the UK (43 articles, 9.8%), Russia (32 articles, 7.3%), and the Netherlands (29 articles, 6.6%). Among the most productive countries, international collaboration is low. Spain is the country with the highest number of MCP (6), followed by the UK (5) and the Netherlands (4). Fig. 7 displays the country of affiliation of the first authors.

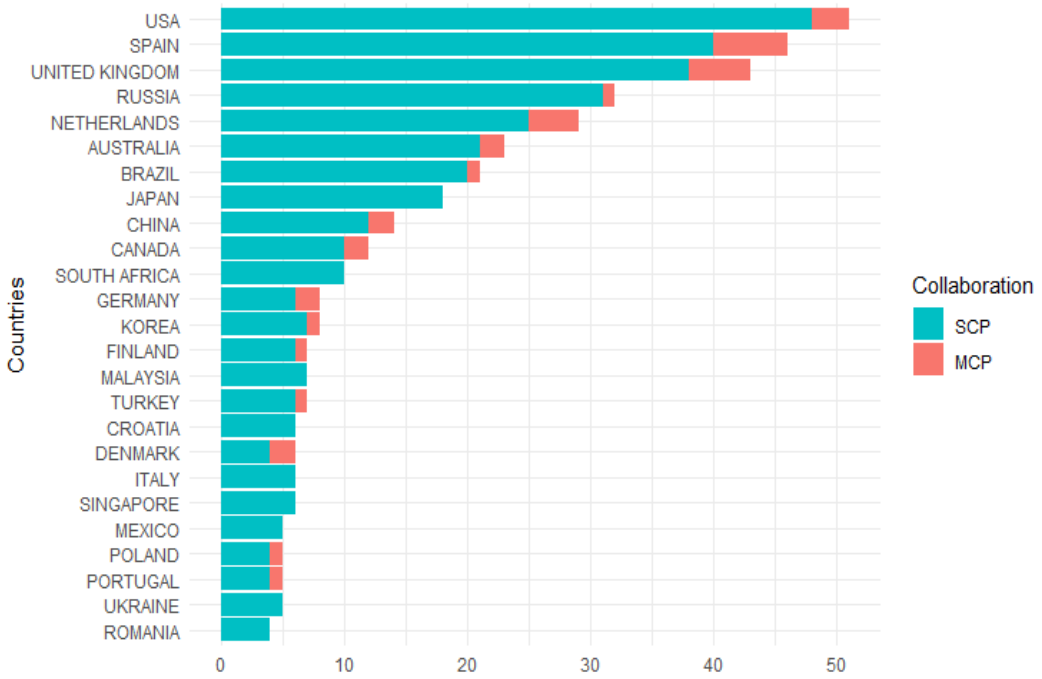

Figure 7 – Most productive countries (First authors): Single Country Publications (SCP) and Multiple Country Publications (MCP)[7]

In Table 6 we may find the countries with the highest number of citations. The Netherlands (1 690 citations), the US (1 566 citations), and the UK (1 402 citations) stand out as the most influent countries. Together, these three countries contribute with 73.3% for the total citations in the corpus. It is interesting to note that, while being the most cited country, the Netherlands has a lower level of production when compared to those of the US, UK, and Spain.

Position in ranking	Country	Total Citations	% for the total dataset	Average article citations	Number of publications (first authors)	% for the total dataset
1	Netherlands	1 690	26.6%	58.28	29	6.6%
2	US	1 566	24.6%	30.71	51	11.6%
3	UK	1 402	22.1%	32.61	43	9.8%
4	Spain	327	5.1%	7.11	46	10.4%
5	Australia	289	4.5%	12.57	23	5.2%
6	Denmark	154	2.4%	25.67	6	1.4%
7	Canada	131	2.1%	10.92	12	2.7%
8	Korea	115	1.8%	14.38	8	1.8%
9	Singapore	97	1.5%	16.17	6	1.4%
10	Finland	64	1.0%	9.14	7	1.6%

Table 6 - Top-cited countries on the topic of the “Network Society”

[7] SCP refers to publications with only one country of affiliation. MCP refers to publications with more than one country of affiliation.

4.1.5. Institutions of affiliation

In respect to the most frequent affiliation institutions of the authors (Fig. 8), the Russian Tomsk State University leads the ranking, with 20 affiliations in this collection. The Spanish Universidade de Santiago de Compostela holds the 2nd position, with 12 affiliations. *Ex-aequo* in the 3rd place, with 11 affiliations each, the also Spanish Universitat Oberta de Catalunya, and the North American Universities of Southern California and California, Berkeley.

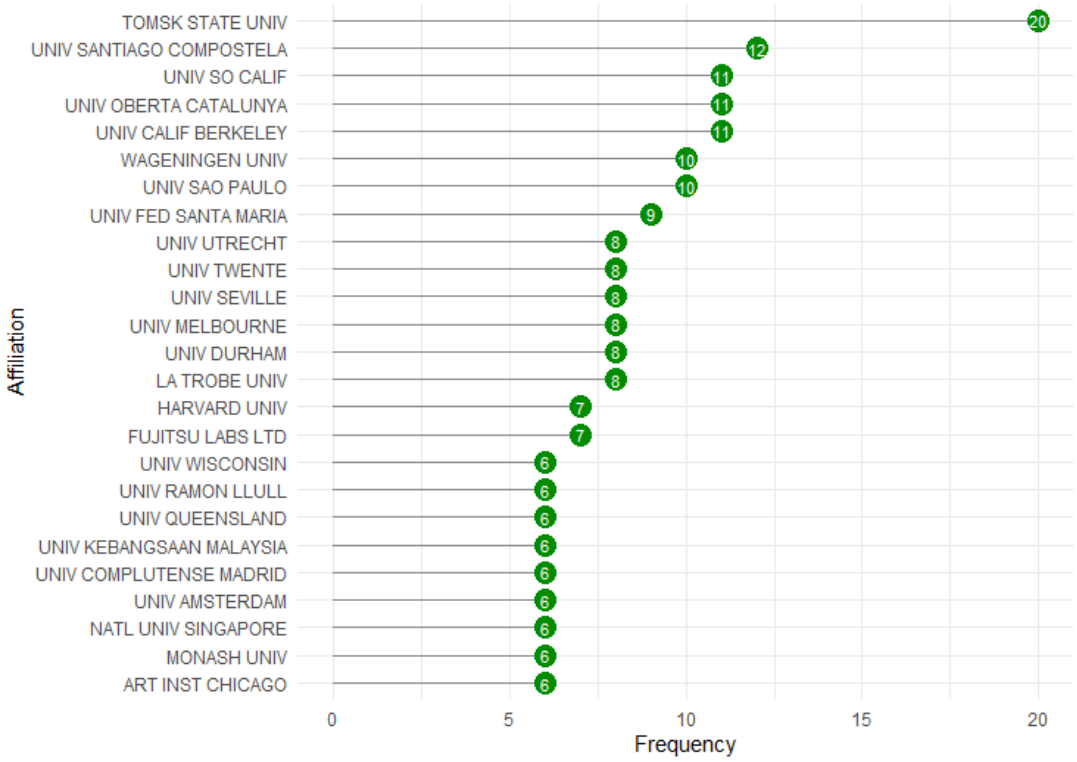

Figure 8 – Most frequent affiliations

This ranking is fully composed by Universities, being Fujitsu Laboratories Ltd the only exception, with seven affiliations. The technological company has research labs in Japan, but also in North America, China, and Europe, developing work related to digital innovation.

4.1.6. Journals

In Fig. 9 we find the ranking of the journals in terms of publication on the Network Society.

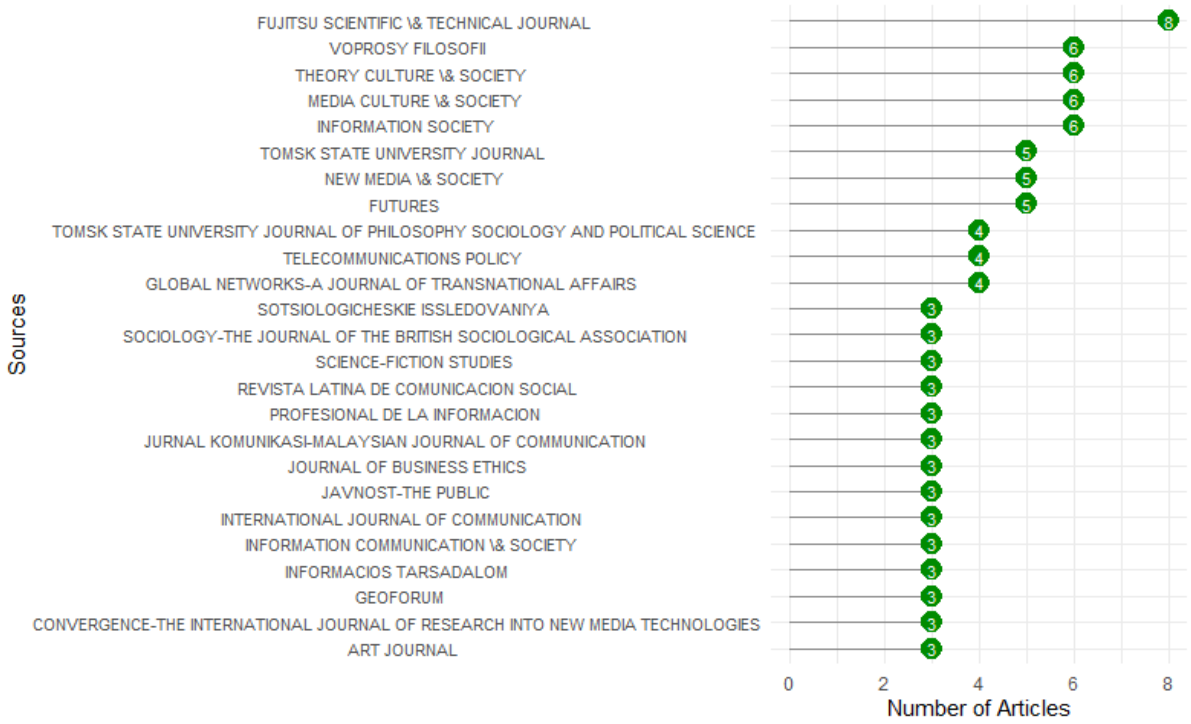

Figure 9 – Top-journals in terms of publication on the "Network Society"

11 journals published four or more articles on the topic of the Network Society. These sources account for 13.4% of the total documents in the dataset. *Fujitsu Scientific & Technical Journal* is the most productive source, with a total of eight articles (1.8% of the total documents). This is the outlet in which the giant Japanese tech company publishes its research, works, and services. In this analysis, it is the only journal whose name is related to a firm. The second position in the ranking is shared by four sources, each with six articles: *Voprosy Filosofii*, *Theory, Culture & Society*, *Media, Culture & Society*, and *Information Society*. Contributing individually with 1.4% of the total documents, this group accounts for 5.4% of the total articles in the dataset.

Table 7 presents the most cited journals. 18 are above the threshold of 100 citations. The top-cited sources are *Information Society* (788 citations, 12.4% of total citations), *British Journal of Sociology* (529 citations, 8.3% of total citations), *Geoforum* (332 citations, 5.2% of total citations), and *Journal of Ethnic and Migration Studies* (309 citations, 4.9% of total citations). *Information Society* is focused on the Information Age. Its scope is information policy issues affecting society, from regulation to organisational performance. As the name indicates, *British Journal of Sociology* is dedicated to the field of Sociology, while *Geoforum* has an interdisciplinary approach to Human Geography and similar areas, addressing issues such as national systems of regulation and governance, and urban and regional development. *Journal of Ethnic and Migration Studies* publishes works related to migration.

It is interesting to note a different profile in the most productive and most cited journals. While *Fujitsu Scientific & Technical Journal* holds the highest number of publications (8), it is not one of the most cited sources, with just nine citations between 1994 and 2020. The same happens with *Voprosy Filosofii* (6 publications, but only 11 citations), *Tomsk State University Journal* (5 publications and 1 citation), and *Tomsk State University Journal of Philosophy*, *Sociology and Political Science* (4 publications and 1 citation). *Fujitsu Scientific & Technical Journal* is a Japanese publication, while the others are from the Russian Federation. In the ranking of the most cited sources, there is not any publication from the Asian continent. The UK emerges as the country with more journals in this ranking.

