APENDIX A

Research methodology for performing an SMS is presented by [1-5]. In this paper, we use the methodology, which is based on the updated SMS guidelines described in [2]. To the best of our knowledge, the concept of edge computing firstly appeared in 2001. Therefore, this SMS covers published research studies from 2001 until the end of 2019 and a review has been conducted on the edge computing research works during this period. Generally, the SMS process of this paper is comprised of three main phases. (i) The planning phase, (ii) Evaluating phase, and (iii) Conducting phase. These phases are depicted in Fig. *1*. In this section, we will explain the details of these three phases.

1 PLANNING THE MAPPING STUDY

At the beginning of the SMS process, the planning phase is performed. It is decomposed into a series of steps, which should be done in sequence. In this subsection, the steps of the planning phase are discussed in sequence.

1.1 Specifying the Scope and Research Questions (RQs)

The primary goal of scientific researchers who accomplish systematic mapping studies is to provide an overview of topics, which can be used as a reference for researches who will be working in this field [3]. To advance the SMS process more objectively, it is essential to design some RQs at a very early stage of review progress. As a consequence, the effort to answer these RQs will form the foundation of the SMS process. In this paper, we have defined 8 RQs. Each RQ, along with its rationality, is summarized in Table 1.

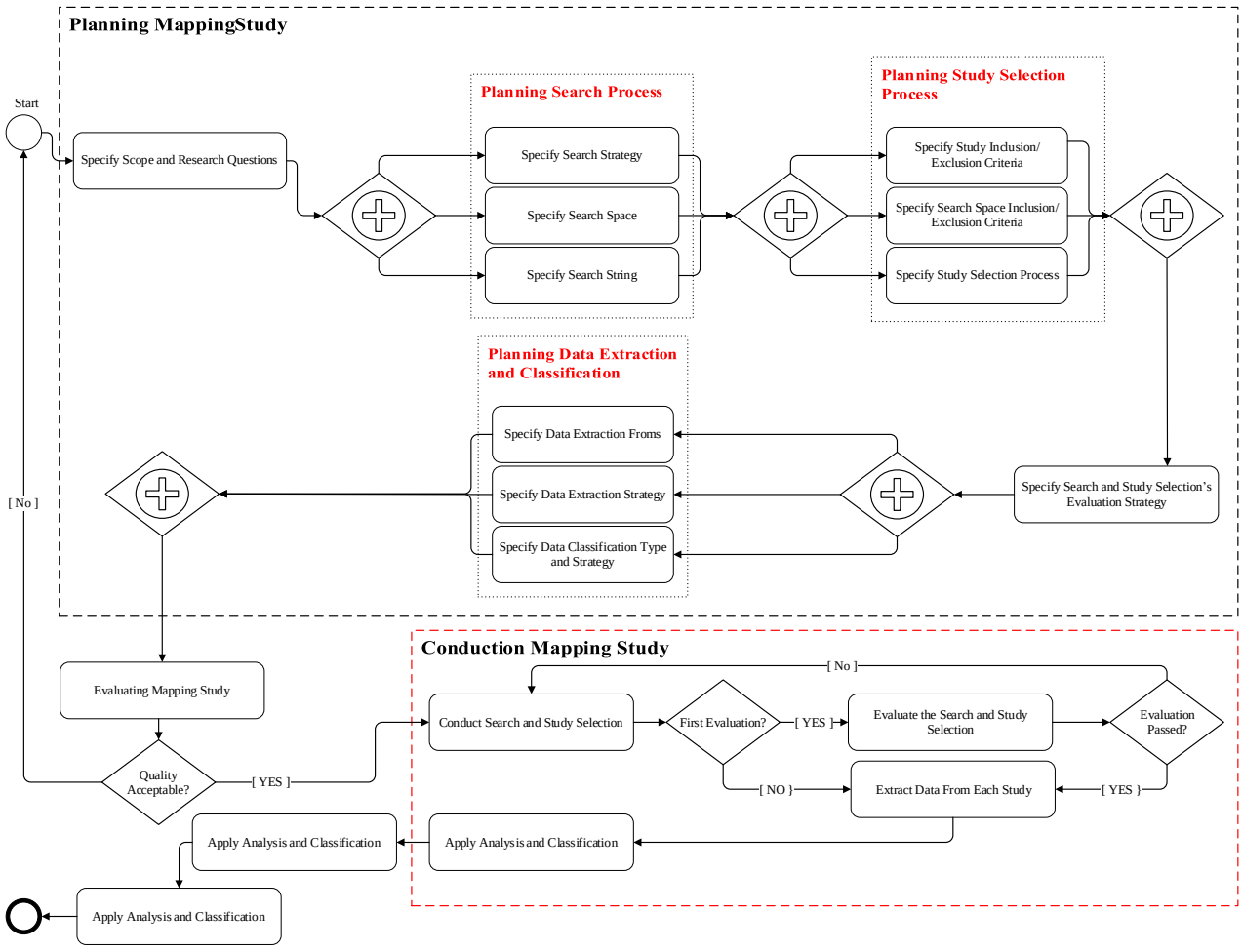

Fig. *1*. SMS Process [6]

To find an appropriate answer for each of these RQs, we attempt to consider published works having a contribution in the field of edge computing. Since the concept of edge computing firstly appeared in 2001, we consider studies from this year. Moreover, as we start conducting this study in 2017, we cover the searches up to the end of 2019. Due to finishing this review in mid-2020, we have omitted the year 2020 to have a reasonable enough analysis.

