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CATÓLICA DEL PERÚ**

**Escuela de Posgrado**



Factores de adopción y retención de CMMI: Revisión  
sistemática de la literatura

Trabajo de investigación para obtener el grado académico de Magíster  
en Informática con mención en Ingeniería de Software que presenta:

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## Informe de Similitud

Yo, Abraham Eliseo Dávila Ramón, docente de la Escuela de Posgrado de la Pontificia Universidad Católica del Perú, asesor el trabajo de investigación titulado Factores de adopción y retención de CMMI: una revisión sistemática de la literatura de los autores Francisco Eduardo ALFARO PONTE y Cynthia Lizeth SILVA OBREGON, dejo constancia de lo siguiente:

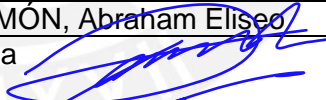
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Apellidos y nombres del asesor DÁVILA RAMÓN, Abraham Eliseo	
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### *Dedicatoria*

*A Dios*

*Por haberme permitido lograr mis objetivos, además de su infinito amor y bondad.*

*A nuestros padres, abuelos y tía*

*Por habernos brindado su apoyo en todo momento, y darnos ánimos para no rendirnos y poder lograr nuestros objetivos.*

*A nuestro asesor*

*Por su paciencia, dedicación, profesionalismo y múltiples palabras de motivación para culminar la maestría.*

# CMMI Adoption and Retention Factors: A Systematic Literature Review

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**Abstract.** CMMI has increased the productivity and reduced the cost of software development in the software industry. However, there are factors that influence the adoption and retention of CMMI in software organizations, and that need to be studied over time. This article aims to identify factors that influence the adoption and retention of CMMI in the software development organizations. A systematic literature review (SLR) was performed for this study. In the first stage, 2507 articles were obtained from 6 relevant databases and after the SLR process, 40 studies on factors and their possible influence were selected. These factor studies were classified according to a taxonomy based on: organization, people, processes and product. The most studied factors are related to people and organizations, in the CMMI adoption and retention processes, which is consistent with the fact that it is the "people" of the software development "organizations" who manage to carry out the software projects. Studies related to retention factors are still scarce, representing only 10% of the total identified. In addition, the use of alternate terms of factors and the use of "critical success factors" and "success factors" are observed without a clear distinction.

**Keywords:** CMMI, adoption factor, critical success factors, SLR.

## 1 Introduction

The maturity model, according to [1], has its origin in the works of Nolan in 1973 and Crosby in 1979, based on a framework of management practices. Also, [2] points out, that CMMI is useful to measure different aspects of a process or an organization. Over time, various maturity models have been developed to help organizations improve software quality, most of them are based on Capability Maturity Model Integration (CMMI) and ISO/IEC 15504 [3], [4], [5], [6]. In particular, in these three decades, since its inception, the Capability Maturity Model for Software (Software CMM), and later CMMI, have an enormous contribution to the productivity and quality of the software industry worldwide [7].

The adoption of a model, such as the CMMI, reveals a series of factors involved in these initiatives that have been studied in [8], and [9], among others. In these studies, factors are analyzed and organized according to various criteria such as the cases of: (i) Bayona [8], the commitment of senior management is mentioned, objectives aligned with the strategic objectives of the business, training, communication, participation, management of change, knowledge and skills, among others; and (ii) Hameed [9], a conceptual model for IT innovation developed, identifying the different factors that influence innovation, organization, environment, CEO and context of acceptance of use.

The aim of this study is to identify the adoption and retention factors of CMMI in software development organizations determining the type of influence. The article is organized as follows: in Section 2, the evolution of Software CMM and CMMI is presented; in Section 3, related studies are described; in Section 4, the definition of systematic literature review is explained; in Section 5, the results of this analysis are shown; and, in Section 6, the conclusions are presented.

## **2. CMMI Evolution**

The foundations of the Capability Maturity Model (CMM) were established by W. Humphrey between 1986-1987 [10] and published under the title “Characterizing the Software Process. A Maturity Framework” as a Software Engineering Institute’s technical report [11]. Its publication was part of a research project funded by the Department of Defense (DoD) [10], [7], with data collected from various projects in the DoD and observation of experiences related to processes in an empirical way rather than a theoretical way [12].