Position in ranking	Journals	Total Citations	% for total citations in dataset	Number of publications	Country
1	Information Society	788	12.4%	6	UK
2	British Journal of Sociology	529	8.3%	2	UK
3	Geoforum	332	5.2%	3	UK
4	Journal of Ethnic and Migration Studies	309	5.9%	2	UK
5	Media, Culture & Society	264	4.2%	6	UK
6	Journal of Public Administration Research and Theory	243	3.8%	1	UK
7	Public Administration Review	171	2.7%	1	UK
8	Journal of Business Ethics	169	2.7%	3	Netherlands
	American Behavioral Scientist	169	2.7%	2	US
9	Millennium – Journal of International Studies	165	2.6%	1	UK
10	Ecology and Society	143	2.3%	1	Canada
11	European Planning Studies	142	2.2%	1	UK
12	Online Information Review	129	2%	1	UK
13	Theory, Culture and Society	127	2%	6	UK
14	New Media & Society	126	2%	5	US
15	Technological Forecasting and Social Change	115	1.8%	1	US
16	Contemporary Sociology – A Journal of Reviews	111	1.7%	1	US
17	Urban Studies	101	1.6%	3	UK

Table 7 – Top-cited journals on the topic of the "Network Society"

When analysing scientific journals, SCImago Journal & Country Rank (SJR) is a useful source. SJR is a public repository of journal metrics, which yields information regarding the prestige of periodicals. One of these metrics are the Quartiles, a yearly classification attributed to each category of the subject areas[8] covered by the journal. Quartile 1 (Q1) is the highest, followed by Q2, Q3, and Q4. In Fig.10 we may observe the evolution per year of the average SJR Quartiles (SCImago, 2020), considering all the

[8] Subject areas refer to the main thematic areas, while categories refer to specific sub-fields of those areas.

categories of the most relevant journals in terms of production (with four or more publications) and impact (with more than 150 citations) in this collection. It is put in evidence that the average Quartiles of the relevant journals on the topic of the Network Society tend to evolve towards Q1. In fact, while from 1999 to 2009 several categories are classified in Q2, from 2010 to 2020 Q1 becomes predominant (for full detail by journal and category, see Appendix J). This tendency might be interpreted as a sign of an increasing relative importance of these areas in the agenda.

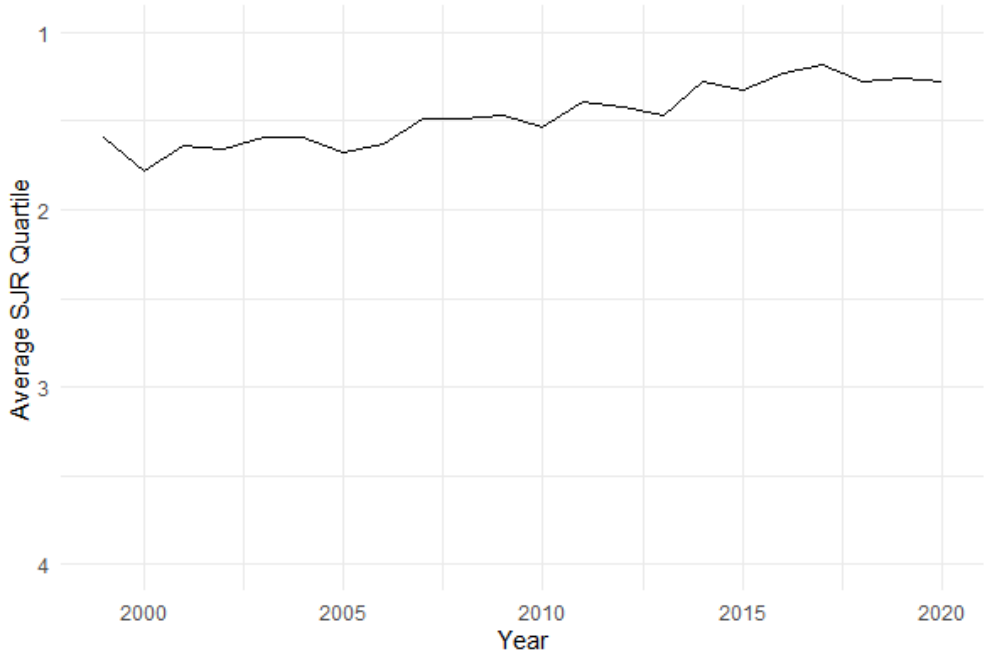

Figure 10 – Yearly evolution of the average of SJR Quartiles of the most relevant sources

While being two of the most active sources, *Fujitsu Scientific & Technical Journal* and *Voprosy Filosofii* are the only outlets in this analysis classified in the lowest Quartile of SJR (Q4). This classification is attributed to different categories, and across the years.

Three journals succeed in being classified in Q1 in all categories and years: *Geoforum*, *Journal of Public Administration Research & Theory*, and *Public Administration Review*; other four achieve the same result, although it is not verified in all the categories. *Theory, Culture & Society* presents a full Q1 line in Social Sciences (miscellaneous), *Information Society* and *American Behavioral Scientist* in Cultural Studies, and the *Journal of Business Ethics* in Business and International Management, Business, Management and Accounting (miscellaneous), and Law.

In this set, 47 journals belong to Zone 1 of Bradford's Law[9]. If we cross this classification with the rankings of the most productive and most cited sources, we conclude that only six journals are part of the three analysis: *Theory, Culture & Society*, *Media, Culture & Society*, *Information Society*, *New Media & Society*, *Journal of Business Ethics*, and *Geoforum*. Broadly, these outlets (mainly dedicated to the Social Sciences) also display the general tendency of belonging to Q1 of SJR from 2010 on. Yet, perhaps the main conclusion to derive from the analysis of the journals is this clear displayed asymmetry: while being notorious in terms of output on the topic of the "Network Society", *Fujitsu Scientific & Technical*

[9] Journals are sorted by number of articles into three Zones (Zone 1 – Core Sources, Zone 2, and Zone 3), with each Zone accounting for one-third of the documents in the collection.

Journal and *Voprosy Filosofii* are not relevant in terms of impact, neither rank high regarding SJR Quartile classification.

4.1.7. Subject categories

Fig. 11 shows the most frequent knowledge categories into which the articles are classified in WoS[10].

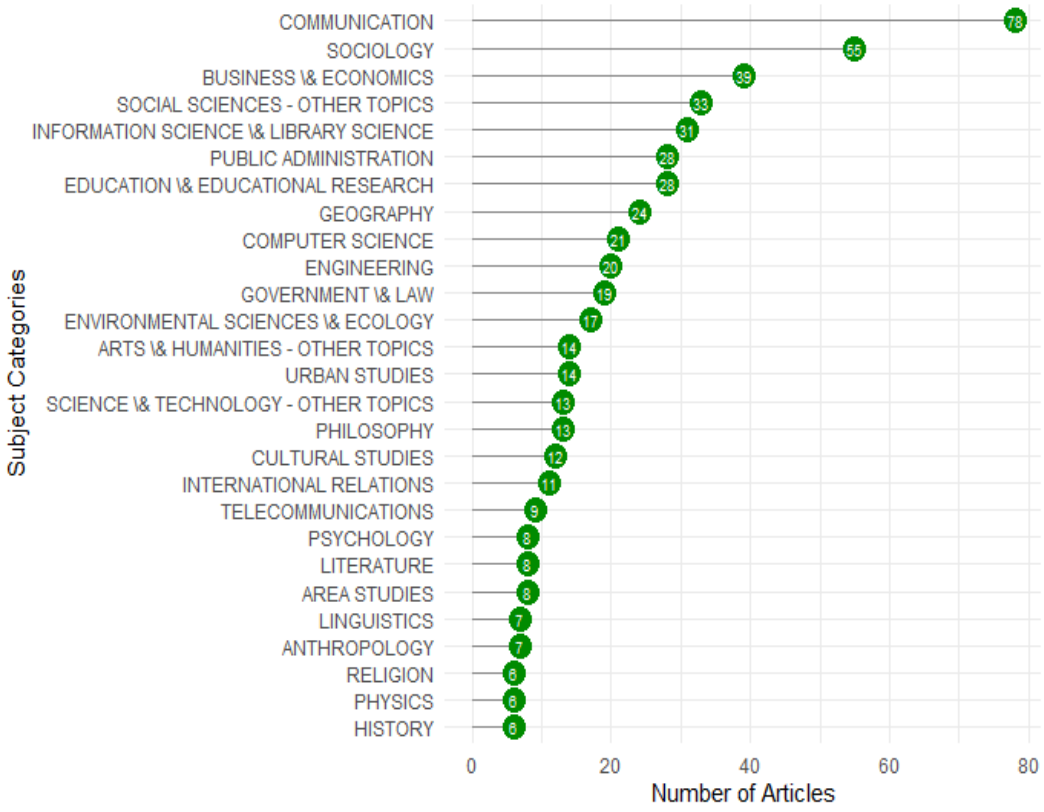

Figure 11 – Most frequent subject categories

Most of the literature related to the topic of the "Network Society" belongs to the fields of Communication (78 articles, 17.7% of the total articles) and Sociology (55 articles, 12.5%). These can be considered the two core areas of research. The categories of Business & Economics (39 articles, 8.8%), other topics of Social Sciences (33 articles, 7.5%), Information Science & Library Science (31 articles, 7%), Education & Educational Research (28 articles, 6.3%), and Public Administration (28 articles, 6.3%) are also of note. This is above all a multidisciplinary field, which comprises areas related to the Social Sciences and Humanities, but also to Engineering, Technology, Economics, Public Policy, and Governance. It is important to bear in mind that the Network Society is by itself defined by interthematicity. Consequently, it is not a surprise that it might be a contribution to research associated to different knowledge territories. Plus, those that we may consider its core areas (Communication and Sociology) are also by nature plural disciplines. These might be justifications for the varied disciplinary panorama that emerges in this analysis.

Fig.12 shows the evolution of the most frequent subject categories per year, in absolute number of articles. Most of the research streams display an increase from 2015 on, which can be associated with a higher level of production in that period. In fields such as Sociology and Public Administration, a relevant increment can be detected sooner, on the verge and on the early 2010s. Among the most

[10] Each document may belong to more than one category, as well as have no categorisation at all.

frequent categories, a more salient growth can be spotted in the areas of Communication, Business & Economics, other topics of Social Sciences, Education & Educational Research, and Computer Science.

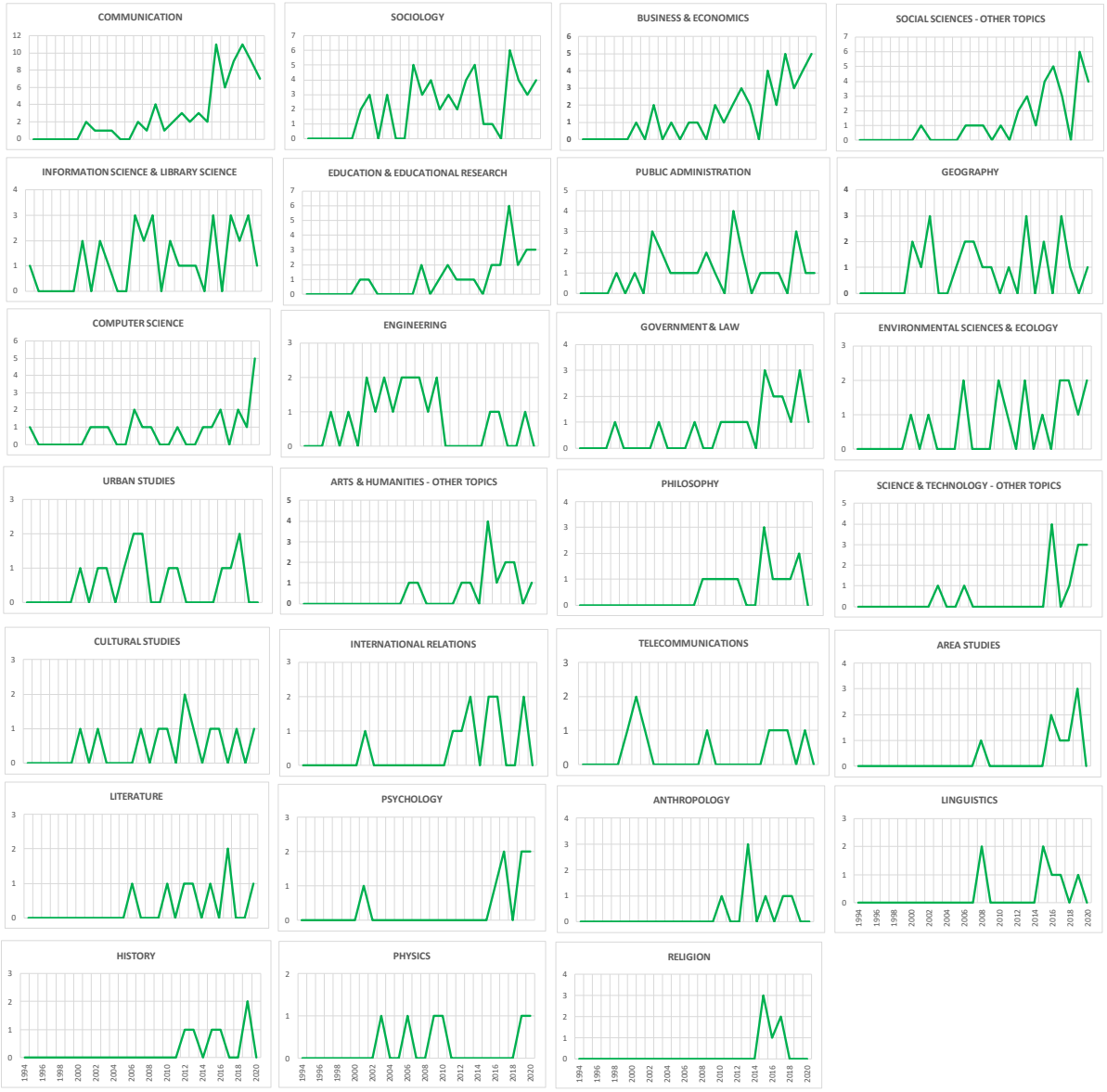

Figure 12 – Evolution of subject categories per year, in absolute number of articles

