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Software Engineering Research in Mexico: A Systematic Mapping Study

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Abstract

Background: Software Engineering (SE) is a young discipline aiming at the systematic application of tools, methods and practices to develop and maintain software products on time, under budget and with a certain degree of quality. Research in SE has gradually attracted the attention of various Mexican higher-education institutions and some Mexican research centers. Objective: This study aims to survey the existing SE research conducted in Mexico to identify areas of research and research gaps. Method: A systematic mapping study was performed to find relevant papers on the topic in a structured and repeatable manner. Results: From a total of 380 documents retrieved by the defined search string, 206 relevant papers were selected. Taking as reference the Knowledge Areas (KAs) of the Software Engineering Body of Knowledge (SWEBOK V3.0), we observe that more than half (69%) of the Mexican states have at least one published paper in one of the KAs. The knowledge areas KA02 (software design) and KA08 (software engineering process) have the most published papers. The most common venue of publication is the conference, and the second most common is the journal article, among other interesting results. Conclusions: Although SE research in Mexico is gradually being strengthened, more research across the Mexican states remains necessary.

***Keywords**: Software Engineering Research, Systematic Mapping Study, SWEBOK, Mexico*

1. Introduction

In all traditional engineering disciplines, it can be observed that their roots lie in the application of ad hoc practices [1]. Techniques and technologies evolve from crafts through routine practice, integrate scientific knowledge and become a professional engineering discipline. The problems with techniques and technologies often encourage the development of scientific knowledge. After the scientific knowledge achieves a certain maturity, scientific findings can be operationalized in terms of solutions to practical problems, and an engineering discipline may arise.

Conversely to classic engineering disciplines such as civil, chemical or mechanical engineering, software engineering (SE) is considered a young discipline that aims at the systematic application of tools, methods and practices to develop and maintain software products on time, under budget and with a certain degree of quality. According to the ISO/IEC/IEEE vocabulary [2], software engineering is defined as “the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software.”

Currently, we observe that software engineering has moved from the craft to the commercial stage, but scientific knowledge remains necessary to establish a mature engineering discipline. In this sense, the software engineering research community acknowledges a lack of theoretical foundations for this discipline [3]-[7]. Thus, we do not currently have enough knowledge to perform a proper evaluation and selection of all of the technologies that are available to the software engineer. In SE, the results of applying certain technologies remain unpredictable [8]. New technologies are commonly adopted without sufficient evidence that they will be effective [9], and there is not sufficient evidence to support or refute the method in which we develop and maintain software products [10].

Although the application of engineering efforts to software development can trace its roots to the 1960s, SE is a new field in the academic context; its academic presence was not separated from computer science until the early 1980s [11]. Since then, multiple venues (ICSE, ESEM, EASE, Mensura, CIbSE, JIISIC) and journals (IST, JSS, SPE, TOSEM, TSE) related to software engineering have emerged. Some topics addressed by the SE research community are tools (including compilers and debuggers), software life cycle, product quality, measurement and metrics, methodology programming languages and project/product management [11].

In order to have better understanding of the SE research done in a particular context, we carried out a systematic mapping study to know how software engineering research is conducted across all entities of the United Mexican States.

A systematic mapping study provides a structure of a determined research topic and it offers a visual summary of the findings [12]. By using this method, a broad review of primary studies in a specific topic area is performed to identify and classify the findings [13].

The remainder of this work is organized as follows. In Section 2, we describe the methodology. In Section 3, we present the results of the systematic mapping study. In Section 4, we discuss the findings in the context of the stated research questions. Finally, we present the conclusions in Section 5.

2. Research Method

As research method, we employed the systematic mapping study approach. Systematic mapping studies or scoping studies are a type of research that focuses on providing a wide overview of a research area [13], [14]. Mapping studies helps objectively and systematically characterize information from primary studies [15]; information is extracted from relevant papers to describe their important aspects.

This type of research can be conducted using an identical approach to a Systematic Literature Review (SLR) [16]. The process to conduct a mapping study can be decomposed into three main activities:

- **Planning.** In this activity, the mapping study protocol is developed, which implies a rigorous and iterative process to develop the general plan of the mapping study. In this stage, the research questions are stated, and the objectives are defined. In this activity, the sources that are used to perform the searches are specified, the language of the papers is considered, and the exclusion and inclusion criteria are specified.

- **Execution.** In this activity, the mapping study protocol is executed, and the defined search string is run on the defined sources. Document results are assessed according to the inclusion and exclusion criteria. Relevant information from relevant papers (primary studies) is synthesized and recorded.

- **Reporting**. This activity involves reporting the mapping study findings.

After describing the general process to conduct a mapping study, we present the protocol that we followed in this systematic mapping study.

2.1. Research Question Definition (Research Scope)

The main goal of our work is to provide an overview of the conducted software engineering research across all entities of the United Mexican States. This implies identifying the available quantity and types of research according to the defined goal. This goal is reflected in the following research questions:

- **RQ1:** What is the distribution of SE contributions across the Mexican States?
- **RQ2:** What is the distribution of SE contributions across organizations such as research centers, higher education institutions and industry (private)?
- **RQ3:** Taking as reference the knowledge areas (KAs) defined in the Software Engineering Body of Knowledge (SWEBOK), we define this RQ as follows: Which KAs have been addressed?
- **RQ4:** Which KAs have been addressed by organizations (research centers, higher education institutions and industry) in the Mexican states?
- **RQ5**: Which Mexican organizations are more similar in terms of KAs?
- **RQ6:** What types of venues are used for publication?
- **RQ7:** How many (co)authors participate in SE research per Mexican state?

