Revista de Gestão e Projetos – GeP
eISSN: 2236-0972
DOI: https://doi.org/10.5585/GeP.v10i1.10910
Data de recebimento: 11/11/2018
Data de Aceite: 16/1/2019
Editora-chefe: Rosária de Fátima Segger Macri Russo
Editor Científico: Luciano Ferreira da Silva

Communication Management and Knowledge Management in complex projects: a literature review

Gestão da Comunicação e Gestão do Conhecimento em projetos complexos: uma revisão da literatura

Jeniffer de Nadae[1]

Marly Monteiro Carvalho[2]

Abstract

The complexity of projects can intensify the role of communication and team knowledge due to the increased need for coordination and decision-making. Thus, the objective of this work is to analyze publications on communication and knowledge in complex projects, through a systematic literature review and bibliometrics. For the systematic review of the literature, articles using the terms communication * and complex * and project * and knowledge "were searched in the Scopus and Web of Science databases, allowing to analyze the principal authors on the theme, research tendencies and gaps in the literature that will enable the development of future research that will contribute to the issue. It is noteworthy that the literature encompasses studies on communication management in project teams, more precisely on the storage and sharing of knowledge in IT, health, physics, chemistry and construction projects, among others. Few studies focus on complex projects, mainly analyzing the two topics together. Communication management and knowledge management in complex projects, which according to the theory are projects with difficult understanding and prediction, with complex information, many involved, with interdependence between projects, among other properties that differ from projects, complex projects already presents diverse challenges which include problems with communication and knowledge management. Thus, based on the articles investigated few studies relate to communication management and knowledge management in projects. Individually the themes are studied by several authors, as presented in the tables and analyzes of this study. This paper contributes to a better understanding of the knowledge management and communication management in complex projects, as well as this research can pave the way for a better academic understanding of the mechanisms underlying the barriers and resistance to the knowledge and communications in complex projects and of better ways to address and reduce these barriers.

Keywords: Communication. Knowledge. Complex. Project. Bibliometric Analysis.

Resumo

A complexidade dos projetos pode intensificar o papel da comunicação e do conhecimento da equipe, devido à maior necessidade de coordenação e tomada de decisão. Assim, o objetivo deste trabalho é analisar publicações sobre comunicação e conhecimento em projetos complexos, através de uma revisão sistemática da literatura e bibliometria. Para a revisão sistemática da literatura, buscou-se artigos utilizando os termos "comunicação * e complexo * e projeto * e conhecimento" nas bases de dados *Scopus* e *Web of Science*, permitindo analisar os principais autores sobre o tema, tendências de pesquisa e lacunas literatura que possibilitará o desenvolvimento de pesquisas futuras que contribuirão para a questão. Vale ressaltar que a literatura abrange estudos sobre gestão da comunicação em equipes de projetos, mais precisamente sobre o armazenamento e compartilhamento de conhecimento em TI, saúde, física, química e construção. A gestão da comunicação e a gestão do conhecimento em projetos complexos, que segundo a teoria são projetos de difícil entendimento e previsão, com informações complexas, muitos envolvidos, com interdependência entre projetos, entre outras propriedades que

1 Universidade de São Paulo; Universidade Federal do Cariri; Brasil.
jnadae@gmail.com

2 Escola Politécnica da Universidade de São Paulo; Brasil.
marlymc@usp.br

diferem de projetos, projetos complexos já apresenta diversos desafios que incluem problemas com comunicação e gestão do conhecimento. Assim, com a base de artigos investigados, poucos estudos relacionam-se com a gestão da comunicação e gestão do conhecimento em projetos. Individualmente os temas são estudados por diversos autores, conforme apresentados nas tabelas e análises deste estudo. Este trabalho contribui para uma melhor compreensão da gestão do conhecimento e gestão da comunicação em projetos complexos, bem como esta pesquisa pode abrir caminho para uma melhor compreensão acadêmica dos mecanismos subjacentes às barreiras e resistência ao conhecimento e comunicação em projetos complexos e de melhores maneiras de abordar e reduzir essas barreiras.

Palavras-chave: Comunicação. Conhecimento. Complexo. Projeto. Bibliometria.

1 Introduction

Managing project complexity is a critical factor that affects the success of the project (Allen, 2008; Baccarini, 1996). The complexity of the project is usually related to the way in which the design system is modeled Vidal and Marle (2008).

Project complexity can be considered the property of a project that makes it difficult to understand, predict, and maintain its overall behavior even when there is reasonably complete information about the project system.

According to Maylor, Vidgen, and Carver (2008) Random House Webster's College Dictionary says the complex means "made up of many interconnected parts". In a complex system, the different elements interact and produce non-linear and unpredictable results. It may be possible to recognize qualitative patterns of behavior, but complex systems are not amenable to treatment by the analysis of traditional systems where regularity, separability of elements, and clear cause and effect relationships are assumed.

The complexity of the projects receives different analyzes according to different authors. Maylor (2003) summed up complexity as three factors: organizational complexity (number of people, departments, organizations, localities, nationalities, languages and time zones involved, level of organizational commitment, authority structure), complexity of resources scale of the project, often indicated by budget size) and technical complexity (the level of novelty of any technology, system or interface and uncertainty about the processor requirements). For Turner and Cochrane (1993) and Williams (1999) the effect of uncertainty on design makes it complex. Vidal, Marle and Bocquet (2011) propose that the complexity of the project is classified according to the size, variety, interdependence and context of the project systems, as well as the technical and organizational dimensions. He *et al.* (2015) propose a structure of six categories of project complexity: technological, organizational, objective, environmental, cultural and information complexities.

Carvalho, Patah, and Bido (2015) presented criteria and variables to classify the complex projects: Financial; Contractual; Technical complexity and organizational considerations. While for Santos *et al.* (2016) projects are considered complex due to the number of participants, the diversity of skills and the uncertainty involved. Thus, different authors from different perspectives can categorize complex projects.

Managing a complex project involves several different phases, sometimes overlapping. Many of the available methods, techniques and available project management tools are applied in managing a complex project. In practice, this would mean that more than 60% of project competence elements could be applied to complex projects (International Project Management Association, 2006).

The complexity of the projects may intensify the role of communication and team knowledge due to the increased need for coordination and decision-making (Marks, Mathieu, & Zaccaro, 2001). Also according to Santos, Soares, and Carvalho (2012) many projects are considered complex because of a high degree of collaboration, complex projects involve social interactions among different participants that enable knowledge sharing.

For the authors Rabechini Jr., Carvalho, and Laurindo (2002) to achieve effective communication, a process of management of the communication system is required, which at the most comprehensive stage is called knowledge management. Alonso *et al.* (2013) indicate that since knowledge is transmitted primarily through human relations, any noise generates distortions in information, creating barriers to communication and making it difficult to store and share knowledge, thus creating barriers to knowledge management. Therefore,

it can be stated that many of the barriers present in knowledge transfer are Fukuyama *et al.* (2015) and the same can also occur. Knowledge's management subject has been an addressed topic in the literature, but its immersion in project management is still recent (Nadae & Carvalho, 2017).

Therefore, the objective of this paper is to analyze the publications about communication, knowledge of complex projects, through a systematic literature review and bibliometrics. For the systematic review of the literature, articles using the terms communication* and complex * and project * and knowledge were searched in the Web of Science and Scopus database, allowing to analyze the principal authors on the topic, research tendencies and gaps in the literature that future research that will contribute to the theme.

Due to the objective of the research, a Systematic Literature Review (SLR) and biliometrics was performed to help answer the following research questions: How does the literature relate communication management and knowledge management in complex projects? and What are the main trends in the academic literature on communication management and knowledge management in complex projects?

This research was carried out at the end of May 2018, and the results over a period of approximately 50 years of research on the subject, with the first article published in 1969.

For the accomplishment of the proposed this work is divided into 5 sections. The first one contextualizes the topic addressed. A brief presentation of the concepts is presented in section 2, as well as the search method, search steps in the Web of Science and Scopus database, the analysis software and networks are shown in section 3. The results and discussion on the topic are presented in section 4 and the conclusions in section 5.

2 Literature review

2.1 Complex projects

Project complexity is the property of a project that makes it difficult to understand, predict, and maintain its overall behavior even when there is reasonably complete information about the project system. The factors related to project size, project variety, project interdependence and project context can help to scale the complexity of a project (Vidal & Marle, 2008).