4.1.8. Documents

Regarding the most cited documents (Table 8), 13 (2.9% of the total documents) receive more than 100 citations. The sum of the total citations obtained by these 13 papers equals 3 044, which represents 47.9% of the total citations in this collection (6 353 citations). This means that almost half of the total citations are concentrated in slightly less than 3% of the total documents analysed. 381 papers (86.4% of the total documents) obtain less than 20 citations each.

“The digital divide as a complex and dynamic phenomenon”, by Jan van Dijk and Kenneth Hacker, is the most cited article (541 citations). This paper emphasises the usage gap in what regards Information Technology. The authors study the concepts of “possession”, “skills”, and “usage gap”, analysing Dutch data.

Position in ranking	Document	Authors	Year	Journal	Total Citations	% for total citations in dataset	Total Citations per Year	Local Citations
1	The Digital Divide as a Complex and Dynamic Phenomenon	Jan van Dijk & Kenneth Hacker	2003	Information Society	541	8.5%	28.47	0
2	Materials For An Exploratory Theory Of The Network Society	Manuel Castells	2000	British Journal of Sociology	525	8.3%	23.86	0
3	Transnational Elites in Global Cities: British Expatriates in Singapore's Financial District	Jonathan Beaverstock	2002	Geoforum	270	4.2%	13.50	1
4	Transnational elites in the city: British highly-skilled inter-company transferees in New York city's financial district	Jonathan Beaverstock	2005	Journal of Ethnic and Migration Studies	266	4.2%	15.65	0
5	Dealing with Wicked Problems in Networks: Analyzing an Environmental Debate from a Network Perspective	Ellen M. van Bueren, Erik-Hans Klijn & Joop F. M. Koppenjan	2003	Journal of Public Administration Research and Theory	243	3.8%	12.79	0
6	Participation, Remediation, Bricolage: Considering Principal Components of a Digital Culture	Mark Deuze	2006	Information Society	223	3.5%	13.94	0
7	Partnership Arrangements: Governmental Rhetoric or Governance Scheme?	Geert R. Teisman & Erik-Hans Klijn	2002	Public Administration Review	171	2.7%	8.55	0

Table 8 – Top-cited documents on the topic of the “Network Society” *(cont.)*

Position in ranking	Document	Authors	Year	Journal	Total Citations	% for total citations in dataset	Total Citations per Year	Local Citations
8	Global Liberal Governance: Biopolitics, Security and War	Michael Dillon and Julian Reid	2001	Millennium - Journal of International Studies	165	2.6%	7.86	0
9	Disentangling Scale Approaches in Governance Research: Comparing Monocentric, Multilevel, and Adaptive Governance	Catrien J.A.M. Termeer, Art Dewulf and Maartje van Lieshout	2010	Ecology and Society	143	2.3%	11.92	0
10	Spatial Planning in the Network Society-Rethinking the Principles of Planning in the Netherlands	Maarten Hajer & Wil Zonneveld	2000	European Planning Studies	142	2.2%	6.45	1
11	Determinants of web site information by Spanish city councils	Juan L. Gandía & Maria C. Archidona	2008	Online Information Review	129	2%	9.21	0
12	Innovation studies in the 21st century;: Questions from a user's perspective	Ruud Smits	2002	Technological Forecasting and Social Change	115	1.8%	5.75	0
13	Toward a Sociology of the Network Society	Manuel Castells	2000	Contemporary Sociology	111	1.7%	5.05	0

The second most cited article (525 citations) is "Materials for an exploratory theory of the Network Society", by Manuel Castells. This is a journal article in which the author clarifies some main aspects

about the Network Society. Castells is the author of one more paper in this ranking, "Toward a sociology of the Network Society", which closes this top with a total of 111 citations.

While the appearance of Castells' articles amongst the most cited works does not come as a surprise, it is interesting to note that a work examining disconnectivity and the digital divide leads the ranking.

Researcher Jonathan Beaverstock is the author of the next two most cited documents, with 270 and 266 citations, respectively. These articles both conceptualise questions related to skilled international migration in global cities, departing from the examples of specific locations: Britain, Singapore, and New York. In fact, four titles in this ranking mention geographical locations, implying that there is a degree of localism inherent to the literature applying the concept of the Network Society.

Governance and policy-making matters seem to emerge as dominant themes addressed in the most influent documents. This suggests that the concept of Network Society is being used as a tool, available to be applied in different situations, instead of a self-sufficient concept, which would find its application purposes independently from external contexts. There is a sense that the Network Society is a lens that can be used to analyse structures and methods.

Additionally, it is important to notice that the paper by Catrien J.A.M. Termeer, Art Dewulf and Maartje van Lieshout is the only one published in the 2010s. All the others were published in the 2000s. In what concerns the four documents published from 1994 to 1999 (see Appendix B), we may notice that, although the volume of citations is not significant, their metadata provides interesting insights of what could be a possible evolution of the usage of the term. Policy issues are addressed, and two of the papers present a clear technological stamp. One is authored by the IT services Japanese consultant company NTT Data Corporation, and the other is published in *Fujitsu Scientific & Technical Journal*.

This ranking also puts in evidence the discrepancy between global and local citations. Citations coming from inside the dataset are almost null. This may indicate that the authors resort on the same analytical concept, but do not cite each other's works.

4.1.9. Keywords

The term "network society" is the most frequent keyword chosen by the authors (114 occurrences), clearly dominating the word cloud of authors' keywords (Fig.13). The concept appears in 25.9% of the documents published from 1994 to 2020. The second most frequent keyword is "network" (34 occurrences), used in 7.7% of the manuscripts. "Internet" is the third, with a total of 27 occurrences (6.1% of the total articles), followed by "communication" (18 occurrences, 4.1%) and "globalisation" (17 occurrences, 3.9%).

Figure 13 – Word cloud of authors' keywords

The first keywords in this corpus are reported in 2000. The graph in Fig. 14 shows the cumulate word growth of the most relevant authors' keywords between 2000 and 2020.

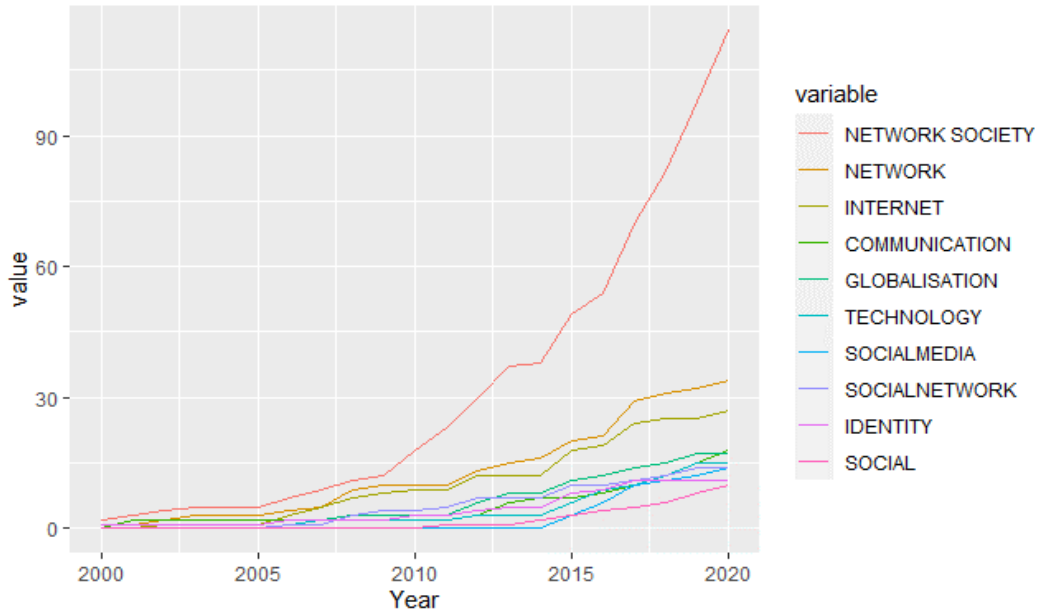

Figure 14 – Authors' keywords growth

The term "network society" shows a robust increase, especially from 2017 on. 2017, 2019, and 2020 are the years in which this keyword has more occurrences (16 in each year). In 2015, half of the top-10 keywords reach a peak of occurrences: "internet" (6), "globalisation" (3), "technology" (3), "social network" (3), and "identity" (3). Plus, "social media" debuts as a keyword. It is worth mentioning this recent adoption by the authors of platform-related terms such as "social media" and "social network", in the context of the study of the Network Society. In fact, "social media" is the top-10 keyword with the most notorious growth (+367%) between 2015 (3) and 2020 (14).

4.2. Science mapping

4.2.1. Co-citation networks of authors

Fig. 15 displays the co-citation network of authors from 1994 to 2020. It shows the frequency with which two authors are cited together in the references. The names that appear in the network are the cited authors. A connection is established when two authors in the references (that is, belonging to the knowledge base) are cited together by one or more documents in the dataset (that is, belonging to the research front). The more frequently this co-citation happens, the stronger is the established connection.

Size: 11 883
Density: 0.005
Diameter: 6
Average path-length: 2.431

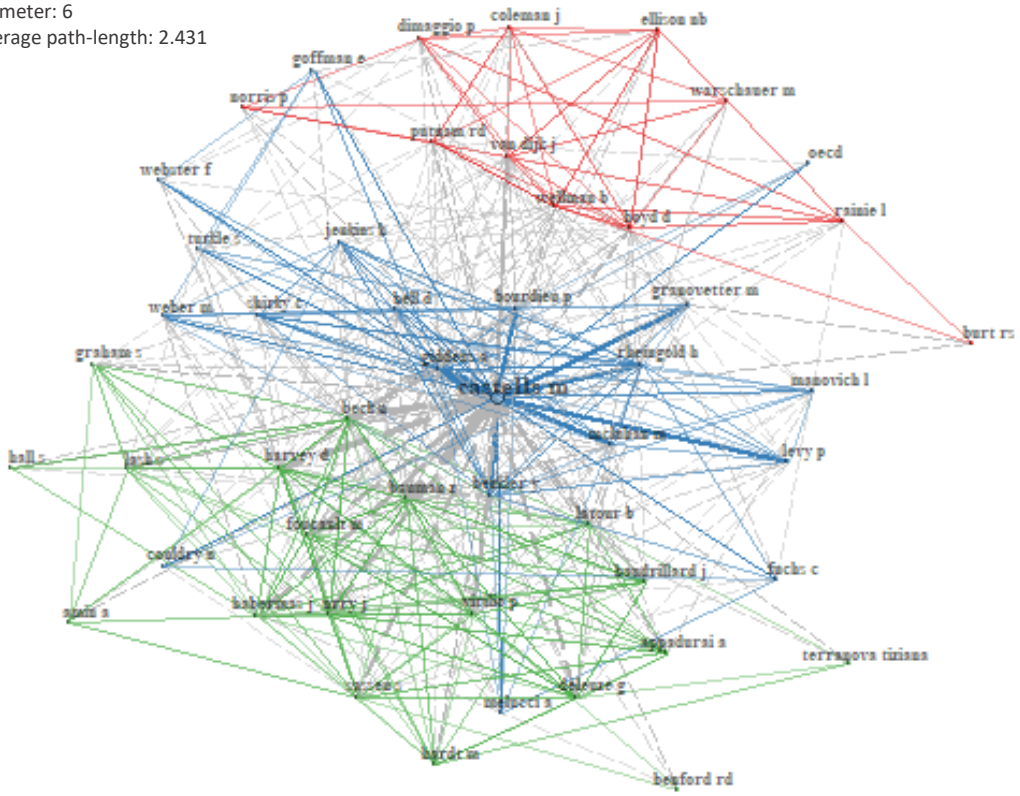

Figure 15 – Co-citation network of authors (1994 to 2020)

Three groups of frequently co-cited authors in the references can be identified (for main measures of centrality of top-vertices in this network, see Appendix C).

