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**BIBLIOMETRIC ANALYSIS OF
PUBLICATIONS RELATED TO THE
IMPLEMENTATION OF AGILE
METHODOLOGIES IN PROJECT
MANAGEMENT IN IT COMPANIES, IN THE
PERIOD 2010-2021**

Tesis para optar el Título Profesional de Ingeniero Industrial

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Abstract

Software development in IT companies is a whole process, so it is important to define the ideal methodology before starting a project. This study describes the literature on project management in 2 periods 2010-2019 and 2020-2021, through a bibliometric review of research indexed in Scopus and Web of Science. The VosViewer tool has been used to visualize the relationships between authors and keywords. A total of 666 publications related to agile methodologies were identified during 2010-2021. The institutions with the highest publishing activity were concentrated in the US, Brazil and Germany. The co-authorship and co-occurrence analyze of keywords show the main authors and research sources in both periods. Publications on agile methodologies in IT companies have been increasing in the last 2 years. In this research, the main authors, journals, thematic areas, institutions, countries and cases of greater scientific relevance were analyzed.

Keywords

Agile Methodologies, Project Management, Scrum, Software and IT.

1. Introduction

Agile methodologies for software development arise from the frustration of various developers, leaders and administrators with the classic methodologies, since these had drawbacks and presented a high risk for companies. When any of these methodologies did not meet the objectives, the company that owned the project lost its reputation and was severely affected financially (Cimolini and Cannell 2012). That is why, at present, more and more organizations implement agile methodologies, which is why the case studies that are carried out about these implementations increase.

A framework that meets the appropriate parameters for optimal project management is Scrum, which delves into project management tasks, using adaptive planning and incremental development of projects with deliveries in short periods of time, this includes a set of good practices for teamwork in order to obtain a good result in an assigned project.

The use of Scrum is directed to projects in complex environments, where immediate results are required, the requirements are changing or poorly defined, where innovation, competitiveness, flexibility and productivity are essential. Likewise,

(Alsaber 2020) regarding Scrum states that: The methodology achieves success by facilitating autonomous and multifunctional teams. In addition, it is based on the importance of change and the continuous fragmentation of projects to improve performance and quality.

To understand the level of impact of the pandemic on scientific research, the discipline used for this work was bibliometrics, which is based on the search for statistically regular behavior over time of the different elements related to the production and consumption of scientific information (Ardanuy and Rey Vázquez 2009).

The circumstances and environment of an investigation is variable, for example the Covid-19 pandemic was an unpredictable event. The search for information in the projects area could reduce its flow of circulation, or also evolve, and continue.

According to Babativa et al. (2016), software systems are increasingly complex, not only because of the same functionality but also because of the environment in which they must be executed (distributed, networked, multiplatform, cloud systems) and because of the variety of technological and methodological solutions today.

2. Méthods

The research design was non-experimental, longitudinal and descriptive. This analysis allows quantitatively identifying and analyzing the most cited sources, the institutions that publish them and the most cited authors and more. The data was produced from publications indexed in the Scopus and Web of Science databases. They are search engines for internationally renowned research that are commonly used for scientific articles.

As a search strategy, the keyword agile methodologies in IT project management was selected. Studies in Spanish, Portuguese and English were considered, from 2010 to 2021, divided into two periods: 2010-2019 and 2020-2021, with the aim of making a bibliographic comparison of research published before and after the appearance of Covid-19.

Regarding the results, the documents found were first classified by the number of publications per year, in the second phase the co-authorship between authors, key words within each cluster, journals to which they belong through the Scimago Journal & Country Rank, the countries and institutions that have the highest level of research. For data analysis and presentation of results, the bibliometric analysis graphs provided by the Scopus and WOS databases were interpreted and the Microsoft Excel tool for Scopus and the text format for WOS were obtained for registration in the Vos Viewer, which was presented in tables according to their analysis.