1.2 Planning of the search strategy

The search process might be repeated several times during the review period. Moreover, as it is a time-consuming process, it is more probable to be performed by different members in a group. In order to make members to follow identical rules and decisions as the review carried out, the exact search process must be previously planned. To do this, the step of planning the search process is categorized into three sub-steps which specify the search strategy, search space, and search strings, as shown in Fig. *1* we have detailed these sub-steps in the following subsections.

1.2.1 Specifying the Search Strategy

As the starting point of our search strategy, a set of initial secondary studies are selected randomly (survey or review) which have investigated the edge computing field. They are listed in Table 2.During the process of our SMS, we found some other reviews. The comparison between this work and the other found secondary studies (survey and review) is given in section 5 of the main article.

As shown in Fig. 2 , three types search strategies, i.e., manual search, backward snowballing, and database search is applied to retrieve studies. In the manual search, we have used the queries to manually search in each venue of the search space list that have been acquired using the search space strategy (see section 1.2.2).In the snowballing method, the references list of each newly added paper is examined to find the new related venues. In the database search phase, a manual search is done using defined keywords in the well-known databases such as Google Scholar, Springer Link, IEEEXplore, ACM Library, and ScienceDirect.

Table 1. Defined Research Questons(RQs)

	RQ	Research Questions	Rationale
General Questions	1	Which researchers and research venues are more active in this field and how are the active researchers distributed geographically?	The demographics of edge computing research provide a useful starting point for interested researchers by identifying active scholars, venues, and countries.
	2	How active is the field of edge computing and how is the distribution of selected studies by type over publication year (journal), and Geographical areas?	To identify the current volume of research and general trends in order to better depict the attractiveness of the field. Comparing the volume of research over publication year and Geographical areas can shed some light on the maturity of edge computing.
Structural Questions	3	What are the core research topics in the field of edge computing?	To identify and classify the current research topics in the field of edge computing, the evolution and distribution of each topic, and the potential trends.
	4	What is the distribution of applications in each research topics?	To identify the percentage of applicability and the importance of each research topics based on the number of studies published in each application relative to the total number of studies.
	5	What is the distribution of different architectures in each topic?	Architecture can be Fog Computing, Cloudlet, MEC and so on.
	6	Which techniques are more used in the field?	To identify main techniques used in each topic of edge computing field and analyzing the relation between techniques with other aspects. Techniques can be game theory, heuristic and so on
	7	Which forms of empirical evaluation have been used?	Empirical evaluation means whether the environment is real or simulation or testbed.
	8	Mostly, Which Qualitative Requirements (QoS) have been considered to move towards edge computing?	Answering this research question will make it possible to understand when a researcher must use edge computing. QoS can be time, cost, energy, and so on.

By applying all search phases together, we have arrived at a large dataset of related studies in the field of the edge computing from 2001 to the end of 2019. To distinguish between these three methods, we have defined a flag called S-Flag, which is valued 0 and 1 for backward snowballing and manual search steps, respectively.

To increase the accuracy of the search process and coverage of the domain, improvements have been made to our previous works in the search process. For this purpose, in the snowballing stage, in addition to extracting new venues, a list of unseen studies

was also extracted. Unseen studies are the study whose venue (search space) has been searched for before, but these studies have not been found in the results of search queries in that venue. The study selection process is then applied to the unseen studies and, the selected studies are added to the included studies set. As a result, we are one step closer to coverage of the domain.

Using these three search methods, our overall search strategy consists of seven main steps, as follows:

Stage 1: By specifying the initial set of secondary studies, the initial set of keywords are extracted. final queries for manual searching are created using some combination of these keywords, which is described in section 1.2.3. Also, we have defined a variable named “phase”, which shows the number of passed steps in each cycle of search strategy execution.

Stage 2: The initial set of search spaces is created by backward snowballing the cited papers in each secondary study of the initial set. Notably, only search spaces that satisfy some defined quality criteria are added to the initial set of search spaces. These quality criteria will be discussed later in section1.3. Whenever a new search space is found in the process of examining the secondary studies, the following stage 3 will be executed; otherwise, the process jumps to stage 5 (backward snowballing). In this step, S-Flag is set to zero.

Stage 3: Firstly, the new found search spaces from stage 2 are added to the search space set. Secondly, the manual search is applied to them (newly added search spaces) by considering the initial keyword set and extracted queries. This stage outputs a new search study set.

Stage 4: This stage considers new search studies set and study selection process applied to them. It should include/exclude studies based on defined inclusion/exclusion criteria, which are discussed in section 1.3.1. The search process jumps to stage 5 if at least one search study has been included; otherwise, it jumps to stage 2. Moreover, if there is any new related keyword in an included study, it will be added to the keyword set to complete it gradually.

Stage 5: For any included study found by manual search, the backward snowballing should be applied to (S-Flag set to one). The backward snowballing is defined as investigating the reference section of an included study and extracting the related cited papers. By founding any new related study, the process will jump to stage 4.

Stage 6: With applying a set of pre-defined keywords, a database search is done, and new unseen papers are extracted.

Stage 7: At the last step, the study selection process should be executed on the recently found papers and after that, the search process ends.