We decided to use the SWEBOK (Software Engineering Body of Knowledge) [17] as the reference for RQs 3-5 because it is a well-known international standard (ISO/IEC TR 19759:2005) [18]; it was created through the cooperation of several professional bodies and members of both industry and academia. The SWEBOK encompasses the principal knowledge of this discipline. The recent version (in late 2013) of the SWEBOK is composed of the following 15 knowledge areas (KAs):

1) Software requirements
2) Software design
3) Software construction
4) Software testing
5) Software maintenance
6) Software configuration management
7) Software engineering management
8) Software engineering process
9) Software engineering models and methods
10) Software quality
11) Software engineering professional practice
12) Software engineering economics
13) Computing foundations
14) Mathematical foundations
15) Engineering foundations

2.2. Identification and Selection of Sources

Among several existing sources, we selected the Scopus database. This well-known database includes a wide range of scientific literature and offers a reliable and friendly search engine and a range of result exportation facilities [19]. Figure 1 shows the overall workflow of the search process we followed in this mapping study.

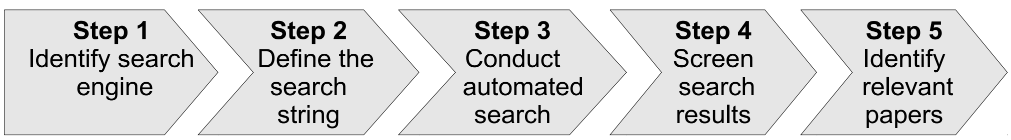

Figure 1. Workflow of the Proposed Mapping Search Process

The search string was defined with different terms, which were extracted from the research questions. We combined these terms with logical operators "AND" and "OR". The resulting search string is defined in Table 1. Table 1 shows that most terms are related to the core KAs of the SWEBOK (KAs 1-12). The last three KAs are supporting areas of this engineering discipline and were not considered.

Table 1. Search String Defined for the Mapping Study

Search string
`AFFILCOUNTRY(Mexico) AND TITLE-ABS-KEY("software requirements" OR "software design" OR "software construction" OR "software testing" OR "software maintenance" OR "software configuration management" OR "software engineering management" OR "software engineering process" OR "software engineering models" OR "software engineering methods" OR "software quality" OR "software engineering professional practice" OR "software engineering economics") AND PUBYEAR < 2016`

After the source for searching was selected and the search string was defined, we delimited the selection of primary studies in terms of the inclusion criteria (IC) and exclusion criteria (EC). Inclusion and exclusion criteria is shown in Table 2.

Table 2. Inclusion and Exclusion Criteria for this Mapping Study

Criteria	Description
IC1	Include papers whose titles are related to the descriptions of the core SWEBOK KAs and at least one of the (co)authors is affiliated with a Mexican academic or research organization.
IC2	Include papers that contain terms related with the defined terms in the search string.
IC3	Include papers whose abstracts are related to the descriptions of the core SWEBOK KAs and one of the (co)authors is affiliated with a Mexican organization.
EC1	Exclude papers that are not related with the previous inclusion criteria.

After we defined the inclusion and exclusion criteria, we ran the search string on the Scopus database. We examined the search results with regards to the descriptions of the core KAs of the SWEBOK. Regarding the selection procedure, we considered the papers according to the inclusion and exclusion criteria. We read the titles, abstracts and keywords of all document search results. In some cases, the entire paper had to be screened. Table 3 shows the document results and the number of selected relevant papers.

As shown in Table 3, after examining the search results and applying the inclusion and exclusion criteria, we selected 206 relevant papers (primary studies)[1].

[1] The catalog of relevant papers may be provided upon request to the corresponding author.

Table 3. Document Search Results and Relevant Selected Papers

Source	Searching date	Document results	Relevant papers
Scopus	04/15/2016	380	206

We defined a template to register the information of the relevant papers selected. We defined the following fields in the template: identifier, year, document's title, abstract, affiliation, author(s) name(s), document's type and the SWEBOK knowledge area related to the paper. The extracted information was put on the described template. Relevant papers were classified according to the defined categories in the template; these categories serve to address the defined research questions. Figure 2 shows the number of documents identified, screened, excluded and included in this mapping study.

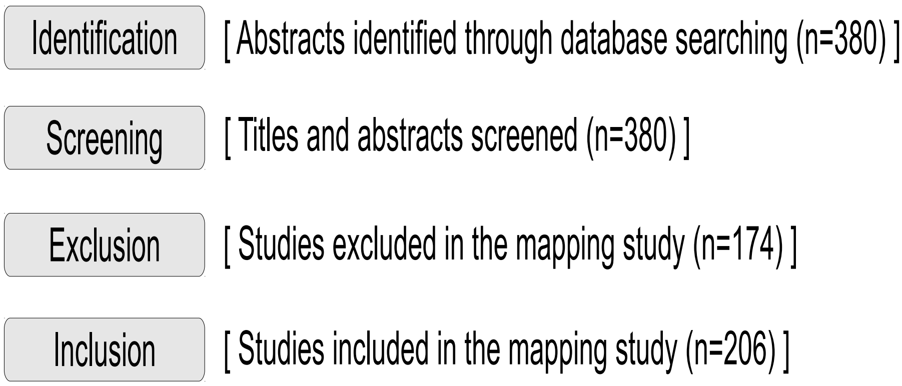

Figure 2. Document Results of the Mapping Process

Figure 3 shows the trend line per year of the number of selected primary studies (relevant papers). As shown in Figure 3, the number of relevant papers appears to increase since 2008; on average, the number of published papers between 2008 and 2015 is 23.