Finally, 10 studies with the greatest impact were presented using bibliometric indicators to evaluate the quality and influence of the research. For this, the articles with the highest number of citations in both periods were chosen, based on data from Scopus, WOS, cross-reference. Finally, the bibliometric network analysis tool VOSviewer was used to graphically describe the relationships between the most used keywords, the level of cooperation between the identified authors and the relationship between those found in both periods.

3. Results

3.1 Number of publications on agile methodologies in IT project management

As of December 31, 2021, a total of 666 publications were found on the topic of agile methodology in project management in IT companies, of which 524 belong to Scopus and 142 to Web of Science. In Scopus, the year with the highest number of publications was 2021 (n=81). In WOS, the highest number of publications occurred in the same year as Scopus (n=52). Figure 1 below shows the publications found in the 2010-2021 research period according to the database.

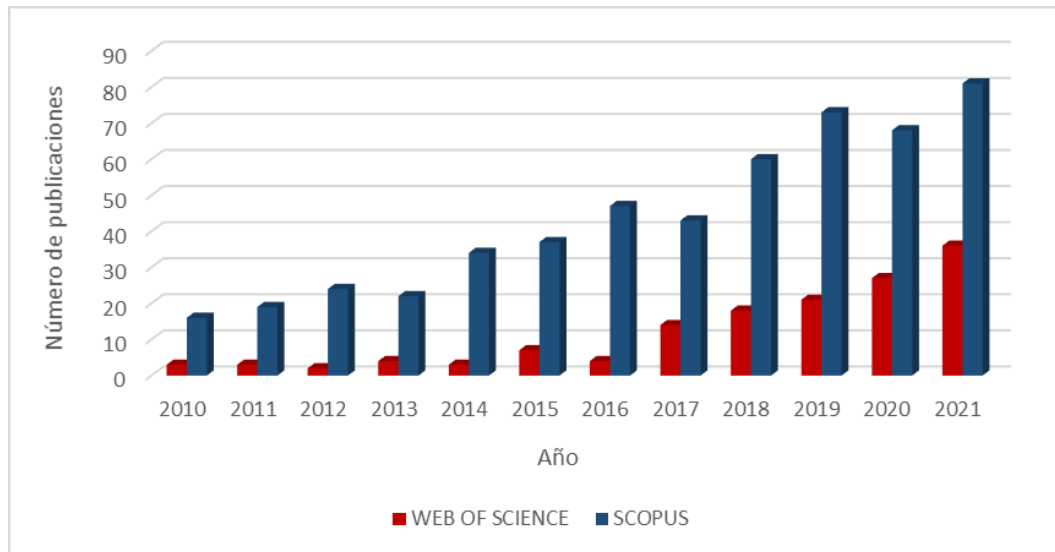


Figure 1. Number of publications on agile methodologies in IT project management

3.2 Distribution of literature by country

More than 40 countries around the world have published on agile methodology in project management in IT companies. The main countries with more investigations in Scopus were the USA (n=52), Brazil (n=45) and Germany (n=32). On the other hand, the countries with the highest number of studies in the Web of Science database were the USA (n=17), Brazil (n=16), Australia and Spain with the same mean (n=10).

3.3 Leading authors, institutions, and journals in literatura

Scopus found 1,374 authors who conducted research on the subject, of which 928 were published between 2010 and 2019, being Escalona, M. and Pinheiro, P. the most active as seen in the Figure 2. On the other hand, in Figure 3, reports 446 authors published between 2020 and 2021, with Hardian, B. and Guevara, V. having the highest number of publications.

In the case of Web of Science, a total of 410 authors who have published in this database have been identified, of which 200 published in the first period, with Devane, M. having the highest number of publications. In the following period, 210 authors published, of which Kumar, R. have the most posting activity. For the analysis of the relationships between authors, the criterion was that the authors had at least 2 published works. In the first period, of the 1128 authors, 24 clusters were identified and in the case of the authors who published in the second period, of the 656 authors, 63 clusters were identified.