The Version 1.0 of the Software CMM was published in 1991 [13], [14] based on experience and previous documents used to identify problems and improving processes. The Software CMM was a model to judge the maturity of an organization’s software process and helps organizations improve the process to increase the maturity [15]. Some characteristics of mature organizations are: software development is performed according to a planned, process that include roles and responsibilities are well defined, schedules and budgets are established using historical data, and product quality is achieved [15]. In 1993, Software CMM Version 1.1 was released [7], and in 1997, it was decided to stop the development of draft of Software CMM Version 2C (draft) in favor to development CMMI.

In 2000, CMMI Version 1.02 was published [16],[17]. CMMI integrated the Software CMM v2C, System Engineering Capability Model and Integrated Product Development [16]. CMMI v 1.02 was published for use by development organizations [17]. The CMMI v1.1 was launched in 2002, v1.2 was launched in 2004 and v.1.3 was launched in 2010 [17]. The CMMI v 1.3 includes 3 constellations for development, services and acquisition [18]. The CMMI was based on the need for a software project process management and improvement framework [18], and on the need to identify the key practices that a contractor should perform during software intensive development of systems for [17]: (i) improve the reliability of the software development process; (ii)

help the organization improve software development skills; and, (iii) successfully balancing time, budget, and quality requirements.

Finally, in 2018, the CMMI V 2.0 [19] was published, which focuses on improving business performance on operational and business objectives. The CMMI changes in terms of its internal nomenclature, the measurement framework (it uses practice area levels instead of process area capacity levels); reviews the process areas of V1.3 [18] and presents them as a single practice area; and, it defines a maturity model that is easier to understand, maintaining the 5 levels of organizational maturity [19]. It also presents a change in its approach, introducing agility in the organization of the model and showing that the responsibility for the practices lies with the developers.

In the next sections, when a sentence refers CMMI, it includes also CMM.

### **3. Related work**

Some secondary studies were identified CMMI adoption factors, but none studies of CMMI retention factors. The identified studies are:

- In [20], using a systematic literature review, establishes: (i) a list of success factors, barriers, motivators and demotivators when implementing CMM; (ii) factors grouped in 23 categories based on semantic similarities of the terms used to name them; and (iii) that 14 of the 22 process areas of the People CMM model can be related to 11 of the 23 categories of factors identified.
- In [21], based on the identified studies, a catalog of human factors that influence software process improvement (SPI) is elaborated, considering: (i) 15 factors related to people were identified; and (ii) the factor most studied is “senior management commitment” and the second most studied is “role responsibility”.
- In the article by [22], based on a mail survey on the influence of six organizational factors and organizational performance, it was established that: (i) small organizations implemented software process improvement (SPI) effectively like big companies; and (ii) small companies as a strength the participation of employees and exploration of new knowledge.

### **4. Research Method**

This research was performed using a systematic literature review (SLR) based on [23]. The SLR is on CMMI adoption and retention factors, determining the type of influence and its context.

#### **4.1 Systematic Literature Review**

According to [23], an SLR has the following stages: (1) planning the review, (2) conducts the review; and finally, (3) document the review. Stage 1 is presented in this section; stage 2, in section 5; and stage 3, throughout the document. The design of the

protocol and the execution of the SLR were developed by the first two authors and validated by the third author.

**Identify the need for realization.** The identification of CMMI adoption and retention factors in software development organizations will be a contribution for those who wish to establish adoption and retention strategies based on the identified factors.

**Research Purpose and Questions.** For the elaboration of the objective, a scheme taken from the GQM - Goal Question Metrics [24] was used in which it is defined as: (i) objective of the study - capability maturity model integration; (ii) purpose - identify; (iii) focus - adoption and retention factors; and (iv) involved - software development organizations. So, the purpose of the SLR is "*to identify in the software development organizations the CMMI adoption and retention factors.*" The research questions (RQ) and motivation are listed in Table 1. The size of the company was not considered, since in a preliminary review of 10 articles, to confirm the research questions and the search string, none of them made reference to the size of the company. The date was not restricted to cover the largest number of studies. In addition, the Bayona's taxonomy [25] was used for categorization and sub-categorization of the selected factors.