Different classifications of complex projects are presented in the literature. Baccarini (1996) considers the complexity of the project through the concepts of technological complexity and organizational complexity. While Shenhar, Dvir, and Shulman (1995) distinguish two dimensions of project complexity: "technological uncertainty" and "system scope." Shenhar (2001) extends the framework to encompass three dimensions of project complexity: "uncertainty," "rhythm," and "complexity/scope" where "rhythm" is added to reflect "speed and creativity" of time objectives.

For some authors complex projects can be defined as projects that can not be fully specified and planned in advance (Loch, Demeyer & Pich, 2006; Snowden, 2002; Williams, 2002).

Homer-Dixon (2000) evaluate complex projects according to: Multiplicity (number of components); Causal connections (number of links between components); Interdependence (the greater the module that can be removed from the complex system without affecting the overall behavior of the system); Environments; Synergy (the degree to which the whole system is more than the sum of the parts); and non-linear behavior (the effect on the system is not proportional to the size of the change in a component).

According to Kim and Wilemon (2003), the sources of complexity of the projects are multiple and can be categorized into technological complexity, market complexity, development complexity, marketing complexity, organizational complexity and intra-organizational complexity.

For the International Project Management Association to be considered a complex project it must meet the following criteria:

- Many sub-systems / sub-projects and interrelated elements;
- Several organizations involved in the project and/or different units in the same organization;
- Several different disciplines work in a complex project;

Vidal and Marle (2008) argue that some factors classified into four families can characterize the complexity of the project. The first family covers factors related to project size. The second brings together a variety of project factors. Also, the third brings together those that are related to interdependencies and interrelationships within the project system. Finally, the fourth deals with the dependence of the context of the complexity of the project (Vidal & Marle, 2008)

Girmscheid and Brockmann (2008) divided the complexity into five categories: task, society, culture, operation, and cognitive complexity. Vidal, Marle, and Bocquet (2011) propose that the complexity of the project is classified according to the size, variety, interdependence, and context of the project systems, as well as the technical and organizational dimensions.

Geraldi, Maylor, and Williams (2011) summarized in their studies the attributes of complexity dimensions in 5 categories: 1. Structural complexity: Size (or number) (Crawford, Hobbs & Turner, 2005; Geraldi & Adlbrecht, 2007), which is based on the results obtained by Chapman *et al*. (2005); Williams (1999); Xia (2005); 2. Uncertainty Novelty / Innovation (Shenhar, 2001; Tatikonda & Rosenthal, 2000); Experiment (Geraldi *et al*., 2011; Mykytyn & Green,

Table 1: Dimensions of Project Complexity

# Complexity Dimensions	Autor
• Technological complexity • Organizational complexity	Baccarini (1996)
• Technological uncertainty • System scope	Shenhar, Dvir, and Shulman (1995)
• Uncertainty • Rhythm • Complexity/scope	Shenhar (2001)
• Multiplicity • Causal connections • Interdependence Environments • Synergy • Non-linear behavior.	Homer-Dixon (2000)
• Technological complexity • Market complexity • Development complexity • Marketing complexity • Organizational complexity • Intra-organizational complexity.	Kim and Wilemon (2003)
• Many sub-systems / sub-projects and interrelated elements • Several organizations involved in the project and/or different units in the Same organization • Several different disciplines	International Project Management Association (2006)
• Project size • Variety of project factors • Interdependencies and interrelationships • Dependence of the context	Vidal and Marle, (2008)
• Task • Society • Culture • Operation • Cognitive complexity	Girmscheid and Brockmann (2008)
• Size • Variety • Interdependence • Context of the project systems • Technical and organizational dimensions	Vidal, Marle, and Bocquet (2011)
• Structural complexity • Uncertainty Novelty / Innovation • Dynamic • Rhythm • Socio-political complexity	Geraldi, Maylor, and Williams (2011)
• Financial • Contractual • Technical complexity • Organizational Considerations	Carvalho, Patah and Bido (2015)
• Technological • Organizational • Objective • Environmental • Cultural • Information	He et al. (2015)
• Number of participants • Diversity of skills • Uncertainty involved	Santos et al. (2016)

Source: The authors.

1992); Availability of information (Geraldi & Adlbrecht, 2007; Hobday, 1998; Maylor, Vidgen & Carver, 2008); 3. Dynamic: Change in (Maylor, Vidgen & Carver, 2008); 4. Rhythm: Rhythm of (Richmond *et al*., 2006; Shenhar & Dvir, 2007; Williams, 2005); 5. Socio-political complexity: Importance of support to the project or stakeholders (Mayer, Vidgen, & Carver, 2008), which is based on the modeling of the convergence model.

Still Carvalho, Patah and Bido (2015) presented criteria and variables to classify the complex projects: Financial: Financial volume; Percentage value of estimated risks; Project sales margin; and Percentage value of the research and development or engineering investment for the project; Contractual: Contractual position of the company in the project; Number of external partners contractually associated; Internal partners of the company; and Degree of relationship with the client; Technical complexity: Clarity of product definition or project scope; and the need for new technological development; and Organizational Considerations: Type of project (supply, system or turnkey); Contractual complexity; Strategic importance of the project to the company; and Strategic relevance for the client (Carvalho, Patah & Bido, 2015).

He *et al*. (2015) propose a structure of six categories of project complexity: technological, organizational, objective, environmental, cultural and information complexities. Already for Santos *et al*. (2016) projects are considered complex due to the number of participants, the diversity of skills and the uncertainty involved. The Table 1 shows a sumarize about complex projects according to some authors.

2.2 Communication management

Communication is considered a "process of exchange of information between sender and receiver to equalize the information on both sides" (Otter & Prims, 2002, p. 3).

The process of communication is influenced by several environmental factors, including location, initiator, a power relation, group size and composition, physical disposition, purpose and time (Johansen & Gillard, 2005). The barriers can occur due to several factors, such as conflicts, distinct cultural environments, lack of feedback, information censorship and inadequate channels (Carvalho & Rabechini Jr, 2015). Alencar, Souza, and Viana (2008) reinforce the need to eliminate any types of barriers that hinder communication or impede the clear and objective transmission and understanding of the message.

For Johansen and Gillard (2005) the barriers to communication may be at the most basic level, in the "Words" themselves. The words can be Interpretive words; Perceptual words and personal reflexive words. Some of these barriers embodied in language are words that invite interpretation (connotations, euphemisms), words that depend on perceptions of reality (abstractions, inferences, evaluations) and words that reflect attitudes, opinions, emotions and experiences (Johansen & Gillard, 2005).

Still for the same authors the barriers may still include personal characteristics such as social style, personality type, physical appearance, clothing, gender and cultural heritage; psychological distractions such as nervousness or tension; emotional distractions, such as extreme happiness or sadness; and physiological distractions such as fatigue or disease (Johansen & Gillard, 2005).

The geographic distribution of the Teams; Communication and coordination; Integrated systems; Business processes and communication structures can also represent barriers to communication (Bano, Zowghi & Sarkissian, 2016). While for Carvalho (2013) the barriers to communication can be divided into three: Trust, Priority, Semantics, and Environment.

Johannessen and Olsen (2011) emphasize the importance of communication in projects, particularly those that are large and complex. They argue that companies must move from the use of communication processes to the use of communication skills during projects.

Also according to Santos *et al*. (2016) in complex projects, one of communication barriers is knowledge management. Knowledge management and communication management comprise interrelated processes because to share knowledge it is necessary to create adequate medias of communciation for this. Also, the communication management among Project stakeholders is required to know complexity of the Project phases (Senaratne & Sexton, 2009; Whyte et al., 2016, Eriksson, Larsson & Pesamaa, 2017).

2.3 Knowledge management

Knowledge is a "specific data and information in the human mind related to intelligence, experience skills, and attitude, which can be the subject of manipulation regarding navigating, combining, reflection, synthesizing or even redefining the meaning of data strings". (Otter & Prims, 2002, p. 3).

Knowledge sharing can be viewed as the process of transferring knowledge from individuals, groups or organizations, which may include relevant information, ideas, and skills (Lee, 2001). In terms of knowledge sharing in complex projects, there are two dimensions of knowledge to be addressed: (1) knowledge about the project object, ie the product to be developed and the technical specifications that lead to a project that meets requirements, such as parts, components, parts or assemblies, and / or technologies used; (Santos *et al*., 2016). To achieve this, it is necessary to have a working knowledge of the project and the knowledge and skills required to carry out the project.