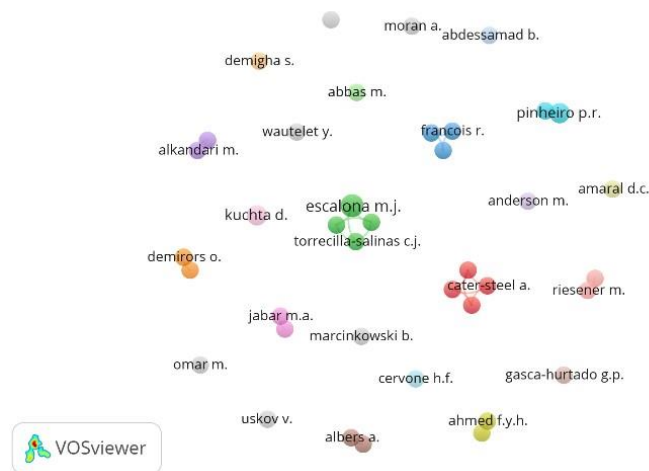


Figure 2. Level of cooperation between identified authors who publish on agile methodologies in project management of IT companies in the period 2010-2019(A)

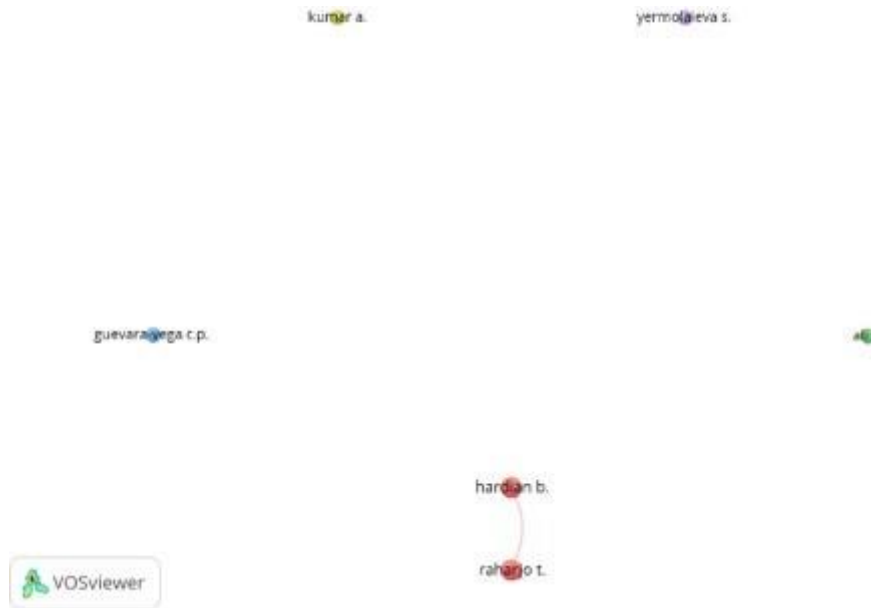


Figure 3. Level of cooperation between identified authors who publish on agile methodologies in project management of IT companies in the period 2020-2021(B)

The two graphs show that there are many authors who have published studies on this literature, especially within the first period, but there is almost no interrelation between the groups, which shows a low strength of co-authorship between them.

However, in some groups there is a high connection between authors of the same cluster. In case (A), the size of the circles of authors shows that there are only two groups with greater activity, which is the case of Escalona, M. and Pinheiro, P. In the second map (B), the clusters have a low relationship between different groups and the size of the labels is almost the same for all.

Table 1 shows the detail of the Co-authorship clusters for the first period 2010-2019 and the second period 2020-2021.