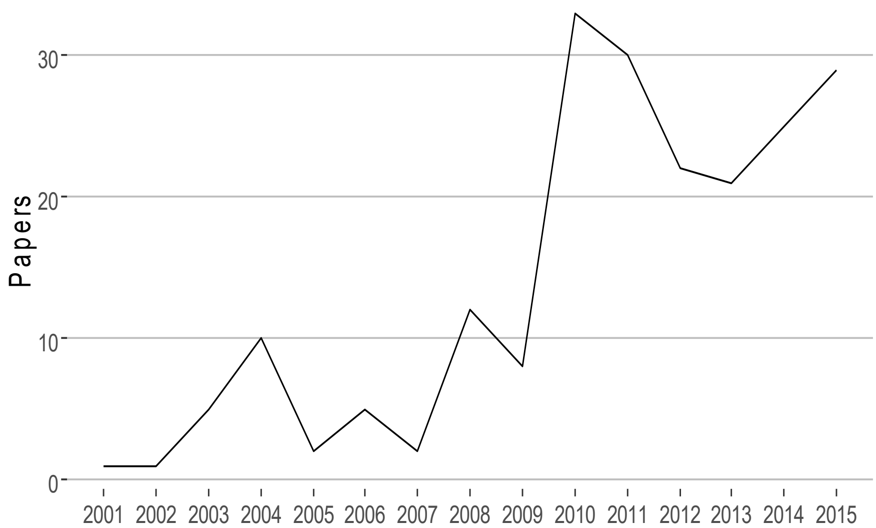

Figure 3. Distribution of Relevant Papers Published per Year

3. Results

In this section, we present the finding results and analyses of the paper categorization. According to the findings, we address each of the seven research questions (RQs) defined in Section 2.

3.1. What is the Distribution of SE Contributions across the Mexican States? (RQ1)

The first research question aims to identify the number of published papers across the Mexican states. We categorized the papers according to the authors' affiliation (if one of them belongs to a Mexican organization) and organized them based on their respective Mexican state. If the papers were written by two or more authors of different Mexican states, these papers were duplicated and accounted for in each Mexican state to which the authors belong. Figure 4 shows a choropleth map of the distribution of papers across the Mexican states.

Figure 4 shows that most Mexican states (22 of 32 [including the Mexico City]) have published papers. We identified five Mexican states with the greater number of published papers (138): Baja California (36 papers), Mexico City (before known as D.F., 31 papers), Jalisco (24 papers), Tamaulipas (24 papers) and Zacatecas (23 papers). The remaining published papers (98) belong to 17 states: Sonora (14), Oaxaca (14), Puebla (12), Nuevo Leon (10), Morelos (9), Aguascalientes (9), Veracruz (7), Sinaloa (6), Colima (3), Guanajuato (3), Queretaro (3), San Luis Potosi (3), State of Mexico (1), Chihuahua (1), Nayarit (1), Michoacan (1) and Hidalgo (1 paper). This finding suggests that Software Engineering research is of interest in most Mexican states, though most of the publications belong to the northern, western and central Mexican states.

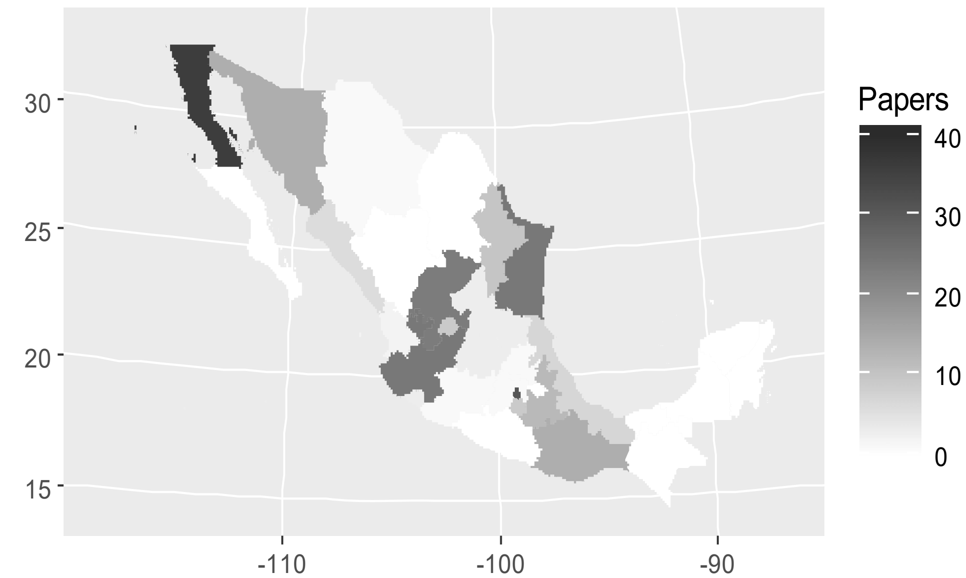

Figure 4. Choropleth Map that Visualizes the Number of Papers Published in the Mexican States

3.2. What is the Distribution of SE Contributions across Organizations? (RQ2)

This research question aims to identify and analyze the type of organization where researchers publish their works. We considered three types of organizations: 1) Academia, which is higher-education institutions such as (polytechnic) universities; 2) research centers, which are organizations that are primarily dedicated to knowledge generation; and 3) Industry, which is private and lucrative organizations.

For research centers that belong to an academic organization, the papers were accounted for the research center and not to the academic organization. Additionally, organizations with campuses in several Mexican states were considered a unique organization. Figure 5 shows a histogram with the distribution of number of papers by organization type. As shown in this figure, academia has the most published papers (163), followed by the research centers (80 papers). Finally, we identified 7 published papers from the industry.

