

Systematic review of scrum harmonization and software process models

Revisión sistemática de la armonización de scrum con los modelos de procesos de software

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Abstract

Agile methodologies such as Scrum are being used in most of the current projects, due to their flexibility and speed in the processes and because it offers a great increase in productivity, quality and efficiency, as well as promotes teamwork.

However, in different situations companies need more than one model to improve their competitiveness in the software development industry and achieve the organization's goals, so many organizations that implement a software process model seek to harmonize them with agile methodologies such as scrum.

This paper, through the methodology known as systematic review, analyzes multiple studies from national and international sources in order to provide a broad overview of the harmonization of scrum with software process models and identify strengths, weaknesses and areas of opportunity in order to contribute to the improvement of software processes for future research.

Scrum, Process Model, Software Engineering

Resumen

Las metodologías ágiles como Scrum están siendo empleadas en gran parte de los proyectos actuales, esto debido a su flexibilidad y rapidez en los procesos y porque nos ofrece un gran aumento en productividad, calidad y eficiencia, así como también promueve el trabajo en equipo.

Sin embargo, en distintas situaciones las empresas necesitan más de un modelo para mejorar su competitividad en la industria de desarrollo de software y lograr los objetivos de la organización, por ello que muchas organizaciones que implementan algún modelo de procesos de software buscan armonizarlos con metodologías ágiles como scrum.

El presente trabajo, a través de la metodología conocida como revisión sistemática, se analizan múltiples estudios de fuentes nacionales e internacionales con la finalidad ofrecer un amplio panorama sobre la armonización de scrum con los modelos de procesos de software e identificar fortalezas, debilidades y áreas de oportunidad con el fin de contribuir a la mejora de los procesos de software para futuras investigaciones.

Scrum, Modelo de Procesos, Ingeniería de Software

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Introduction

Scrum is one of the most popular agile methodologies for software development project management. It is based on the definition of the rules for the joint use of the elements listed below:

Three roles: Product Owner, Developers and Scrum Master.

Three artifacts: Product Backlog, Sprint Backlog, and Increment.

Five events: Sprint, Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective.

The importance of process models in the software industry lies, as described by Oud (2005), in the capacity they have to improve the competitiveness of organizations, fundamentally with an abstract description of the activities for which the software is developed. Providing benefits when evaluating and institutionalizing new or improved processes, becoming more competitive and producing high quality products.

On the other hand, software development organizations face the challenge of needing more than one model to support and achieve the strategic objectives of the organization, seeking the resolution of structural differences, terminology or homogenization, comparing elements and combining or integrating the practices agile with reference models. (O. Salo and P. Abrahamsson, 2005)

However, there is a lack of proposals to harmonization problems between different standards, models and methodologies, so it is not an easy task for organizations to carry out the implementation and management of the different events that must be considered to harmonize more than two approaches or models as references for the improvement of software processes. (C. Jesús and P. Calvache, 2012)

According to various studies in the last 5 years the software engineering community has shown increasing interest in harmonizing multiple models. (Pardo, 2012)

In the software development industry, various models and standards have been implemented that serve as a reference for different objectives and needs (De la Villa et al, 2004).

The software process is made up of several activities focused on the creation of a software product, essentially: Specification, Design and implementation, validation and evolution. (Sommerville, 2009)

Wang (2008) defines it as a set of sequential practices that are functionally coherent, repeatable and reusable for the organization, development and administration of software engineering.

According to Sommerville (2009) a software process model is a simple definition of a software process that presents a vision of that process.

Four software process models are usually presented: Cascade development, step-by-step refinement, incremental development and releases, military and industrial standards, and capacity models. (Buede, 2011)

The main agile methodologies most used in the software development industry are: Agile Modeling, Extreme Programming, Pragmatic Programming and Scrum (Abrahamsson et al., 2002)

Scrum provides a framework for project management, while the other methodologies mentioned above focus on describing practices, activities, and work product techniques related to software development. (Pino et al. , 2010)

Because Scrum is a methodology in which several processes and techniques can be used and it is not a process or a technique to create products (Schwaber & Sutherland, 2020) and also has the ability to complement other existing methods and processes (From the new et al., 2011) allows harmonization with various process models.