Table 1. Co-authorship of the most relevant groups by year

Period	Cluster	Items	Co-authoring
2010-2019	1	8	Cater-Steel A., Shrestha A., Tan W., Toleman M., Escalona M. J, Mejias M., Sedeño J., Torrecilla-Salinas C.J.
2010-2019	2	2	Francois R., Hassan A.
2010-2019	2	15	Ahmed Fy.H. Fong S.L., Alkandari M. El-Najart, Almeida L.H. Pinheiro P.R., Demirors O. Hacaloglu T., Albers A. Heimicke J, Jabar M.A., Mohanarajah S., Riesener M, Schuh G.
2010-2019	3	14	Abbas M., Abdessamad B., Amaral D.C., Anderson M., Cervone H.F., Demigha S., Gasca-Hurtado G.P., Kuchta D., Marcinkowski B., Moran A., Nyandongo K.M., Omar M., Uskov V., Wautelet Y.
2020-2021	1	5	Hardian B., Raharjo T., Ali S., Guevara-Vega C.P., Kumar A., Yermolaieva S.

The main journals that published more articles on the subject in both periods are International Journal of Project Management and Project Management Journal, International Journal of Information Systems and Project Management, International Journal of Project Organization and Management.

The institutions with the highest participation in both databases during both periods were the University of Johannesburg, Universidade de São Paulo, Universidade do Minho, University of Brasilia, Dublin City University, Federal University of Pernambuco and University of Seville.

A large number of Brazilian institutions have published on project management in IT companies.

3.4 Bibliographic Research Category

The main thematic areas of the works published in Scopus in both periods were Computer Science, Engineering, Business Management, Social Sciences, occupying 73% within the other areas.

In addition, the WOS database focused on areas very similar to that of Scopus, they were Management, Business, Computer Science Information Systems, Computer Science Software Engineering occupying 64% compared to the other areas.

3.5 Co-occurrence of keywords

The research carried out on agile methodologies from 2010-2019, 114 keys were extracted and for the second period of 44 words. A minimum number of occurrences of 5 was obtained as a criterion for the 2 cases. Table 2 presents the different details of the keyword co-citation groups for the first and second periods where new studies of agile methodologies within the covid 19 pandemic are perceived. In Figure 4, PROJECT MANAGEMENT was the most prominent word with 182 occurrences, followed by SOFTWARE DESIGN with a total of 129 occurrences. Three clusters with keywords were identified, as, for example, in the second cluster of scrum methodologies with agile methodologies that represent the dependence on each other. A strong interrelationship between groups are the blue and purple clusters.

In Figure 5, PROJECT MANAGEMENT was the most used keyword with 68 occurrences, followed by SOFTWARE DESIGN (n=44). Four groups were distinguished, of which the blue and red clusters reflected a higher frequency of occurrence of the terms in the published studies. This shows that there is a high interrelationship between keywords in all groups before and after COVID-19. It is evident that in both cases there is a strong relationship between the clusters and that a large number of words abound in the area of project management for the implementation of agile methodologies. However, the size of the conglomerates is not the same in the first two graphs (A and B) because it is proportional to the number of investigations carried out within the years.

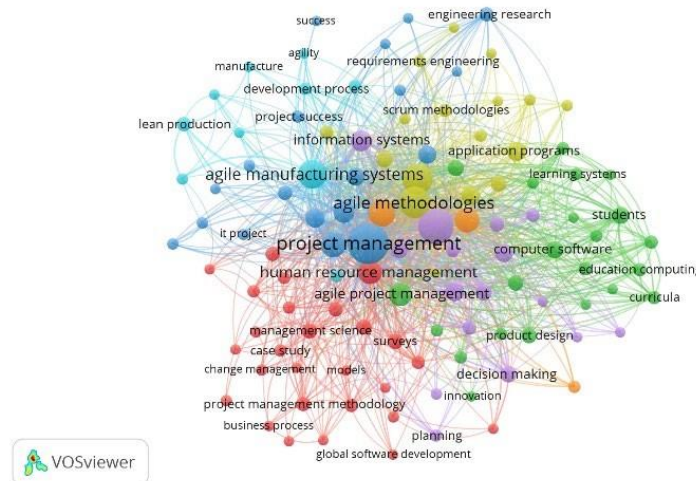


Figure 4. Clusters of keywords on agile methodologies in project management of IT companies in the period 2010-2019(A)