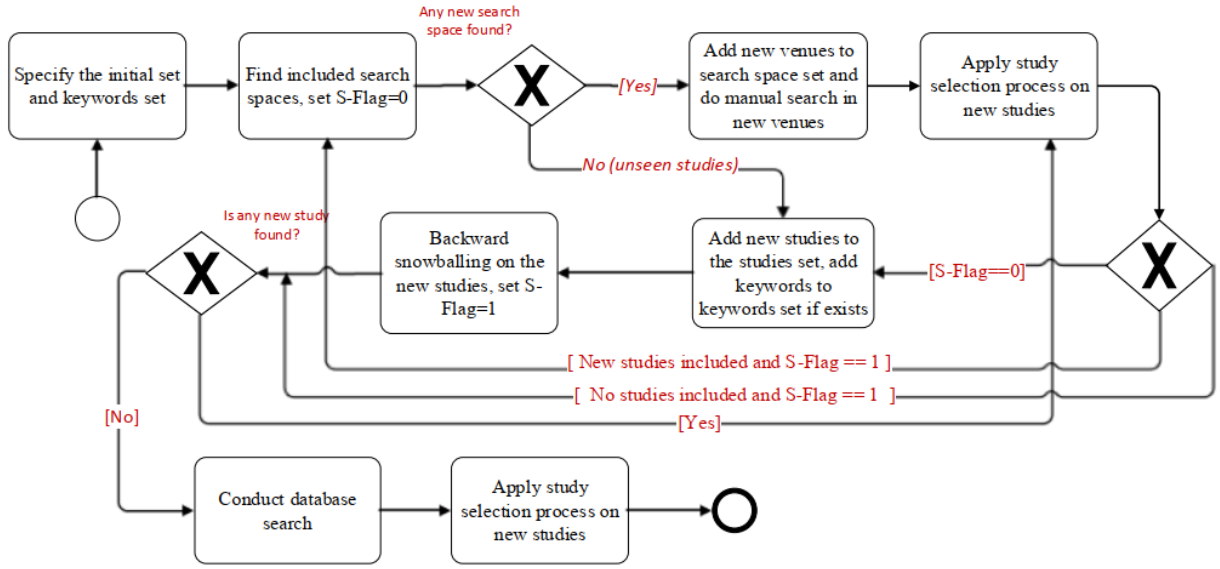

Fig. 2. The Search Strategy

Table 2. Initial Set (secondary studies) of Our SMS

#	Secondary Study Title	Type	Year	Ref.
1	A Comprehensive Survey on Fog Computing: State-of-the-Art and Research Challenges	Survey	2018	[7]
2	A Taxonomy for Management and Optimization of Multiple Resources in Edge Computing	Survey	2018	[8]
3	Mobile Edge Computing, Fog et al.: A Survey and Analysis of Security Threats and Challenges	Survey	2018	[9]
4	Survey on Fog Computing: Architecture, Key Technologies, Applications and Open Issues	Survey	2017	[10]
5	Moving from Vehicular Cloud Computing to Vehicular Fog Computing: Issues and Challenges	Survey	2017	[11]
6	On Multi-Access Edge Computing: A Survey of the Emerging 5G Network Edge Cloud Architecture and Orchestration	Survey	2017	[12]
7	Edge Cloud Computing Technologies for Internet of Things: A primer	Survey	2017	[13]
8	Fog Computing for Vehicular Ad Hoc Networks: Paradigms, Scenarios, and Issues	Survey	2016	[14]
9	A Systematic Literature Review of Fog Computing	Survey	2016	[15]
10	Edge Computing: Vision and Challenges	Survey	2016	[16]
11	Edge-centric Computing: Vision and Challenges	Survey	2015	[17]
12	An overview of Fog Computing and Its Security Issues	Survey	2015	[18]

1.2.2 Specifying the Search Space

Generally, the word search space refers to venues such as journals, conferences, and workshops. As shown in Fig. *1*, at the first step in conducting the search strategy, a set of initial search spaces are provided and placed in the secondary study database. Our SMS has been covered related papers in the period time of 2001 to 2019. When the search process begins, the search space set is empty. As mentioned before, the first step in search strategy is to examine the cited papers in the previously found secondary studies (listed in Table 2), which leads to adding some journals to the set of search spaces. The search space set will be gradually completed as the search process advances. The $SupFile_{W3,T4}$ shows a complete list of all included search spaces. Fig. 3, shows the process of extracting search spaces.

1.2.3 Specifying the Search Study String

Although we aim at finding studies having a contribution in the field of edge computing, utilizing the "Edge Computing" keyword by itself cannot lead to finding all relevant papers. Therefore, we firstly found a set of keywords, called search strings, which was completed as the process of searching carried out, by the three phases mentioned in section1.2. As mentioned earlier, we have generated some queries by some combination of defined keywords, which are listed in Table 3. These queries are utilized to search through databases of different publishers. The defined keywords can be seen in the $SupFile_{w3,T3}$.

Table 3. Constructed Queries for Finding Related Paper

ID	Search query
1	"edge computing" OR ("edge processing" AND cloud) OR ("mobile edge" AND (cloud OR computing))
2	fog AND (computing OR node OR cloud)
3	(offloading AND (edge OR "mobile cloud"))
4	((micro-data center OR micro-datacenter) AND (cloud OR edge)) OR microcloud OR micro-cloud OR cloudlet
5	"nomadic computing" OR "mist computing" OR "osmotic computing"

1.3 Planning of the Study Selection Process

According to the search strategy as mentioned earlier, papers are found by using manual search and backward snowballing methods. Although in the manual search method, we use the constructed queries to find papers in determined search spaces, there

might be some papers which only mentioned our keywords as a general concept, without really addressing our main focus. Moreover, in the backward snowballing stage, it is more probable that there exist irrelevant studies in the reference section of the related papers. Consequently, we need to define an inclusion/exclusion strategy for selecting papers by specifying some inclusion/exclusion criteria. Furthermore, some inclusion/exclusion criteria must be specified for selecting search spaces. In this subsection, we will discuss these issues.