- The blue cluster assumes a central position in the network. Castells belongs to this group, being the vertex with the highest values for degree centrality (0.7206), that is, links to other vertices, and betweenness centrality (0.6399), representing the number of shortest paths which flow through it[11]. This cluster comprises some of the authors whose work and concepts may have theoretically paved the way to Castells' Network Society (Daniel Bell and Marshall McLuhan), just as others who delve into similar knowledge fields (Webster is a well-known critic of the Information Society, Benkler and Rheingold both study networks in a digital context). This cluster also includes names such as Anthony Giddens, Pierre Bourdieu, Mark Granovetter, and Max Weber. Those are distinguished names in Social Sciences, particularly in Sociology. Their contributions are regarded as hallmark studies that undoubtedly shaped research in the social field. We may notice that the strength of links established between Castells and these authors is of considerable significance.

- Included in the green cluster, we may find the second vertex with the highest degree (0.1515) and betweenness (0.0232) in this network: Zygmunt Bauman, another unavoidable name in the sociological conceptualisation of postmodernity. Ulrich Beck, Michel Foucault, Bruno Latour, Jürgen Habermas, Gilles Deleuze, and Jean Baudrillard are also part of this cluster. This is a community formed by notable names in social theory, as well as academics and authors.

[11] Regarding closeness centrality, the values presented by the generated networks in this analysis are very similar in all the nodes, meaning that the geodesic distance between them is identical.

The majority is related to Sociology, although we may also find individuals whose fields of knowledge are Geography, Philosophy, Anthropology, and research related to technologies.

- In the red cluster, Jan van Dijk and Danah Boyd are the nodes with the highest values for degree centrality (0.0773 and 0.0693, respectively). This means that they are the vertices linked to the highest average number of nodes. van Dijk and Boyd are also the most relevant vertices in this cluster regarding betweenness centrality (0.0065 and 0.0066, respectively), meaning that they are the most important gatekeepers. In this cluster, although the relevance of Sociology is still verified, there is a tendency to themes related to Media and Communication, Politics, and the online sphere.

It is not a surprise to verify that the intellectual structure showed by this network puts in evidence the central role played by Manuel Castells in this knowledge field. His work is the home of the Network Society, so it is logical that his writings constitute a mandatory reference for research developed around this theme. In fact, Castells is the only node able to reach some type of differentiation in this network. The cluster to which the author belongs brings together mainly major names in Sociology. These are the authors with who Castells is more frequently co-cited. They happen to move in very similar theoretical grounds. Their similarity is easy to be justified, mainly by the existence of common fields of study. This cluster may be broadly classified as mandatory reference support for works developed in the social field, which is known to be by nature transversal and multidisciplinary.

The green cluster maintains a focus on Sociology, albeit a tendency to co-citation between authors related to Geography is to be noted. In the red cluster, this tendency seems to be more related to Communication and the digital world. Although these clusters suggest some specific subject enhancing these co-citations, Sociology prevails as the dominant theme in this network. It is difficult to clearly discern different communities. The nodes are spread, and while different clusters exist, they are all seemingly gravitating around Castells' name. It is also interesting to note that (and also apart from Castells) this co-citation network of authors does not put in evidence the presence of authors belonging to the ranking of the most productive authors in this collection. This might point to the fact that the concept of Network Society is part of a knowledge base used simultaneously with many other studies of Sociology. However, the authors citing it do not usually cite other authors using the same concept, being that the reason why the most productive authors in this bibliometric analysis are not a relevant part of the co-citation network of authors.

Regarding the co-citation network of authors encompassing the years 2000 to 2009 (Fig.16), although several clusters are formed, just three might be considered more defined communities (for main measures of centrality of top-vertices in this network, see Appendix D).

Size: 2 440
Density: 0.019
Diameter: 5
Average path-length: 2.353

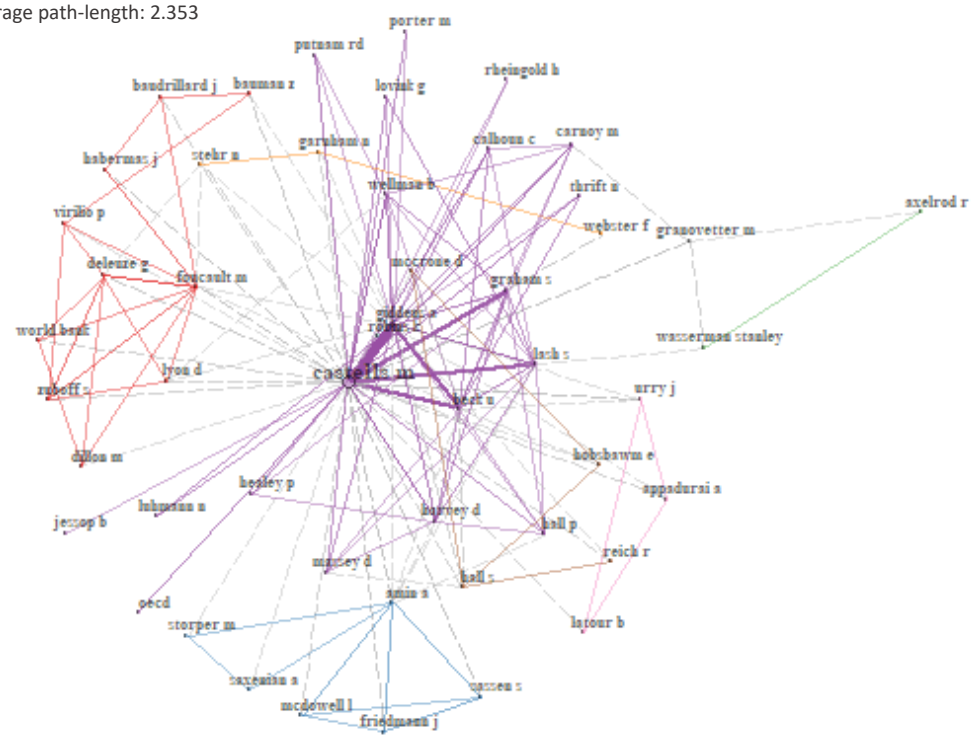

Figure 16 – Co-citation network of authors (2000 to 2009)

- The purple cluster includes the two more prestigious vertices in this network: Castells (0.7077 of degree centrality and 0.5831 of betweenness centrality), and Giddens (0.2747 of degree centrality and 0.0510 of betweenness centrality).

- In the red cluster, Michel Foucault is the node linked to the highest average number of nodes in the network (degree centrality of 0.1222). Theories on power and control developed by Foucault are an influential basis for science construction. We may find in this cluster co-citations between authors who follow this line of research mainly related to control, security, and surveillance.

- The blue cluster is fully composed by geographers. In this group, Ash Amin obtains the highest value for connections to the highest average number of vertices (degree centrality of 0.1025).

Castells holds a central position in the co-citation network of authors from 2000 to 2009. Giddens stands out as a relevant node as well. Several clusters are identified, but just three can be more comfortably identified as communities. Overall, the network is sparse and the communities seem to be aggregated in the periphery of Castells' name, without relevant co-citation connections between them.

In the co-citation network of authors from 2010 to 2020 (Fig. 17), only two clusters are formed (for main measures of centrality of top-vertices in this network, see Appendix E).

Size: 9 888
Density: 0.006
Diameter: 6
Average path-length: 2.425

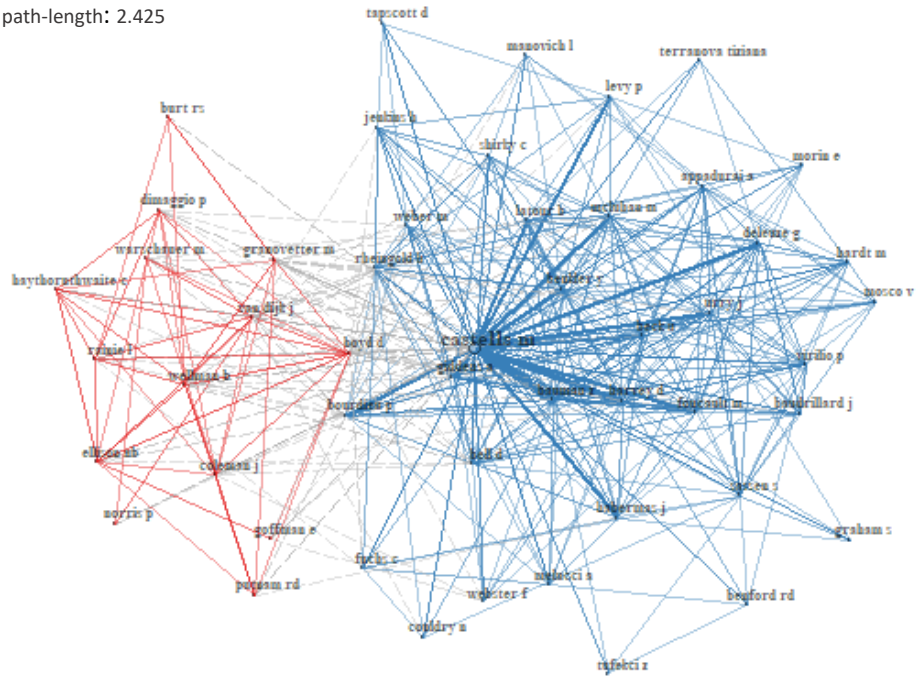

Figure 17 – Co-citation network of authors (2010 to 2020)

- The blue cluster is the biggest. It hosts the two vertices with the highest degree and betweenness centrality in this network: Castells (0.7246 of degree centrality and 0.6485 of betweenness centrality), and Zygmunt Bauman (0.1638 of degree centrality and 0.0272 of betweenness centrality). This means that these two authors present the highest average number of connections to nodes in this network, as well as the highest number of appearances in shortest paths between any pair of nodes in the network.

- In the red cluster, van Dijk (0.0897 of degree centrality and 0.0085 of betweenness centrality) and Boyd (0.0833 of degree centrality and 0.0090 of betweenness centrality) emerge again as relevant nodes, in a co-citation cluster to which Castells does not belong. This is a community dedicated to the study of social networks and the digital panorama.

This is a network in which all the nodes seem to be around the dominant Castells' vertex, but somehow in a partitioned way. Two distinct groups are formed. One apparently aggregates a majority of nodes related to Social Sciences, but without a clearly defined subcategory. A smaller cluster is able to differentiate itself in the network. This is a group focused on the study of networks in the online sphere.

In an overview of these co-citation networks of authors, we may conclude that seminal names in Social Sciences and Sociology are frequently cited together. From 2000 to 2009, several clusters are formed. Two special communities are worth to mention: one dedicated to Geography, and another to studies of power, control, and surveillance. From 2010 to 2020, the community detection decreases significantly, although a group devoted to research in online social networks stands out. All the three co-citation networks of authors are sparse. Castells is a relevant node, holding its nuclear position across time.

4.2.2. Bibliographic coupling networks of authors

The bibliographic coupling network of authors from 1994 to 2020 (Fig. 18) connects the citing authors by the number of shared bibliographic references in their works (for main measures of centrality of top-vertices in this network, see Appendix F). The names that appear in the networks are those of the authors in the research front, connected by similarity of bibliographies.

