IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received March 16, 2020, accepted April 19, 2020, date of publication May 8, 2020, date of current version June 2, 2020.

Digital Object Identifier 10.1109/ACCESS.2020.2993248

Open Source Adoption Factors–A Systematic Literature Review

VÍCTOR REA SÁNCHEZ[1], PABLO NEIRA AYUSO[2], JOSÉ A. GALINDO[2], AND DAVID BENAVIDES[2]

[1]Facultad de Ciencias E Ingeniería, University of Milagro, Milagro 091050, Ecuador
[2]Departamento Lenguajes y Sistemas Informáticos, University of Seville, 41012 Seville, Spain

Corresponding author: Víctor Rea Sánchez (vreas@unemi.edu.ec)

This work was supported in part by the EU FEDER Program, in part by the MINECO Project OPHELIA under Grant RTI2018-101204-B-C22, in part by the Juan de la Cierva Postdoctoral Program, in part by the TASOVA Network under Grant MCIU-AEI TIN2017-90644-REDT, and in part by the Junta de Andalucia METAMORFOSIS Project.

ABSTRACT Nowadays, Free/Libre/OpenSource Software (FLOSS) is becoming a strategic option for many organizations in the public and the private sector. The lack of well defined guidelines for IT managers may jeopardize the FLOSS adoption process. FLOSS adoption procedures are developed ad-hoc in every organization, hence, leading to potential wheel reinvention situations. Identifying factors that influence and determine adoption is crucial. In this article, we survey existing literature through systematic review methodologies to make visible the technical, organizational and economic factors that must be evaluated in the adoption process. We also provide hints for researchers on publications and the type of research that already covered this topic in the past. We studied almost 500 papers from which we selected a final set of 54 primary studies directly related to FLOSS adoption. We found twenty-two different adoption factors categorized as technical (nine), organizational (nine) and economic (four). This article aims to provide the basic building blocks to step into the creation of a guide for the FLOSS adoption. All the data we used in this study is available at this online repository: https://github.com/jagalindo/rea.victor.19-foss and doi: https://doi.org/10.5281/zenodo.2632543

INDEX TERMS Free software adoption, open source adoption, libre software adoption.

I. INTRODUCTION

Free/Libre/OpenSource Software (FLOSS) is becoming ubiquitous. The ability to achieve a higher degree of vendor independence, interoperability and potential cost reductions are motivating organizations to consider FLOSS adoption [14], [18], [19]. A annual survey[1] highlights that 90 percent of respondents have already adopted FLOSS for their business in some way. According to this survey, adoptions are rapidly happening with no formal process and effective management. Problems in the adoption of FLOSS may set a bad precedent in the organization that may increase resistance for migrating to more FLOSS solutions among organization members, or even lead to a roll back to proprietary software solutions in some cases.

Identifying factors that influence the FLOSS adoption is a fundamental initial step to define guidelines. This allows IT managers and experts to evaluate potential risks and to allocate the necessary resources to mitigate possible downsides. Factors such as compatibility with existing data formats in use in the organization, ease of use of the FLOSS software, availability of documentation, external support, maintenance and training among many others need to be conveniently evaluated. This problem is not new and it has already been covered, from different perspectives, in a significant amount of literature review contributions in the last two decades [1], [12], [21] and, according to the results that we provide in this article, we consider it an active domain of research. We define a set of factors that generally cover aspects relevant to a FLOSS evaluation. This article is intended to be an important basis for the construction of a guide for the adoption of FLOSS in public and private institutions.

This article revisits primary source literature through systematic review procedures to identify and to classify factors that literature highlights as relevant in the FLOSS adoption process. We followed a systematic review process inspired by the guidelines of [2] and [3] to extract relevant literature on FLOSS adoption. We filtered from more than 2,000 papers from the last twelve years to finally obtain 54 primary studies from which we gathered data and analyses. As a result,

The associate editor coordinating the review of this manuscript and approving it for publication was Luca Ardito.

[1]10th Annual Future of Open Source Survey, http://nbvp.northbridge.com/2016-future-open-source-survey-results, including 1300 respondents from 64 countries

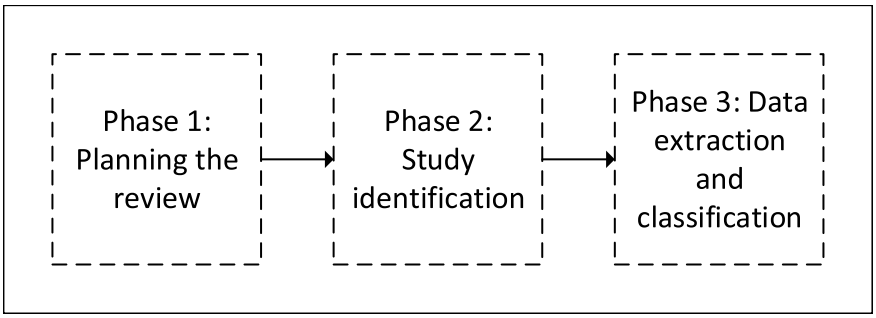

FIGURE 1. Systematic process definition [3], [4].

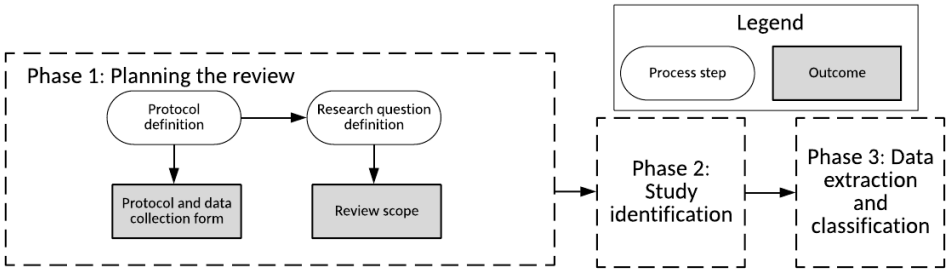

FIGURE 2. First phase of the study [3], [4].

we discovered twenty two different factors that influence on the FLOSS adoption decision making. Nine technological, other nine organizational and four economic factors. In addition, we also define and describe these factors and we classify them by relevance according to the appearance in the literature review. We provide a number of realistic adoption scenarios to be used as examples and that are described in the selected literature. Moreover, this article provides hints for researchers that are interested in this problem in case they want to direct their contributions to conferences and publications that have already covered this topic.

The rest of the paper is organized as follows: Section V outlines related works that describe FLOSS adoption experience in organizations as well as formal models to adopt and to evaluate the impact of FLOSS adoption. Section II describes the methodology for the systematic review that we performed in this research work, this covers review planning procedures, identification of relevant studies, data extraction and classification; and threats to validity. Then, Section III describes the organizational, technical and economic factors to adopt FLOSS according to the primary source articles that we have selected. We also provide what type of research works are covering FLOSS adoption factors and the number of publications in the last twelve years in Section IV. Finally, Section VI provides conclusions on this work.

II. SYSTEMATIC PROCESS DEFINITION

The systematic process that we have followed for this study is based on the guidelines proposed by Kitchenham [2], and Petersen *et al.* [3]. Figure 1 summarizes the different phases we followed:

1) Planning the review, whose main output is the search protocol that affects all the other phases.
2) Study identification, where the studies are selected according to the defined search protocol.
3) Data extraction and classification, where the data from the studies are extracted and the papers are classified.

Next, we describe more in details each of the phases.

A. PHASE 1: PLANNING THE REVIEW

This phase is composed of two process as shown in Figure 2:

1) **Protocol definition**: where we decide how to do the literature review.
2) **Research questions definition**: where we define the questions that we want to answer and focus our research scope. We defined the following research questions:
   - **RQ1**. What factors influence the adoption of FLOSS?
   - **RQ2**. What is the scope of the research in adoption factors in FLOSS solutions?
     - **RQ2.1** What type of research works are covering FLOSS adoption?
     - **RQ2.2** How many publications related to FLOSS were published in the years covered by this review?

   In RQ1, we want to identify the factors that influence the adoption of FLOSS in organizations according to what the literature reports. In RQ2, with this general

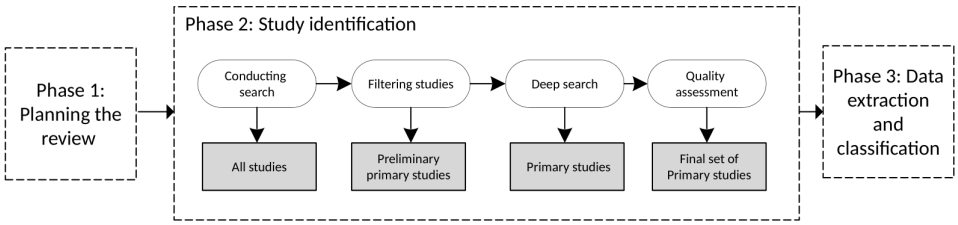

FIGURE 3. Second phase of the study [3], [4].

question, we intend to gather knowledge on the scope of the research in FLOSS adoption and more specifically in the sub questions:

RQ2.1, with this question, we search for the type of studies related to the adoption of FLOSS. Likewise, we intend to detect research gaps that allow researchers to identify the downsides in the research dedicated to FLOSS.