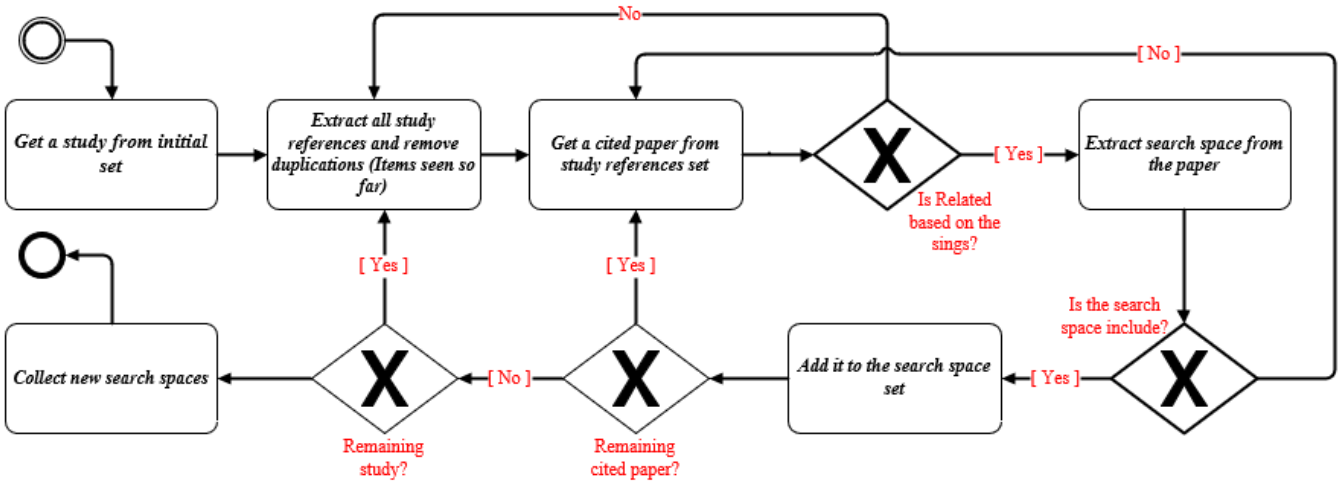

Fig. 3. The Process of Included Search Space Extraction [5]

1.3.1 Specifying the search space inclusion/exclusion criteria

To find more reliable answers for RQs, the analysis must be performed on the studies with appropriate quality. As goodness of the search spaces can affect the quality of the studies, the search spaces must be selected based on some inclusion/exclusion criteria. Our initial studies showed that the number of published studies in the field of edge computing is very large and it is very

difficult and even impossible to review all of them in one survey. For this reason, we only consider journals in our SMS process and discard any other type of search spaces such as conferences and workshops. Later, we will discuss this limitation and its conditions in section 2. Furthermore, we filter available journals based on some criteria, which are introduced in Table 4 below.

As shown in Table 4, each journal will be selected if its JCR is available, and also its defined aims and scopes are related to our focus in this SMS process. The thresholds used for the exclusion criteria are obtained empirically. It is notable that in specifying the JCR threshold, we consider two points: firstly, the number of include/exclude papers must not be hugely affected by a slight change in the threshold value; secondly, qualified papers must not be excluded by our defined threshold.

1.3.2 Specifying the study inclusion/exclusion criteria

To determine studies that are qualified enough to answer our RQs, we include/exclude the found studies in the search process based on some criteria, as shown in Table 5. As can be seen in this table, a found study will be excluded from the study set of our SMS process, if at least one of the conditions PEC1 to PEC5 is met.

Among the five criteria mentioned in Table 5, PEC1 is the only criterion, which is related to the content of studies. To increase the accuracy of selecting studies based on PEC1, we defined some signs based on extracted keywords. By using these signs, members of our team cloud include/exclude studies more accurately. Generally, we investigated title, abstract, and keywords of extracted papers to determine its inclusion/exclusion state. However, for some cases, the whole text of the paper has been studied. The complete list of included papers, excluded papers, secondary papers, and specified signs is available in $SupFile_{E2,T1}$, $SupFile_{E2,T3}$, $SupFile_{E2,T2}$, $SupFile_{w3,T1}$ respectively.

Table 4 Search Space Exclusion Criteria

Criterion	Description
JEC1	(JCR is not available)
JEC2	Aim and scope are not related
JEC3	Magazine

Table 5 Study Exclusion Criteria

Criterion	Description
PEC1	The study does not relate to edge computing 1-1)
PEC2	The contribution of paper does not relate to field of study (The study does not have any of the signs in table
PEC3	The study is not a journal paper, e.g., it is a magazine paper, conference paper, gray literature, conference cover, poster, etc.
PEC4	The study is not a primary study (e.g., survey)
PEC5	The paper cannot be accessed (e.g., not indexed) or belongs to an excluded journal

1.3.3 Specifying the Study Selection Process

To apply the criteria mentioned above, for select of studies, we must follow a predefined strategy. As papers are written in different ways, understanding their main contribution may require different levels of reading, including title, keywords, abstract, and full text. In this SMS we used a two-step strategy: 1) First we tried to include/exclude each paper by reading its title, abstract, and keywords part, 2) For papers which their contribution is not recognizable by applying step one, we reading the whole text. After applying this strategy for each paper, three states may occur: the relevant paper will be included, the irrelevant paper will be excluded, and when the relevance of the paper is not recognizable, it will be evaluated by another expert. Fig. 4 describes the strategy used to select studies.