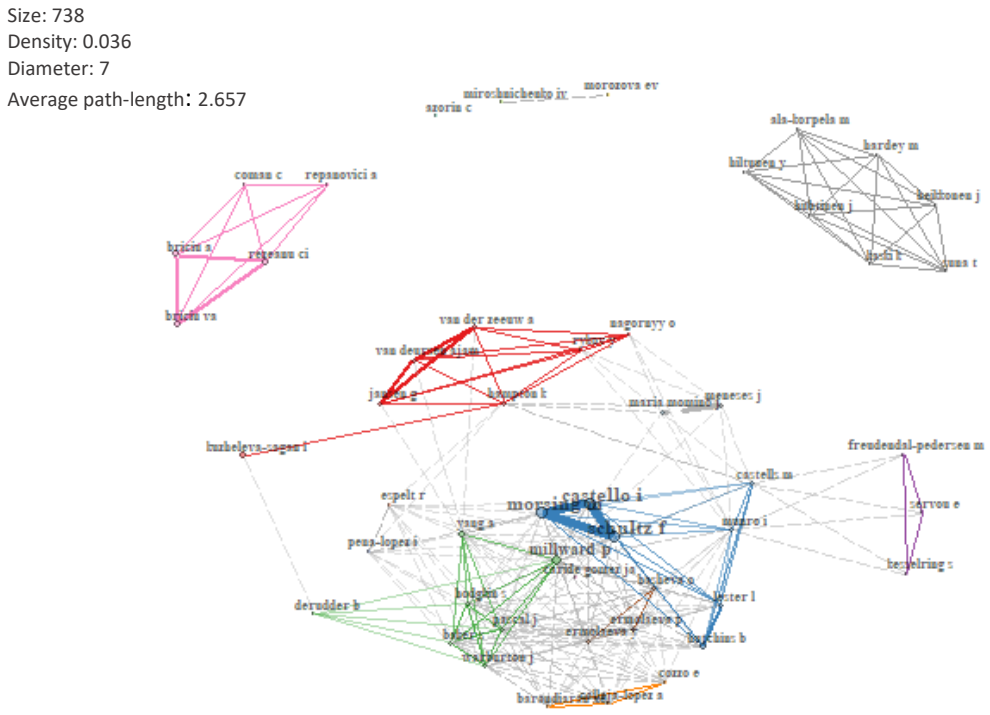

Figure 18 – Bibliographic coupling network of authors (1994 to 2020)

From 1994 to 2020, the bibliographic coupling network of authors is mainly composed by different groups that frequently co-authorship papers. Relevant bridges binding these isolated communities do not appear to exist. The vertices with the highest average number of connections to nodes in the network are Castells (0.229), Millward (0.225), and Hampton (0.218).

From 2000 to 2009 (Fig.19), the coupling network of authors presents a discontinuous pattern, with isolated groups and nodes (for main measures of centrality of top-vertices in this network, see Appendix G). Castells occupies the first position both in the degree (0.241) and betweenness (0.0467) centrality rankings.

Size: 175
Density: 0.054
Diameter: 5
Average path-length: 2.35

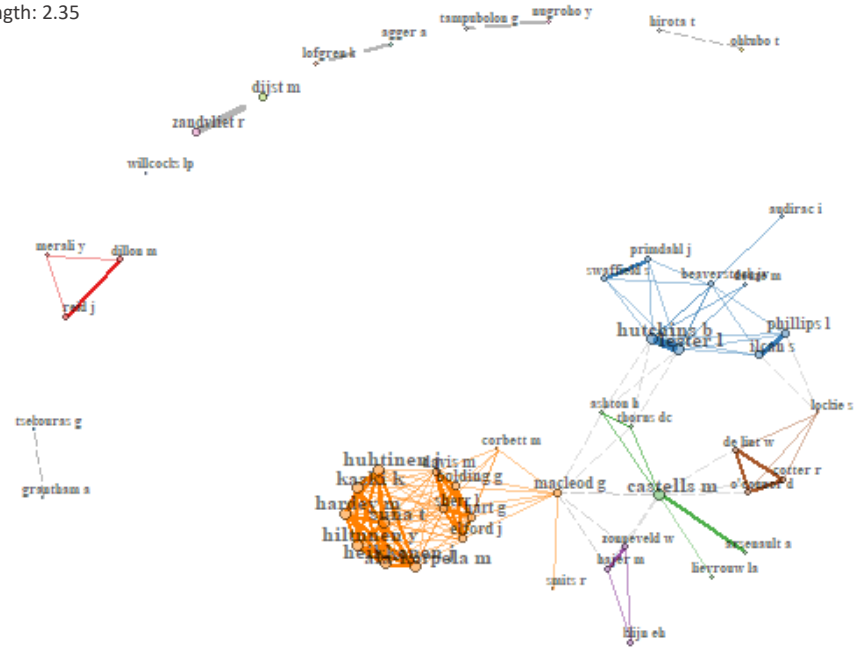

Figure 19 – Bibliographic coupling network of authors (2000 to 2009)

The bibliographic coupling network of authors from 2010 to 2020 (Fig. 20) brings a novelty for the analysis so far: Castells is not part of the top-25 vertices in this network, for the centrality measures analysed (see Appendix H).

Size: 566
Density: 0.04
Diameter: 7
Average path-length: 2.793

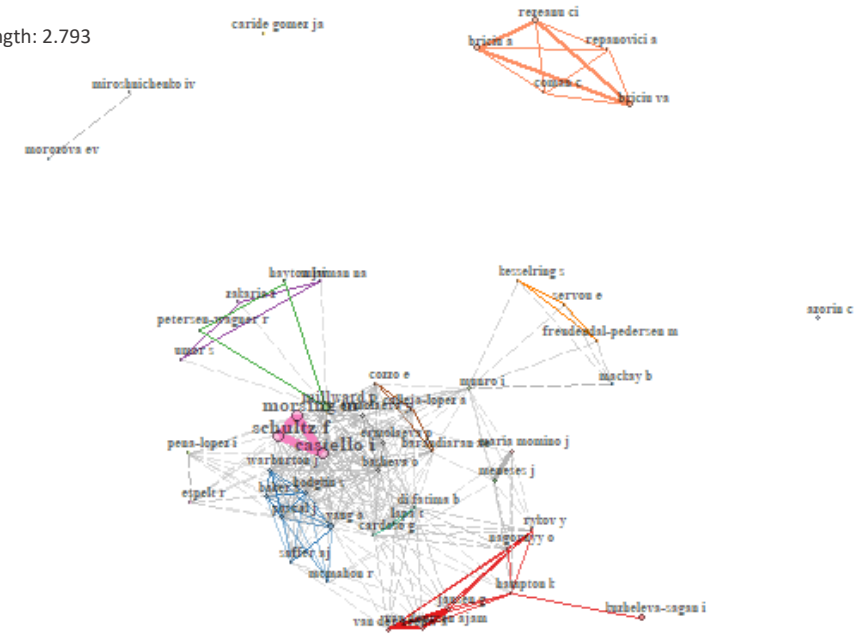

Figure 20 – Bibliographic coupling network of authors (2010 to 2020)

A bibliographic coupling network of authors links the citing authors in a collection by the frequency in which common references co-occur in their papers. Therefore, connections between authors who co-authored articles are common in these networks, as the bibliographies of their works overlap. What is also put in evidence by this analysis is that, whereas strong links exist between authors who work together, they are not expanded outside the borders of these groups. These networks are formed by closed communities, far from each other. Castells' absence as a relevant vertex in the bibliographic coupling network of authors from 2010 to 2020 might be related to the fact that his last publication in this collection was in 2010. This means that, in the last decade analysed, the author's contribution to the research front was not as relevant as in the decade before.

4.2.3. Thematic maps and thematic evolution

In order to study the conceptual structure of the research field of the Network Society, and track its evolution in the time periods analysed, a co-word analysis was carried out (Callon et al., 1991; Cobo et al., 2011). Fig.21 and Fig.22 show the thematic maps from 2000 to 2009, and from 2010 to 2020, respectively. These maps are created having as a basis a co-occurrence network of author's keywords for each period. Each bubble represents a cluster in that network. It is named after the keyword with the higher number of occurrences in the cluster, and its size is proportional to the number of keywords belonging to the cluster (Aria & Cuccurullo, 2017). Each bubble represents a research theme and they are plotted in the quadrants of the diagram (see Appendix A) according to their measures of centrality (external ties) and density (internal ties). Tables 9 and 10 enumerate the research themes in each period. An interpretation is carried out for the research field from 2000 to 2009, and from 2010 to 2010. Afterwards, a thematic evolution (Fig.23) is generated, with the goal of tracking the dynamics of these themes through both periods, and identify main thematic areas.

In the thematic map from 2000 to 2009 (Fig.21), it is possible to identify four motor themes: "society", "castells", "social movement", and "innovation". These are internally well-developed themes, which also present important connections to other themes in the research field. A word for the research theme of "society", which is positioned in the most upper-right zone of this quadrant, meaning that it achieves a notable relevance in terms of both external and internal ties. The theme "network society" appears between the motor and the transversal quadrants, from 2000 to 2009. From 2010 to 2020 (Fig.22), it is clearly positioned in the transversal zone, meaning that it remains important for the research field, but becomes internally undeveloped. From 2000 to 2009, we may find the themes "network", "internet", and "globalisation" in the transversal quadrant. These may be considered mainstream themes in this period. The majority of research themes from 2000 to 2009 is found on the left side of the thematic map, meaning that they have lower centrality, that is, less relevance for the development of the research field. Several themes are juxtaposed, due to proximity of clusters. The theme "social sciences" comes into view as a declining theme, as it disappears in the following period. Themes placed on the right side of the diagram, besides being more important for the whole research field, also appear to be more remarkable in terms of number of occurrences, as the size of the bubbles is considerably superior to those of the themes on the left side of the map.

In what concerns the thematic map from 2010 to 2020, we may observe that the number of research themes (25) does not differ significantly from the number of themes identified from 2000 to 2009 (29), although their arrangement in the map is distinct. The majority of themes is placed in the highly developed and isolated and the basic and transversal themes quadrants. There is a considerable inferior number of themes in the motor and in the emerging or declining themes quadrants.

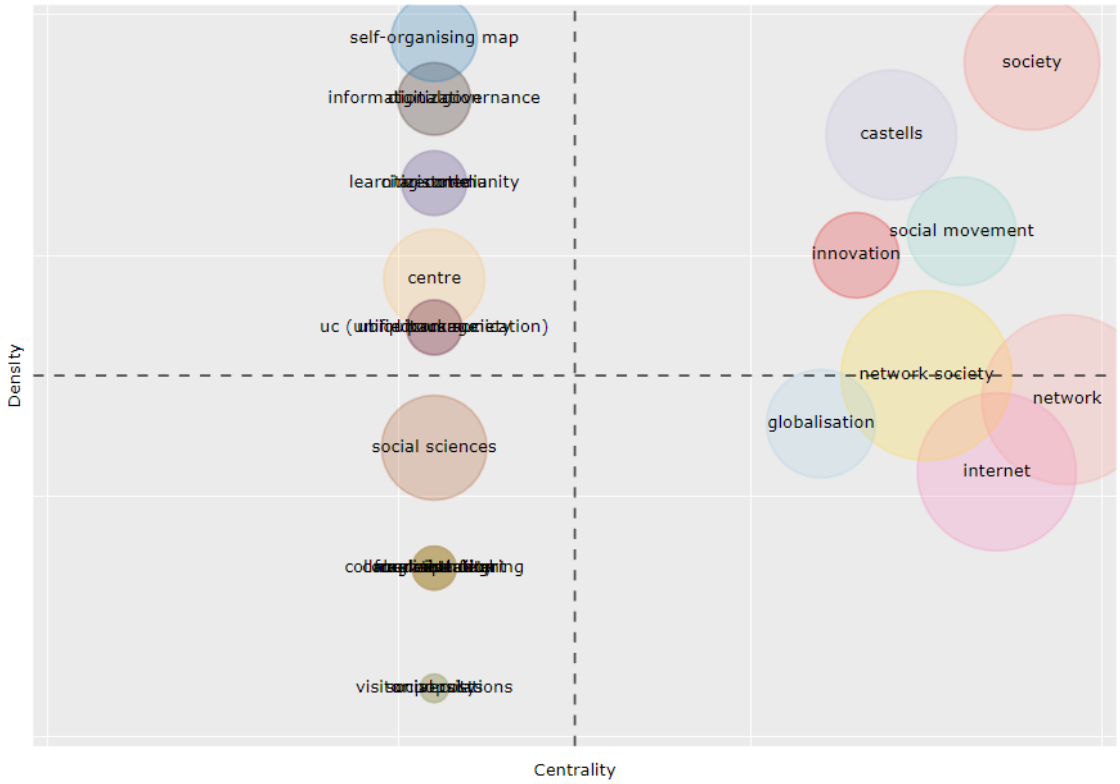

Figure 21 – Thematic map from 2000 to 2009

Research themes (2000 to 2009)		
3d package	Informational governance	Social movement
Aristotle	Innovation	Social sciences
Castells	Internet	Society
Centre	IP	Ubiquitous society
Citizen media	Learning community	UC (unified communication)
Collaborative filtering	Media society	University
Complex thought	Network	Visitor populations
Digitization	Network society	
Fragmentation	Rural education	
Globalisation	Self-organising map	
ICT	Social costs	