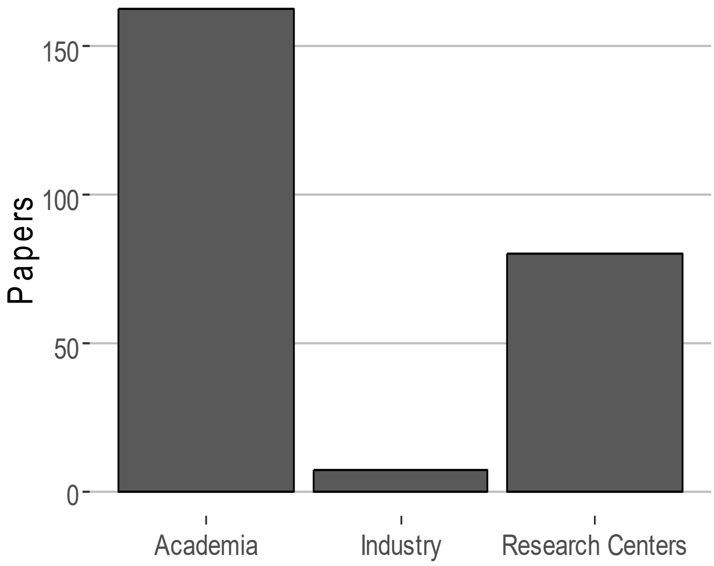

Figure 5. Distribution of Papers Published by Types of Organization

3.3. Which KAs of the SWEBOK have been Addressed? (RQ3)

This research question aims to answer the published papers according to the KAs of the SWEBOK. The papers were classified based on the following core KAs: Software requirements (KA01), software design (KA02), software construction (KA03), software testing (KA04), software maintenance (KA05), software configuration management (KA06), software engineering management (KA07), software engineering process (KA08), software engineering models and methods (KA09), software quality (KA10), software engineering professional practice (KA11), and software engineering economics (KA12). Figure 6 shows a histogram of the distribution of papers per KA.

Figure 6 shows that there are published papers in most SWEBOK knowledge areas. Software design (KA02) and software engineering process (KA08) have 44% of the published papers. Similarly, software requirements (KA01), software testing (KA04), software engineering management (KA07) and software engineering professional practice (KA11) have 45% of the published papers. The knowledge areas of software construction (KA03), software maintenance (KA05), software engineering models and methods (KA09), and software quality (KA10) cover 11%. According to the defined search string, we did not find papers related to the KAs of software configuration management (KA06) and software engineering economics (KA12).

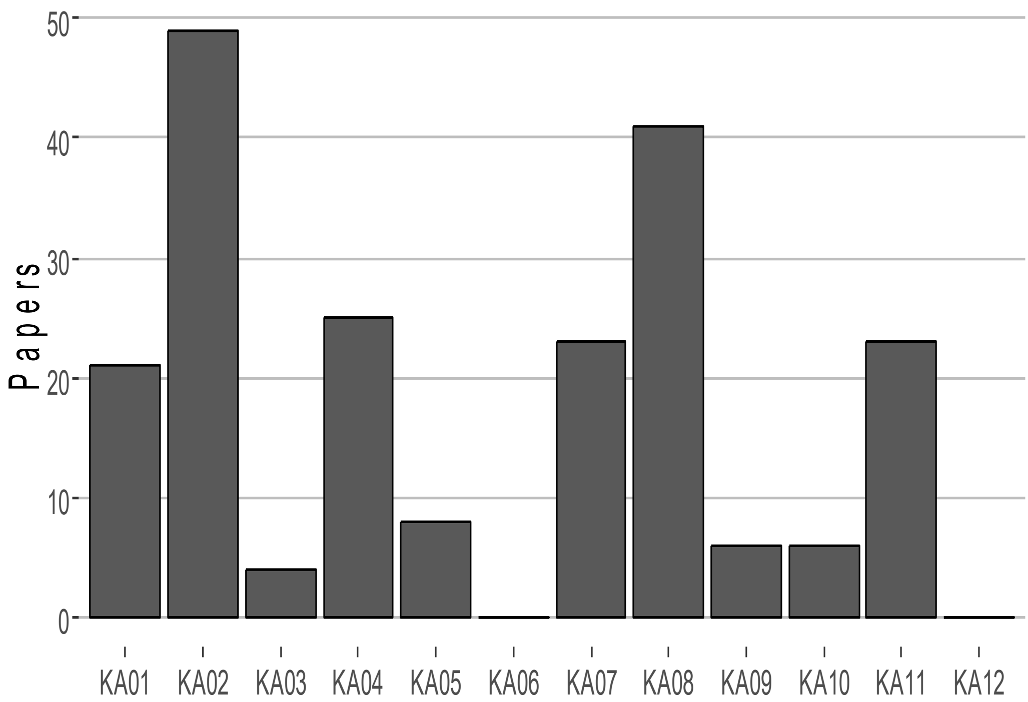

Figure 6. Distribution of Papers Published by the Core KAs of the SWEBOK

3.4. Which KAs have been Addressed by Organizations in the Mexican States? (RQ4)

For this research question, we considered the number of papers published by authors of different Mexican states and classified them in terms of the defined KAs in the SWEBOK. Figure 7 shows a bubble plot with the number of published papers classified per KAs and Mexican states.

Figure 7 shows that the software design knowledge area (KA02) is the area with major interest: 15 Mexican states have published papers in this area. Other KAs of interest are software engineering professional practice (KA11) and software requirements (KA01), with 11 states each; similarly, software engineering process (KA08) has 10 interested states.

We also observe that the software construction (KA03) knowledge area is not as attractive: this area is only addressed by three states (Sinaloa, Colima and Mexico City). We observe that Tamaulipas has the largest number of papers (21) related to software testing (KA04), Jalisco has the largest number of papers (13) related to software engineering management (KA07), and Zacatecas and Baja California have the largest number of papers (13) related to software engineering process (KA08) and software engineering professional practice (KA11), respectively.