1.4 Specifying the Search and Study Selection Evaluation Strategy

To ensure the trustworthiness of SMS results, an evaluation strategy needs to be defined. However, it is difficult to determine the exact set of related studies. To do this, a test-set is commonly constructed, which is a collection of known papers expected to be found during the SMS process [19]. For constructing this test-set, we apply the quasi-gold standard (QGS) metric introduced by [20]. It refers to a set of studies published in well-known research communities. For this aim, two members are assigned to perform the evaluation phase. At first, the test-set is empty. Specified members identify several pioneer researches in the field of edge computing by searching in Google Scholar. Then, the home pages of pioneers are examined to find the related papers and these papers are added to the test-set. After constructing the test set, the inclusion/exclusion criteria applied to them.

In order to assess the completeness of the found studies, we have used the quasi-sensitivity formula, as shown in Eq. 1 [20, 21]. Then the result is compared with a predefined threshold. If the number resulted from the formula is less than the threshold, it is expected to redo the whole SMS process to obtain more complete results. Since an acceptable threshold is known to be in the range of 70%-80% percent [20], our acquired 90.34 % shows that the result of our SMS process has enough accuracy.

$$Sensivity = \frac{\#\ of\ found\ included\ studies}{\#\ of\ total\ included\ studies} \times 100 \quad (1)$$

1.5 Planning of the Data Extraction and Classification Process

Having the set of included papers, we should specify some required information to be extracted from included studies to answer RQs mentioned in section 1.1. Table 6 illustrates that which information is useful for answering which RQs. Notably, the "Topic" word in Table 6 is obtained from the "Keywords" field using a keyword clustering and expert knowledge described in section 3.1.4.

2 EVALUATING THE MAPPING STUDY

This step is responsible for checking the output of the previous phase and transiting the SMS process to the next phase if the output has an acceptable quality. However, if the evaluation quality was not acceptable, revising the planning phase is required before moving to the next phase. To evaluate the mapping study, we have utilized the evaluation metrics described in [22]. Based

on the information provided in the work of [2], we conclude that our mapping study phase has the acceptable quality, and it is reasonable to move toward the next phase (conducting the mapping study).. $SupFile_{E7,T1-T3}$ shows the necessary information and details.

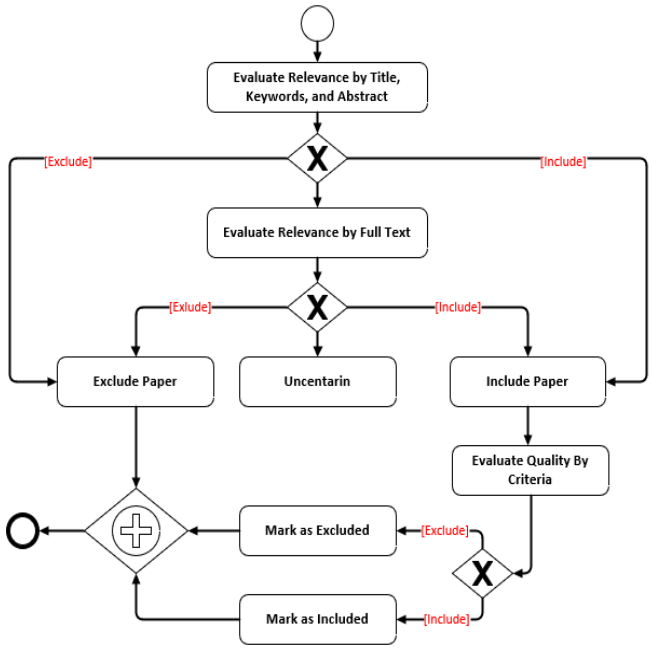

Fig. 4. The Study Selection Strategy [6]

Table 6. Extracted items needed for answering RQs

RQ#	Items
1	Author name, author affiliation, country
2	Search space, Paper Title/abstract Paper context, Keyword, Topics, Publication year
3	Topics, Author Keywords
4	Topics, Paper context
5	Topics, Paper context
6	Topics, Paper context
7	Paper context
8	Topics, Paper context
9	Topics, Paper context

3 CONDUCTING THE MAPPING STUDY

Until now, sections 1 and **Error! Reference source not found.**2 describe the strategies used in this SMS. In the following sections, the results of the implementation of these strategies will be stated.

3.1.1 Conducting the process of search space and study selection

This section provides complete details of the search and study selection process. These details include completing keywords during the search process, finding search spaces set, and conducting a set of studies to provide relevant papers.

Based on the phases described in Section1.2.2, the initial keyword set is used in Phase 1 (see $SupFile_{w3,T3}$). Next, the extracted keywords of each phase are used in the next phase. For example, the keywords extracted from the initial set and included studies of phase 1 are used in phase 2.

The complete information about the search spaces obtained during the search process, along with the exclusion reason for each of excluded search space, is reported in $SupFile_{w3,T4}$. Furthermore, in $SupFile_{W3,T5}$, the aim and scope of each found search space are listed. We also provided some signs in the field of edge computing that are given in $SupFile_{W3,T1}$ and can be used as an indication to include/exclude a study and search space easily. For example, from the studies numbered 1, 4, and 5 in Table 2, several search spaces are obtained, which some of them are shown in Table 7. The quality of each search space is evaluated

based on the exclusion criteria defined in Table 4, and its inclusion/exclusion status is shown in the last column of the same table. For example, in Table 7, the journal with the JID = 92 is excluded because no information about Q and IF has been found for it. Also, the journal with the JID = 20 is not related to the field of edge computing, and so it is excluded. The information is described in $SupFile_{w3,T4}$.