RQ2.2, this question tries to determine how papers have evolved according to the publication types. We want to identify the current state and tendencies of a topic to find opportunities of further collaboration in the FLOSS adoption area.

B. PHASE 2: STUDY IDENTIFICATION

This phase involved the execution of four process as shown in Figure 3:

1) Conducting search, where we performed a search on several databases which are relevant to our research topic.
2) Filtering studies, which consists of applying the inclusion and exclusion criteria to filter out what we do not consider relevant, and to collect what we do consider useful for our goals.
3) Deep search, where new studies were added manually to broad the sample of primary studies.
4) Quality assessment, where we performed a quality assessment of the final set of selected articles to ensure that they are relevant to this research.

In what follow, we explain how we identified the studies included in the systematic process.

1) CONDUCTING SEARCH

For this first process we design specific search queries. Specifically, we relied on relevant keywords and some of the most common synonyms. Search was conducted over four databases with a great coverage in the field of Software Engineering [5]. They are: ACM Digital Library (Expanded ACM Guide to Computing Literature), IEEE Xplore Digital Library, Scopus and Web of Science.

Results obtained in each database are presented in Table 1, where it is may be seen that 4429 works were obtained. It is also noted that search queries were formulated with aim to achieve all the relevant results related to adoption (including its term variants) and FLOSS (including its most common synonyms).

TABLE 1. Results from the search conducted on the databases.

Database	Query	Search results
IEEE	(adopt*) AND ("free software" OR "libre software" OR "os software" OR "open source software" OR floss OR foss OR oss)	516
ACM	((+adopt*) AND ("free software" OR "libre software" OR "free libre" OR "os software" OR "open source software" OR floss OR foss OR oss))	519
Scopus	TITLE-ABS-KEY ((adopt*) AND ("free software" OR "libre software" OR "os software" OR "open source software" OR floss OR foss OR oss))	2248
WOS	TS= ((adopt*) AND ("free software" OR "libre software" OR "os software" OR "open source software" OR floss OR foss OR oss))	1146
Total		4429

2) FILTERING STUDIES

To filter the different papers we obtained previously, we applied a set of inclusion and exclusion criteria that are described below.

Inclusion Criteria:

- Papers published between January 2008 and December 2019. The rationale behind this selection is our intention to update the review conducted in [1], which covered works until 2008.
- Peer reviewed articles journals. With this filter, we assure that our results come from high quality sources.
- Papers published and written in English.
- Papers are related to FLOSS adoption. During the filtering process, we selected the candidate papers whose title and abstract refer to FLOSS adoption. We also conducted a series of meetings to validate that the selected papers are relevant to the topic.

Exclusion Criteria:

- Papers published in Conference Proceedings or as Book chapters.

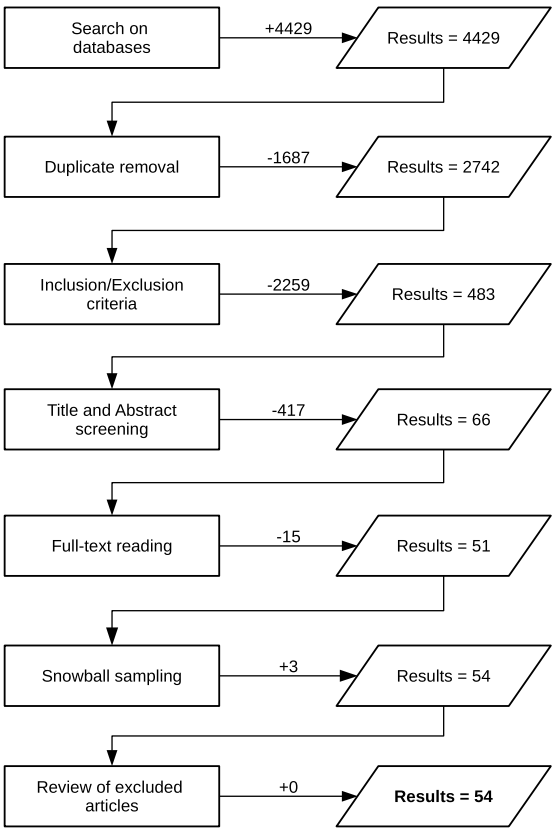

FIGURE 4. Search process of papers [3], [4].

- Papers that while related to FLOSS adoption, do explicitly described adoption factors.
- Duplicated papers

The number of included and excluded studies at each stage is shown in Figure 4. There, it can be seen that 2742 papers resulted after removing duplicates. Further, 2259 studies were excluded after applying the inclusion and exclusion criteria. The remaining 483 were subject of title and abstract screening and full-text reading, which allowed to identify 51 relevant works.

In the different stages described above, authors were divided in groups to double check the selection and, if needed, discuss and reach a consensus.

3) DEEP SEARCH

To avoid missing relevant papers, we proceeded to perform a snowball reading search, as suggested in [5], [6]. Of course, we constrained our search to the same document type (journal articles) and time period (2008-2019). We used both: backward and forward snowball reading strategies. In this regard, we found 3 additional papers that we added to the 51 papers obtained from the previous step. Thus, 54 papers were considered to conduct the review. This process is depicted by Fig 4.

4) QUALITY ASSESSMENT

Additional to the quality requirements considered in the previous steps (e.g. papers from respectable databases and published as journal articles), we assessed the quality of the 54 primary sources encountered considering only papers indexed in the Scimago Journal & Country Rank.[2] Then, for each selected article, we gave a score from 1 to 5 (1 being the least relevant and 5 the most relevant) according to our criteria and experience selecting only those that scored from 4 to 5. We assessed that all the 54 selected primary studies passed this quality assessment.

C. PHASE 3: DATA EXTRACTION, SYNTHESIS AND CLASSIFICATION

This phase involves the execution of two process as shown in Figure 5. In this phase, we extracted the necessary data to determine conclusions from the set of selected papers.

- **Topic Keywording**: We classified the papers using two dimensions: *i)* the factors; *ii)* the type of research.
  These dimensions are based on the process described by Petersen *et al.* [3] which relies on a keywording process to define the scope of a systematic research. This keywording process consists of two parts. First, we read the abstract to review and identify the keywords that may contribute to our study. If the abstract does not have relevant information, we may have to read other parts of the article that we believe are necessary for the understanding of the information to be collected. With this information, we defined a set of categories to perform a systematic process that identifies the main contributions of our research study. As a result of this keywording process, we defined the dimensions of the FLOSS adoption factors:
  - **Technological Factor**: These are the factors that are related to technical characteristics of the products that are considered for adoption.
  - **Organizational Factor**: This refers to the factors related to organizational aspects and human resources of the institution that adopt a product.
  - **Economic factor**: This refers to the factors related to economic aspect that are used to acquire, sell or rent products and services that allow to satisfy organizational needs.

  To define the type of research dimension, we used the proposal of Wieringa *et al.* [7] and Petersen *et al.* [3]. More specifically:
  - **Experience papers**: They describe the experience that was performed in practice (what and how). This is author's own experience on a given topic in real situations. Papers reporting real FLOSS adoption scenarios.

[2]http://scimagojr.com/

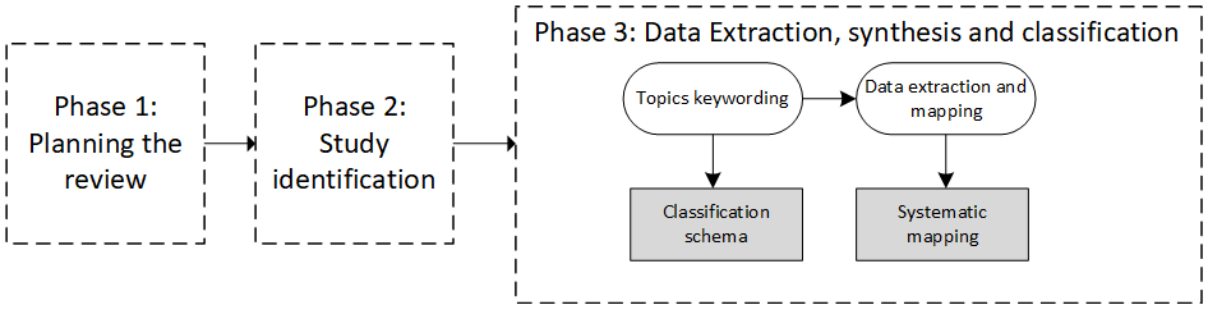

FIGURE 5. Third phase of the study [3], [4].