Table 9 – Research themes in the thematic map from 2000 to 2009

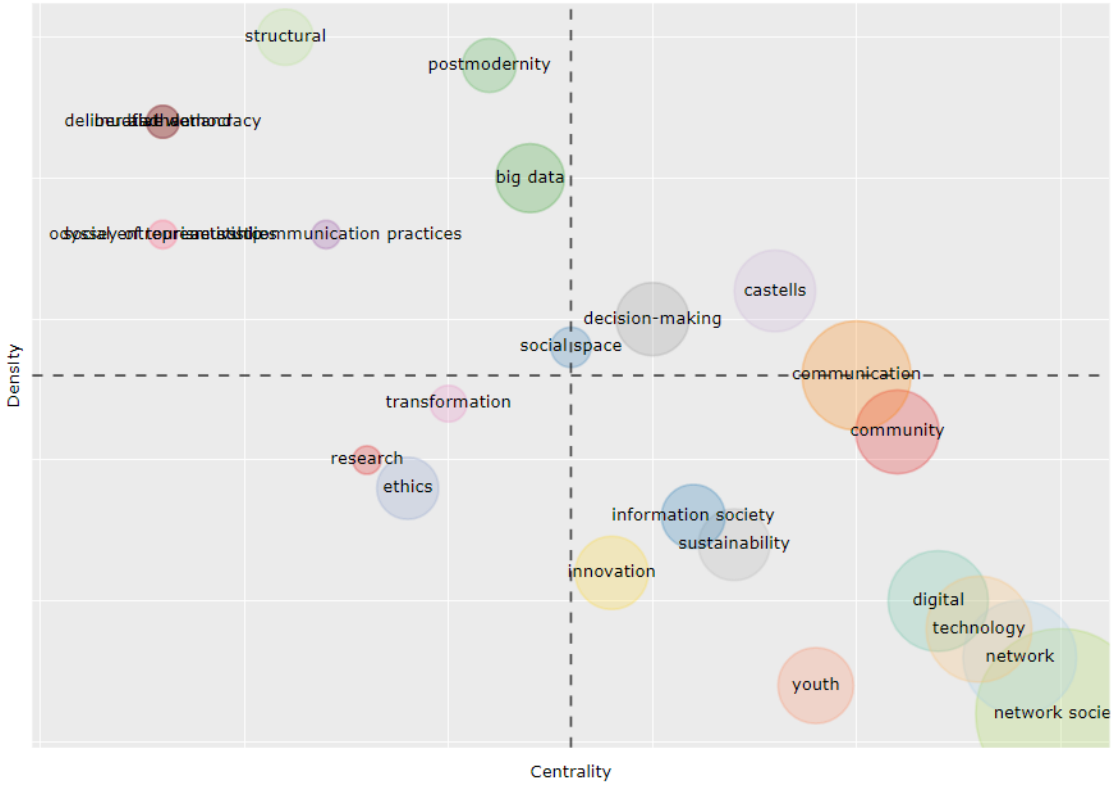

Figure 22 – Thematic map from 2010 to 2020

Research themes (2010 to 2020)		
Aadhaar	Innovation	Technology
Activist communication practices	Mudflat wetland	Transformation
Big data	Network	Youth
Castells	Network society	
Communication	Odyssey of tourism studies	
Community	Postmodernity	
Decision-making	Research	
Deliberative democracy	Social entrepreneurship	
Digital	Social space	
Ethics	Structural	
Information society	Sustainability	

Table 10 – Research themes in the thematic map from 2010 to 2020

Only four research themes are present in both periods analysed:

- The theme “network society”, which from 2000 to 2009 appeared between the motor and the transversal quadrants, falls now completely in the transversal quadrant, with a high strength of external ties, but low strength of internal ties. From 2000 to 2009, this theme is formed by 45 keywords, and the higher number of occurrences belong to “network society” (12), “information and communication technology” (2), “development” (2), “technology” (2)”, and “Denmark” (2). From 2010 to 2020, the number of keywords belonging to this theme rises to 378, being the most frequent “network society” (102), “internet” (19), “social media” (14), “globalisation” (14), “social” (10), and “social network” (10).

- The theme “network” remains in the transversal quadrant, although internally it becomes more undeveloped from 2010 to 2020, when compared to the previous period.

- The theme “castells” is a motor theme in both periods, that is, a central and developed theme. Nevertheless, from 2010 to 2020, it has moved closer to the transversal quadrant.

- The theme “innovation” is a motor theme from 2000 to 2009, while from 2010 to 2020 has moved to the quadrant of basic themes. It should also be noted that this is the only theme in both periods which is not semantically or eponymically related to the concept of Network Society.

All the remaining themes from 2010 to 2020 are new in the research field. The theme “decision-making” is a motor theme, whose keywords with more occurrences are “decision-making” (3), “privacy” (3), and “space” (3). Between the motor themes and the basic themes quadrant emerges the theme of “communication”, which includes terms such as “communication” (16), “theory” (5), “mobility” (5), “digital technology” (4), and “misinformation” (3). To be noted the emergence of the theme “ethics”.

A major conclusion can be derived from the analysis of the thematic evolution of the research field of the Network Society (Fig.23): from 2010 to 2020, the theme “network society” absorbs a multiplicity of prior granular themes which existed individually in the previous period. This creates a thematic area remarkable in terms of size, but rather indiscriminate in terms of content, as it aggregates under the big label of the “network society” a myriad of themes and concepts.

The themes “innovation” and “university” split into two different topics. While being absorbed by the theme of the “network society” from 2010 to 2020, and thus becoming part of that big thematic area, both are also part of other thematic areas in that period; “innovation” remains as an individual theme, while “university” is linked to the theme “youth”.

It is also worth mentioning the behaviour of the themes “digitization” and “social sciences”, both belonging to the period between 2000 and 2009. The first is linked to “ethics” from 2010 to 2020, while the latter is connected to “communication”. We can interpret these thematic areas as specifications. In other words, these thematic areas initiated with the themes “digitization” and “social sciences” from 2000 to 2009, and evolved to the more specific themes of “ethics” and “communication”, from 2010 to 2020.

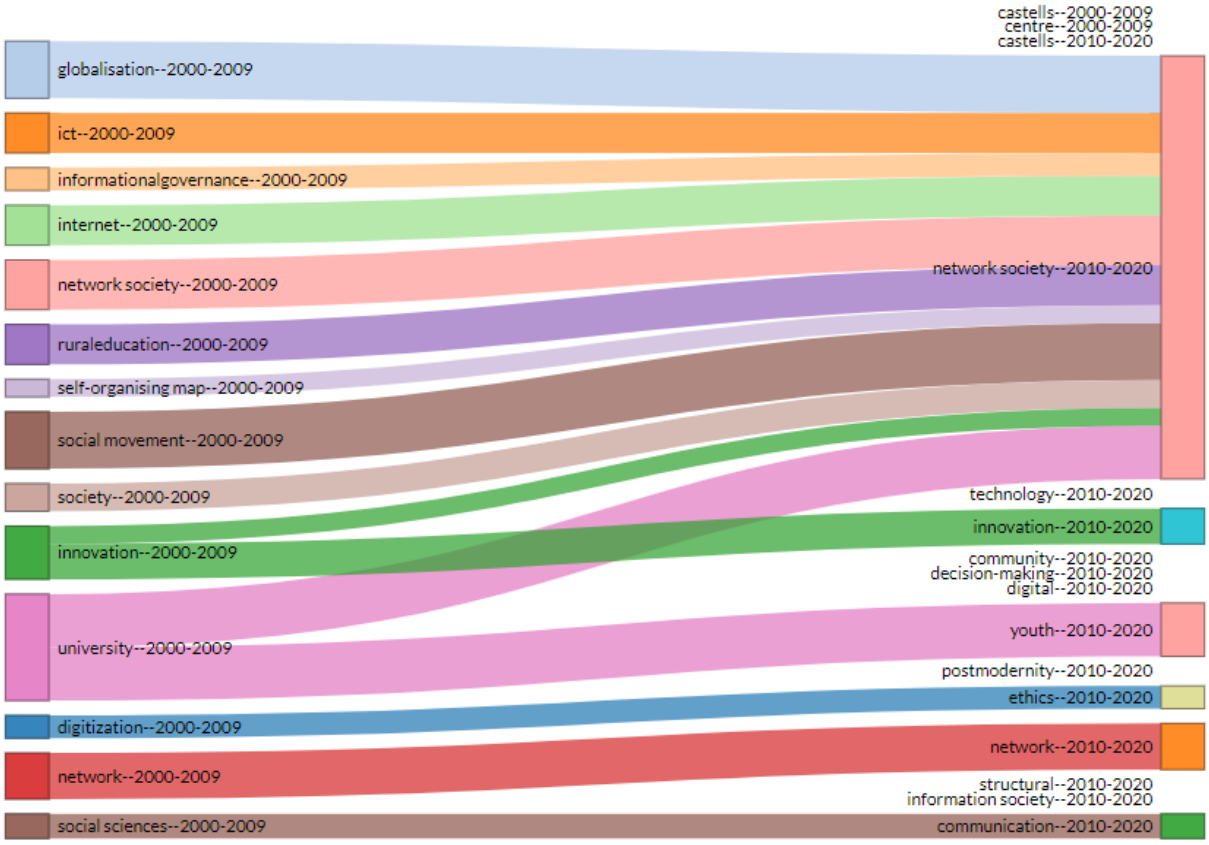

Figure 23 – Thematic evolution of the research field of the “Network Society”

It is interesting to note that some themes do not integrate any thematic area. This is the case of “castells”. Considering that it is a motor theme in both periods analysed, one possible reason not to integrate any thematic area might be a weak definition of the theme by keywords, probably related to the almost omnipresence of the author throughout the analysis. In what regards the cases of “technology”, “community”, “digital”, and “information society”, as all refer to basic themes, the fact that they are transversal to many areas might transform them in difficult subjects to categorise. Concerning the theme “decision-making”, as it appears from 2010 to 2020 as a motor theme, it might be seen as the beginning of a new thematic area in the field.

5. CONCLUSIONS

This dissertation aims to trace the impact of the Network Society concept, presented and developed by sociologist Manuel Castells. We target professional research audiences publishing in peer-reviewed academic journals, with the goal of understanding how this concept has been used formally by the scientific community. To this end, bibliometrics is the applied methodology, as it allows a comprehensive analysis of journal-based scientific literature.

This work is focused on a concept, and we are particularly interested in its evolution over time. Therefore, time is an important driver in this approach. As a departing point, we first tried to understand the concept in its origins, tracing a timeline of possible theoretical roots from the 1960s until the 1990s. This brief review of works developed in the 2nd half of the 20th century reveals that the concept of "Information Society", regardless of different terminological formulations, brings together the notion that society was going through a transition phase, which would ultimately lead to a more interconnected (or Networked) world. This period was propelled by ITCs and had great impact at economical level. Simultaneously, the individuals, their knowledge, and intrinsic human characteristics remained or perhaps became more relevant in this context.

The Network Society is born in a multidimensional perspective, moving and flowing in different grounds. Technology, communication, media, and politics are key areas. Digital globalisation, sustained by a networked-structure and by a networked-logic of information, is perhaps one of the best forms to envision the concept introduced by Castells at the verge of the 21st century. As the century changed, the debate around the topic of digital networks continued. An optimistic discourse about their democratic potential in the first decade of the century was followed by a clearly more skeptical perspective, which raises concerns about expanded and polarized power and brings to the surface questions related to regulation, anti-trust, privacy, and ethics.