Table 8, shows the final statistics of search spaces set, 805 distinct search spaces are found during the search process of which 112 of them are included and added to the search spaces set. More information on included/excluded search spaces in each phase is provided in Table 8 . In this table, for example, NI1 and NE1 show the number of included and excluded search spaces in phase 1, respectively.

The included and excluded studies set are reported in $SupFile_{E2,T1}$ and $SupFile_{E2,T3}$ respectively. Moreover, the statistical information about studies in each search space is provided in $SupFile_{W3,T11}$. Table 9 shows a sample of these studies from the search spaces presented in Table 7. In this table, for instance, the contribution of the second study is not in the field of edge computing, so it is excluded. After adding the included studies, if there are new keywords, the existing keywords set is updated by adding these new keywords.

The final statistics of the studies in Table 10 reveals that out of 8725 papers have been identified during the search process, 1440 studies are included and added to the final studies set. In this table, for example, NI1 and NE1 show the number of search spaces for included and excluded studies in phase 1, respectively.

3.1.2 Evaluating the Search and Study Selection Process

The validity of our SMS has been verified by conducting a validation, as previously described in section 1.4. During this phase, the home page of some pioneer researchers in the field of edge computing was explored to find unseen studies. The list of unseen studies during conduction search phases presented in $SupFile_{E7,T1}$. According to the information in this table, there are 12 studies that were not found during the search process.

3.1.3 Data Extraction

After completing and identifying the included studies, the process of reading and extracting information from them began. Information related to this process is provided in $SupFile_{E5,T5}$. During this process, the study and extraction of information were done by five team members, and then this information was reviewed by three other members.

3.1.4 Analysis and Classification of data

As mentioned earlier, the primary goal of this SMS is to answer the previously identified RQs, described in Table 1, and identify the main topics and sub-topics in the field of edge computing. For this purpose, the data which have been extracted and organized in the previous steps should be analyzed at this stage.

So far, several techniques have been proposed to identify the scopes of one research field based on keywords. Two well-known methods are statistical similarity factor [23, 24] and the use of co-occurrences matrix [25, 26]. The disadvantage of the first method is that it considers only a small part of the text (such as a paragraph) to identify topics and sub-topics, which is not accurate. Besides, usually, the similarity-based keywords clustering techniques cannot classify well [27]. In the second method, the keywords are placed in several clusters using the co-occurrence matrix, and the topics and sub-topics related to a similar cognitive orientation are determined between them. However, the co-occurrence matrix method is only appropriate when both the study domain and the number of keywords are small. Due to the breadth of this field and scatter of keywords, the use of this method was not useful. Therefore, in this research, the topics and sub-topics have been determined based on the knowledge of experts. In the following, our method is described in detail.

We tried to build a research tree for the field of edge computing according to reviewed studies. The research tree contains topics and sub-topics in the desired field and on several levels. The first level of the tree is the most important level for responding to the RQs.Due to the high dispersion of keywords, an accurate method for finding and analyzing keywords is necessary. The following steps describe the construction process of the first level of the research tree:

Step1 – In this step, the keywords of all included studies are extracted. If keywords were not specified by the author(s), an expert member of the team, defined them. More information is provided in $SupFile_{E3,T1}$.

Step 2 – After extracting or defining keywords for all studies, we try to categorize them. For this purpose, keywords which have similar meanings (such as resource allocation, allocation of computing resources, and resource management) are allocated to the same category. We have used an incremental approach to categorize the keywords. At first there is no category. An expert examines

keywords one by one and decides to which category they should added. Each new keyword can be added to an existing category, or a newly created category according to its concept. As a result of doing this step, 1560 categories are created.

Step 3 – In this step, an initial view of existing topics in the field of edge computing is determined by an expert, using existing topics in other review papers. Then, the categories of the previous step are mapped to corresponding topics. (see $SupFile_{E3,T3}$). The final topics are reviewed by other experts of the team, which may also lead to addition of a new topics. This step led to creation of the first level of the research tree.

Step 5- After specifying the main topics in the field of edge computing, which are located at the first level of the research tree, the expert can extend each topic by defining its sub-topic. To do this, he/she should examine the existing keywords in each topic, and try to categorized them according to his/her experience. Besides, obtained thematic similarities are also used to determine tree topics. Table 11 shows a list of these thematic similarities.Table 7. Sample Extracted Journal Search Space and Results of Search Selection Process

JID	Journal Name	Topic	IF (JCR-2017)	Q (JCR-2017)	Publisher	ROE	Type
3	Future Generation Computer Systems	• Computer Science Theory and Methods	4.639	Q1	Elsevier	-	JCR
11	IEEE Access	• Engineering Electrical and Electronic	3.557	Q1	IEEE	11	JCR
13	Journal of Internet Services & Applications	• Computer Science • Computer Networks and Communications • Computer Science Applications	0.401	Q2	Springer	JEC1	SJR
20	IEEE Systems Journal	• Engineering Electrical and Electronic • Computer Science Information Systems • Telecommunications • Operations Research and Management Science	4.337	Q1	IEEE	JEC2	JCR
69	Journal of Parallel & Distributed Computing	• Computer Science Theory and Methods	1.815	Q2	Elsevier Inc.	-	JCR
92	ACM Sigmobile Mobile Computing & Communications Review	-	N/A	N/A	ACM	JEC1	JCR