**Table 1.** Research questions and motivation

Research Question	Motivation
RQ-1 What factors and degree of influence are observed in the adoption when implementing CMMI?	Identify factors when adopting CMMI to improve the quality of your software processes, considering the version of the model.
RQ-2 What factors and degree of influence are observed in the retention of CMMI?	Identify factors in retention the practices required by CMMI after their adoption.
RQ-3 What factors are categorized according to an established taxonomy (organization, people, process, product)?	Identify how the factors are categorized according to the defined taxonomy.

**Search string.** To define the search string, the Population (P) and Intervention (I) from PICO strategy, established in [23], was used. The P&I components allowed us to cover the largest number of studies and use selection criteria to filter empirical studies. In this study, we have:

- 'P' with the main term "Capability Maturity Model" and alternate terms to CMM-Sw, CMM and CMMI.
- 'I' with the main term "adoption or retention factors" and alternative terms success, failure, barriers, resistance, motivators, de-motivators and duration.

From the above, the search string was as follows: "*(CMMI OR CMM OR "Capability Maturity Model") AND (factors OR adopting OR success OR failure OR barriers OR resistance OR motivators OR "de-motivators" OR duration)*".

**Selection Criteria and Quality Assessment.** The inclusion criteria (IC) and exclusion criteria (EC) are presented in Table 2. The search date was left unrestricted to cover all versions of CMMI. It was established to work with an automatic search in the digital databases: Scopus, ACM, ScienceDirect, ProQuest, IEEE Xplore, and Web of Science. The questionnaire used for the quality evaluation was based on [26] and which is presented in Table 3. In addition, for this questionnaire a score taken from [27] was used: Yes = 1, Partly = 0.5 or No = 0. The selection and quality evaluation criteria were applied in 5 stages. In the first stage, the meta-data was extracted from the digital databases. In the second stage, IC.1, IC.2, IC.3, EC.1, EC.2 and EC.4 were applied to the titles. In the third stage, IC.3, IC.4, EC.3 and EC.4 were applied to the abstracts. In the fourth stage, IC.5, EC.5 and EC.6 were applied for a preliminary review of the content. In the fifth stage, the quality assessment was carried out with which the primary studies were determined.

**Table 2.** Inclusion Criteria (IC) and Exclusion Criteria (EC)

Item	Criteria
IC1	Articles extracted from indexed databases.
IC2	Academic articles in scientific journals, specialized conferences.
IC3	Primary studies (case studies, experiences, lessons learned, survey, etc.).
IC4	Articles where CMMI has been implemented of any capacity level.
IC5	Articles that mention factors of adoption or retention in CMMI.
EC1	Duplicate items.
EC2	Articles whose title is not related to the topic of the RSL.
EC3	Articles whose abstract is not related to the topic of the RSL.
EC4	Secondary and tertiary studies, newspaper articles and books.
EC5	Insufficient presentation of results.
EC6	Articles that mention factors of adoption or retention, but without considering the CMMI.

**Table 3.** Questionnaire used for the quality evaluation based on [26]

#	Question
1	Is the article based on research?
2	Is there a clear statement of the research objectives?
3	Is there an adequate description of the context in which the investigation was carried out?
4	Is the article appropriate to address the objectives of the research?
5	Was the selection strategy appropriate for the research objectives?
6	Was there a control group with which to compare treatments?
7	Was the data collected in a way that addressed the research topic?
8	Was the data analysis sufficiently rigorous?
9	Has the relationship between the researcher and the participants been an adequate degree?
10	Is there a clear statement of the results?
11	Is the study relevant to research or practice?