Cicmil (2005) offers a conceptual framework for capturing knowledge, proposing five aspects of project knowledge: context; content; organizational behavior; communication and project congruence.

Eliminating barriers to knowledge management is essential as they can affect the performance of projects. Knowledge sharing barriers in the context of projects include coding, inadequate information technology, lack of initiative and workers' strategy, and lack of time and resources (Santos *et al.,* 2016).

Alonso *et al*. (2013) indicate that since knowledge is transmitted mainly through human relations, any noise generates distortions in information, creating barriers to communication and making it difficult to store and share knowledge, thus creating barriers to management of knowledge. Therefore, it can be stated that many of the barriers present in knowledge transfer are communication (Fukuyama *et al.,* 2015) and the opposite can also occur. Thus, many models of knowledge transfer encompass communication (Ko, Kirsch & King, 2005).

In complex projects, the knowledge sharing and media or communication management need to be properly managed so that the knowledge acquired can be shared and communication among projet stakeholders flows positively.

3 Methodology

To obtain an overview of the literature on the subject, the ISI Web of Science and Scopus database was consulted because articles published in indexed and impact factor journals calculated by the Journal Citation Report (JCR) are located on this basis. About the selected databases the ISI Web of Science has high relevance in the academic field, as well as differential data treatment options (Franco, Hirama & Carvalho, 2017). And the Scopus database is considered the largest database of abstracts and citations in the peer-reviewed literature: scientific periodicals, books and congress proceedings (Scopus, 2018).

The procedures were organized at each stage of the research protocol proposed by Littell, Corcoran and Pillai (2008), following three steps: data collection, data analysis, and synthesis. (Tranfield, Denyer & Smart, 2003).

This research was carried out at the end of May/2018, and the results cover a period of approximately 50 years of research on the subject, with the first article published in 1969, the search was conducted following four steps as shown in Table 2.

First of all we looked at the two databases and checked for duplicated articles and removed them. Applying the filters in step 1 to 3 a manual filter was conducted (4), all

Table 2: Search criteria in the database

	Steps	Database	
		Scopus	ISI Web of Science
#1	Search in: Article title, Abstract and Keywords: *communication* AND complex* AND Project* AND knowledge*	1,404	914
#2	Filter by document type: *Article+Review+Article in Press*	725	492
#3	Filter by language: *English +Portuguese*	678	461
#4	Manual filter: *Reading all abstract to eliminate out-of-scope articles*	447	371
Final		818	

Source: The authors.

the abstracts were read to remove the papers out-of-scope, articles dealing with health research and education (epidemiological research, animal testing, agricultural research) research on global warming, which deal with complex projects and their relationship to communication management and knowledge management, and also articles due to lack of quality criteria, such as lack of refrences and research methods, were removed. Thus, 231 articles were removed from the base of Scopus and 90 from the ISI Web of Science totaling a final agglutinated base (Scopus + ISI Web of Science) of 818 articles. So only articles that fit the scope of knowledge and communication in project and/or complex project contexto were selected to the next step. After selecting the 818 articles, the data analysis stage was conducted, merging bibliometrics and systematic review of the literature.

The network analysis was carried out using the following software: VosViewer that generated the network of citation of keywords, citation of the main authors. Besides, a descriptive analysis was carried out with the database, creating graphs, through the excel of the countries with the highest number of publications on the subject, evolution of researches over the years, main periodicals that publish on the subject, the most cited authors, outliers with total citations by authors. Subsequently, content analysis was performed, when the articles searched were classified and coded.

The Keywords analysis was used to highlight concepts associated with the research question, giving greater consistency to the conceptual discussion of sustainable development and performance indicators related to this theme. Then, the content analysis was conducted based on the summary reading and the last section of each article, called "discussions", "conclusions", "results", among others (Locke & Golden-Biddle, 1997). The choice of this part of the article is given by the fact that this content often brings a summary of the article and also contains the main results of the research. This allows identifying the contribution of each article as well as knowledge gaps.

Finally, the third step, the synthesis of bibliometry was conducted. According to Crossan and Apaydin (2010), this step in which more value is added to the bibliometric analysis since this is where the creation of new knowledge is based on the complete and thorough review of the data. Emerging insights from the previous two steps brought the material needed to construct a conceptual model through an inductive process.

4 Results

The research resulted in a base of 818 articles, with average citations of 16.34 per paper. Starting analysis of articles by the number of publications per year (Figure 1), it is noted that the first publication appeared in 1969, and the years 2015, 2016 and 2017 have a more considerable sum of articles on the subject. The first article dated 1969 was based upon a survey conducted at the Department of Youth Work, University of Manchester, England, in a National Investigation into the Social Adjustment of Deaf Adolescents.

In the year 2015, the studies are focused on projects of innovation, construction and management and health focused on knowledge transfer and translation. As of 2016, the projects are about research projects (health, environmental, sustainability) and software projects and involve learning, communication process, information, and knowledge.

The articles of 2017 and 2018 mostly deal with topics of knowledge and learning, trust and communication, complex projects in IT and health, sustainability in projects and the influence of knowledge and communication on the environmental changes of projects.

Table 3 presents the journals with three or more publications on the subject, we analyzed the scope of the journals, highlighting the scope included project management, communication and knowledge management.

The Impact Factor (IF) is a measure of the frequency with which the average article in a journal was cited in a given year. It is used to measure the importance or ranking of a periodical by calculating the hours in which the articles are cited. The calculation is based on a two-year period and involves dividing the number of times the articles were cited by the number of articles that can be mentioned (Research Guides, 2018).

It should be noted that the periodical with the highest number of publications does not necessarily have the highest IF. In this case, the journal with the highest number of publications is the Journal of Management in

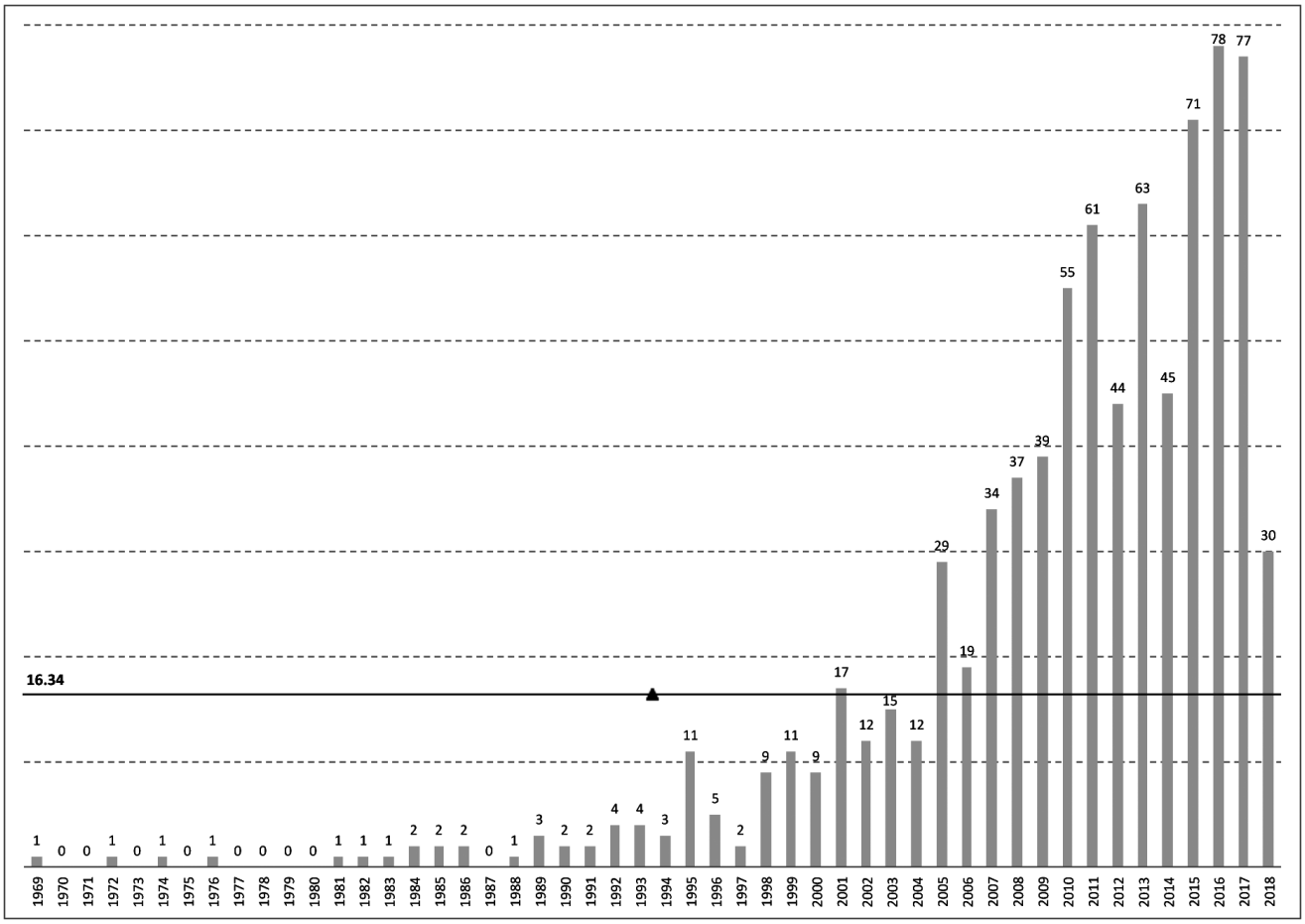

Figure 1: Publications per year
Source: The authors.