- **Validation research**: This type of research evaluates techniques with end users that have not deployed FLOSS in production.
- **Evaluation research**: This work covers an evaluation of an existing FLOSS deployment. The result of the study will help to define positive or negative conclusions.
- **Solution proposal**: This type of research work proposes a solution to the FLOSS adoption problem following a new or existing methodology. This may be applied to case studies without the need to be validated or evaluated.
- **Philosophical papers**: This type of paper helps us to define the area for our study through a classification or conceptual framework.
- **Opinion papers**: They describe personal opinions about techniques used. They are not based on research methodologies.

- **Data Extraction and Mapping**: It is composed of the following steps:
  1) We created a database with all the items to be classified. We decided to consume a bibtex database through a bibliographic reference manager JabRef.[3] The database contains the following fields for each paper: i) title; ii) the facet of factors; iii) the type of research; iv) factors.
  2) Through coordinated meetings of the researchers of this study, we analyzed the categories to be used and we created a taxonomy of factors, grouping them according to a topic.
  3) We performed a synthesis of each factor where we described a general concepts and examples that we found in the literature.
  4) Two of the authors of this study identified the papers by each dimension individually and entered them into a spreadsheet matrix.
  5) A third author reviewed the work done in the previous step and, in a meeting where all the authors of this study participated, we achieved consensus of the criteria to define the proposed taxonomy.

[3]http://www.jabref.org/

D. VALIDITY

Although in this paper we followed a systematic mechanism, there are some assumptions that we made that may affect its validity [8]:

External Validity: We included papers that were cited in journals from different databases as shown in Table 1, we might have missed some relevant contributions not published in such venues. Likewise, the decision not to include documents published in Conference Proceedings could have kept out relevant knowledge on the adoption of FLOSS. We minimized the impact of this threat by performing the snowball reading technique. We consider that the most important threat to external validity are:

- Population validity, through the databases selected for this research work, we obtained 54 documents that are related to the adoption of FLOSS. These documents refer to the factors that we have defined in this research work. Therefore, when searching these databases, we did not identify that they contain different factors related to FLOSS adoption. We assume that the factors we did not select in our research are irrelevant to the adoption of FLOSS solutions according to the literature. We created manually this classification of factors by reading our selected set of papers. For the generation of graphs, we generated them semiautomatically by extracting data from our local database, we also selected the primary keys for each dimension.
- Ecological validity, is focused on possible errors in the materials and tools used in the experiment. The manual process for the classification of the factors could generate distrust among the researchers of the community. To avoid this perception, all the authors of this study individually performed the classification of factors and then, we aggregated the results to build a general classification.

Internal validity is a measure that ensures that the design of the researcher's experiment follows the principle of cause and effect. In this study of literature review, we performed a systematically structured process. However, the grouping of factors and a manual classification process of them may result in errors. Once again, we considered pertinent that the manual classification process was reviewed individually by

each of the authors of this study to minimize the impact of a misclassification.

III. FACTORS IN FLOSS ADOPTION

In this section, we address the first research question (RQ1) that we defined in Section II-A:

RQ1: What Factors Influence the Adoption of FLOSS? The factors that influence FLOSS adoption are classified into technological, organizational and economic factors. We classified the papers in groups according to these factors in sections III-A, III-B and III-C.

A. TECHNOLOGICAL FACTORS

These are the factors that are related to technical characteristics of the products that are considered for adoption. We found that this is a typical factor that is commonly addressed in the literature.

Table 2 shows a summary of the papers within this category. Concretely, we observed 49 related papers that represent around 91% of the total of papers reviewed, of which there is a high amount that make reference to the factor of compatibility, reliability, usability, customization and documentation. We realized that in most papers the factors related to triability, reusability and portability were not mentioned. Following, we describe in detail the different technological factors found in our study.

- **Compatibility**[4]**:** This factor refers to the compatibility of the solution to be adopted with regards to the data formats. We found 34 papers that refer to this factor. This is the most referenced factor in the technological group. For example, when adopting *OpenOffice*, we could find compatibility problems with the existing proprietary formats in the organization. In [10], some compatibility problems were reported when importing files in proprietary formats.
- **Reliability:** This factor refers to how a solution to be adopted is used under some conditions for a given period of time. Low reliability creates discomfort in the users and it complicates operations in the organization, particularly, in early stages of the FLOSS adoption. For example, Linux is a very popular and successful FLOSS operating system that has been widely adopted because it could be considered a reliable and well-tested operating system that users will perform normally.
- **Usability:** This factor refers to how intuitive and satisfying the software user interface is. For example, when deploying a system that registers patient blood tests in a health center, it is important that that system to be adopted is easy to use to ensure that the software is successfully adopted. A common criticism of FLOSS solutions is that they do not consider usability as a first element when designing a software solution and, although it can be well designed and implemented from a technological point of view, the user experience is laid aside. However, we can find examples such as the Gnome desktop solution that claim usability to play a critical.
- **Customization:** This factor refers to the degree of personalization allowed by the software through changes in its default configuration. Hence, it becomes easier to fulfill new custom requirements. For example, the FLOSS WordPress web platform [5] offers a wide range of configuration options that allow changing from the colours to the data base used. This can ease of The adoption of FLOSS solutions.
- **Documentation:** This factor refers to the quantity, availability and quality of the FLOSS documentation such as user, administrator and developer documentation. Scarce and incomplete documentation makes it harder to adopt new software. For example, the office suite OpenOffice [6] offers basic and advanced online documentation for users. Lack of documentation increases the degree of dependence on external IT providers, which may result in extra costs.
- **Maintainability:** This factor refers to the amount of resources that need to be dedicated to maintain the FLOSS solution. This includes easy installation of software updates to fix bugs, to support new features and, therefore, to improve usability. A well-maintained FLOSS solution by external IT provider is convenient. Moreover, a ticketing system to report incidents to solve problems and to assist users is also a desiderable option. Maintainability also refers to security updates that may compromise sensible user information.
- **Trialability:** This factor refers to how easy is to prove the solution to adopt. An easy installation and deployment of the solution allows technicians to evaluate the adoption factors detailed in this paper. More specifically, this factor is key to evaluate factors such as usability, customization, reliability, mantainability or compatibility among others. For example, when making a FLOSS adoption for a solution based on office solutions, it is convenient to have a downloadable version that is easy to install and try (e.g. *OpenOffice*). This allows the preliminarily evaluation of the software to have a first hand opinion on the software.
- **Reusability:** This factor refers to the capability of FLOSS solutions to be reused by different organizations or units. One of the principles of FLOSS is that the code can be copied and modified. We found eight papers that refer to this factor. We conjecture that this is because is an intrinsic property of FLOSS. For example, if a programmable statistical environment wants to be adopted in public schools, using a FLOSS solution will allow to

[4]We only considered data format compatibility in this factor. We classified the OS compatibility (and any other software dependency) within the portability factor which refers to the platform compatibility.

[5]https://www.wordpress.com/

[6]https://www.openoffice.org/support/books.html

TABLE 2. Classification of papers based on technological factors.

Technological Factors			
Factors	**Description**	**Reference**	**# Articles**
Compatibility	The compatibility of the solution to be adopted with regards to the data formats	[11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [10] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43]	34
Reliability	The number of programming bugs that a user encounters when using computer software	[11] [13] [15] [16] [17] [18] [19] [44] [45] [24] [46] [30] [29] [47] [31] [33] [35] [36] [38] [39] [48] [49] [50]	23
Usability	How intuitive and satisfying the software user interface is	[11] [13] [15] [17] [19] [20] [45] [30] [28] [47] [34] [35] [48] [51] [52] [50] [43]	17
Customization	The degree of personalization allowed by the software through changes in its default configuration	[11] [12] [13] [15] [16] [17] [19] [46] [33] [34] [53] [35] [36] [51] [49] [54] [50]	17
Documentation	The quantity and quality of the available documentation of the solution to be adopted	[11] [17] [19] [20] [44] [24] [55] [34] [35] [48] [41] [54]	12
Maintainability	The amount of resources that need to be dedicated to maintain the FLOSS solution	[11] [12] [15] [16] [17] [44] [24] [31] [53] [35] [48] [49]	12
Trialability	The ease to prove the solution to adopt	[15] [19] [56] [57] [47] [33] [35] [38] [48]	9
Reusability	Amount of code that can be reused through libraries and bundles	[14] [17] [19] [58] [31] [35] [48] [52]	8
Portability	The possibility of deploying a solution in more than one platform, such as different operating systems	[11] [17] [31] [36] [51] [54]	6
	Total	**49**	

reuse any software that is developed in such environment without paying any license fee.

- **Portability:** This factor refers to the possibility of deploying a solution in more than one platform, such as different operating systems. We found six papers that refer to this factor and therefore it becomes the least cited factor of the reviewed papers. A portable FLOSS solution might be a desirable choice to promote independence from the underlying platform. For example, OpenOffice can be easily installed in different operating systems being a well known example of portable FLOSS.