Table 8. Search Space Set Statistics

No.	Search Spaces	NI_1	NE_1	NI_2	NE_2	NI_3	NE_3	NI_4	NE_4	NI_5	NE_5	Total
1	Journals	59	110	48	486	4	54	1	43	0	0	805
2	Conferences	-	-	-	-	-	-					-
3	Workshops	-	-	-	-	-	-					-
4	Total	59	110	48	486	4	54	1	43	0	0	805

Table 9. Sample Studies from Included Search Space of Table 8 and Results of Study Selection Process

Paper Title	Journal Name	Year	Exclusion Criteria
A fog computing-based concept drift adaptive process mining framework for mobile APPs	Future Generation Computer Systems	2018	-
A multimedia healthcare data sharing approach through cloud-based body area network	Future Generation Computer Systems	2017	PEC1
Augmenting computing capabilities at the edge by jointly exploiting mobile devices: A survey	Future Generation Computer Systems	2018	PEC3

Table 10. Study Set Statistics

No.	Search Spaces	NI_1	NE_1	NI_2	NE_2	NI_3	NE_3	NI4	NE4	NI5	NE5	Total
1	Journals	599	1770	158	3669	13	1084	0	43	671	718	8725
2	Conferences	-	-	-	-	-					-	-
3	Workshops	-	-	-	-	-					-	-
4	Total	599	1770	158	3669	13	1084	0	43	671	718	8725

Table 11. Sample of Thematic Similarities between keywords

Topic	Thematic similarities	Sub Topic
Computation Offloading	Offloading/Outsourcing/ Cooperative task computing/ Task outsourcing/Verifiable outsource	Computation Migration
	Mobility/ Follow me edge/ Distributed mobility management/ E-mobility/ Seamless application execution/handover/Service handoff	Mobility-Management
	Decision making/ Collaborative decision-making/ Computing mode selection	Decision-Making
	Partitioning/ Computation partitioning/Data segmentation strategy/ Dynamic partitioning of computation	Partitioning

During the search process (including planning phase or conducting phase), various factors may affect the validity of SMS. Therefore, one of the crucial rubrics mentioned in Section 2. is the discussion of threats to validity. The primary purpose of the validation process is to provide evidence to respond to all the threats that the systematic review process may face. Some of these salient evidences are discussed below:

Having a set of qualified studies: We tried to take advantage of two popular search methods, including SLR and SMS, to design a comprehensive process and thus obtain a set of related studies. We have also evaluated our search process. Therefore, we believe that our review is reliable.

Having the most related studies: A key point in this regard is to apply an evolutionary process for completing the keywords set during the search process. It is worth mentioning that in edge computing, some keywords alone did not have a specific meaning. So, we integrated all these words using logical operators (AND, OR). Also, in manual snowballing, unseen studies were extracted and reviewed, which is an improvement over our previous works.

Reviewer's biases or misunderstandings during the process of study selection: To address this challenge, two researchers have independently conducted the study selection process. Any possible disagreement on their part has been resolved by the third researcher or by using the decision rules (see Section 1.3.3).

Having a complete set of search spaces: At the end of the search process, some high-quality studies may not be found from the search spaces. To avoid this problem, a process was considered to evaluate the search process and its results. Besides, during the evaluation process, some members of the group created a test-set to eliminate any effect of individual orientation.

Creating some forms to extract raw-data: Some papers may not have the author's keyword during the data extraction process. Due to the importance of this information in analysis and classification, several keywords for each of these papers have been extracted using the full-text of papers and stored in the relevant forms.

Selecting an appropriate name for each level-one topic: After the keyword clustering step using the knowledge of the expert, a proper name was selected for each cluster. Likewise, due to the wide range of topics in the field of edge computing, there is much scattering in keywords. For example, in the "Resource Management" topic, there are some keywords such as "Resource Management", "VM migration", "Service provisioning", and "Task allocation". We chose the name "Resource Management" for this topic, because it shows the conceptual similarity between these words at a higher level. To eliminate the effect of individual orientation in the choice of topic names, the proposed names for topics were discussed and agreed upon by team members in joint meeting.

Lack of coverage of conferences and workshops: Although among the studies published in conferences and workshops, there are studies related to the field of edge computing with appropriate quality; due to the large volume of studies in this field, we had to limit our review to studies published in journals. On the one hand, to the best of our knowledge, it doesn't affect the entire process. Because as stated in [2], mapping studies often limit the scope of their searches in various ways such as only selecting journal papers, or only searching a specific set of sources, or only searching papers published in specific years. As a result, this means that a mapping study can be auditable, but not necessarily completed. This functionality allows other researchers to expand and complete this SMS. On the other hand, the primary responsibility of an SMS is to identify the main research topics and sub-topics [3]. To this end, as mentioned earlier, other secondary studies (e.g., surveys) were used to obtain topics and sub-topics in the research tree. These secondary studeis cover related papers from other search spaces (conference and workshop). Consequently, we hope that the coverage of topics and sub-topics has reached the desired level. To improve this review, in the future, one can have an independent review of studies published in conferences and workshops.

Refrences:

[1] B. A. Kitchenham, D. Budgen, and O. P. Brereton, "Using mapping studies as the basis for further research–a participant-observer case study," *Information and Software Technology,* vol. 53, no. 6, pp. 638-651, 2011.

[2] K. Petersen, S. Vakkalanka, and L. Kuzniarz, "Guidelines for conducting systematic mapping studies in software engineering: An update," *Information and Software Technology,* vol. 64, pp. 1-18, 2015.