Engineering (10 papers), but the journal with the largest IF is the IEEE Transactions on Wireless Communications (4 articles).

It is noteworthy that some journals do not indicate their IF and in the classification of the scope, some journals do not emphasize project management, communication, and knowledge management as part of their scope, but they cover the topics: information management and lessons learned that are related to the subject of this study.

About the author's keywords, Figure 2, of the 2,512 authors keywords, 50 meet the threshold, a minimum number of occurrences of a keyword is 5. For each of the 50 keywords, the total strength of the co-occurrence links with other keywords is calculated. The keywords with the highest total link strength will be selected.

Mapping the most commonly used keywords and terms can help searchers in defining search topics in their searches and studies. The VosViewer software offers a series of graphical analyzes based on the co-occurrence of the analyzed items (Van Eck & Waltman, 2010).

The system shows the connection between related terms and authors, providing division into groups called clusters. Each cluster is represented by a color and aggregates all items considered similar. The size of the circles of the maps shows the number of occurrence of the issue and the proximity between two items reveals their degree of relationship, the closer they are, the more closely related (Van Eck & Waltman, 2010). The more critical an issue, the higher its writing and its representative circle (Van Eck & Waltman, 2010).

The keywords are grouped into seven clusters and the occurrences are presented in Table 4. A map of terms demonstrates the structure of a scientific field, showing the relationship between important terms in the area. During the selection of the terms, the main topics of

Table 3: Main journals, impact factor and scope

			SCOPE		
Source title	**#**	**IF**	**PM**	**C**	**K**
Journal of Management in Engineering	10	2.282			
Journal of Medical Internet Research	8	4.671			
Automation in Construction	8	4.032			
International Journal of Project Management	8	4.328			
Implementation Science	7	4.345			
Journal of Interprofessional Care	7	1.601			
International Journal of Medical Informatics	6	2.957			
IEEE Transactions On Professional Communication	5	0.756			
Trials	5	2.067			
Project Management Journal	4	1.957			
Journal of Engineering and Technology Management	4	2.686			
Research in Engineering Design	4	2.625			
BMC Public Health	4	2.420			
Computers & Education	4	4.538			
Computers in industry	4	2.850			
IEEE Transactions on Wireless Communications	4	5.888			
Environmental Science and Pollution Research	3	2.800			
MIS Quarterly	3	5.430			
Journal of the American Society For Information Science and Technology	3	2.452			
Information and Software Technology	3	2.627			
Journal of Systems and Software	3	2.278			
Computers in Human Behavior	3	3.536			
Journal of Knowledge Management	3	2.551			
AI Edam-Artificial Intelligence For Engineering Design Analysis and Manufactur	3	1.045			
IEEE Transactions On Engineering Management	3	1.416			
Electronic Journal of Information Technology in Construction	3	-			
International Journal of Engineering Education	3	0.575			
Technical Communication	3	1.188			
Technological Forecasting and Social Change	3	3.129			
Modern Journal of Language Teaching Methods	3				
Journal of Digital Imaging	3	1.536			
PLoS ONE	3	2.766			
Procedia Manufacturing	3	-			

IF = Impact Factor / PM = Project Management / C = Communication/ K = Knowledge

Source: The authors.

the area and the relationship of the terms with them are verified to identify their relevance in differentiating each article (Van Eck & Waltman, 2010).

Cluster # 1 has the word collaboration with greater prominence and link strength and suggests interdisciplinary projects focused on knowledge management as a

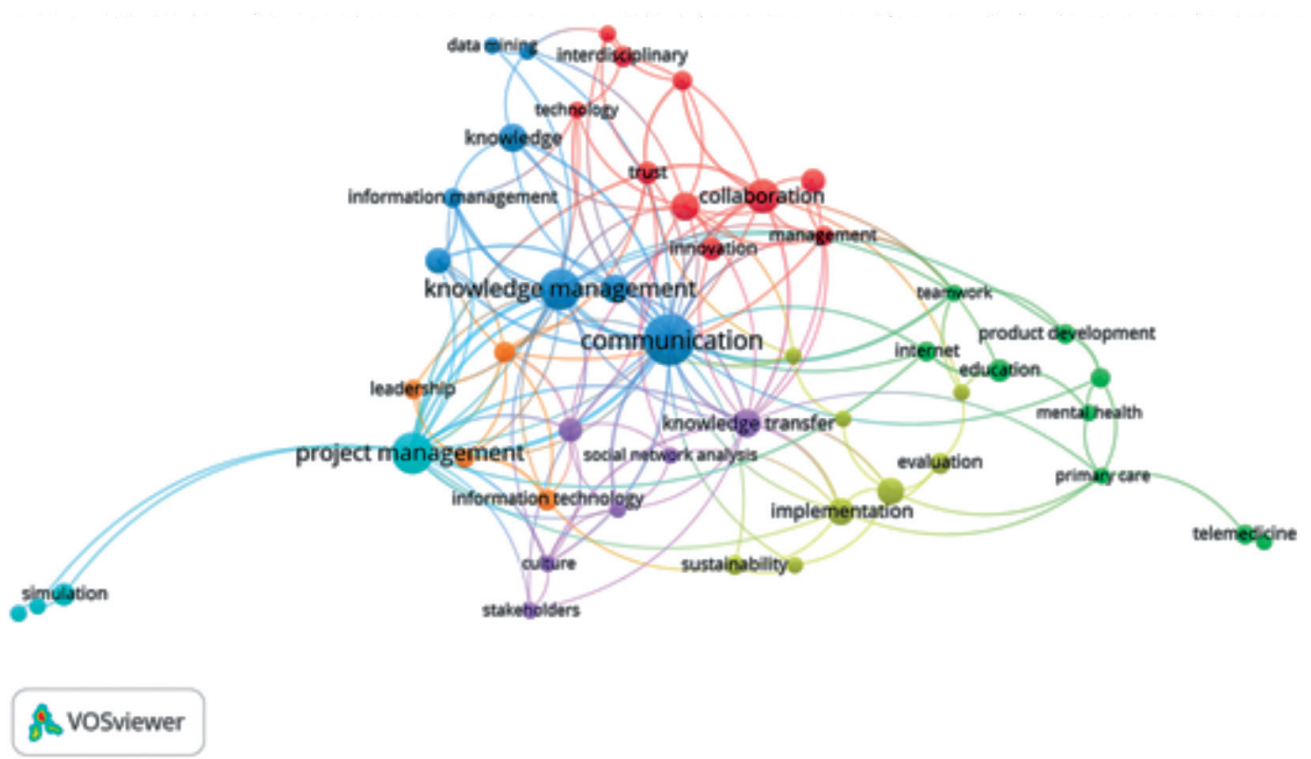

Figure 2: Co-occurrence of authors Keywords
Source: The authors.

source of collaboration, participation, team involvement and transmission of trust.

Cluster # 2 has the word Education with the highest occurrence suggesting work with research projects in education and health involving knowledge processes. In cluster # 3 the word communication stands out, followed by the word knowledge management both with greater occurrence and link strength, these words besides being related were used in the search for the formation of the database of this research. Besides, the work in this cluster suggests complex IT projects.