In order to obtain better quality in software development companies, the need arises to make compatible the use of Agile Scrum-type methodologies and good practice standards. (Pasini et al ., 2013)

However, the effort that is needed to implement the models can be unfavorable for companies since there is a difficulty in relating them to the business need. (Suárez & León, 2019)

Two approaches assiduously used in companies for the use of software process models are presented, the conventional approach that uses reference models, such as CMMI-DEV v1.2 and MoProSoft, and the agile approach that uses agile methodologies, such as Extreme Programming (XP, Extreme Programming) and Scrum. (Garcia, 2014)

Using the systematic review, it will be possible to identify, evaluate, interpret and synthesize a set of existing and relevant research in order to know the trends of the research carried out on the harmonization of scrum with the software process models. The results obtained will allow us to provide a broad overview of the main aspects involved, strengths, weaknesses and areas of opportunity in order to contribute to the improvement of future research software processes. (Biolchini et al., 2005)

This work is organized in such a way that the methodology to develop the systematic review of the harmonization of scrum with the software process models is presented, describing the application of the systematic review protocol, the extraction of the information and the summary of the results.

Methodology to be developed

The systematic review (SR) according to Biolchini et al. (2005) "is used to refer to a specific research methodology, developed in order to collect and evaluate the available evidence pertaining to a focused topic" which is detailed below:

- A. Protocol development: rigorous and iterative phase. Covers the general plan for the systematic review of the literature.
 1. Question formulation: section where important research questions that must be answered during the SR are identified. In this section the objectives of the investigation should be clearly defined.

2. Identification and selection of sources: section whose objective is to identify and select the sources where the search for primary studies will be carried out. It is made up of the following sections: definition of the criteria for the selection of sources, language of the studies, identification of sources, selection of sources after evaluation, verification of sources.
3. Selection of studies: section that aims to identify primary and secondary studies. Studies are selected after application of the inclusion and exclusion criteria.

B. Information extraction: phase in which the search for studies is carried out in the defined sources, the studies found are evaluated with the defined criteria.

1. Definition of the information inclusion criteria (ICinf) and information exclusion (ECinf), which aims to define the criteria with which the information will be evaluated.
2. Templates for information extraction: section that aims to register the primary studies derived from the selection process.
3. Execution of the extraction: section in which the evaluation of the studies is carried out using the defined criteria.

Systematic review of the harmonization of Scrum with the Software Process Models

A. Development of the Protocol

Formulation of the question

a) Focus of the question

Many organizations that implement a software process model seek to harmonize them with agile methodologies such as scrum, through this research process models that have enough methods to achieve complete harmonization with scrum and those that lack it will be identified.

b) Breadth and quality of the question.**(1) Problem**

Companies need more than one model to improve their competitiveness in the software development industry and achieve the objectives of the organization.

It is essential to identify process models that do not yet have sufficient methods to achieve full alignment with Scrum or that lack it.

(2) Question

What are the process models that have or lack sufficient harmonization methods with Scrum?

(3) Keywords and synonyms**The following definitions were used:**

Process Model, Scrum, Process Improvement, Harmonization, Implementation, Integration, Fusion, Adaptation, Process Reference Model, Software Engineering, Process Model, Process Improvement, Harmonization, Implementation, Fusion, Adaptation, Integration, Process Reference Model Software Engineering.

(4) Intervention

Aspects involved in software process models and their ability to harmonize with scrum.

(5) Effect

Studies that allow identifying the main trends in the harmonization of software and scrum process models.

(6) Population

Publications related to the harmonization of software and scrum process models, experiences, use cases and lessons learned.

(7) Application

Organizations dedicated to the software industry.

Selection and identification of sources**a) Definition of source selection criteria:**

- Keyword search mechanisms.
- Posts suggested by other authors.
- Publications available on websites.

b) Language of studies:

- Spanish.
- English.

c) Identification of sources**(1) Source search methods**

The systematic review has been carried out using web search engines.

(2) Search strings

Logical connectors “AND”, “OR” and “NOT” were used in combination with the list of keywords identified in both Spanish (Table 1) and English (Table 2) and general basic search strings were obtained.