**Data Extraction and Synthesis.** A format to perform data extraction from primary studies was defined based on [26]. The structure of the format included data such as: study identifier, article date, authors, title, source, study objectives, adoption factors indicating whether it was with positive or negative influence, retention factors, benefits obtained, the study’s contribution, among others. The narrative synthesis developed by [28] was used: first, identifying the main concepts that allow answering the research questions; and second, applying the grouping and clustering technique.

## 5. Analysis of Results

This section presents the results of the SLR according to Section 4. The steps of the selection process from the data extraction to primary studies selected are presented in Figure 1. The total number of studies selected from digital databases, in January 2021, were 2507 articles, and after process selection 40 primary studies were selected. The list of selected primary studies is presented in Appendix A and the results of the quality assessment are presented in Appendix B. The answers to the research questions are presented below.

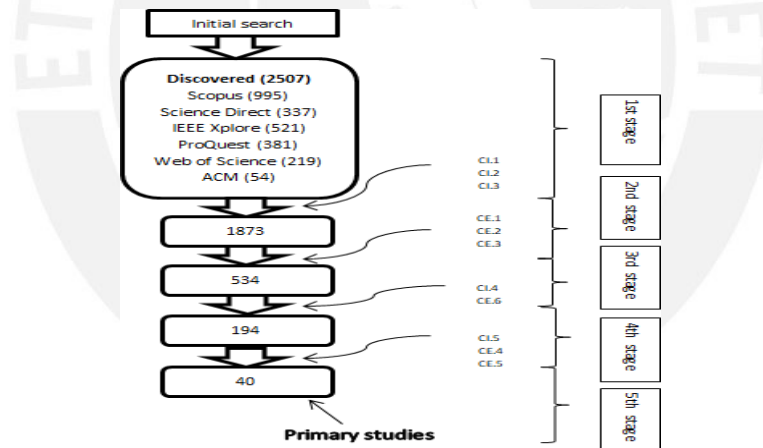


Fig. 1. Primary studies process selection

### 5.1 RQ-1 What factors and degree of influence are observed in the adoption when implementing CMMI?

In the identification of CMMI adoption factors, 30 studies were identified out of a total of 40 selected. Of these, 22 articles studied adoption factors (S18, S16, S01, S02, S05, S07, S15, S09, S11, S12, S13, S38, S37, S36, S35, S34, S33, S27, S29, S30, S31,

S22) and 8 articles reported adoption factors in conjunction with retention factors (S14, S25, S28, S24, S26, S23, S20, S21).

Appendix C presents the ordered list of factors, according to the descending frequency of studies. In the list they are identified taking into consideration the following: (a) if the analyzed factor coincides or is close to one that is within the taxonomy [25] used then the factor is as defined by Bayona; (b) if the analyzed factor coincides or is close to a previously established one, which is not in Bayona's taxonomy, then the factor is as it has been established; and (c) if the factor does not coincide with the previous ones, then a new one is established, seeking to be as clear as possible in its description.

Table 4 presents a list of those adoption factors that are indicated in at least 20% of the studies. From the first two rows, it can be seen that "Senior management commitment" and "Experienced staff", 24 and 21 references respectively, are the two factors most studied or reported as influential. Likewise, from the perspective of the type of criticality, they have been reported for: (i) "Senior management commitment" at 50% (12 of 24 references) as a Critical Success Factor (CSF) and 25% (6 of 24 references) as a Success Factor (SF); what could be considered 75% relevance; and (ii) "Experienced staff", 43% (9 of 21 references) as CSF and 29% (6 of 21 references) as SF; so, 72% relevance can be considered. Both factors are very relevant to take into account in any CMMI adoption strategy.

Likewise, Table 4 shows that the factors "Commitment of stakeholders" and "Formal documentation of processes" have had a negative influence on the different implementations. For the factor "Commitment of stakeholders", 25% (3 of 12 references) consider it CSF and 33% (4 of 12 references) consider it SF, so 58% consider it relevant for the success of the process improvement. For the factor "Formal documentation of processes" 43% (3 of 7 references) consider it as CSF and 29% (2 of 7 references) consider it SF, therefore, 72% consider it relevant.