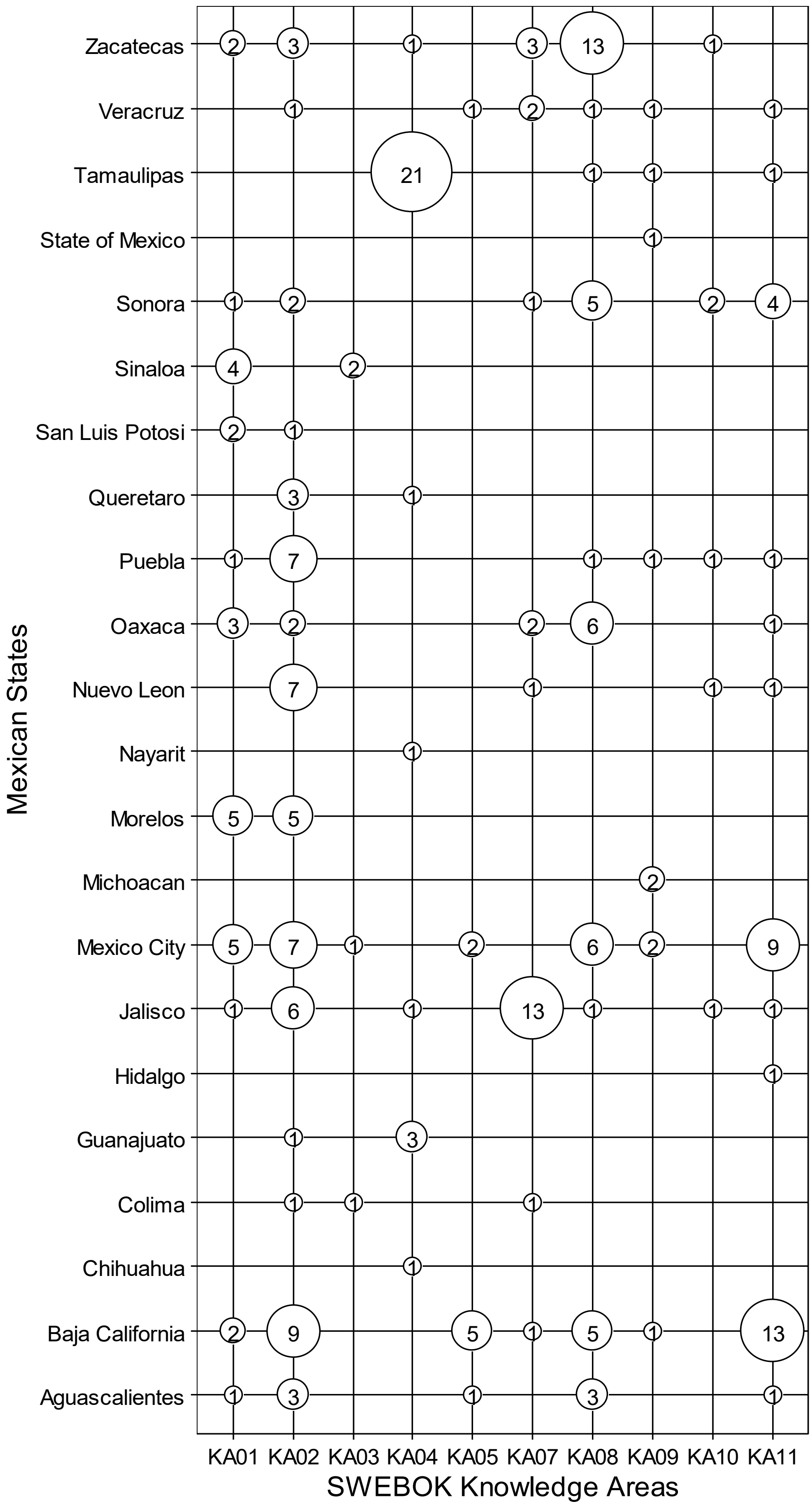

Figure 7. Bubble Plot of the Number of Papers Distributed per KAs across the Mexican States

As shown in Figure 7, 22 of the 32 states have published papers in at least one KA of the SWEBOK. Eleven states concentrate the major number of KAs: Mexico City (before known as D.F.), Baja California and Jalisco with 7 KAs, Puebla, Sonora, Veracruz and Zacatecas with 6 KAs, Oaxaca and Aguascalientes with 5 KAs, Nuevo Leon and Tamaulipas with 4 KAs. Figure 8 shows a complementary choropleth map of the distributions of KAs per state.

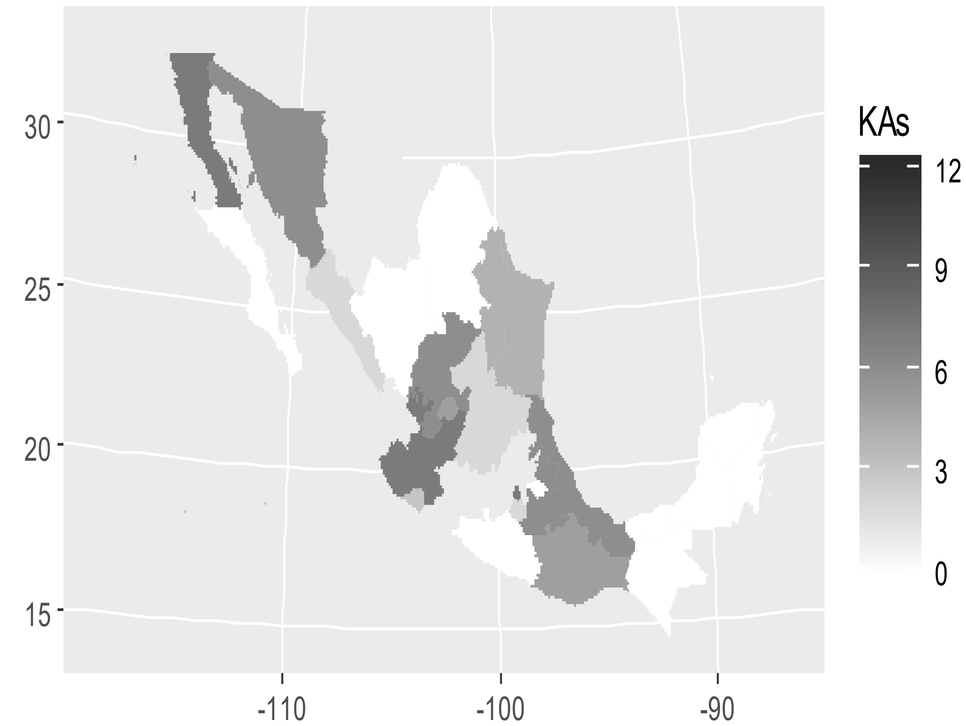

Figure 8. Choropleth Map of the Number of KAs Addressed in the Mexican States

3.5. Which Mexican Organizations are Similar in Terms of KAs? (RQ5)

This research question is answered using a hierarchical clustering analysis (HCA) [20]. We computed a (dis)similarity matrix with the Jaccard index [21] and transformed it to an Euclidean distance matrix. A dendrogram was used to represent this analysis.