Keywords with logical operators
(“Process Model” OR “Process Improvement”) AND (“Harmonization” OR “Combination” OR “Integration”) AND (“Scrum”)

Table 1 Search string in Spanish

Source: Own elaboration

Keywords with logical operators in English
(“Process Models” OR “Process Improvement”) AND (“Harmonization” OR “Combination” OR “Integration”) AND (“Scrum”)

Table 2 Search string in English

Source: Own elaboration

(3) List of sources

- DIALNET.
- Google Scholar.
- SciELO.
- Redalyc.
- Research Gate.

d) Source selection after criteria evaluation.

A verification of the sources was carried out and they conform to the previously defined criteria, and the list of sources was established, shown in Table 4.

Number	Sources
1	DIALNET
2	Google Scholar
3	SciELO
4	Redalyc
5	Research Gate

Table 3 Sources used
Source: Own elaboration

Verification of sources

All sources were verified and approved.

Selection of studies

a) Definition of studies

(1) Definition of inclusion criteria (IC) of studies and exclusion (CE) of studies.

Four studies (CI) and two study exclusion criteria (CE) were identified, as shown in Table 5.

Criterion	Description
CI1	Includes publications whose titles are related to Scrum and Software Process Models.
CI2	Includes posts that contain keywords that match those defined in the search string.
CI3	Includes publications whose abstract is related to the selected topic.
CI4	Includes posts that have been partially or fully read.
CE1	Exclude publications that do not match the previous inclusion criteria.
CE2	Exclude all duplicate posts.
CE3	It excludes all publications that comprise other agile methodologies in harmonization.

Table 4 Inclusion and exclusion criteria
Source: Own elaboration

(2) Definition of types of studies:

Studies related to the harmonization of Scrum and Software Process Models in organizations from various countries were analyzed.

(3) Procedure for selecting studies:

The criteria considered were: the title of the publication, the summary of each one and in some cases it was required to review the complete content.

b) Execution of the selection:

The searches were carried out, adapting the chains to the engines of each search engine, to determine the quality of the studies, the inclusion and exclusion criteria were applied.

B. Information Extraction.

1. Definition of the criteria for inclusion of information (CIinf) and exclusion of information (CEinf).

Two information inclusion criteria (CIinf) and one exclusion (CEinf) were identified. Table 6 shows a description of these criteria.

Criterion	Description
CI1inf	Collect information on the harmonization of Scrum and Software Process Models.
CI2inf	Identify the main trends in the harmonization of software and scrum process models
CE1inf	Exclude information that is not related to the inclusion criteria defined above

Table 5 Information inclusion and exclusion criteria
Source: Own elaboration

2.- Templates for Information Extraction.

To record the identification data of the study, the template detailed below was implemented.

Qualification	
Year	
Authors	
Summary	

Table 6 Information extraction
Source: Own elaboration

3.- Execution of Extraction

The records obtained were placed in the templates for the extraction of the information. The evaluation was carried out through observations of the main ideas, using the information inclusion and exclusion criteria.

The information of the primary publications was stored in the templates as shown in tables 8, 9 and 10.

MEX-ALVAREZ, Diana Concepción & UC-RIOS, Carlos Eduardo. Systematic review of scrum harmonization and software process models. Journal Applied Computing. 2021

Title	Implementation of ISO / IEC 15504 and ISO / IEC 12207 with agile methods and SCRUM
Year	2019
Authors	García, M & Garzás J.
Abstract	A study is presented on the degree of coverage between the processes of ISO / IEC 15504 - ISO / IEC 12207: 2008 and SCRUM.

Table 7 Example of information extraction
Source: Own elaboration

Title	Systematic Mapping of the Harmonization of SCRUM and ISO 9001.
Year	2021
Authors	Burbano-Delgado, D. L., Pardo-Calvache, C. J., & Orozco-Garcés, C. E.
Abstract	It presents a systematic mapping in order to identify related studies between Scrum and ISO 9001.