Ranging from 1994 to 2020, our empirical analysis strives precisely to capture the essence of these more recent decades, by exploring bibliometric data. We are particularly interested in uncovering specific forms this concept may have adopted and how it evolved over time, considering its own meaning, but especially the meaning researchers extract from it.

We find that in fact the periods from 2000 to 2009 and 2010 to 2020 may be considered distinct in what concerns an evolutionary perspective of the Network Society. The two time slices have rather different profiles. The first decade is less productive but more impactful, whereas the second is more productive but less impactful. Indeed, the peak of citations is reached in 2003, while the maximum of publications only happens in 2017. A considerable number of the most productive authors start publishing from 2012 on, in a chronologically discontinuous manner. We may therefore conclude that the concept presented by Castells in 1996 did not trigger a prompt appropriation by researchers. A common point for both periods is the importance held by Castells over time, although it seems to be more meaningful in the first decade.

In what regards the intellectual structure of the field of the Network Society, we may notice that, from 2000 to 2009, three communities are frequently co-cited: one dedicated to the Social Sciences in general, other to questions related to power, control, and surveillance, and another one to Geography. In fact, even portrayed as separated communities, all three have similarities with Castells' work. In the following decade, while a community formed by co-citation of seminal names in the Social Sciences

greatly prevails, it is possible to identify a branch specialised in online social networks. In this period, Jan van Dijk, an author devoted to the Network Society, but perhaps with a more obvious focus on the divide, is relevant in co-citation. This may imply that attention is being paid to online disconnection, even if connection is the study object. Adding up to this, the appearance of the theme "decision-making" as central and developed may indicate that the field is probably embracing a period of reorganisation, transformation, and shift towards a more critical phase. This may also be related to the discussion taking place about the concerns of deregulated networks, and ultimately to the role each individual plays on this issue, emphasizing once again the human importance in this field.

We may also outline that the field of the Network Society is marked by heterogeneity and paradoxical patterns: just as the most productive period is not the most cited period, the most productive authors are not the most cited authors, and the most productive journal (*Fujitsu Scientific & Technical Journal*) is not the most cited journal (*Information Society*). The Japanese outlet differs greatly from the remaining relevant sources, by belonging to the lowest SJR Quartile in a group of journals that tends to evolve towards a higher classification, and by publishing about Computer Science and Engineering. This might indicate that a greater level of production in the technological field is not followed by citation impact, which remains in the Social Sciences. Communication and Sociology emerge as core research areas in the field.

Apart from Castells and van Dijk, the general absence of the most productive authors from the co-citation networks, and the low number of local citations, suggest that the concept is being used as a tool. Researchers applying the term do not usually resort on each other's outputs. This might indicate that the concept of Network Society is used in parallel with akin sociological constructs. While a study branch to which van Dijk is an important contributor seems to be initiating a rather divergent way, this can still be considered embryonic. In short, a disruptive community is not formed. While the concept of Network Society is found to remain as an important component in social theorisation, it is difficult to affirm that a new school of thought is already formed. If we analyse the most cited documents in this collection, we may notice that the themes of governance and policy-making prevail. Moreover, specific geographical locations are often mentioned in the titles, which points to an inherent degree of localism in these studies. Interestingly, a global, interactive, and expandable concept seems to be also applied at a local dimension, reverberating Castells' terminological paradox of the global and the local. This might suggest that the concept is being used as a lens to look at specific phenomena, while a degree of dynamism and interconnection is maintained.

Up to 2020, the concept of Network Society seems to remain relevant to academic circles. It stays faithful to its scientific homeland, the Social Sciences, and also to its human face: Manuel Castells. However, this bibliometric analysis shows that the concept is on the move, which is in fact one of its intrinsic features. This study offers some hints about the importance that the Network Society may obtain in the future regarding citizenship, management, public policy, and regulation. Informational forces are undoubtedly achieving relevance in a society where platforms and digital connectivity are growing every day. Debates about ethics and privacy are predicted to remain in the agenda. The scientific community applying the concept of Network Society seems to be currently attentive to the online world, deconstructing its links with a concept that is intrinsically adequate for that task.

Some methodological limitations should be considered when interpreting the findings of this study. When performing this bibliometric analysis, our goal was to investigate the appropriation of the

concept by professional research audiences. Consequently, the undertaken methodological choices attempt to reach the most purely academic sense possible. For this reason, we only considered articles and reviews in peer-reviewed academic journals indexed in WoS. Considering that the studied topic is strongly related to the Social Sciences, more information surely exists in books, press, and grey literature that are not included in this analysis.

This refinement also excludes from the corpus proceedings papers, which are arguably a more technical type of literature. We believe that future studies may benefit from incorporating these documents in the dataset. Considering that we are on the verge of a 5G-technology era, connectivity would almost certainly remain in the agenda (see Mendonça et al., 2022). This debate is foreseen to take place in a time of a double transition. Technological innovations would be developing in a framework where strategies regarding sustainability and circularity obtain a wider relevance in economy (Castaldi, 2021; de Jesus et al., 2021). In this scenario, it would be interesting to understand how the Network Society keeps up with the more recent technological improvements (such as Artificial Intelligence, digital currencies, metaverse, etc.), in future decades when the global and the local would perhaps be even closer.

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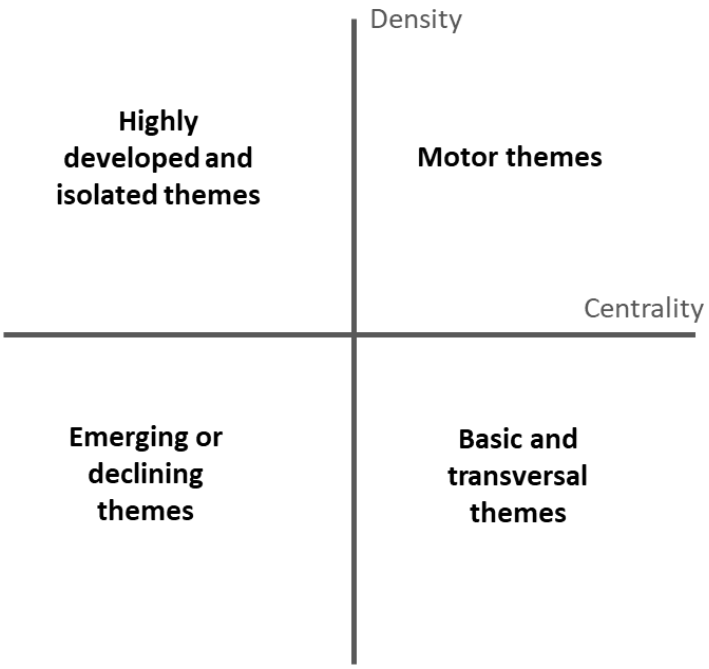
7. APPENDIX

Appendix A – Strategic diagram



Appendix B – Articles published from 1994 to 1999

Position in ranking	Document	Authors	Year	Journal	Total Citations	% for total citations in dataset	Total Citations per Year	Local Citations
1	The Autopoietic State – Communication and Democratic Potential in the Net	Sandra Braman	1994	Journal of the American Society for Information Science	14	0.22%	0.5	0
2	New Orders, Disorders and Creative Chaos: The Information Age and the Network Society	Sophie Watson	1998	Policy and Politics	1	0.02%	0.0417	0
3	Technology Development at NTT Data – Developing an Information Network Society	NTT Data Corporation NTTDC	1999	NTT Review	0	0%	0	0
4	Information Sharing Using WWW in WHIST	Hiroshi Tsuda, Kanji Uchino & Kunio Matsui	1997	Fujitsu Scientific & Technical Journal	0	0%	0	0

Appendix C – Top-25 nodes for the centrality measures regarding the co-citation network of authors (1994 to 2020)

Position in ranking	Author	Degree Centrality	Author 2	Betweenness Centrality
1	Castells M	0.7206	Castells M	0.6399
2	Bauman Z	0.1515	Bauman Z	0.0232
3	Giddens A	0.1278	Foucault M	0.0202
4	Beck U	0.1150	Beck U	0.0196
5	Foucault M	0.1103	Habermas J	0.0187
6	Harvey D	0.1038	Giddens A	0.0135
7	Habermas J	0.1038	Rheingold H	0.0112
8	Latour B	0.0945	Granovetter M	0.0098
9	Benkler Y	0.0945	Harvey D	0.0095
10	Urry J	0.0855	Benkler Y	0.0092
11	Bourdieu P	0.0793	Latour B	0.0087
12	Van Dijk J	0.0773	Deleuze G	0.0085
13	Granovetter M	0.0742	McLuhan M	0.0077
14	McLuhan M	0.0741	Chen X	0.0074
15	Rheingold H	0.0738	Urry J	0.0073
16	Deleuze G	0.0736	Watts DJ	0.0068
17	Sassen S	0.0708	Boyd D	0.0066
18	Boyd D	0.0693	Van Dijk J	0.0065
19	Virilio P	0.0685	Nonaka I	0.0061
20	Appadurai A	0.0638	Bourdieu P	0.0060
21	Wellman B	0.0602	Bell D	0.0059
22	Hardt M	0.0523	Baudrillard J	0.0057
23	Graham S	0.0516	Virilio P	0.0055
24	Webster F	0.0504	Putnam LL	0.0052
25	Putnam RD	0.0500	Goffman E	0.0050

Appendix D – Top-25 nodes for the centrality measures regarding the co-citation network of authors (2000 to 2009)

Position in ranking	Author	Degree Centrality	Author 2	Betweenness Centrality
1	Castells M	0.7077	Castells M	0.5831
2	Giddens A	0.2747	Giddens A	0.0510
3	Beck U	0.1546	Habermas J	0.0268
4	Foucault M	0.1222	Granovetter M	0.0222
5	Lash S	0.1218	Rheingold H	0.0155
6	Habermas J	0.1111	Beck U	0.0150
7	Amin A	0.1025	Wellman B	0.0141
8	Graham S	0.1021	CEC	0.0137
9	Harvey D	0.0984	Klijn EH	0.0136
10	Granovetter M	0.0976	FAO	0.0136
11	Deleuze G	0.0923	Foucault M	0.0130
12	Urry J	0.0923	Axelrod R	0.0129
13	Bauman Z	0.0890	Rutten R	0.0124
14	Wellman B	0.0853	Garnham N	0.0120
15	Sassen S	0.0841	Bryson JM	0.0113
16	Garnham N	0.0804	Kooiman J	0.0106
17	Webster F	0.0795	Webster F	0.0103
18	Porter M	0.0754	Hall P	0.0096
19	Stehr N	0.0730	Featherstone M	0.0090
20	Rheingold H	0.0730	Graham S	0.0083
21	Zuboff S	0.0726	Eur Comm	0.0076
22	Putnam RD	0.0722	Hardey M	0.0073
23	Hall S	0.0709	Healy P	0.0071
24	Luhmann N	0.0709	Lash S	0.0067
25	OECD	0.0697	Wasserman Stanley	0.0067

Appendix E – Top-25 nodes for the centrality measures regarding the co-citation network of authors (2010 to 2020)

Position in ranking	Author	Degree Centrality	Author 2	Betweenness Centrality
1	Castells M	0.7246	Castells M	0.6485
2	Bauman Z	0.1638	Bauman Z	0.0272
3	Benkler Y	0.1084	Foucault M	0.0211
4	Foucault M	0.1058	Beck U	0.0186
5	Harvey D	0.1034	Habermas J	0.0154
6	Beck U	0.1034	Benkler Y	0.0120
7	Latour B	0.1019	Latour B	0.0103
8	Habermas J	0.1002	Harvey D	0.0099
9	Giddens A	0.0919	McLuhan M	0.0099
10	Van Dijk J	0.0897	Rheingold H	0.0093
11	Bourdieu P	0.0860	Boyd D	0.0090
12	McLuhan M	0.0843	Chen X	0.0088
13	Boyd D	0.0833	Van Dijk J	0.0085
14	Urry J	0.0831	Deleuze G	0.0083
15	Rheingold H	0.0721	Urry J	0.0083
16	Virilio P	0.0700	Watts DJ	0.0080
17	Deleuze G	0.0679	Zhang J	0.0075
18	Granovetter M	0.0678	Granovetter M	0.0073
19	Sassen S	0.0659	Nonaka I	0.0073
20	Appadurai A	0.0643	Giddens A	0.0070
21	Hardt M	0.0604	Bourdieu P	0.0068
22	Fuchs C	0.0576	Virilio P	0.0065
23	Bell D	0.0555	Bell D	0.0065
24	Wellman B	0.0537	Putnam LL	0.0061
25	Jenkins H	0.0502	Goffman E	0.0060