We ran this analysis to identify similarities among the organizations in terms of KAs. In total, 63 organizations (research centers, higher-education institutions or industry companies) were considered (see appendix A for a complete list). Figure 9 shows the resulting dendrogram. Values near zero indicate a major degree of similarity among the organizations, whereas values near one indicate a major dissimilarity.

We observe that some organizations have one of the KAs in common. For example, as shown in Figure 9, organizations 14, 12, 25, 40, 43-45, 48-51, 53 and 60 have papers related to only KA02 (software design). Organizations 15, 2, 20, 39, 55 and 57 have works related to KA11 (software engineering professional practice). Similarly, organizations 31, 7, 33, 38 and 58 share AC04 (software testing). Other organizations have some KAs in common, *e.g.,* organizations 37 and 61 share four knowledge areas: KA01 (software requirements), KA07 (software engineering management), KA08 (software engineering process) and KA011 (software engineering professional practice).

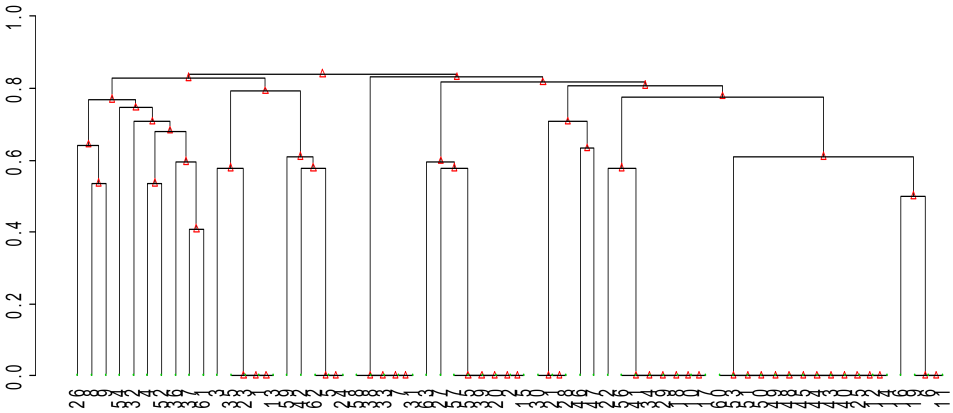

Figure 9. Similarity of Organizations in Terms of KAs they Publish

3.6. What Types of Venues are used for Publication? (RQ6)

This research question aims to answer the methods of publication. Four types of publication were identified: Conference, article, book chapter and book. Figure 10 shows a histogram with the respective frequencies.

As observed in Figure 10, the two most common types of publications are conferences (151 papers) and journal articles (53). We only identified one work categorized as book chapter and another work identified as book.

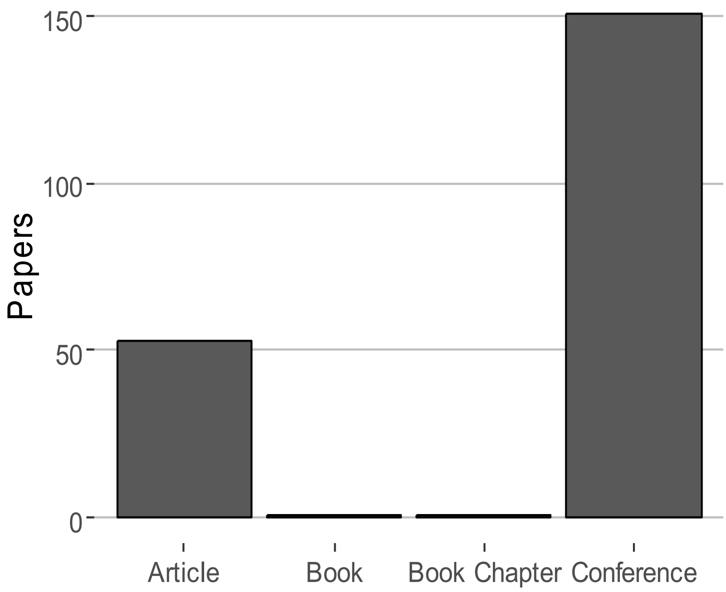

Figure 10. Types of Publication Venues

3.7. How Many (co)authors Participate in SE Research per Mexican State? (RQ7)

This last research question aims to know how many (co) authors publish across the Mexican states. (Co) authors with more than one published paper were counted once. The (co) authors were classified regarding to their affiliation. Figure 11 shows a choropleth map of the distribution of (co) authors per state.

As shown in Figure 11, most (co) authors (142) are concentrated in 5 Mexican states: Mexico City (D.F.) (41), Baja California (41), Zacatecas (23), Morelos (19) and Puebla (18 [co] authors). The remaining (co) authors (113) correspond to 16 Mexican states: Tamaulipas, Jalisco, Nuevo Leon, Oaxaca, Veracruz, Aguascalientes, Sinaloa, Sonora, Colima, San Luis Potosi, Michoacan, Queretaro, Guanajuato, State of Mexico, Chihuahua and Hidalgo.