Table 8 Example of information extraction
Source: Own elaboration

Title	Integration of frameworks for software development: Scrum, PSP and ISO 25000.
Year	2015.
Authors	Barrera, J. A. H.
Abstract	A study that contains the definition of a software development process in an SME through the integration of various frameworks (Scrum, PSP and ISO 25000).

Table 9 Example of information extraction
Source: Own elaboration

C. Summary of Results

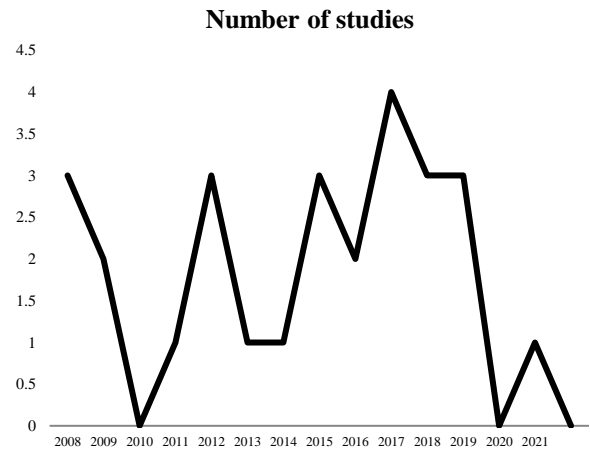
Results

A statistical analysis was carried out on the specific studies to which the information extraction was applied, analyzing different perspectives, among them: Study trends covering publications by year, models used, type of research carried out, countries and languages of the studies.

1.- Study trend

Publications per year

In graph 1 it can be seen that between 2017 and 2019 were the years that more studies were published related to a harmonization of Scrum with other models. Being in 2017 the year with the highest amount and the years 2010 and 2020 in which no related studies were found.



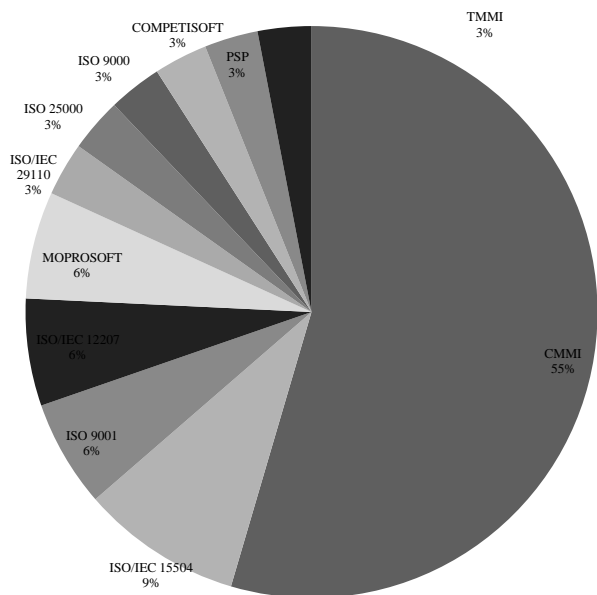
Graphic 1 Studies related to the harmonisation of Scrum and other models, published by year
Source: Own elaboration

Models used

It is important to highlight the different models in the studies involved in the harmonisation with Scrum, as shown in Table 10 and Graphic 2, the most used models in the harmonisation with Scrum are CMMI (54.55%) and ISO/IEC 15504 (9.09%), followed by ISO 9001, ISO/IEC 12207 and MOPROSOFT with 6.06% in each model. ISO/IEC 29110, ISO 25000, ISO 9000, COMPETISOFT, PSP and TMMI with 3.03% each.

Model	Total	Percentage
CMMI	18	54.55%
ISO/IEC 15504	3	9.09%
ISO 9001	2	6.06%
ISO/IEC 12207	2	6.06%
MOPROSOFT	2	6.06%
ISO/IEC 29110	1	3.03%
ISO 25000	1	3.03%
ISO 9000	1	3.03%
COMPETISOFT	1	3.03%
PSP	1	3.03%
TMMI	1	3.03%