B. ORGANIZATIONAL FACTORS

These are the factors that are related to organizational aspects and human resources of the institution that adopts a product. We found in our study that this is a typical factor that appears in the literature. In this group, summarized in Table 3 and described below, we observed 50 related papers that represent around 93% of the total of papers reviewed. Support is the most referenced factor. This might indicate that companies need to have guarantees to solve problems to not lose time in their activities. We also found factors such as training, top management support, vendor locks-in or attitude towards change among others. We also observed that the majority

of investigations do not make reference to certain factors such as: case studies of FLOSS adoption, time adoption, centrality of IT and business processes reengineering. Following, we describe in detail the different organizational factors found in our study.

- **Support:** This factor refers to the availability of internal and external technical support. Such support provides expertise, knowledge and skills in the FLOSS solution to be adopted in order to assist and to help solve problems within an organization. Lack of technical support from IT experts may jeopardize FLOSS adoption in an organization [21]. We found 45 papers that refer to this factor, being the most referenced factor within the papers that we selected in our study and in that sense being the most important according to the literature that we reviewed.
- **Training:** This factor refers to training actions to improve skills and knowledge of the users within the organization. Training helps users solve technical problems by themselves. This also helps support other users who are part of the organization. According to [10], interviews with users and managers confirmed that training is essential to increase the acceptance of technology. Lack of sufficient training is usually related to insufficient budget. Identifying skilled users that can train less skilled ones is also important [10].
- **Top Management Support:** This factor refers to degree of backing from the management to the decision of adopting the FLOSS solution. The reviewed literature describes two similar adoption scenarios, one where management backs the adoption decision and another where they do not [10]. Lack of backing from the management results in uncertainty among users. Without proper management backing, users find it easy to express resistance to change [9].
- **Vendor Lock-In:** This refers to dependencies on a specific software solution in a way that makes it costly to change to an alternative one. Software vendors decide when software products enters End of Life (EoL). From that time on, the software becomes unmaintained, thus, no more updates are available. This is particularly a problem in terms of security, since vulnerabilities will accumulate waiting to be exploited by attackers along time, exposing the software to security breaches. Ease of upgrading and well known EoL dates are fundamental to estimate upgrade costs. Diversity of providers is convenient to have a wider supplier choice which allows organizations to become more independent from the IT provider.
- **Attitude Towards Change:** This factor refers to how employees behave when they face technological changes in the organization. It is convenient to evaluate the predisposition of the members of the organization to adopt a new software solution. Six articles (see Table 3) suggest that organizations should consider incentives to reduce the resistance towards change when planning for adopting FLOSS solutions. For example, when upgrading to a new platform, such as one based on the Linux operating system, new equipment can be offered to the crowd if they accepted to migrate their old desktops to Linux.
- **Successful FLOSS Adoption Cases:** This factor refers to existing successful stories of the FLOSS adoption by similar organizations. Many IT providers show their customer portfolios as a marketing strategy to attract more new customers to adopt their software. They also document successful stories regarding satisfactory product deployment and improved operations. This includes quotes from customer describing the outcome of the FLOSS adoption.[7] Successful stories help organizations consider FLOSS adoption in the decision making process. For example, the Blind Audio Tactile Mapping System (BATS) [8] provide access to maps for the blind and visually impaired people. This success history of Python programming language, may foster others potential users of a programming language to adopt this FLOSS programming language solution.
- **Time to Adopt:** This factor refers to the time that an organization requires to deploy the FLOSS solution. This factor depends on the training level and the skills of the organization members, the availability of an external IT provider which may help in the adoption process; and the user resistance towards change. Longer times to adopt may result in extra costs in the adoption process. Compatibility between the older and new software solutions is also a desired property.
- **Centrality of IT:** This factor refers to the degree of dependency of the organization on its own IT infrastructure. If the organization is highly dependent on the software that is planning to replace, then the effectiveness of the organization may be affected. For example, problems in the deployment of a FLOSS-based VoIP/PBX solution may have a negative impact on business operations in case telecommunications are crucial to daily operations of the organization. Therefore, switching to the new software incurs in a high risk.
- **Business Process Reengineering:** This factor may appear when an organization is changing its internal business processes due to any particular circumstance (e.g. quality improvement, organizational restructure). We found only one paper that refers to this factor, being the least cited factor within the papers that we selected in this group of factors. For example, if a business process quality improvement is perform within an organization, IT management may take the opportunity to integrate new technologies so that FLOSS solutions could be used to different tasks (e.g. generate documents in open standards). Users would be forced to use the new solution to handle these documents, gaining then confidence in the new technology [10].

[7] https://www.python.org/about/success/
[8] https://www.python.org/success-stories/bats/

TABLE 3. Classification of papers based on organizational factors.

Organizational Factors			
Factors	**Description**	**Reference**	**# Articles**
Support	The availability of internal and external technical support	[11] [12] [13] [14] [15] [16] [17] [18] [19] [59] [56] [21] [60] [22] [61] [45] [23] [26] [27] [46] [55] [30] [57] [28] [47] [31] [32] [62] [33] [34] [53] [35] [36] [38] [39] [40] [48] [41] [51] [49] [54] [52] [42] [50] [43]	45
Training	Actions to improve skills and knowledge of the users in the organization	[14] [15] [17] [20] [22] [44] [10] [23] [26] [27] [55] [30] [57] [31] [32] [34] [37] [38] [39] [40] [48] [41] [49] [54] [50]	25
Vendor lock-ins	Dependencies on a specific software solution in a way that makes it costful to change to an alternative one	[15] [17] [19] [60] [27] [46] [31] [33] [34] [53] [37] [41] [50]	13
Top management support	Degree of support from the management to the decision of adopting the FLOSS solution	[15] [17] [19] [21] [60] [10] [25] [26] [27] [57]	10
Attitude towards change	Behavior of employees related to technological changes to be adopted	[15] [20] [10] [45] [27] [33]	6
Case studies of FLOSS adoption	Existing successful stories of the FLOSS adoption by similar organizations	[14] [15]	2
Time adoption	The time that an organization requires to deploy the FLOSS solution	[11] [13]	2
Centrality of IT	The degree of dependency of the organization on its own IT infrastructure	[15] [10]	3
Business processes reengineering	A change in the solution motivated by an improvement in the quality of the service	[10]	1
	Total	**50**	

C. ECONOMIC FACTORS

These are the factors that are related to economic aspect that are used to acquire, sell or rent products and services that allow to satisfy organizational needs. Table 4 summarized the papers within this group. We observed 32 related papers that represent around 60% of the total of papers reviewed. Next, we describe in detail the different economic factors found in our study.

- **Total Cost of Ownership (TCO):** This factor, according to the literature, refers to the licensing, operating and support costs among others. This is a general factor that can be interpreted differently depending on the organization. IT experts may just take licensing costs into consideration, however, other costs associated, for instance with deployment and support are also relevant. We categorized papers here when they explicitly referred to TCO without any other detail. We found 19 articles that refer to this factor. For instance in [33], some organizations considered migrating to FLOSS solutions due to low hardware and software costs. Five organizations that previously used Unix stated that the use of Linux resulted in significantly reduced hardware costs due to Linux is compatible with Intel hardware, which is relatively cheaper than Unix hardware.
  - **Licensing Costs:** This factor refers to the cost of acquiring a license of the software solution. In [21], the IT Manager of a health center have observed that licensing costs of privative solutions for a clinical laboratory became more expensive along time, while FLOSS costs remained much more economical.

- **Operational Cost:** This factor indicates the cost of migration, maintenance and deployment. For example, in [36], FLOSS is promoted as a solution for the computerization of public health care institutions. The FLOSS model allows for the sharing of development and maintenance costs between institutions that have limited funding resources and similar goals.
- **Support Cost:** This factor refers to external support and access to updates. Therefore, it is convenient to survey in the market for companies that can provide support for FLOSS solutions. We only found two studies referring to this factor. For example, in case of adopting the OpenOffice suite, there is a public list of consultants that are available to provide external support.[9]

To better explain the different factors in the subsequent sections, we selected FLOSS adoption scenarios that are described in the selected literature:

1) **Adoption of office suite solution in public administration:** In [10], the authors describe the adoption of *OpenOffice* by the public administration in the Alto Adige-Sudtirol (North Italy). Among the relevant factors to be considered in the adoption of this solution are the support for the existing document formats, the level of user training and the licensing costs.
2) **FLOSS Adoption in Health Care Organizations:** In [21], the authors describe an adoption model for health centers and hospitals in Quebec. Experts from the area of information technology in the health sector and IT providers participated in this study. The reliability of the solution to be adopted is a fundamental aspect in this case since loss of medical records and problems in the image visualization may severely obstruct daily operation of health professionals.
3) **Adoption of FLOSS VoIP/PBX telephony solution:** This document [19] detail the experience of adopting FLOSS telecommunication solutions. In [19], explores opportunities for adoption of FLOSS products such as databases, application servers, etc., at the Swedish organisation Telenor Norway IT. This study involved experts from the IT department as application developers, systems specialists, area managers and managers. In this case, IT solution support, top management support, employee training and compatibility between FLOSS products are essential factors considered for the FLOSS adoption.