Additionally, using the same reasoning, it can be noted that the next relevant factors are "Tools" and "Staff participation".

In [20], a result is related to the number of factor references, until 2012. According to [20], the two most mentioned factors are "senior management commitment" and "implementation strategy" with 36 and 28 references respectively. The first of them coincides with our study, and the second relates to the following two factors, but with other names. In [21], the most mentioned factors are "senior management commitment" with 11 references and "staff participation" with 4; which is consistent with the results of our study.

## **5.2 RQ-2 What factors and degree of influence are observed in the retention of CMMI?**

In the identification of CMMI retention factors, 18 studies were identified out of a total of 40 selected. Of these, 8 articles studied retention and adoption factors jointly (S14, S25, S28, S24, S26, S23, S20, S21), another 9 articles studied only retention factors (S08, S19, S17, S03, S04, S06, S32, S39, S40), and one article studied transition factors (S10) between the CMMI maturity levels, which was considered retention.

**Table 4.** Adoption factors. The first three columns are for study identifiers that have positive influence "Id I +", negative influence "Id I-" and influence not determined (not declared) "Id Io". The Total column refers to the number of studies that mention this factor and the percentage it represents with respect to the total number of studies. In addition, the last three columns report, as indicated in each study, the level of criticality relevance of the factor as CSF = Critical Success Factor, SF = Success Factors and F = Factor (without declaring criticality).

Id I+	Id I-	Id Io	Factor	Tot	%	Id CSF	Id SF	Id F
S02, S07, S14, S37, S36, S35, S33, S27, S28, S29, S26, S20	S16, S05, S12, S34, S29, S22	S18, S15, S11, S38, S23, S21	Senior management commitment	24	80%	S18, S16, S02, S07, S15, S14, S11, S37, S29, S26, S21, S29	S12, S36, S33, S27, S20, S22	S05, S38, S35, S34, S28, S23
S02, S14, S37, S33, S25, S27, S28, S29, S30, S31, S26	S16, S12, S36, S34, S22	S18, S09, S11, S23, S21	Experienced staff	21	70%	S16, S02, S14, S11, S37, S29, S30, S26, S21	S09, S12, S36, S33, S27, S22	S18, S34, S25, S28, S31, S23
S35, S07	S18, S16, S12, S37, S36, S34, S33, S22	S38, S23	Commitment of stakeholders	12	40%	S16, S37, S07	S12, S36, S33, S22	S18, S38, S35, S34, S23
S07, S12, S36, S29, S30, S31	S14, S28, S22	S01, S21	Tools	11	37%	S01, S07, S14, S29, S30, S21	S12, S36, S22	S28, S31
S02, S05, S12, S37, S30, S20	S16, S28, S29, S22	S09	Staff participation	11	37%	S16, S02, S37, S30	S09, S12, S20, S22, S29	S05, S28
S12, S28, S29, S31, S22	S16, S05, S36	S11, S23	Organizational change	10	33%	S16, S11, S29	S12, S36, S22	S05, S28, S31, S23
S37, S30, S26, S20	S02, S27, S24, S22	S15	Staff time/resources	9	30%	S02, S15, S37, S30, S26	S27, S20, S22	S24
S37, S36, S25, S31, S26		S15, S23, S21	Formal methodology for deploying processes	8	27%	S15, S37, S26, S21	S36	S25, S31, S23
S12, S37, S36, S33, S30	S16, S34	S23	Staff training program according to needs	8	27%	S16, S37, S30	S12, S36, S33	S34, S23
S12, S36	S16, S07	S18, S01, S21	Available budget, material, and human resources	7	23%	S18, S16, S01, S07, S21	S12, S36	
	S16, S12, S34, S22	S11, S23, S21	Formal documentation of processes, reviewed, and approved	7	23%	S16, S11, S21	S12, S22	S34, S23
S14, S33, S28, S31	S16, S13, S34		Leadership	7	23%	S16, S14	S33	S13, S34, S28, S31
S07, S27	S18, S12	S33, S23	Effective communication	6	20%	S07	S12, S33, S27	S18, S23

In Appendix D the ordered list of factors is presented according to the descending frequency of studies. The structure and considerations in its elaboration are similar to the one explained in the previous Section 5.1 for Appendix C.