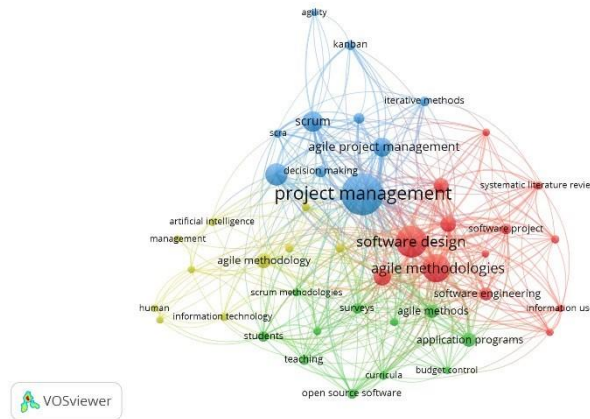


Figure 5. Clusters of keywords on agile methodologies in project management of IT companies in the period period 2020-2021(B)

Table 2. Keyword co citations per year

Period	Cluster	Number of ítems	Keyword co-citation
2010-2019	1	49	Agile software development, business process, case study, change management, commerce, competition, customer satisfaction, enterprise resource global software, etc.
2010-2019	2	62	Agile methodologies, agile process, application programs, project development requirements engineering, research and development management, risk assessment, risk management, scrum methodologies, software engineering, etc.
2010-2019	3	3	Agile software development, extreme programming, scrum
2020-2021	1	13	Agile manufacturing, agile software development, human resource management, information systems, software design, software engineering, etc.
2020-2021	2	11	Agile development, agile methods, application programs, budget control, scrum methodologies, students, etc.
2020-2021	3	10	Agile project management, agility, decision making, extreme programming, iterative methods, Kanban, project management, etc.
2020-2021	4	10	Agile methodology, artificial intelligence, humans, information technology, it project, knowledge management, etc.

10 impact research projects were identified, which are listed in Table 3 along with their respective bibliometric indicators.

Table 3. Research on the first and second periods with the greatest impact

Number	Title	Authors	Year	Full citation	Magazine	Percentile prominence
1	Does Agile work? - A quantitative analysis of agile project success	Serrador, P., Pinto, J.K.	2015	302	International Journal of Project Management	97.131
2	A contingency fit model of critical success factors for software development projects: A comparison of agile and traditional planbased methodologies	Ahimbisibwe, A., Cavana, R.Y., Daellenbach, U.	2015	85	Journal of Enterprise Information Management	88.123
3	SCRUMIA - An educational game for teaching SCRUM in computing courses	Von Wangenheim, C.G., Savi, R., Borgatto, A.F.	2013	80	Journal of Systems and Software	88.000
4	Performance on agile teams: Relating iteration objectives and critical decisions to project management success factors	Drury-Grogan, M.L.	2014	60	Information and Software Technology	90.176
5	Creating an innovative digital project team: Levers to enable digital transformation	Guinan, P.J., Parise, S., Langowitz, N.	2019	49	Business Horizons	97.265
6	Project management: Recent developments and research opportunities	Hall, N.G.	2012	46	Journal of Systems Science and Systems Engineering	48.012
7	Estimating, planning and managing Agile Web development projects under a value-based perspective	Torrecilla-Salinas, C.J., Sedeño, J., Escalona, M.J., Mejías, M.	2015	45	Information and Software Technology	90.101
8	Individual empowerment of agile and non-agile software developers in small teams	Tessem, B.	2014	45	Information and Software Technology	90.780
9	Complex software project development: Agile methods adoption	Mishra, D., Mishra, A.	2011	40	Journal of Software Maintenance and Evolution	28.322