Table 10 Models used in harmonization with scrum
Source: Own elaboration



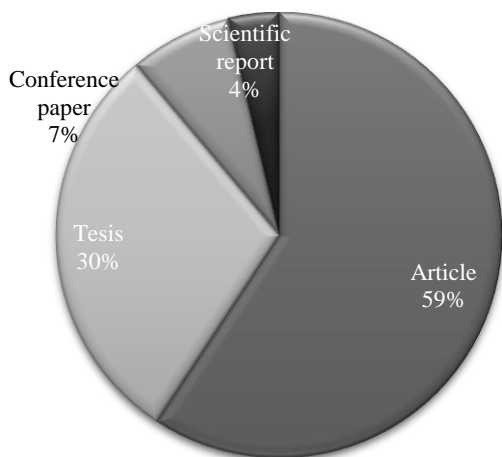
Graphic 2 Percentage of models used
Source: Own elaboration

Types of studies carried out.

The studies found come from different types of research (Table 11) such as articles, thesis, conference papers, and scientific reports. Graphic 3 shows the percentages of the types of studies found.

Type of study	Number
Article	16
Thesis	8
Conference paper	2
Scientific report	1

Table 11 Types of studies carried out
Source: Own elaboration



Graphic 3 Percentage of types of studies carried out
Source: Own elaboration

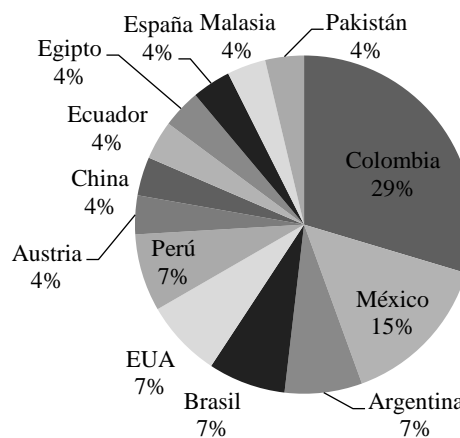
Study countries

In the analysis of the publishing countries, the countries where the research of the selected studies was carried out was identified.

Table 12 shows the number of studies carried out by country. Similarly, Graphic 4 shows the percentage of studies in each country. The country with the highest number of studies is Colombia (29.6%), followed by Mexico (14.8%), Argentina, Brazil, USA, Peru with 7.4% each and Austria, China, Ecuador, Egypt, Spain, Malaysia and Pakistan.

Country	Number of studies
Colombia	8
Mexico	4
Argentina	2
Brazil	2
USA	2
Peru	2
Austria	1
China	1
Ecuador	1
Egypt	1
Spain	1
Malaysia	1
Pakistan	1

Table 12 Countries where the studies have been carried out
Source: Own elaboration



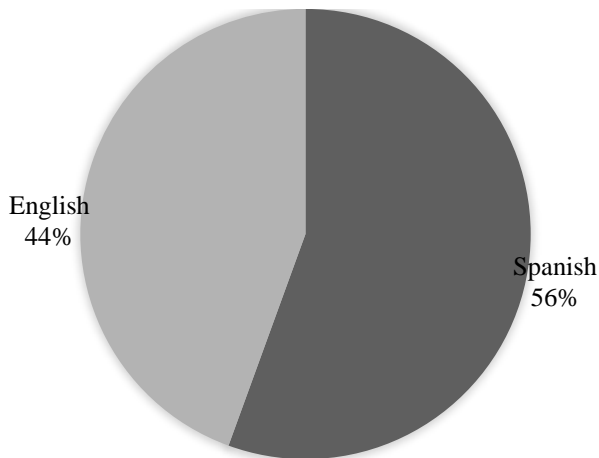
Graphic 4 Percentage of countries in the studies carried out
Source: Own elaboration

Languages of the studies carried out.

Most of the studies found with the search strings were in the Spanish language (Table 13). with 55.6% while in English 44.4% (Graphic 5).

Idiom	Number of studies
Spanish	15
English	12

Table 13 Languages of studies carried out
Source: Own elaboration



Graphic 5 Percentage of languages of the studies carried out

Source: Own elaboration

Acknowledgments

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Conclusions

The studies found were published between 2008 and 2019. With 2017 being the year in which more studies were published. In 2010 and 2020, no related studies were found. The most used model is the CMMI (54.55%) and ISO / IEC 15504 (9.09%)

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