D. SUMMARY

In Table 5, we describe the factors that we identified in each paper during our systematic study. In particular, the group of organizational factors are considered the most relevant ones since 93% of the selected papers refer to them. Likewise, technological factors are also very relevant since they are described in 91% of the selected papers. Lastly, economic factors are the least referenced factors referred in the 60% of the studies.

Figure 6, depicts the ranking of factors according to the information we discovered in this systematic study.

IV. RESEARCH SCOPE IN FLOSS ADOPTION

In this section, we address the second research question (RQ2) previously defined in Section II-A:

RQ2: What is the scope of the research in adoption factors in FLOSS solutions? With this question, we aim to provide guidelines for FLOSS researchers to explore new research lines. We split this question into three more specific questions:

- RQ2.1: What type of research works are covering FLOSS adoption factors? (see Section IV-A)
- RQ2.2: How many publications related to FLOSS have been published in the years covered by this review? (see Section IV-B)

A. WHAT TYPE OF RESEARCH WORKS ARE COVERING FLOSS ADOPTION FACTORS?

This research question aims to find areas that are lacking research contributions related to the FLOSS adoption in organizations. Figure 7, presents a heatmap were we have classified the number of papers that we collected based on the two dimensions that we defined in Section II-C.

First, regarding research types, it is worth highlighting that the high number of evaluation papers and the increase of validation contributions reflects the maturity FLOSS adoption studies. However, this research area is not yet to the point of contributing experience reports. Second, regarding FLOSS adoption factors we observe that most of the studies have been focusing on the organizational and technological factors leaving the economic factors not so well covered. We suspect that this lack of research results in economic factors is due the reluctance of companies to provide economic details. Also, FLOSS experts consider that organizations are already aware of the hidden costs when adopting FLOSS, and therefore, they tend to focus more on researching technological and organizational factors. Additionally, we only found two solution proposals related with economic factors and one with technological and organizational factors. We also observed that validation research, opinion papers and philosophical papers are gaining maturity in the FLOSS adoption area because we found taxonomies, literature reviews and systematic maps.

B. HOW MANY PUBLICATIONS RELATED TO FLOSS WERE PUBLISHED IN THE YEARS COVERED BY THIS REVIEW?

In this question, we present the evolution of different trends depending on the year of publication (see Figure 8). The axis *y* shows the percentage of papers by the factors, thus, we extract the researchers' interests per year. We observe that there are areas that remain stable attention along time such as the organizational and the technological factors. Nonetheless,

[9]https://www.openoffice.org/bizdev/consultants.html/

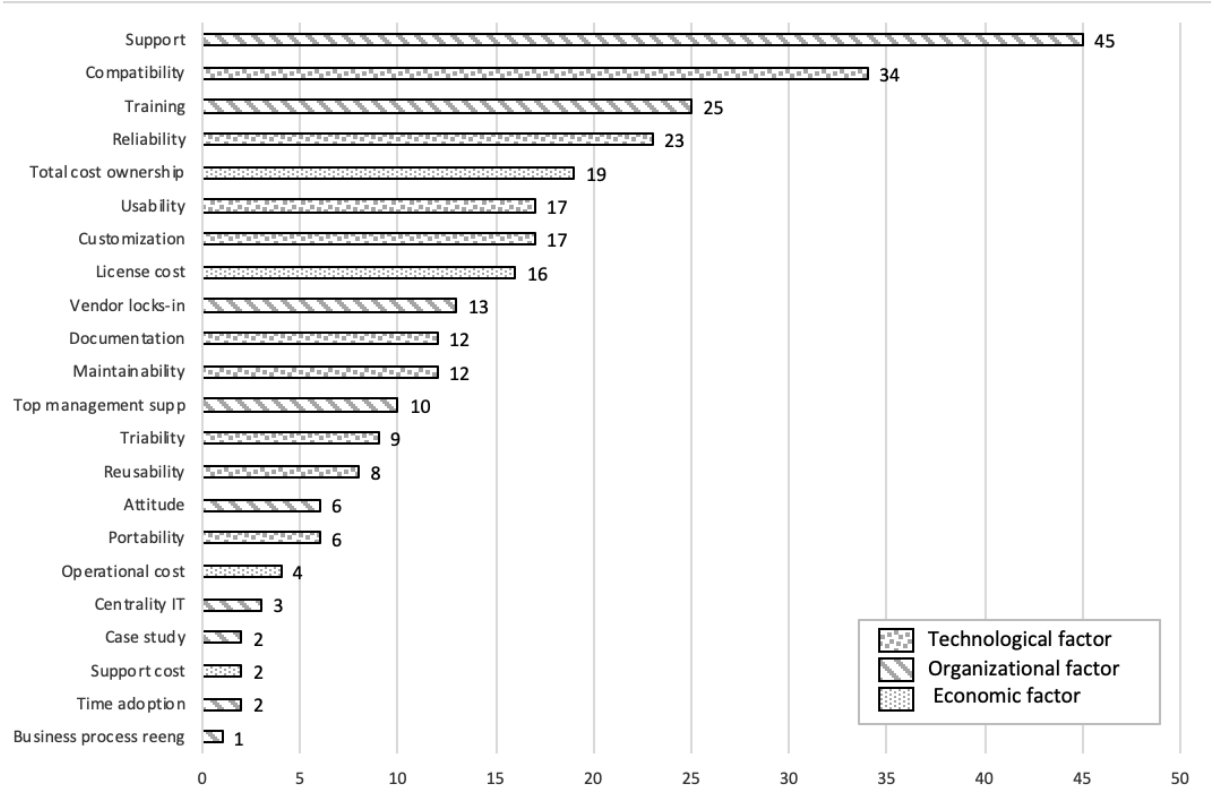

FIGURE 6. Rank of factors.

TABLE 4. Classification of papers based on economic factors.

Economic Factors			
Factors	**Description**	**Reference**	**# Articles**
Total cost of ownership (TCO)	The licensing, operating and support costs	[11] [12] [13] [16] [17] [19] [23] [26] [63] [29] [31] [33] [34] [39] [40] [51] [49] [54] [52]	19
Licenses costs	The cost of acquiring a license of the software solution	[12] [14] [15] [56] [21] [22] [44] [46] [30] [28] [47] [31] [32] [53] [36] [40]	16
Operational cost	The cost of maintenance, development, deployment and migration	[60] [28] [36] [38]	4
Support cost	External support and access to updates	[27] [39]	2
	Total artículos	**32**	

the economic factor experienced a greater variation in the last years.

In this context, we want to highlight that the organizational factor has the highest number of papers per factors with a total of 50 according to Table 3. We think that researchers are more interested in identifying organizational factors that may influence the FLOSS adoptions, because these factors are related to the organization members that participate in the FLOSS adoption decision making process, such as managers, IT experts and final users, among many others.

Likewise, we observe that the technological factor and the organizational factors are equally important since we found a total of 49 papers according to Table 2. There is one exception though in 2013, where the organizational factor apparently started attracting more interest among researchers. Finally, we observe that interest in economic factors have remained variable. In 2009, 2014 y 2017 we observe that

TABLE 5. Summary of identified factors by paper.