Appendix F – Top-25 nodes for the centrality measures regarding the bibliographic coupling network of authors (1994 to 2020)

Position in ranking	Author	Degree Centrality	Author 2	Betweenness Centrality
1	Castells M	0.229	Smith C	0.0377
2	Millward P	0.225	Hampton K	0.0279
3	Hampton K	0.218	Ricuarte P	0.0216
4	Munro I	0.183	Heikka T	0.0188
5	Baker S	0.178	Castells M	0.0170
6	Warburton J	0.178	Alleyne B	0.0164
7	Hodgkin S	0.178	Yang A	0.0162
8	Pascal J	0.178	Alcantara PLA M	0.0152
9	Hutchins B	0.172	Munro I	0.0131
10	David M	0.171	Hutchins B	0.0128
11	Kirton A	0.171	Miroshnichenko IV	0.0114
12	Yang A	0.170	Morozova EV	0.0114
13	Marshall JP	0.168	Merali Y	0.0108
14	Goodman J	0.168	Rykov Y	0.0108
15	Alleyne B	0.168	Nagornny O	0.0108
16	Cardoso G	0.167	Millward P	0.0101
17	Lapa T	0.167	Scott-Smith G	0.0096
18	Di Fatima B	0.167	Baumgaertel M	0.0096
19	Castelló I	0.156	Deuze M	0.0094
20	Morsing M	0.156	Espelt R	0.0087
21	Schultz F	0.156	Pena-Lopez I	0.0087
22	Massidda L	0.151	Ure M	0.0075
23	Parisi S	0.151	Hermans L	0.0075
24	Lester L	0.149	Drok N	0.0075
25	Rykov Y	0.145	Hodge B	0.0074

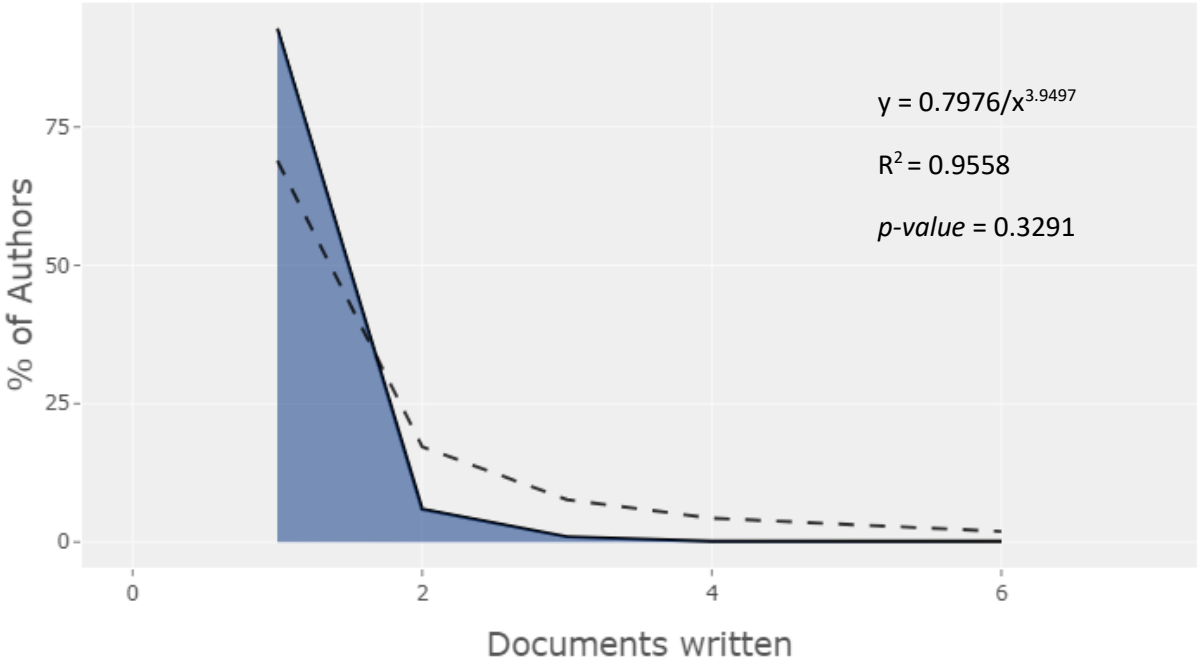
Appendix G – Top-25 nodes for the centrality measures regarding the bibliographic coupling network of authors (2000 to 2009)

Position in ranking	Author	Degree Centrality	Author 2	Betweenness Centrality
1	Castells M	0.241	Castells M	0.0467
2	Macleod G	0.195	Kristofic B	0.0363
3	Kelly P	0.184	Merali Y	0.0356
4	Kenway J	0.184	Lievrouw LA	0.0302
5	Lievrouw LA	0.184	Hajer M	0.0173
6	Lury C	0.178	Zonneveld W	0.0173
7	Merali Y	0.167	Audirac I	0.0169
8	Hajer M	0.161	Smits R	0.0128
9	Zonneveld W	0.161	Macleod G	0.0117
10	De Lint W	0.155	Lester L	0.0117
11	O'Connor D	0.155	Hutchins B	0.0117
12	Cotter R	0.155	Beaverstock JV	0.0112
13	Davis M	0.155	Harding R	0.0083
14	Hart G	0.155	Kelly P	0.0080
15	Bolding G	0.155	Kenway J	0.0080
16	Sherr L	0.155	Chan G	0.0075
17	Elford J	0.155	Ibrahim MZ	0.0075
18	Lester L	0.144	Lury C	0.0067
19	Hutchins B	0.144	Chouliaraki L	0.0068
20	Reed M	0.126	Turner BS	0.0064
21	Tang J	0.126	Davis M	0.0054
22	Gentzler E	0.126	Hart G	0.0054
23	Zandvliet R	0.121	Bolding G	0.0054
24	Dijst M	0.121	Sherr L	0.0054
25	Corbett M	0.115	Elford J	0.0054

Appendix H – Top-25 nodes for the centrality measures regarding the bibliographic coupling network of authors (2010 to 2020)

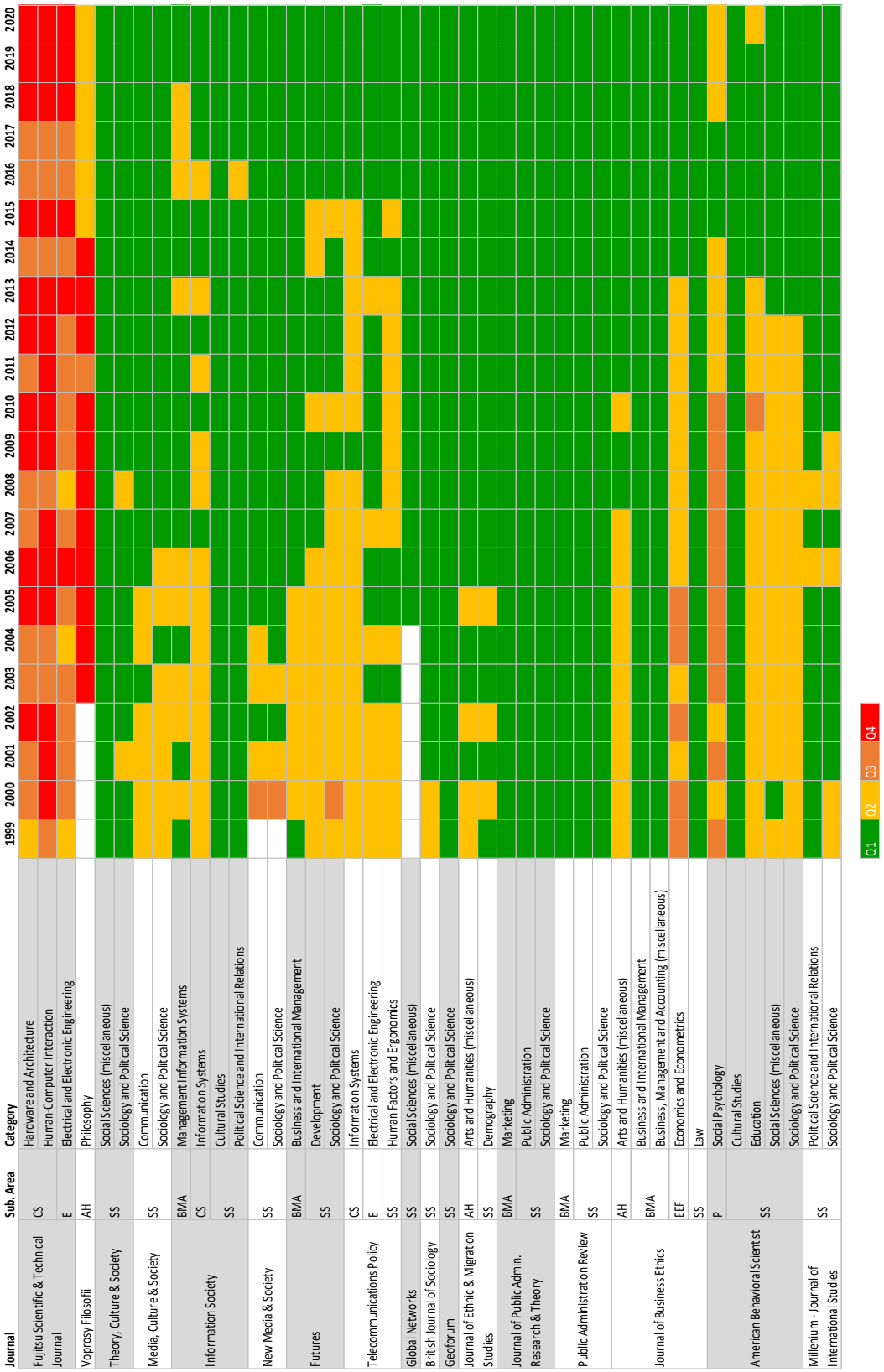
Position in ranking	Author	Degree Centrality	Author 2	Betweenness Centrality
1	Millward P	0.221	Smith C	0.0521
2	Hampton K	0.207	Hampton K	0.0393
3	Yang A	0.184	Ricuarte P	0.0313
4	Marshall JP	0.184	Heikka T	0.0266
5	Goodman J	0.184	Alleyne B	0.0248
6	Baker S	0.181	Yang A	0.0235
7	Warburton J	0.181	Alcantara PLA M	0.0223
8	Hodgkin S	0.181	Scott-Smith G	0.0159
9	Pascal J	0.181	Baumgaertel M	0.0159
10	Munro I	0.177	Millward P	0.0151
11	Cardoso G	0.175	Miroshnichenko IV	0.0149
12	Lapa T	0.175	Moroza EV	0.0149
13	Di Fatima B	0.175	Rykov Y	0.0140
14	Alleyne B	0.175	Nagornny O	0.0140
15	Castelló I	0.172	Ure M	0.0139
16	Morsing M	0.172	Espelt R	0.0132
17	Schultz F	0.172	Pena-Lopez I	0.0132
18	McCarthy MT	0.170	Munro I	0.0132
19	Ermolaeva P	0.165	Saffer AJ	0.0116
20	Ermolaeva Y	0.165	Hodge B	0.0111
21	Basheva O	0.165	Massidda L	0.0111
22	Espelt R	0.163	Parisi S	0.0111
23	Pena-Lopez I	0.163	Hermans L	0.0107
24	David M	0.163	Drok N	0.0107
25	Kirton A	0.163	McMahon R	0.0101

Appendix I – Frequency distribution of author productivity through Lotka's Law



Number of articles	Number of authors	Proportion of authors
1	685	0.928
2	44	0.060
3	7	0.009
4	1	0.001
6	1	0.001

Appendix J – Yearly evolution of SJR Quartiles for the most relevant sources on the topic of the "Network Society"



SJR Subject Areas: AH=Arts and Humanities; BMA=Business, Management and Accounting; CS=Computer Science; E= Engineering; EEF= Economics, Econometrics and Finance; ES= Environmental Science; SS=Social Sciences; P= Psychology.