Table 5 presents a list of those retention factors that are indicated in at least 20% of the studies. Of the first two columns "Id I+", "Id I-" (Id-factor with positive or negative influence respective), it can be seen that the factors of "Senior management commitment" and "Experienced staff", 11 and 10 references respectively, have contributed positively to the achievement of results and are the ones that have the greatest study have been presented in the literature. On the other hand, from the perspective of the type of criticality, 28% (3 of 11 references) as CSF and 18% (2 of 11 references) as SF have been reported for "Experienced staff" and for "Senior management commitment", 40% (4 of 10 references) as CSF and none references as SF; therefore, they can be considered as two very relevant factors to take into account in any CMMI retention strategy. Additionally, using the same reasoning, it can be noted that the next relevant factors are the "Formal methodology for deploying processes" and "Staff time/resources".

The results obtained in this question are consistent with those obtained in [20] in 2012, since they report "senior management commitment" with 16 references as a success factor and 20 as a barrier; and "implementation strategy" with 17 references as a factor and 11 as a barrier.

### **5.3 RQ-3 What factors are categorized according to an established taxonomy (organization, people, process, product)?**

In Table 6, presents a quantified summary of the grouped factors on the Bayona's taxonomy taken as a reference for this study. All factors have been categorized into Bayona's taxonomy, because this categorization level is high and include "others" category. At the sub- categorization level, we identify 2 factors in "others" category related to market and 2 factors in the organization category without sub-category.

In Appendix E, the complete list of adoption and retention factors grouped by the Bayona's taxonomy [25] is shown, which takes five main categories such as organization, people, process, product and other. In addition, in the list in Appendix E, the adoption factors are ordered according to the number of studies that mention it and by the importance of its criticality declared as CSF or SF for each primary study of the SLR.

In Table 7 show a list of adoption factors with respect to the category defined by Bayona's taxonomy. As in the previous cases, the cutoff value is those that are 20% higher in the number of articles that study it or that consider it relevant (classified as CSF or SF). In addition, it is noted in both cases that all the factors most studied or those considered relevant are in the Bayona's taxonomy.

### **5.4 Threats to validity**

Threats to the validity of the study are described below.

**Table 5.** Retention factors. The first three columns are for study identifiers that have positive influence "Id I +", negative influence "Id I-" and influence not determined (not declared) "Id Io". The Total column refers to the number of studies that mention this factor and the percentage it represents with respect to the total number of studies. In addition, the last three columns report, as indicated in each study, the level of criticality relevance of the factor as CSF = Critical Success Factor, SF = Success Factors and F = Factor (without declaring criticality).

Id I+	Id I-	Id Io	Factor	Tot	%	Id CSF	Id SF	Id F
S14, S28, S26, S20,	S08, S32,	S19, S10, S23, S21, S40	Senior management commitment	11	61%	S14, S26, S21,	S19, S20,	S08, S10, S32, S28, S23, S40
S04, S14, S32, S25, S28, S26,		S19, S10, S23, S21,	Experienced staff	10	56%	S14, S32, S26, S21		S19, S04, S10, S25, S28, S23,
S04, S26, S20,	S24	S17, S06, S10,	Staff time/resources	7	39%	S26	S17, S20,	S04, S06, S10, S24,
S25, S26,	S19, S32	S23, S21, S03,	Formal methodology for deploying processes	7	39%	S26, S21		S19, S32, S25, S23, S03,
S32,	S39	S19, S10, S23, S40	Effective communication	6	33%	S32,	S19,	S10, S23, S39, S40
	S08, S19,	S17, S06, S21,	Available budget, material, and human resources	5	28%	S21,	S17,	S08, S19, S06,
	S24,	S10, S23, S21, S40	Investment and cost of the company	5	28%	S21,		S10, S24, S23, S40
S04, S14, S32, S28,		S06,	Leadership	5	28%	S14,		S04, S06, S32, S28,
S04, S32, S28,		S23,	Organizational change	4	22%	S32,		S04, S28, S23,
	S14, S28,	S21, S03,	Tools	4	22%	S14, S21,		S28, S03,
S04, S20,	S28,	S19,	Staff participation	4	22%		S19, S20,	S04, S28,

**Data source.** The selected digital libraries were 5 indexed databases. Some relevant primary studies may not have been included because they are in databases not considered in this research.