Implementation and Knowledge translations are the most prominent words and link strength of cluster # 4 also involve educational research projects and projects including the sustainability theme in knowledge transfer. About the cluster # 5 knowledge transfer and knowledge sharing are the words with the highest occurrence; this suggests that knowledge management research is related to the transfer and sharing processes, it is worth noting that the work of this cluster highlights the importance of the organizational culture to facilitate knowledge management.

Many projects in this base are about engineering design and construction industry, and this is highlighted in cluster # 6, and cluster # 7, as well as IT projects highlighted in # 7.

All clusters present some communication and knowledge barriers as shown by several authors in section 2, as well as introducing variables that characterize projects as complex.

From the network of keywords, such as barriers or difficulties to communication and knowledge management are: collaboration, trust, technology and participation (cluster #1); teamwork and mental health (cluster #2); communication and data mining (cluster #3); , knowledge translation, interprofessional education and narrative (cluster 4); culture (cluster 5); leadership, information systems and information technology (cluster 7). These barriers or difficulties were presented by the authors Cicmil (2005); Johansen and Gillard (2005); Santos *et al.* (2016); Alonso *et al.* (2013); Carvalho and Rabechini (2015).

Also, from the network of keywords it was even possible to identify the variables that characterize the proj-

Table 4: Occurrence of authors keywords

#	Clusters	Occurences	Total link strength
#1	collaboration	20	18
	case study	7	13
	trust	8	12
	management	6	10
	interdisciplinarity	6	6
	technology	5	6
	participation	5	5
	collaborative design	10	4
	innovation	9	4
	interdisciplinary	7	3
#2	teamwork	5	8
	primary care	5	6
	action research	6	5
	education	8	5
	internet	6	5
	product development	6	4
	mental health	5	3
	telemedicine	6	3
	knowledge representatior	5	2
#3	communication	44	47
	knowledge management	29	28
	complexity	13	16
	information management	6	10
	design	11	9
	knowledge	13	7
	decision-making	5	5
	data mining	5	2
#4	implementation	12	11
	knowledge translation	12	7
	narrative	5	5
	interprofessional educatio	5	4
	sustainability	6	4
	evaluation	7	3
	participatory action resear	5	3
	qualitative research	5	2
#5	knowledge transfer	14	25
	knowledge sharing	10	12
	culture	5	10
	coordination	5	8
	social network analysis	5	4
	stakeholders	5	4
#6	project management	29	35
	decision support	7	3
	simulation	8	2
	engineering design	5	1
#7	information systems	7	13
	construction industry	6	7
	information technology	7	7
	leadership	6	6

Source: The authors.

ects as complex: interdisciplinary and innovation (cluster 1); culture and stakeholders (cluster 5) and the most common type of project I consider complex: construction industry (cluster 7). These variables were mentioned by Homer-Dixon (2000); Shenhar (2001); IPMA (2006); Vidal and Male (2008); Gross (2014); He *et al.* (2015); Santos *et al.* (2016). The dispersion of the scientific production on the theme can also be evidenced by the analysis of the productivity of the 2797 authors present in the sample. Approximately 96% of them published only up to two documents; only ten (4%) published more than two papers during the analyzed period, and are presented in Table 5.

Of the ten authors only one has published more than four studies and belonged to the American University. Only one author from China, one from Canada and one from Korea are highlighted in Table 5 because they have three publications on the subject analyzed, with two other residents in England and the rest in the United States.

Three of John E. Taylor's four papers are about architecture, design, and engineering projects, only one deal communication tools in IT project. As for the other Americans, authors Laurie J. Kirsch and William R. King are from the University of Pittsburgh and published an article together on IT projects and knowledge transfer, the other articles of these authors are also from the area of IT. Kalle Lyytinen also studies knowledge management in IT projects and Josh Iorio projects with virtual teams and construction projects.

The Korean Jungwoo Lee is studying knowledge sharing in IT projects. The Canadian Reimer-Kirkham's paper together with other authors deals with the transfer of knowledge in health processes and research projects in the health area. Also, the authors of these papers propose to conceptualize the knower, knowledge, and actions are inseparable.

Table 5: Main authors, institutions, and countries

Authors	# Papers	Affiliations	Countries
Taylor, J.E.	4	Charles E Via Jr Dept Civil & Environm Engn, Virginia Tech	
King, W.R.	3	Katz Graduate School of Business, University of Pittsburgh	
Reimer-Kirkham, S.	3	School of Nursing, Trinity Western University	
Lee, J.	3	Center for Work Science, Yonsei University	
Li, X.	3	Institute of Behavior and Psychology, Henan University	
Austin, S.	3	School Energy Construct & Environm., Coventry University	
Kirsch, L.J.	3	Katz Graduate School of Business, University of Pittsburgh	
Lyytinen, K.	3	Weatherhead School Management, Kalle Case Western Reserve University	
Iorio, J.	3	Civil Engn Network Dynam Lab, Polytech Inst & State University	
Alshawi, M.	3	Research Institute for the Built and Human Environment (BUHU), University of Salford	

Source: The authors.

The studies of Chinese Xiaoming Li are about health projects and studies of mechanisms that facilitate knowledge-sharing teams. About the British Stephen Austin, his reviews are about design projects and a study that analyzes portals as a knowledge repository and transfer tool, and Mustafa Alshawi investigates construction and IT projects.

Table 6 shows the most cited papers among those present in the sample of the study. This analysis allows identifying which articles and authors have more influence on the research, although, as discussed, it is still an emerging issue.

The most cited article was written by Ko, Kirsch, and King (2005) and analyzes knowledge management in complex IT projects, this paper examines the antecedents of knowledge transfer in the context of such an interfirm complex information systems implementation environment. Drawing from the knowledge transfer, information systems, and communication literature, an integrated theoretical model is developed that posits that knowledge transfer is influenced by knowledge-related, motivational, and communication-related factors. Data were collected from consultant-and-client matched-pair samples from 96 ERP implementation projects.

Figure 3 shows the network of quoted authors having at least two articles in the selected database and which were quoted at least twice. The results present nine articles, so the article #ii by Alin, Iorio, and Taylor (2013) cited the article #iv of Boland, Lyytinen, and Yoo (2007). The purpose of Alin, Iorio, and Taylor (2013) article #ii is to explore the role of digital frontier objects in the negotiation of complex design knowledge in a three-dimensional (3-D) virtual workspace. Thus the authors Boland, Lyytinen and Yoo (2007) were mentioned in the introductory section of the article in the section that affirms to be a challenge the development of projects in the network.

Dossick et al. (2000) quoted article #iii by Nayak and Taylor (2009), and the aim of article #ii is to analyze engineering teams that collaborate in virtual environments facing many technical problems, social and cultural, concentrating on distributed teams that make unexpected joint discoveries in virtual environments. Thus, article #iii of Nayak and Taylor (2009) contributed to the theoretical referential of this article with the definition of virtual teams.

Another relation found between the articles is that of the article #vi of the authors Park and Lee (2014) that quoted the article #v of Kanawattanachai and Yoo (2007),