10	Agile Methodologies: Organizational Adoption Motives, Tailoring, and Performance	F. Tripp, J., Armstrong, D.J.	2018	38	Journal of Computer Information Systems	94.134
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From the results of Table 3 it can be seen that 80% of the most relevant studies have a prominence percentile between 80 and 97,265. With respect to each article with its respective journal within the selected studies, it can be seen that 10 of them have more than 30 citations each. On the other hand, the study with the highest number of citations was (Serrador and Pinto 2015), which was published in the first period.

Identifies non-traditional methods to counteract the dangers of traditional methods that often lead to software development phenomena, thus testing the effect of Agile in managing their organizations in two dimensions of the project. Meanwhile, (Ahimbisibwe et al. 2015) does a previous investigation related to the direction of software development projects where he recognizes that contingency has not been fully incorporated as moderation and proposes to fully develop A Contingency Adjustment Perspective on Software Development Driving Agile Methodologies. Other investigations (Drury-Grogan et al. 2014) and (Guinan et al. 2019) summarize projects as an iteration of objectives and decisions managed in a work team. It seems logical that this set of decisions would lead to successful management and even agile software development working in two-week iterations.

To finalize this concept, Gaete et al. (2021) mentions the following: Agile methods take advantage of gaining space and importance in the Software Engineering discipline because they have proven to be much more efficient in environments of high uncertainty and change compared to traditional software development methods.

Likewise, the author Hernández (2017) states the following: Agile methods have gained popularity in recent years due to the better responsiveness they present compared to traditional methods, to market demands. For this reason, organizations saw the need to apply new agile methods, since they bring with them many benefits.

4. Discussion

It is evident that the period with the highest number of publications of agile methodologies in the IT sector was in the years 2010-2019, which may be due to the fact that more years are considered; however, the second chapter presents more publications per year, as a result of the implementation of scientific policies to promote research in this field due to the current crisis.

Of the articles published in the second period, almost none are related to Covid 19, since it is a recent topic and there may not be enough information about the impact of the pandemic on the IT sector of the different countries. The institutions with the highest number of project management publications in both the first and second periods are concentrated in Brazil and Germany. According to a UNESCO report, the number of publications from Brazilian institutions has increased since 2018 due to the constant training in professional development and continuous evaluation of students and professionals (Borja et al. 2021). Of the institutions that published studies related to the implementation of agile methodologies, several in Brazil and one in South Africa (University of Johannesburg) stand out. The latter may be due to the fact that the South African National Board has proposed strategies to support research and development programs for trainees (Burns 2020).

Regarding the analysis of co-authorship, it is observed that in the first period they have had greater editorial activity, which coincides with the size of their clusters. In contrast, in the second period no author predominates because they have a similar number of publications. In the case of keywords, in the first period it is reflected that they focused on the use of frameworks such as Scrum and Kanban for agile project management; while, in the second period, they focus on software design.

5. Conclusion

Companies have undergone various changes in their organizations, and in response to this, agile methodologies can satisfy a wide range of software development projects and any other environment, where these small teams work in Sprint and self-organize, allowing them to learn topics and evolve the learning process, valuing collaborative work. Science and research in the IT sector are important for the development of a country, which is reflected in the technological progress of this industry in nations such as the United States and Brazil. This study will modify, identify and show the differences in scientific research on agile methodologies in IT project management before and after the pandemic in internationally recognized databases. It showed that the number of publications on this industry has been increasing and is expected to continue to do so in the coming years; however, there is no evidence of a large number of publications that are related to Covid-19. It must be taken into account that it is important to fully comply with the learning principle of these methodologies in order to adequately achieve autonomous management in agile projects. Through this research we want to promote the importance of having knowledge about agile methodologies for the automation of various processes in the IT industry.

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