**Table 6.** Factors classified by category of the Bayona's taxonomy [25]

Category	Within
People	42
Organization	25
Processes	25
Product	2
Others (market)	2
Organization (Not sub-categorized)	2

**Selection of studies.** The selection of the studies was based on the professional experience of the first two authors, so there may be a bias in the selection of studies. However, procedures were defined to reduce bias and there was a third author who

**Table 7.** Factors most studied by category of the Bayona's taxonomy [25]

Category	Sub Category	Factor	#	%
Organization	Commitment	Senior management commitment	27	68%
People	Skills	Experienced staff	25	63%
Organization	Infrastructure	Staff time/resources	14	35%
Organization	Commitment	Commitment of stakeholders	13	33%
People	Staff involvement	Staff participation	13	33%
Organization	Organizational culture	Organizational change	12	30%
Organization	Standards and procedures	Tools	12	30%
Organization	Infrastructure	Available budget, material, and human resources	11	28%
People	Communication	Effective communication	11	28%
Process	Deployment Process	Formal methodology for deploying processes	11	28%
People	Training	Staff training program according to needs	10	25%
People	Leadership	Leadership	10	25%

reviewed the work carried out in some stages.

**Quality assessment.** In the quality assessment, the studies were scored according to our personal judgment using an assessment model by the first two authors. It was found that 100% of the studies met the minimum score to be selected, therefore, all the studies were included to answer the research questions.

**Analysis of results.** Of the selected studies, the factors with their influence (positive, negative or neutral) were identified along based on the individual knowledge of the first two authors and reviewed by the third author, who has more professional and research experience. Therefore, there is a risk that some factors may have been omitted.

## 6. Conclusions y Future Work

This article presents the results of an SLR on CMMI adoption and retention factors in software development organizations. The identification of adoption and retention factors are relevant to establish strategies that contribute to the success of process improvement projects and the continuity of practices in organizations that have implemented CMMI.

The main contribution of this study is offered to the development organizations that are interested in implementing or maintaining the CMMI a set of factors and its influences (positive, negative and neutral) of adoption and retention useful to design their strategy.

For the SLR, the term adoption factors have been used considering that it is a neutral term and that it does not imply its type of influence (positive or negative). However, there are other neutral terms that are synonymous and non-neutral terms that are equivalent to "positive factor" as motivators or "negative factor" as barriers that have been included in this study.

Likewise, from the knowledge of the software industry and the associated literature, one has on one side the grouped factor models, such as the Bayona's taxonomy; and on the other, studies on factors that had the greatest impact on process improvement, which are referred to as critical success factors, success factors or simply factors. Additionally, studies on specific factors do not necessarily correspond to the most critical.

From RQ1, the most studied and most relevant adoption factors are those of "Senior management commitment", "Experienced staff". Coincidentally, from RQ2, the most studied and most relevant retention factors are the same as RQ1. However, studies related to retention factors are still scarce, representing only 10% of the total number identified. From RQ3, it is found that the most studied and most relevant factors are associated with the People and Organizations categories, in the CMMI adoption processes. This makes perfect sense considering that people are the center of software production and the foundation of a software development organization.

The need to search and identify models of retention factors as well as the transition between maturity levels in CMMI emerges from this study. Likewise, it is necessary to identify which set of critical success factors is those that must be considered for a software industry with certain specific characteristics.

### Appendix

[https://drive.google.com/drive/folders/1Ki65yDFN9LHRifDCcQP6cm\\_3iw1i1fP?usp=sharing](https://drive.google.com/drive/folders/1Ki65yDFN9LHRifDCcQP6cm_3iw1i1fP?usp=sharing)

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