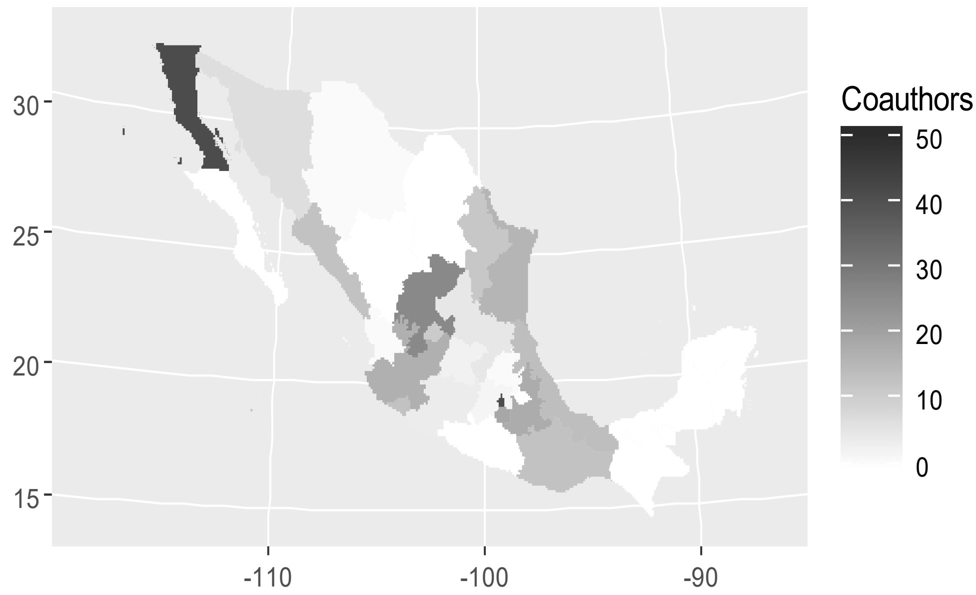

Figure 11. Choropleth Map of the Number of (co)authors per State

4. Discussion

All relevant papers selected in this mapping study were published by different (co)authors who were affiliated with at least one Mexican organization (research center, higher education institution or industry). This number represents more than half (69%) of the Mexican states with at least one publication that is mainly related to a core knowledge area of the SWEBOK. Most Northern (Baja California, Tamaulipas, Nuevo Leon, Sonora, Sinaloa and Chihuahua), central (Aguascalientes, Guanajuato, Queretaro, San Luis Potosi, Zacatecas, Mexico, Mexico City, Morelos), western (Colima, Jalisco, Nayarit and Michoacan) and eastern (Hidalgo, Puebla, Veracruz) Mexican states have publications on the topic. However, we observe the opposite trend in the southern states: only Oaxaca has published papers on the topic (RQ1).

In recent years, we observe that software engineering research has principally gained attention in several Mexican higher-education institutions and research centers. An increase in number of published technical papers is observed since 2008. Mexican higher-education institutions have the highest percentage of published papers (65%), followed by research centers (32%) and industry, with 3% (RQ2).

The SWEBOK knowledge areas with the most published papers are: KA02 (software design) with 24% of the relevant papers selected and KA08 (software engineering process) with 20% of the publications. Both KAs have nearly half of all relevant papers. We did not find published papers related with knowledge areas KA06 (software configuration management) and KA12 (software engineering economics) (RQ3).

The knowledge areas KA02 (software design), K01 (software requirements), KA11 (software engineering professional practice) and KA08 (software engineering process) have greater interest across the Mexican states.

KA02 is addressed by 47% of the states, followed by the knowledge areas KA01, KA11 and KA08, which are addressed by 34%, 34% and 31% of the states, respectively. The states of Tamaulipas, Jalisco, Zacatecas and Baja California have most published papers in the knowledge areas KA04 (software testing), KA07 (software engineering management), KA08 (software engineering process) and KA11 (software engineering professional practice), respectively (RQ4).

We observed certain similarities among the KAs that address different organizations. For example, organizations identified as 14, 12, 25, 40, 43-45, 48-51, 53 and 60 (see appendix A for the complete list of organizations) have only published papers related with KA02 (software design), this represents the large percentage of organizations (21%) that address the same KA (RQ5).

With respect to the methods of publication, the usual venue is conferences (73% of the published papers), followed by journal articles (26%). The other two types of publication, which are less frequently used, are book chapters and books (1%) (RQ6).

We observe that two Mexican states, one in the central part (Mexico City) and the other in the northern part (Baja California) have the major number of (co)authors: 41 each (RQ7).

The findings of our mapping study shed light on the software engineering research performed in the Mexican states. We are also interested in having an initial knowledge of how SE research in Mexico is positioned in comparison to other countries. We reran the search string (defined in Section 2) but excluded the search string AFFILCOUNTRY. We only ran the search string without applying the inclusion and exclusion criteria.

According to the results of the search string, we observe a total of 147 countries with at least one document result (using the adjusted previously discussed search string). After arranging the results in descending order, we notice that Mexico is at the 37th position. In the context of the Iberoamerican community, which includes Spanish and Portuguese-speaking countries, Mexico is at the fourth position after Spain, Brazil and Portugal.

Although SE research conducted in Mexico has achieved certain visibility in the international context, major encouragement remains necessary. As our findings suggest, a large number of published papers concentrates in only a few Mexican states.

4.1. Study Limitations

This work was performed as a systematic mapping study based on the guidelines proposed by [13], [14]. Nevertheless, secondary studies as the one reported here are subject to limitations. Common limitations that may occur in a mapping study are inaccuracy of data extraction (limited coverage), selection of academic search engines, and researcher bias during the mapping study process such as paper selection, data extraction, analysis, and synthesis. We now discuss how these limitations were addressed.

The limitation of selected searching terms and search engines can lead to an incomplete set of primary sources. We addressed this issue by selecting the Scopus database, which includes a wide spectrum of peer-reviewed publications and a friendly interface for advanced search capabilities.

To make this study repeatable for other researchers, the search engine, search terms and inclusion/exclusion criteria were carefully defined and reported. However, it is important to note that the search terms that we used are related to the core KAs of the SWEBOK; existing relevant papers that do not contain any of the used terms could have been missed. However, the identified relevant papers are a representative sample that serves to draw a picture on the topic and provide a generalization of the current state of SE research in Mexico.