Papers	Compatibility	Reliability	Usability	Customization	Documentation	Maintainability	Reusability	Triability	Portability	Support	Training	Top management supp	Vendor locks-in	Attitude	Case study	Time adoption	Centrality IT	Business process reeng	Total cost ownership	License cost	Operational cost	Support cost
Aversano et al. [11]	X	X	X	X	X	X			X	X						X			X			
Ayala et al. [32]	X									X	X									X		
Badampudi et al. [12]	X			X		X				X									X	X		
Benlian et al. [13]	X	X	X	X						X						X			X			
Bouras et al. [14]	X						X			X	X		X		X					X		
Bouras et al. [15]	X	X	X	X		X		X		X	X	X		X	X		X			X		
Choi et al. [52]			X				X			X									X			
Daneshgar et al. [16]	X	X		X		X				X									X			
Del Bianco et al. [17]	X	X	X	X	X	X	X		X	X	X	X	X						X			
Dhir et al. [42]	X									X												
D Macredie et al. [30]	X	X	X							X	X									X		
Fitzgerald et al. [57]								X		X	X	X										
Gallego et al. [27]	X									X	X	X	X	X								X
Gangadharan et al. [18]	X	X								X												
Gurusamy et al. [53]				X		X				X			X							X		
Hanumappa et al. [41]	X				X					X	X		X									
Hauge et al. [19]	X	X	X	X	X		X	X		X		X	X						X			
Idrizi et al. [40]	X									X	X								X	X		
Joia et al. [20]	X		X		X						X			X								
Jusoh et al. [35]	X	X	X	X	X	X	X	X		X												
Kimppa et al. [29]	X	X																	X			
Koloniaris et al. [54]				X	X				X	X	X								X			
Li et al. [26]	X									X	X	X							X			
Li et al. [59]										X												
Lundell et al. [56]								X		X										X	X	
Maglogiannis et al. [36]	X	X		X					X	X										X	X	
Marsan et al. [21]	X									X		X								X		
Meetoo-Appavoo et al. [37]	X										X		X									
Mijinyawa et al. [38]	X	X						X		X	X										X	
Munoz et al. [60]										X		X	X								X	
Nagy et al. [22]	X									X	X									X		
Paschali et al. [58]							X															
Petrinja et al. [44]		X			X	X					X									X		
Poba et al. [50]		X	X	X						X	X		X									
Ponelis et al. [28]	X		X							X										X	X	
Qu et al. [62]										X												
Rafiq et al. [55]					X					X	X											
Rafiq et al. [34]	X		X	X	X					X	X		X						X			
Rossi et al. [10]	X										X	X		X			X	X				
Roumani et al. [61]										X												
Safadi et al. [51]			X	X					X	X									X			
Saghafi et al. [45]		X	X							X				X								
Sarrab et al. [48]		X	X		X	X	X	X		X	X											
Silic et al. [49]		X		X		X				X	X								X			
Silic et al. [23]	X									X	X								X			
Spagnoletti et al. [31]	X	X				X	X		X	X	X		X						X	X		
Stol et al. [25]	X											X										
Stol et al. [24]	X	X			X	X																
Taha et al. [43]	X		X							X												
Tome et al. [39]	X	X								X	X								X			X
Ven et al. [46]		X		X						X			X							X		
Ven et al. [47]		X	X					X		X										X		
Ven et al. [33]	X	X		X				X		X			X	X					X			
Zaffar et al. [63]																			X			
Total	34	23	17	17	12	12	8	9	6	45	25	10	13	6	2	2	3	1	19	16	4	2

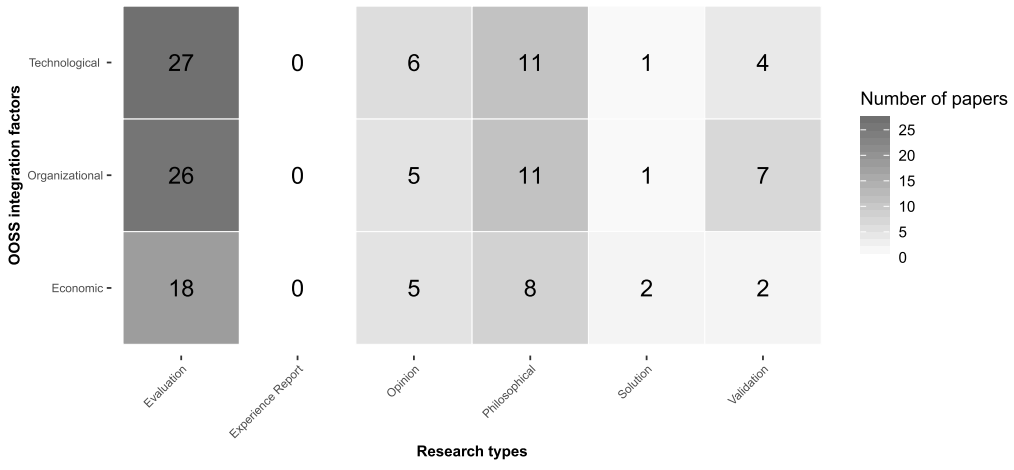

FIGURE 7. Relation between group of factors and types of research.

the percentage of research papers have dropped considerably. We assume that this is due to organizations learning about hidden costs in the FLOSS adoption, therefore, it may be of interest for researchers to explore the economic fields as

TABLE 6. Comparison of related papers.

Review work	Kind	Year	Context	Period	# papers studied	# factors	Common factors
Marsan et al. [21]	LR	2013	It develops a research model to study the background of FLOSS adoption decisions in HCOs.	1992-2003	78	8	compatibility, support, top management support, license cost
Badampudi et al. [12]	SLR	2016	It identifies factors that influence the adoption decision to select between different software components and solutions	2004-2015	24	11	compatibility, customization, maintainability, support, total cost of ownership, license cost
Ven et al. [33]	LR	2012	It identifies factors that influence the adoption of FLOSS products supporting an organization's server infrastructure			7	total cost of ownership, compatibility, reliability, customization, trialability, support

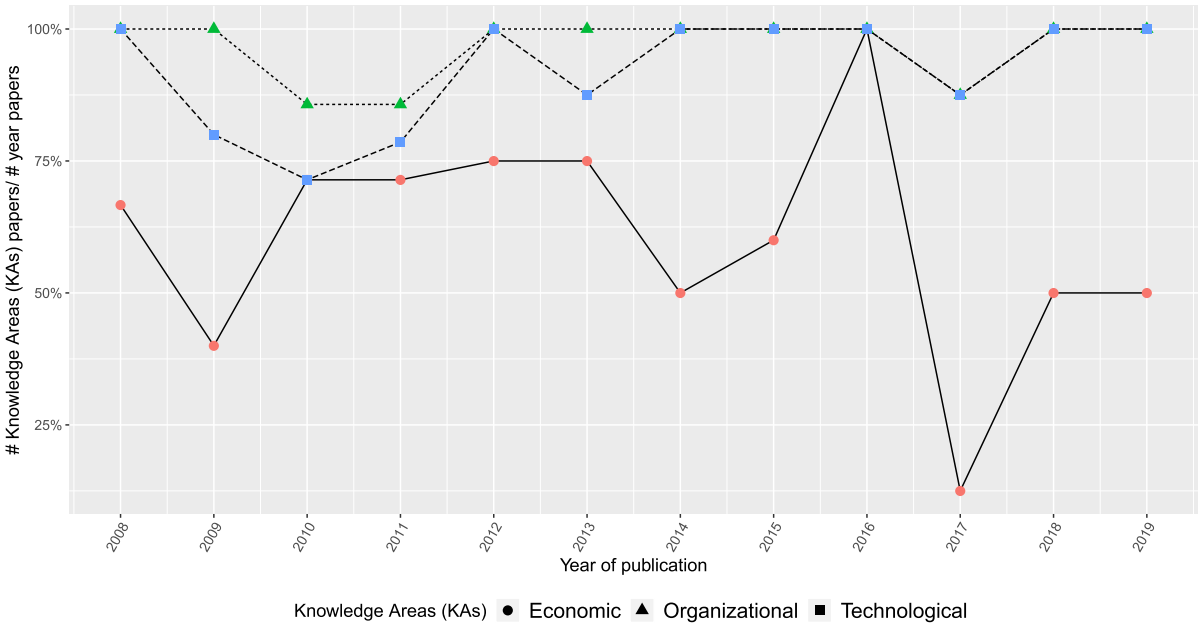

FIGURE 8. Temporary kind of the variability context facet.

well as keep focusing on the technological and organizational factors.

V. RELATED WORK

In this section, we summarize related systematic reviews in the context of FLOSS adoption. We identify the context, the year, the kind of review (LR: Literature Review; SLR: Systematic Literature Review). Also, the period of the papers studied, the number of papers studied and the number of adoption factors that were reported. Table 6 shows the summary of this comparison.

Marsan and Paré [21] presents a literature review (LR) which do not follows a systematic method to investigate existing work on FLOSS adoption in health care organizations. The purpose of this study is to develop a model to investigate the background decision making process in this kind of organizations. Marsan and Paré [21] use a conceptual framework based on the information systems literature on the topic of organizational adoption of software. This work has a specific focus on the health care domain while our review is more general. They identify eight factors.

Badampudi *et al.* [12] present a Systematic Literature Review (SLR) about software component decision-making: In-house, FLOSS, commercial-off-the-shelf (COTS), or outsourcing. The purpose of this study is to identify factors that influence the adoption decision to select between different software components and solutions. These factors are compared between COTS, FLOSS components and home-built solutions. The adoption decision depend on the evaluation of these factors. Note that this study addresses aspects related to proprietary software and FLOSS which differs from our research study that focuses only on FLOSS solutions. They identified eleven factors in their study.

Ven and Verelst [33] presents a review of the literature without a systematic method. The aim of this research paper is to identify factors that influence the adoption decision in Belgian organizations. Ven and Verelst [33] uses a TOE Framework through a case study to compare it with factors already studied previously in the literature. This paper has a specific focus on server infrastructure, while our study is broader by not only considering one type of software. Seven factors are identified.

In our systematic study, we identified primary sources in the literature that describe factors that influence the decision making process to adopt FLOSS in organizations. In this context, we apply a systematic method inspired by the guidelines described in [2] and [3]. In addition, we want to highlight that this research study differs from existing research papers since we define a group of factors that cover all the aspects when evaluating FLOSS in the technological, organizational and economic categories. Likewise, this research study can be applied to any type of public or private institution. We identified 22 different factors while previous studies identified a smaller number.