Table 6: Most cited papers

Authors	Title	Source title	#Citation	%Accum
Ko, Kirsch and King (2005)	Antecedents of knowledge transfer from consultants to clients in enterprise system implementations	MIS Quarterly: Management Information Systems	698	2,9%
Lu, Chang and Liao (2013)	Environmental Informatics for Solid and Hazardous Waste Management: Advances, Challenges, and Perspectives	Critical Reviews in Environmental Science and Technology	430	4,6%
Mammela, Riekki, Kotelba and Anttonen (2018)	Multidisciplinary and Historical Perspectives for Developing Intelligent and Resource-Efficient Systems	IEEE Access	403	6,3%
Choi and Pak (2006)	Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness	Clinical and Investigative Medicine	280	7,4%
Frost and Massagli (2008)	Social uses of personal health information within PatientsLikeMe, an online patient community: What can happen when patients have access to one another's data	Journal of Medical Internet Research	238	8,4%
Klaschka (2008)	A new challenge-development of test systems for the infochemical effect	Environmental Science and Pollution Research	168	9,1%
Setia and Patel (2013)	How information systems help create OM capabilities: Consequents and antecedents of operational absorptive capacity	Journal of Operations Management	161	9,7%
Robbin and FrostKumpf (1998)	Extending theory for user-centered information services: Diagnosing and learning from error in complex statistical data	Journal of the American Society For Information Science	158	10,4%
Chini, Canning, Schreiber, Peschel and Stillwell (2017)	The Green Experiment: Cities, Green Stormwater Infrastructure, and Sustainability	Sustainability	155	11,0%
Delafield-Butt and Trevarthen (2015)	The ontogenesis of narrative: from moving to meaning	Frontiers in Psychology	150	11,6%
Vlaar, van Fenema and Tiwari (2008)	Cocreating understanding and value in distributed work: How members of onsite and offshore vendor teams give, make, demand, and break sense	Mis Quarterly	149	12,3%
Licorish and MacDonell (2017)	Exploring software developers' work practices: Task differences, participation, engagement, and speed of task resolution	Information & Management	143	12,8%
Larsen, Eppinga, Passalacqua, Getz, Rose and Liang (2016)	Appropriate complexity landscape modeling	Earth-Science Reviews	142	13,4%
Su and Contractor (2011)	A Multidimensional Network Approach to Studying Team Members' Information Seeking From Human and Digital Knowledge Sources in Consulting Firms	Journal of the American Society For Information Science and Technology	141	14,0%
Johannsen and Fill (2017)	Meta Modeling for Business Process Improvement	Business & Information Systems Engineering	138	14,6%
Westgate, Likens and Lindenmayer (2013)	Adaptive management of biological systems: A review	Biological Conservation	129	15,1%
Moenaert, Caeldries, Lievens and Wauters (2000)	Communication flows in international product innovation teams	Journal of Product Innovation Management	129	15,6%
Com, Melaine, Chalmel and Pineau (2014)	Proteomics and integrative genomics for unraveling the mysteries of spermatogenesis: The strategies of a team	Journal of Proteomics	122	16,1%
Ingram, Mills, Dibari, Ferrise, Ghaley, Hansen, Iglesias, Karaczun, McVittie, Merante, Molnar and Sanchez (2016)	Communicating soil carbon science to farmers: Incorporating credibility, salience and legitimacy	Journal of Rural Studies	121	16,6%
Wolf, Arnold, Bauersachs, Beier, Blum, Einspanier, Frohlich, Herrler, Hiendleder, Kolle, Prelle, Reichenbach, Stojkovic, Wenigerkind and Sinowatz (2003)	Embryo-maternal communication in bovine - Strategies for deciphering a complex cross-talk	Reproduction in Domestic Animals	118	17,1%
Pons (2008)	Project Management for New Product Development	Project Management Journal	114	17,6%
Weimann, Pollock, Scott and Brown (2013)	Enhancing Team Performance Through Tool Use: How Critical Technology-Related Issues Influence the Performance of Virtual Project Teams	Ieee Transactions On Professional Communication	105	18,0%

Source: The authors.

Continue…

Continue – **Table 6: Most cited papers**

Authors	Title	Source title	#Citation	%Accum
Spink, Hillman, Fryirs, Brierley and Lloyd (2010)	Has river rehabilitation begun? Social perspectives from the Upper Hunter catchment, New South Wales, Australia	Geoforum	105	18,4%
Roberts, Cheney, Sweeney and Hightower (2004)	The effects of information technology project complexity on group interaction	Journal of Management Information Systems	104	18,9%
Smith and Villalba (2008)	Striatal and extrastriatal dopamine in the basal ganglia: An overview of its anatomical organization in normal and Parkinsonian brains	Movement Disorders	103	19,3%
Van Ban and Hadikusumo (2017)	Culture EPC oil and gas project in Vietnam: grounded theory	International Journal of Energy Sector Management	103	19,7%
Chrysoulakis, Lopes, San Jose, Grimmond, Jones, Magliulo, Klostermann, Synnefa, Mitraka, Castro, Gonzalez, Vogt, Vesala, Spano, Pigeon, Freer-Smith, Staszewski, Hodges, Mills, Cartalis (2013)	Sustainable urban metabolism as a link between bio-physical sciences and urban planning: The BRIDGE project	Landscape and Urban Planning	103	20,1%
Kanawattanachai and Yoo (2007)	The impact of knowledge coordination on virtual team performance over time	Mis Quarterly	103	20,5%
Kleinschmidt, de Brentani and Salomo (2010)	Information Processing and Firm-Internal Environment Contingencies: Performance Impact on Global New Product Development	Creativity and Innovation Management	102	21,0%
Säderberg and Holden (2002)	Rethinking cross cultural management in a globalizing business world	International Journal of Cross Cultural Management	101	21,4%
	Others (#140) > 50 and ≤100		9468	60,2%
	Others (#642) ≤ 50		9724	100,0%
	Total		24408	

Source: The authors.

where these last authors helped, with the theory presented in their studies, in the construction of the hypothesis: "Trust in the partner is positively related to knowledge sharing" in article #vi.

The first cluster presents studies on complex projects in general, projects with virtual teams, IT and innovation. The studies of the second cluster, composed by Youngjin Yoo, Jun-Gi Park, and Jungwoo Lee, focus on knowledge management studies, knowledge and information sharing in project development and their relation to project performance. In both the most recent article is the year 2016.

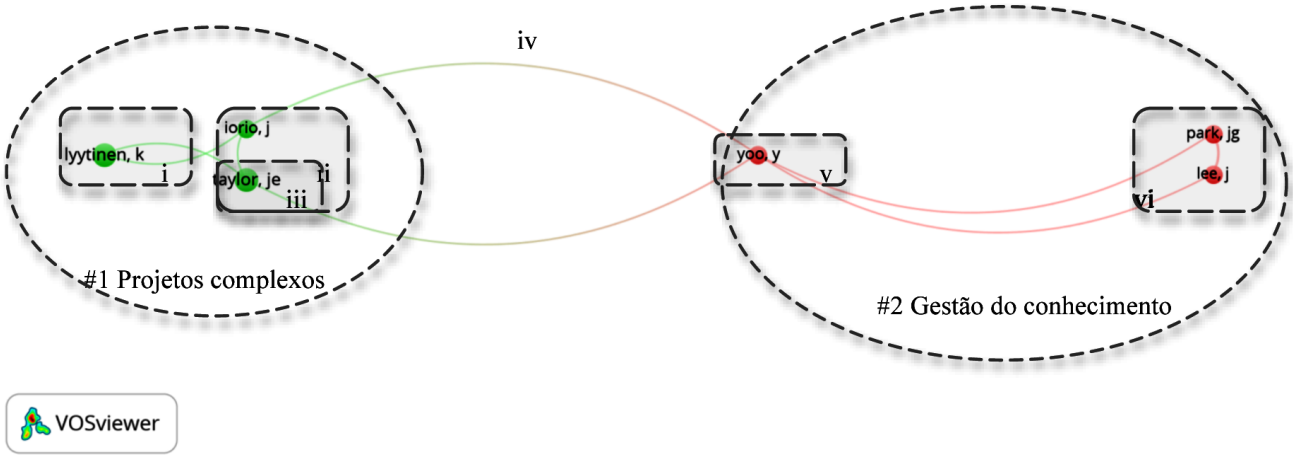

Figure 3: Citation Authors.
Source: The authors.

Cluster #1

i. LINDBERG, A.; BERENTE, N.; GASKIN, J.; **LYYTINEN, K**. Coordinating Interdependencies in Online Communities: A Study of an Open Source Software Project. Information Systems Research, vol. 27, n. 4, 2016.

i. KARSTEN, H; **LYYTINEN, K;** HURSKAINEN, M; KOSKELAINEN, T. Crossing boundaries and conscripting participation: representing and integrating knowledge in a paper machinery Project. European Journal of Information Systems, vol. 10, n. 2, 2001.

ii. DOSSICK, C.S.; ANDERSON, A.; AZARI, R.; **IORIO, J.**; NEFF, G.; **TAYLOR, J. E**. Messy Talk in Virtual Teams: Achieving Knowledge Synthesis through Shared Visualizations. Journal Of Management In Engineering, vol. 28, n. 1, 2015.

ii. ALIN, P.; **IORIO, J.**; **TAYLOR, J. E**. Digital Boundary Objects as Negotiation Facilitators: Spanning Boundaries in Virtual Engineering Project Networks. Project Management Journal, vol. 44, n. 3, 2013.

iii. NAYAK, N. V.; **TAYLOR, J. E.** Offshore Outsourcing in Global Design Networks. Journal Of Management In Engineering, vol. 25, n. 4, 2009.

iv. BOLAND, R. J., JR.; **LYYTINEN, K.**; **YOO, Y**. Wakes of innovation in project networks: The case of digital 3-D representations in architecture, engineering, and construction. Organization Science, vol. 18, n. 4, 2007.