Our findings are based on published papers in the English language, and papers published in non-English were excluded from this study. We consider that the pooled papers contain sufficient information to represent the knowledge reported on the topic.

The application of inclusion and exclusion criteria and categorization of papers can be affected by the researchers' judgment and experience, and there could have been a personal bias. To alleviate this bias, joint voting was applied in the paper selection and categorization; disagreements were resolved by consensus among the authors of this work.

5. Conclusions

In this paper, we characterized the software engineering research conducted in Mexico through a systematic mapping study of scientific and technical relevant papers on the topic that were published until the year 2015. As part of the paper characterization, we use the first twelve knowledge areas of the Software Engineering Body of Knowledge (SWEBOK V3.0), which are the core areas of this discipline, as the reference. The main contribution of this study is the characterization of the software engineering research conducted in Mexico considering different perspectives. Our findings can serve as a reference to make informed decisions about the SE engineering research areas that can be addressed in Mexico and future directions on this topic.

The SE research performed in Mexico has gradually gained attention in different Mexican states. Regarding the SWEBOK knowledge areas, KA02 (software design) and KA08 (software engineering process) have the most published papers. We did not observe research in the knowledge areas KA06 (software configuration management) and KA12 (software engineering economics), and this gap can be filled by attracting researchers into these areas. Although SE research in Mexico is slowly gaining worldwide recognition, based on the findings of our study, we conclude that there remains much room for improvement in this relevant discipline.

Appendix A. Organizations Listing

In this appendix, we list all organizations identified in our mapping study. Tables 4 and 5 show the identifications (Id), organization names and Mexican states to which they belong.

Table 4. List of Identified Organizations in the Mapping Study

Id	Organization	State
1	ARGUS Tecnologias, S.A. de C.V.	Baja California
2	Banorte	Mexico City
3	Benemerita Universidad Autonoma de Puebla	Puebla
4	Centro de Investigacion en Matematicas	Zacatecas unit
5	Centro de Investigaciones en Ecosistemas	Michoacan
6	Centro Nacional de Investigacion y Desarrollo Tecnologico	Morelos
7	Centro Nacional de Metrologia	Queretaro
8	CICESE	Baja California and Nayarit unit
9	CINVESTAV	Mexico City; Tamaulipas and Jalisco units
10	ENTIA	Jalisco
11	Fondo de Informacion y Documentacion Para la Industria (INFOTEC)	Mexico City
12	GPPI Telecomunicaciones S. de R.L. de C.V	Baja California
13	INNEVO	Mexico City
14	Instituto de Investigaciones Electricas IIE	Morelos

15	Instituto Mexicano del Petroleo	Mexico City
16	Instituto Nacional de Astrofisica, Optica y Electronica	Puebla
17	Instituto Nacional de Estadistica, Geografia e Informatica	Aguascalientes
18	Instituto Nacional de Investigacion Nuclear ININ	Mexico City
19	Instituto Politecnico Nacional	Mexico City
20	Instituto Tecnologico Autonomo de Mexico	Mexico City
21	Instituto Tecnologico de Colima	Colima
22	Instituto Tecnologico de Culiacan	Sinaloa
23	Instituto Tecnologico de Hermosillo	Coahuila
24	Instituto Tecnologico de Morelia	Michoacan
25	Instituto Tecnologico de Oaxaca	Oaxaca
26	Instituto Tecnologico de Orizaba	Veracruz
27	Instituto Tecnologico de Sonora	Sonora
28	Instituto Tecnologico de Zacatecas	Zacatecas

Table 5. List of Identified Organizations in the Mapping Study (continuation)

Id	Organization	State
29	Instituto Tecnologico de Zacatepec	Morelos
30	Instituto Tecnologico Superior de Nochistlan	Zacatecas
31	Instituto Tecnologico Superior de Salvatierra	Guanajuato
32	Instituto Tecnologico y de Estudios Superiores de Monterrey	Nuevo Leon
33	Instituto Tecnologico y de Estudios Superiores de Occidente	Jalisco
34	ProTech I+D	Sinaloa
35	Ultrasist	Mexico City
36	Universidad Autonoma de Aguascalientes	Aguascalientes
37	Universidad Autonoma de Baja California	Baja California
38	Universidad Autonoma de Ciudad Juarez	Chihuahua
39	Universidad Autonoma de Nuevo Leon	Nuevo Leon
40	Universidad Autonoma de Queretaro	Queretaro
41	Universidad Autonoma de Sinaloa	Sinaloa
42	Universidad Autonoma de Tamaulipas	Tamaulipas
43	Universidad Autonoma del Estado de Morelos	Morelos
44	Universidad Autonoma Metropolitana	Mexico City
45	Universidad Autonoma San Luis Potosi	San Luis Potosi
46	Universidad de Colima	Colima
47	Universidad de Guadalajara	Jalisco
48	Universidad de Guanajuato	Guanajuato
49	Universidad de las Americas	Puebla
50	Universidad de Montemorelos	Nuevo Leon
51	Universidad de Puebla	Puebla
52	Universidad de Sonora	Sonora
53	Universidad del Mar	Oaxaca
54	Universidad Nacional Autonoma de México	Mexico City
55	Universidad Politecnica de Altamira	Tamaulipas
56	Universidad Politecnica de San Luis Potosi	San Luis Potosi
57	Universidad Politecnica de Tulancingo	Hidalgo
58	Universidad Politecnica de Victoria	Tamaulipas
59	Universidad Popular Autonoma del Estado de Puebla	Puebla
60	Universidad Regiomontana	Nuevo Leon

61	Universidad Tecnologica de la Mixteca	Oaxaca
62	Universidad Tecnologica de Morelia	Michoacan
63	Universidad Veracruzana	Veracruz

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