VI. CONCLUSIONS

In this article, we propose two research questions to understand the state of FLOSS adoption research by applying a systematic method of literature review. We identify groups of relevant factors that may influence the decision to adopt FLOSS; the type of research proposed; what is the trend about the use of factors for FLOSS adoption that generated attention by researchers in recent years; and the amount of publications related to FLOSS that were published.

The most referenced factor *support* which gives hints that is one of the major concerns when adopting FLOSS solutions is the availability of internal and external support.

The primary sources surveyed point out that the FLOSS adoption is a topic that is the attracting attention of researchers and that is leading to research in related topics such as the creation of guides, policies and metrics to adopt FLOSS in organizations.

However, according to the facts detected in the research studies, IT managers are neither using any tool nor procedures that allows them to evaluate the adoption of FLOSS solutions. For this reason, this contribution can motivate researchers to work on the creation and publication of guidelines for adopting FLOSS. The purpose of this study is to guide future research in the application of FLOSS in new domains as a guide for the correct selection of FLOSS to help IT managers make appropriate decisions for organizations, define policies for FLOSS adoption, among others.

REFERENCES

[1] Ø. Hauge, C. Ayala, and R. Conradi, "Adoption of open source software in software-intensive organizations—A systematic literature review," *Inf. Softw. Technol.*, vol. 52, no. 11, pp. 1133–1154, Nov. 2010.

[2] B. Kitchenham, "Procedures for performing systematic reviews," Dept. Comput. Sci., Keele Univ., Keele, U.K., Tech. Rep. 0400011T.1, 2004, pp. 1–26, vol. 33.

[3] K. Petersen, R. Feldt, S. Mujtaba, and M. Mattsson, "Systematic mapping studies in software engineering," in *Proc. 12th Int. Conf. Eval. Assessment Softw. Eng.*, Jun. 2008, pp. 1–10.

[4] L. Montalvillo and O. Díaz, "Requirement-driven evolution in software product lines: A systematic mapping study," *J. Syst. Softw.*, vol. 122, pp. 110–143, Dec. 2016. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S0164121216301510

[5] K. Petersen, S. Vakkalanka, and L. Kuzniarz, "Guidelines for conducting systematic mapping studies in software engineering: An update," *Inf. Softw. Technol.*, vol. 64, pp. 1–18, Aug. 2015.

[6] C. Noy, "Sampling knowledge: The hermeneutics of snowball sampling in qualitative research," *Int. J. Social Res. Methodol.*, vol. 11, no. 4, pp. 327–344, Oct. 2008.

[7] R. Wieringa, N. Maiden, N. Mead, and C. Rolland, "Requirements engineering paper classification and evaluation criteria: A proposal and a discussion," *Requirements Eng.*, vol. 11, no. 1, pp. 102–107, Mar. 2006.

[8] H. K. Wright, M. Kim, and D. E. Perry, "Validity concerns in software engineering research," in *Proc. FSE/SDP Workshop Future Softw. Eng. Res. (FoSER)*, 2010, pp. 411–414.

[9] B. Ramdani and P. Kawalek, "SMEs & is innovations adoption: A review & assessment of previous research," *Academia Revista Latinoamericana de Administración*, vol. 39, pp. 47–70, Jan. 2007.

[10] B. Rossi, B. Russo, and G. Succi, "Adoption of free/libre open source software in public organizations: Factors of impact," *Inf. Technol. People*, vol. 25, no. 2, pp. 156–187, Jun. 2012.

[11] L. Aversano and M. Tortorella, "Quality evaluation of floss projects: Application to ERP systems," *Inf. Softw. Technol.*, vol. 55, no. 7, pp. 1260–1276, Jul. 2013.

[12] D. Badampudi, C. Wohlin, and K. Petersen, "Software component decision-making: In-house, OSS, COTS or outsourcing—A systematic literature review," *J. Syst. Softw.*, vol. 121, pp. 105–124, Nov. 2016.

[13] A. Benlian and T. Hess, "Comparing the relative importance of evaluation criteria in proprietary and open-source enterprise application software selection–a conjoint study of ERP and office systems," *Inf. Syst. J.*, vol. 21, no. 6, pp. 503–525, Nov. 2011.

[14] C. Bouras, A. Filopoulos, V. Kokkinos, S. Michalopoulos, D. Papadopoulos, and G. Tseliou, "Policy recommendations for public administrators on free and open source software usage," *Telematics Informat.*, vol. 31, no. 2, pp. 237–252, May 2014.

[15] C. Bouras, V. Kokkinos, and G. Tseliou, "Methodology for public administrators for selecting between open source and proprietary software," *Telematics Informat.*, vol. 30, no. 2, pp. 100–110, May 2013.

[16] F. Daneshgar, G. C. Low, and L. Worasinchai, "An investigation of 'build vs. buy' decision for software acquisition by small to medium enterprises," *Inf. Softw. Technol.*, vol. 55, no. 10, pp. 1741–1750, Oct. 2013.

[17] V. del Bianco, L. Lavazza, S. Morasca, and D. Taibi, "A survey on open source software trustworthiness," *IEEE Softw.*, vol. 28, no. 5, pp. 67–75, Sep. 2011.

[18] G. R. Gangadharan, "Open source solutions for cloud computing," *Computer*, vol. 50, no. 1, pp. 66–70, Jan. 2017.

[19] Ø. Hauge, D. S. Cruzes, R. Conradi, K. S. Velle, and T. A. Skarpenes, "Risks and risk mitigation in open source software adoption: Bridging the gap between literature and practice," in *Proc. 6th Int. IFIP WG 2.13 Conf. Open Source Syst. (OSS)*, Notre Dame, IN, USA: Springer, May/Jun. 2010, pp. 105–118.

[20] L. A. Joia and J. C. dos Santos Vinhais, "From closed source to open source software: Analysis of the migration process to open office," *J. High Technol. Manage. Res.*, vol. 28, no. 2, pp. 261–272, 2017.

[21] J. Marsan and G. Paré, "Antecedents of open source software adoption in health care organizations: A qualitative survey of experts in canada," *Int. J. Med. Informat.*, vol. 82, no. 8, pp. 731–741, Aug. 2013.

[22] D. Nagy, A. M. Yassin, and A. Bhattacherjee, "Organizational adoption of open source software: Barriers and remedies," *Commun. ACM*, vol. 53, no. 3, pp. 148–151, Mar. 2010.

[23] M. Silic and A. Back, "Open source software adoption: Lessons from linux in munich," *IT Prof.*, vol. 19, no. 1, pp. 42–47, Jan. 2017.

[24] K.-J. Stol, M. A. Babar, and P. Avgeriou, "The importance of architectural knowledge in integrating open source software," in *Proc. Grounding Res. 7th IFIP WG 2.13 Int. Conf. Open Source Syst. (OSS)*. Salvador, Brazil: Springer, Oct. 2011, pp. 142–158.