Cluster #2

v. KANAWATTANACHAI, P.; **YOO, Y**. The impact of knowledge coordination on virtual team performance over time. MIS Quarterly, vol. 31, n. 4, 2007.

vi. PARK, J-G.; LEE, J. Knowledge sharing in information systems development projects: Explicating the role of dependence and trust. International Journal of Project Management, vol. 32, n. 1, 2014.

vi. LEE, S.; **PARK, J-G**; **LEE, J**. Explaining knowledge sharing with social capital theory in information systems development projects. Industrial Management & Data Systems, vol. 115, n. 5, 2015.

Note: This network was performed with boundary criteria of at least two citations from a reference cited by the VosViewer software using extracted from the database.

in the academic literature on communication management and knowledge management in complex projects?

It is noteworthy that the literature encompasses studies on communication management in project teams, more precisely on the storage and sharing of knowledge in IT, health, physics, chemistry and construction projects, among others. Few studies focus on complex projects, mainly analyzing the two topics together. Communication management and knowledge management in complex projects, which according to the theory are projects with difficult understanding and prediction, with complex information, many involved, with interdependence between projects, among other properties that differ from projects, complex projects already presents diverse challenges which include problems with communication and knowledge management.

5 Conclusions

The objective of this paper was to analyze publications on communication and knowledge management in complex projects, through a systematic review of literature and bibliometrics. For the systematic review of the literature, articles were searched using the terms communication * and complex * and project * and knowledge in the Web of Science and Scopus database, allowing to analyze the principal authors on the topic, research trends and gaps in the literature which will enable the development of future research that will contribute to the theme. Also, it was possible to answer the question: How does the literature relate communication management and knowledge management in complex projects? also, What are the main trends

Thus, based on the articles analyzed few studies relate to communication management and knowledge management in project complex but individually the themes are studied by several authors, as presented in the tables and analyzes of this study.

The articles of the year 2017 mostly deal with topics of knowledge and learning, trust and communication, complex projects in IT and health, sustainability in projects and the influence of knowledge and communication on the environmental changes of projects. Moreover, the most recent articles of the year 2018 deal with the analysis of learning in health projects, communication in sustainable projects, knowledge and interpersonal communication in educational projects, knowledge of politics in megaprojects.

Interprofessional education, interpersonal communication, data mining, interprofessional education, collaboration, confidence, technology, participation, teamwork, mental health, culture, leadership, information systems, information technology. These barriers or difficulties were presented by the authors Cicmil (2005); Johansen and Gillard (2005); Santos *et al.* (2016); Alonso *et al.* (2013); Carvalho and Rabechini (2015).

Also, from the network of keywords, it was even possible to identify the variables that characterize the projects as complex: interdisciplinary, innovation, culture, stakeholders, and the most common type of project I consider complex: construction industry. These variables were mentioned by Homer-Dixon (2000); Shenhar (2001); IPMA (2006); Vidal and Male (2008); Gross (2014); He *et al.* (2015); Santos *et al.* (2016).

The literature analyzed, in general, deals with communication barriers and barriers of knowledge management, often relating communication as a barrier to knowledge management in complex projects. Also, it addresses the difficulties of communication in projects and the tools for storing knowledge and lessons learned in complex projects.

The research trends on the analyzed subject are studies on communication channels, relationships and interpersonal communication as mechanism of storage and knowledge sharing throughout the phases of complex projects.

This paper contributes to a better understanding of the knowledge management and communication management in complex projects, as well as this research can pave the way for a better academic understanding of the mechanisms underlying the barriers and resistance to the knowledge and communications in complex projects and of better ways to address and reduce these barriers.

Future research may analyze communication management and knowledge management in complex projects; the barriers and main challenges of complex projects; the differences between communication management in traditional projects and complex projects and the same for knowledge management.

This study confines itself to analyzing only the articles in the Web of Science and Scopus database, and other bases could be incorporated and analyzed, as well as articles from other languages.

Acknowledges

The author thank the reviewers for their relevant contributions. This research was supported by National Counsel of Technological and Scientific Development (CNPq) and Coordination for the Improvement of Higher Education Personnel (CAPES). We greatly thank them for supporting this research.

References

Ahern, T., Leavy, B., & Byrne, P. J. (2014). Complex project management as complex problem solving: A distributed knowledge management perspective. International Journal of Project Management, 32(8), 1371-1381. https://doi.org/10.1016/j.ijproman.2013.06.007

Alencar, L. H., Souza, V. A., & Viana, J. C. (2008). Uma análise do gerenciamento da comunicação em empresas de grande porte em Pernambuco. Anais dos Encontro Nacional de Engenharia de Produção, ENEGEP, p. 1-13.

Allen, P. M. (2008). The importance of complexity for the research agenda in the built environment. Architectural Engineering and Design Management, 4(1), 5-14. https://doi.org/10.3763/aedm.2008.S907

Alonso, L. B. N., Campos, R. P. De, Cruz, K. C. B. Da, & Hedler, H. C. (2013). Comunicação e compartilhamento do conhecimento entre equipes em automação de processos. Revista Comunicologia, (2002), 165-183. Retrieved from http://portalrevistas.ucb.br/index.php/RCEUCB/article/view/5286/3341

Baccarini, D. (1996). The concept of project complexity – A review. International Journal of Project Management, 14(4), 201-204. https://doi.org/10.1016/0263-7863(95)00093-3

Bano, M., Zowghi, D., & Sarkissian, N. (2016). Empirical study of communication structures and barriers in geographically distributed teams. IET Software, 10(5), 147-153. https://doi.org/10.1049/iet-sen.2015.0112

Carvalho, M. M. de. (2013). An investigation of the role of communication in IT projects. International Journal of Operations & Production Management, 34(1), 36-64. https://doi.org/10.1108/IJOPM-11-2011-0439

Carvalho, M. M., & Rabechini Jr, R. (2015). Fundamentos em Gestão de Projetos: Construindo Competências para Gerenciar Projetos (Atlas). São Paulo: 4.

Carvalho, M. M., Patah, L. A., & Bido, D. de S. (2015). Project management and its effects on project success: Cross-country and cross-industry comparisons. International Journal of Project Management, 33(7), 1509-1522. https://doi.org/10.1016/j.ijproman.2015.04.004

Chapman, R., & Hyland, P. (2004). Complexity and learning behaviors in product innovation. Technovation, 24(7), 553-561. https://doi.org/10.1016/S0166-4972(02)00121-9

Cicmil, S., & Marshall, D. (2005). Insights into collaboration at the project level: Complexity, social interaction and procurement mechanisms. Building Research and Information, 33(6), 523-535. https://doi.org/10.1080/09613210500288886

Corbett, C. J., & Kirsch, D. A. (2004). Response to "Revisiting ISO 14000 Diffusion: A New 'Look' at the Drivers of Certification", 13(3), 268-271.

Crawford, L., Hobbs, B., & Turner, J. . (2005). Project Categorization Systems. Newton Square: PMI.

Eriksson, P. E., Larsson, J., & Pesämaa, O. (2017). Managing complex projects in the infrastructure sector – A structural equation model for flexibility-focused project management. International Journal of Project Management, 35(8), 1512-1523. https://doi.org/10.1016/j.ijproman.2017.08.015

Franco, E. F., Hirama, K., Carvalho, M. M. (2017). Applying system dynamics approach in software and information system projects: A mapping study. Information and Software Technology.