[3] B. Kitchenham *et al.*, "Systematic literature reviews in software engineering–a tertiary study," *Information and software technology,* vol. 52, no. 8, pp. 792-805, 2010.

[4] C. Zhang and D. Budgen, "What do we know about the effectiveness of software design patterns?," *IEEE Transactions on Software Engineering,* vol. 38, no. 5, pp. 1213-1231, 2011.

[5] B. B. Mayvan, A. Rasoolzadegan, and Z. G. Yazdi, "The state of the art on design patterns: A systematic mapping of the literature," *Journal of Systems and Software,* vol. 125, pp. 93-118, 2017.

[6] A. J. Jafari and A. Rasoolzadegan, "Security patterns: A systematic mapping study," *Journal of Computer Languages,* vol. 56, p. 100938, 2020.

[7] C. Mouradian, D. Naboulsi, S. Yangui, R. H. Glitho, M. J. Morrow, and P. A. Polakos, "A comprehensive survey on fog computing: State-of-the-art and research challenges," *IEEE Communications Surveys & Tutorials,* vol. 20, no. 1, pp. 416-464, 2017.

[8] K. Toczé and S. Nadjm-Tehrani, "A taxonomy for management and optimization of multiple resources in edge computing," *Wireless Communications and Mobile Computing,* vol. 2018, 2018.

[9] R. Roman, J. Lopez, and M. Mambo, "Mobile edge computing, fog et al.: A survey and analysis of security threats and challenges," *Future Generation Computer Systems,* vol. 78, pp. 680-698, 2018.

[10] P. Hu, S. Dhelim, H. Ning, and T. Qiu, "Survey on fog computing: architecture, key technologies, applications and open issues," *Journal of network and computer applications,* vol. 98, pp. 27-42, 2017.

[11] V. G. Menon and P. J. Prathap, "Moving from vehicular cloud computing to vehicular fog computing: Issues and challenges," *International Journal on Computer Science and Engineering,* vol. 9, no. 2, pp. 14-18, 2017.

[12] T. Taleb, K. Samdanis, B. Mada, H. Flinck, S. Dutta, and D. Sabella, "On multi-access edge computing: A survey of the emerging 5G network edge cloud architecture and orchestration," *IEEE Communications Surveys & Tutorials,* vol. 19, no. 3, pp. 1657-1681, 2017.

[13] Y. Ai, M. Peng, and K. Zhang, "Edge computing technologies for Internet of Things: a primer," *Digital Communications and Networks,* vol. 4, no. 2, pp. 77-86, 2018.

[14] K. Kai, W. Cong, and L. Tao, "Fog computing for vehicular ad-hoc networks: paradigms, scenarios, and issues," *the journal of China Universities of Posts and Telecommunications,* vol. 23, no. 2, pp. 56-96, 2016.

[15] A. T. Thien and R. Colomo-Palacios, "A systematic literature review of fog computing," *NOKOBIT 2016, Bergen, 28–30 Nov. NOKOBIT, Bibsys Open Joumal Systems,* vol. 24, no. 1, 2016.

[16] W. Shi, J. Cao, Q. Zhang, Y. Li, and L. Xu, "Edge computing: Vision and challenges," *IEEE internet of things journal,* vol. 3, no. 5, pp. 637-646, 2016.

[17] P. Garcia Lopez *et al.*, "Edge-centric computing: Vision and challenges," ed: ACM New York, NY, USA, 2015.

[18] I. Stojmenovic, S. Wen, X. Huang, and H. Luan, "An overview of fog computing and its security issues," *Concurrency and Computation: Practice and Experience,* vol. 28, no. 10, pp. 2991-3005, 2016.

[19] "Chinese consumers at the forefront of digital technologies," Deloitte releases China Mobile Consumer2018.

[20] B. Varghese and R. Buyya, "Next generation cloud computing: New trends and research directions," *Future Generation Computer Systems,* vol. 79, pp. 849-861, 2018.

[21] D. G. Altman and J. M. Bland, "Diagnostic tests. 1: Sensitivity and specificity," *BMJ: British Medical Journal,* vol. 308, no. 6943, p. 1552, 1994.

[22] C.-H. Hong and B. Varghese, "Resource management in fog/edge computing: a survey on architectures, infrastructure, and algorithms," *ACM Computing Surveys (CSUR),* vol. 52, no. 5, pp. 1-37, 2019.

[23] H. Li and K. Yamanishi, "Topic analysis using a finite mixture model," *Information processing & management,* vol. 39, no. 4, pp. 521-541, 2003.

[24] H. Li and K. Yamanishi, "Text classification using ESC-based stochastic decision lists," *Information processing & management,* vol. 38, no. 3, pp. 343-361, 2002.

[25] T. Hofmann, "Unsupervised learning by probabilistic latent semantic analysis," *Machine learning,* vol. 42, no. 1-2, pp. 177-196, 2001.

[26] C. Kotropoulos and A. Papaioannou, "A novel updating scheme for probabilistic latent semantic indexing," in *Hellenic Conference on Artificial Intelligence*, 2006, pp. 137-147: Springer.

[27] T. Verbelen, P. Simoens, F. De Turck, and B. Dhoedt, "Cloudlets: Bringing the cloud to the mobile user," in *Proceedings of the third ACM workshop on Mobile cloud computing and services*, 2012, pp. 29-36.

[28] H. Zhang, M. A. Babar, and P. Tell, "Identifying relevant studies in software engineering," *Information and Software Technology,* vol. 53, no. 6, pp. 625-637, 2011.