[25] K.-J. Stol and B. Fitzgerald, "Inner source-adopting open source development practices in organizations: A tutorial," *IEEE Softw.*, vol. 32, no. 4, pp. 60–67, Jul. 2015.
[26] J. P. Li, R. Chen, J. Lee, and H. R. Rao, "A case study of private-public collaboration for humanitarian free and open source disaster management software deployment," *Decis. Support Syst.*, vol. 55, no. 1, pp. 1–11, Apr. 2013.
[27] M. D. Gallego, P. Luna, and S. Bueno, "Designing a forecasting analysis to understand the diffusion of open source software in the year 2010," *Technol. Forecasting Social Change*, vol. 75, no. 5, pp. 672–686, Jun. 2008.
[28] S. R. Ponelis and P. Adoma, "Diffusion of open source integrated library systems in academic libraries in africa," *Library Manage.*, vol. 39, no. 6/7, pp. 430–448, Aug. 2018.
[29] K. Kimppa, G. Miscione, and K. Johnston, "Free and open source software in developing contexts," *J. Inf., Commun. Ethics Soc.*, vol. 8, pp. 42–56, Mar. 2010.
[30] R. D. Macredie and K. Mijinyawa, "A theory-grounded framework of open source software adoption in SMEs," *Eur. J. Inf. Syst.*, vol. 20, no. 2, pp. 237–250, Mar. 2011.
[31] P. Spagnoletti and T. Federici, "Exploring the interplay between FLOSS adoption and organizational innovation," *Commun. Assoc. Inf. Syst.*, vol. 29, no. 1, p. 15, 2011.
[32] C. P. Ayala, D. Cruzes, O. Hauge, and R. Conradi, "Five facts on the adoption of open source software," *IEEE Softw.*, vol. 28, no. 2, pp. 95–99, Mar. 2011.
[33] K. Ven and J. Verelst, "A qualitative study on the organizational adoption of open source server software," *Inf. Syst. Manage.*, vol. 29, no. 3, pp. 170–187, Jun. 2012.
[34] M. Rafiq, "LIS community's perceptions towards open source software adoption in libraries," *Int. Inf. Library Rev.*, vol. 41, no. 3, pp. 137–145, Sep. 2009.
[35] Y. Jusoh, K. Chamili, J. H. Yahaya, and N. C. Pa, "The selection criteria of open source software adoption in Malaysia," *Int. J. Adv. Comput. Technol.*, vol. 4, no. 21, pp. 278–287, Nov. 2012.
[36] I. Maglogiannis, "Towards the adoption of open source and open access electronic health record systems," *J. Healthcare Eng.*, vol. 3, no. 1, pp. 141–162, Mar. 2012.
[37] A. Meetoo-Appavoo, A. Chutoo, P. Appavoo, and B. Durgahee, "Open source ICT framework for developing countries," *IEEE Technol. Soc. Mag.*, vol. 32, no. 3, pp. 39–47, Sep. 2013.
[38] M. K. Mijinyawa and L. Abdulwahab, "An extended framework for evaluation of open source software adoption in small businesses," *Res. J. Inf. Technol.*, vol. 6, no. 4, pp. 248–269, Apr. 2014.
[39] L. Tome, K. A. Johnston, A. Meadows, and M. Nyemba-Mudenda, "Barriers to open source ERP adoption in South Africa," *Afr. J. Inf. Syst.*, vol. 6, no. 2, p. 1, 2014.
[40] B. Idrizi, S. Zhaku, S. Izeiroski, I. Kabashi, and P. Nikolli, "Defining methodology for selecting most appropriate GIS software," *Surv. Rev.*, vol. 46, no. 338, pp. 383–389, Sep. 2014.
[41] A. Hanumappa, M. Dora, and V. Navik, "Open source software solutions in indian libraries," *Library Hi Tech*, vol. 32, no. 3, pp. 409–422, Sep. 2014.
[42] S. Dhir and S. Dhir, "Adoption of open-source software versus proprietary software: An exploratory study," *Strategic Change*, vol. 26, no. 4, pp. 363–371, Jul. 2017.
[43] A. M. Taha, "Identifying the affecting factors for adoption of open source software in it community," *J. Eng. Appl. Sci.*, vol. 13, no. 14, pp. 5771–5780, 2018.
[44] E. Petrinja, A. Sillitti, and G. Succi, "Adoption of OSS development practices by the software industry: A survey," in *Proc. Grounding Res. 7th IFIP WG 2.13 Int. Conf. Open Source Syst. (OSS)*. Salvador, Brazil: Springer, Oct. 2011, pp. 233–243.
[45] F. Saghafi, E. Noorzad Moghaddam, and A. Aslani, "Examining effective factors in initial acceptance of high-tech localized technologies: Xamin, iranian localized operating system," *Technol. Forecasting Social Change*, vol. 122, pp. 275–288, Sep. 2017.
[46] K. Ven, J. Verelst, and H. Mannaert, "Should you adopt open source software?" *IEEE Softw.*, vol. 25, no. 3, pp. 54–59, May 2008.
[47] K. Ven and J. Verelst, "An empirical investigation into the assimilation of open source server software," *Commun. Assoc. Inf. Syst.*, vol. 28, no. 1, p. 9, 2011.
[48] M. Sarrab and O. M. H. Rehman, "Empirical study of open source software selection for adoption, based on software quality characteristics," *Adv. Eng. Softw.*, vol. 69, pp. 1–11, Mar. 2014.
[49] M. Silic, A. Back, and D. Silic, "Taxonomy of technological risks of open source software in the enterprise adoption context," *Inf. Comput. Secur.*, vol. 23, no. 5, pp. 570–583, Nov. 2015.
[50] P. Poba-Nzaou, S. Uwizeyemungu, and M. Saada, "Critical barriers to business intelligence open source software adoption," *Int. J. Bus. Intell. Res.*, vol. 10, no. 1, pp. 59–79, Jan. 2019.
[51] H. Safadi, D. Chan, M. Dawes, M. Roper, and S. Faraj, "Open-source health information technology: A case study of electronic medical records," *Health Policy Technol.*, vol. 4, no. 1, pp. 14–28, Mar. 2015.
[52] J. Choi, M.-H. Hwang, H. Kim, and J. Ahn, "What drives developing countries to select free open source software for national spatial data infrastructure?" *Spatial Inf. Res.*, vol. 24, no. 5, pp. 545–553, Oct. 2016.
[53] K. Gurusamy and J. Campbell, "Enablers of open source software adoption: A case study of APS organisations," *Australas. J. Inf. Syst.*, vol. 17, no. 2, pp. 5–23, 2012.
[54] S. Koloniaris, G. Kousiouris, D. Anagnostopoulos, M. Nikolaidou, and K. Tserpes, "Survey-based investigation, feature extraction and classification of greek municipalities maturity for open source adoption and migration prospects," *J. Syst. Softw.*, vol. 158, Dec. 2019, Art. no. 110431.
[55] M. Rafiq and K. Ameen, "Issues and lessons learned in open source software adoption in Pakistani libraries," *Electron. Library*, vol. 27, no. 4, pp. 601–610, Aug. 2009.
[56] B. Lundell, B. Lings, and A. Syberfeldt, "Practitioner perceptions of open source software in the embedded systems area," *J. Syst. Softw.*, vol. 84, no. 9, pp. 1540–1549, Sep. 2011.
[57] B. Fitzgerald, "Open source software adoption: Anatomy of success and failure," *Int. J. Open Source Softw. Processes*, vol. 1, no. 1, pp. 1–23, 2009.
[58] M.-E. Paschali, A. Ampatzoglou, S. Bibi, A. Chatzigeorgiou, and I. Stamelos, "Reusability of open source software across domains: A case study," *J. Syst. Softw.*, vol. 134, pp. 211–227, Dec. 2017.
[59] Y. Li, C.-H. Tan, and X. Yang, "It is all about what we have: A discriminant analysis of organizations' decision to adopt open source software," *Decis. Support Syst.*, vol. 56, pp. 56–62, Dec. 2013.
[60] G. Munoz-Cornejo, C. B. Seaman, and A. G. Koru, "An empirical investigation into the adoption of open source software in hospitals," *Int. J. Healthcare Inf. Syst. Inform.*, vol. 3, no. 3, pp. 16–37, 2008.
[61] Y. Roumani, J. K. Nwankpa, and Y. F. Roumani, "Adopters' trust in enterprise open source vendors: An empirical examination," *J. Syst. Softw.*, vol. 125, pp. 256–270, Mar. 2017.
[62] W. G. Qu, Z. Yang, and Z. Wang, "Multi-level framework of open source software adoption," *J. Bus. Res.*, vol. 64, no. 9, pp. 997–1003, Sep. 2011.
[63] M. A. Zaffar, R. L. Kumar, and K. Zhao, "Diffusion dynamics of open source software: An agent-based computational economics (ACE) approach," *Decis. Support Syst.*, vol. 51, no. 3, pp. 597–608, Jun. 2011.

VÍCTOR REA SÁNCHEZ received the M.Sc. degree in information and communication technology from the University of Milagro, Ecuador, in 2015. He is currently pursuing the Ph.D. degree in computer engineering with the University of Seville, Spain. He has a work trajectory on development of enterprise information systems for decision making. He is currently an Associate Professor with the University of Milagro. His primary areas of interest are open source software, business intelligent, and the development of technological tools.

PABLO NEIRA AYUSO received the M.Sc. degree in computer science engineering from the University of Seville, Spain, the master's degree in advanced studies from INSA Lyon, France, and the Ph.D. degree in software engineering. He was an Intern with the RESO Group, Ecole Normal Superieure (ENS) of Lyon. He is currently an Assistant Professor with the University of Seville. His main research interests include computer networks, computers security and opensource software. He has been participating in the development of several OpenSource Software Projects since 20 years ago in collaboration with leading ICT industry companies.

JOSÉ A. GALINDO received the Ph.D. degree from the University of Seville and the University of Rennes 1, in March 2015. He has developed his professional activity in the United States, France, and Spain. He has developed his Postdoctoral Research Activity with INRIA, France. He is currently working as a Juan de la Cierva Researcher with the University of Seville, he continues his line of research on configuration, testing, and the evolution of highly configurable systems. His research areas are product lines software and the configuration of such products. Dr. Galindo received the award for the Best National Thesis by SISTEDES.

DAVID BENAVIDES received the B.S. degree in information systems from the Institute Superieur d'Electronique de Paris, France, in 2000, and the M.Sc. degree in computer engineering and the Ph.D. degree in software engineering from the University of Seville, Spain, in 2001 and 2007, respectively. He is currently an Associate Professor with the University of Seville. His main research interests include software product line and artificial intelligence applied to engineering education.