Fukuyama, K., Lopes, A. P. V. B. V., Nadae, J., & Carvalho, M. M. (2015). Barreiras à comunicação e suas influências no desempenho de projeto. Mundo PM, 1–56. https://doi.org/10.1017/CBO9781107415324.004

Geraldi, J., & Adlbrecht, G. (2007). On faith, fact, and interaction in projects. IEEE Engineering Management Review, 36(2), 35-49. https://doi.org/10.1109/EMR.2008.4534318

Geraldi, J., Maylor, H., & Williams, T. (2011). Now, let's make it really complex (complicated). International Journal of Operations & Production Management, 31(9), 966-990. https://doi.org/10.1108/01443571111165848

Girmscheid, G., & Brockmann, C. (2008). The Inherent Complexity of Large Scale Engineering Projects. Project Perspectives, 29, 22-26. https://doi.org/10.3929/ETHZ-B-000225616

Gross, U. (2014). Fighting the fire: improvisational behavior during the production launch of new products. International Journal of Operations & Production Management, 34(6), 722-749. https://doi.org/10.1108/IJOPM-08-2012-0306

He, Q., Luo, L., Hu, Y., & Chan, A. P. C. (2015). Measuring the complexity of mega construction projects in China-A fuzzy analytic network process analysis. International Journal of Project Management, 33(3), 549-563. https://doi.org/10.1016/j.ijproman.2014.07.009

Hobday, M. (1998). Product complexity, innovation and industrial organisation. Research Policy, 26(6), 689-710. https://doi.org/10.1016/S0048-7333(97)00044-9

Homer-Dixon, T. F. (2000). The ingenuity gap: Facing the economic, environmental, and other challenges of an increasingly complex and unpredictable world. New York.: Knopf.

IPMA - Internacional Project Management Association (2006). ICB – IPMA Competence Baseline, Version 3.0.

Johannessen, J. A., & Olsen, B. (2011). Projects as communicating systems: Creating a culture of innovation and performance. International Journal of Information Management, 31(1), 30-37. https://doi.org/10.1016/j.ijinfomgt.2010.04.006

Johansen, J., & Gillard, S. (2005). Information resources project management communication: Personal and environmental barriers. Journal of Information Science, 31(2), 91-98. https://doi.org/10.1177/0165551505050786

Kim, J., & Wilemon, D. (2003). Sources and assessment of complexity in NPD projects. R and D Management, 33(1), 15-30. https://doi.org/10.1111/1467-9310.00278

Ko, D., Kirsch, L., & King, W. (2005). Antecedents of Knowledge Transfer from Consultants to Clients in Enterprise System Implementations. MIS Quarterly, 29(1), 59-85. doi:10.2307/25148668

Lee, J.-N. (2001). The impact of knowledge sharing, organizational capability and partnership quality on IS outsourcing success. Information & Management, 38(5), 323-335.

Littell, J. H., Corcoran, J., & Pillai, V. (2008). Systematic reviews and meta-analysis. New York: Oxford University Press.

Loch, C. H., DeMeyer, A., & Pich, M. . (2006). Managing the Unknown: A New Approach to Managing High Uncertainty and Risks in Projects. Hoboken, NJ: Wiley.

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A Temporally Based Framework and Taxonomy of Team Processes Author (s): Michelle A . Marks , John E . Mathieu and Stephen J . Zaccaro Source: The Academy of Management Review , Vol . 26 , No . 3 (Jul ., 2001), pp . 356-376 Published by: Academy of M. The Academy of Management Review, 26(3), 356-376.

Maylor, H., Vidgen, R., & Carver, S. (2008). Managerial Complexity in Project- Based Operations: A Grounded Model and Its Implications for Practice. Project Management Journal, 39(Supplement,), S15-S26.

Mykytyn, P. P., & Green, G. I. (1992). Effects of computer experience and task complexity on attitudes of managers. Information and Management, 23(5), 263-278. https://doi.org/10.1016/0378-7206(92)90057-M

Nadae, J. De, & Carvalho, M. M. (2017). A knowledge management perspective of the project management office. Brazilian Journal of Operations & Production Management, 14(3), 350. https://doi.org/10.14488/bjopm.2017.v14.n3.a8

Otter, A. D., & Prins, M. (2002). "Architectural design management within the digital design team." Eng. Constr. Archit. Manage, 9(3), 162-173.

Rabechini Jr., R., Carvalho, M. M. De, & Laurindo, F. J. B. (2002). Fatores críticos para implementação de gerenciamento por projetos: o caso de uma organização de pesquisa. Produção, 12(2), 28-41. https://doi.org/10.1590/S0103-65132002000200004

Richmond, A., Skitmore, M., Regev, S., Shtub, A., Ben-Haim, Y., Scott Sutterfield, J., … Deshayes, P. (2006). Making Project Management Indispensable for Business Results: Managing Project Risks As Knowledge Gaps. PROJECT MANAGEMENT JOURNAL Research Quarterly, 37(5).

Santos, V. R., Soares, A. L., Carvalho, & St-Pierre, J. Á. (2016). Knowledge Sharing Barriers in Complex Research and Development Projects: an Exploratory Study on the Perceptions of Project. Knowledge and Process Management, 23(2), 110-123. https://doi.org/10.1002/kpm

Santos, V.R., Soares, A.L., & Carvalho, J.A. (2016). Knowledge Sharing Barriers in Complex Research and Development Projects: an Exploratory Study on the Perceptions of Project Managers, Knowledge and Process Management.

Scopus. What is scopus (2018). Disponível em:< https://www.elsevier.com/solutions/scopus>. Acesso em jul. 2018.

Senaratne, S., Sexton, M. (2009). Role of knowledge in managing construction project change. Eng. Constr. Archit. Manag. 16(2), 186-200

Senescu, R. R., Aranda-Mena, G., & Haymaker, J. R. (2012). Relationships between Project Complexity and Communication. Journal of Management in Engineering, 29(2), 183-197. https://doi.org/10.1061/(asce)me.1943-5479.0000121

Shenhar, A. J. (2001). One size does not fit all projects: exploring classical contingency domains. Management Science, 47(3), 394-414.

Shenhar, A. J., & Dvir, D. (2007). Reinventing Project Management: The Diamond Approach to Successful Growth and Innovation. Boston, MA: HBS Press Book.

Shenhar, A. J., Dvir, D., & Shulman, Y. (1995). A two-dimensional taxonomy of products and innovations. Journal of Engineering and Technology Management, 12(3), 175-200. https://doi.org/10.1016/0923-4748(96)80015-4

Snowden, D. (2002). Complex acts of knowing: paradox and descriptive self-awareness. Journal of Knowledge Management, 6(2), 100-111. https://doi.org/10.1108/13673270210424639

Tatikonda, M. V., & Rosenthal, S. R. (2000). Technology novelty, project complexity, and product development project execution success: A deeper look at task uncertainty in product innovation. HPAC Heating, Piping, Air Conditioning, 72(2), 74-87. https://doi.org/10.1109/17.820727

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review*. British Journal of Management, 14, 207-222. https://doi.org/10.1111/1467-8551.00375

Turner, J.R., & Cochrane, R. (1993). Goals and methods matrix: Coping with projects with ill-defined goals and/or methods of achieving them. International Journal of Project Management, 11(2), 93-102.

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523-538. https://doi.org/10.1007/s11192-009-0146-3

Van Eck, N. J., Waltman, L., Dekker, R., & den Berg, J. van. (2009). A Comparison of Two Techniques for Bibliometric Mapping: Multidimensional Scaling and VOS. Communications in Information Literacy, 3(2), 80-90. https://doi.org/10.1002/asi

Vidal, L., & Marle, F. (2008). Understanding project complexity: implications on project management. Kybernetes, 37(8), 1094-1110. https://doi.org/10.1108/03684920810884928

Whyte, J., Stasis, A., Lindkvist, C. (2016). Managing change in the delivery of complex projects: configuration management, asset information and 'big data'. Int. J. Proj. Manag. 34(2), 339–351.

Wiliams, T. (1999). The need for new paradigms for complex projects. International Journal of Project Management, 11, 269–273.

Williams, T. (1999). The need for new paradigms for complex projects. International Journal of Project Management, 17(5), 269–273. https://doi.org/10.1016/S0263-7863(98)00047-7

Williams, T. (2002). Modelling Complex Projects. [s.l.] Wiley, Chichester.

Williams, T. (2005). Assessing and moving on from the dominant project management discourse in the light of project overruns. IEEE Transactions on Engineering Management, 52(4), 497–508. https://doi.org/10.1109/TEM.2005.856572

Williams, T. (2007). Post-project reviews. Newtown Square, Pennsylvania: Project Management Institute, Inc.

Whyte, J., Stasis, A., Lindkvist, C., 2016. Managing change in the delivery of complex projects: configuration management, asset information and 'big data'. Int. J. Proj. Manag. 34(2), 339–351.

Xia, W., & Lee, G. (2005). Complexity of Information Systems Development Projects: Conceptualization and Measurement Development Complexity of Information Systems Development Projects: Conceptualization and Measurement Development Abstract. Journal of Management Information Systems, 22(1), 45–83.