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A Protocol Based on Systematic Mapping Studies for Searching Health Applications in Non-Academic Repositories

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Abstract Systematic mapping studies (SMSs) help obtain an overview of a research topic. SMSs are conducted with protocols that ensure their reliability and allow their replication by other researchers. The focus of an SMS is to identify peer-reviewed articles indexed in academic databases. Therefore, conducting an SMS does not encompass identifying software applications hosted in non-academic repositories. This article presents a protocol for systematic mappings in non-academic repositories (SMNARs). The SMNAR protocol was developed from adaptations of an SMS methodology consolidated in the literature and was aimed at assisting in the search, cataloging, and analysis of health software applications hosted in non-academic application and source code repositories. Thus, part of the adaptations was based on health application search approaches found in the literature. Two SMNAR user guides were developed, one designed for healthcare professionals and the other for software developers. To assess the feasibility of these guides, a study was conducted with participants from the healthcare and computer science fields. This study had both synchronous and asynchronous moments. In the former, a presentation contextualized the SMNAR protocol, proposed guides, and study procedures. In the latter, the participants partially planned and conducted an SMNAR using the proposed guides as support. Online forms were applied to obtain participants' perceived ease of use, perceived usefulness, and intention to use the proposed guides. The participants indicated good acceptance of the guides and suggested possible improvements in the protocol description. These results contributed to refining the SMNAR user guides.

Keywords: Systematic Mapping Study, Health Applications, Application Repositories, Source Code Repositories

1 Introduction

The investigation of the state-of-the-art of a research topic is a step for the theoretical foundation of a study. This often helps the researcher contextualize and generate hypotheses regarding a proposed approach (Mafra and Travassos, 2006). This search for correlated results in the literature can occur by conducting secondary studies. According to Kitchenham and Charters (2007), secondary studies aim to identify, evaluate, and interpret research that is relevant to a given area of interest. Therefore, their aim is to identify primary studies, which characterize technologies used in specific contexts through experiments and case studies (Mafra and Travassos, 2006; Azevedo and Sousa-Pinto, 2019).

Systematic mapping studies (SMSs) and systematic literature reviews (SLRs) are examples of secondary studies[1]. SMSs and SLRs differ by their scope (Dermeval *et al*., 2019). SMSs are more comprehensive; they can be associated with breadth-first search and conducted to obtain an overview of a given topic, helping to identify research gaps (Petersen *et al*., 2015). In contrast, SLRs are more specific; they are associated with depth-first search for a topic that is already known (Kitchenham and Charters, 2007). This way, SLRs can be conducted from the results of an SMS.

Despite these differences, the planning and conduction of SMSs and SLRs are similar: both follow a methodology formalized in protocols that contain the procedures for carrying them out. Therefore, these studies are replicable and improve the reliability of results when compared to informal reviews Mafra and Travassos (2006). The contribution of secondary studies also lies in the possibility of incorporating reliability, rigor, auditing, and impartiality aspects to the research Kitchenham and Charters (2007).

The main focus of secondary studies is to identify peer-reviewed articles in journals and events—such as congresses and symposia—that are indexed in academic databases. Productions known as grey literature (GL) are commonly disregarded in these studies for not being controlled by scientific and commercial publishers (Mahood *et al*., 2014; Bonato, 2022). However, GL can complement results obtained in secondary studies, contributing to the identification of practical and up-to-date evidence (Kamei *et al*., 2020). Thus, the inclusion of GL in secondary studies has been highlighted, even with the support of specific methodologies for this purpose (Garousi *et al*., 2019).

It is also important to note that secondary studies and GL respectively use digital libraries and regular search engines as their databases. Therefore, none of them encompass non-academic repositories such as application and source code repositories, which host and give free access to application source codes as well as their executable formats. This

[1] The scoping review (SR) is another example of a secondary study commonly used in health to synthesise knowledge. SR is conducted through a systematic evidence-mapping approach to identify the main concepts, theories, sources, and understanding of a topic of interest (Tricco *et al*., 2018). However, RE differs from an SLR because it addresses broader topics and research questions (Arksey and O'Malley, 2005).

way, non-academic repositories can provide data management with security features and offer plugins for their use (Costa *et al*., 2021), enabling the practical benefits expected from the use of open source code[2].

Using open source code in the healthcare field fosters collaboration between software developers and users, contributing to increase the visibility of public policies, actions, and use of resources (Brasil, 2008). This way, the practical application of open source code can expand social participation and access to information (Brasil, 2008). Furthermore, open source development results in superior healthcare software solutions—especially in terms of security, usability, and reliability—and can also contribute to cheaper modernization, integration, and maintenance of these solutions (Reynolds and Wyatt, 2011).

Given this gap, the present article proposes a protocol for systematic mappings in non-academic repositories (SMNARs) and aims to evaluate the feasibility of two SMNAR protocol user guides. The remainder of this article is structured as follows: Section 2 presents the background of the study. Section 3 presents related works. Section 4 presents the adaptations made to the protocol and the SMNAR user guides. Section 5 presents the feasibility study. Sections 6 and 7 present the quantitative and qualitative results, respectively. Section 8 discusses the results. Section 9 describes the second version of the SMNAR user guides. Section 10 reports on threats to the validity of the study. Finally, in Section 11, the final considerations and suggestions for further research are presented.

2 Background

The SMS protocol proposed by Kitchenham and Charters (2007) is divided into three phases: (1) Planning, (2) Conducting, and (3) Reporting. These phases, in turn, are divided into activities Figure 1.

Phase (1), *Planning*, begins with activity (1.a), *defining the objective*, which should describe the purpose of conducting the SMS. Paradigms such as the "Goal/Question/Metric" (GQM) (Basili and Rombach, 1988) can help in this definition. Subsequently, activity (1.b) consists in *defining the research questions* (RQs), which should determine what will be answered by the end of the SMS. In this activity, one main RQ and specific sub-questions (SQs) about the research topic are formulated. This phase ends with activity (1.c), *defining the search strategy*, which involves choosing the keywords and digital libraries for the searches. Methodologies such as "Population, Intervention, Comparison, Outcome, Context" (PICOC) (Kitchenham and Charters, 2007) can be used to help define the keywords. Once those are defined, the keywords and their variations (plural forms, terms in other languages, and synonyms) are grouped into search expressions by Boolean operators (AND and OR). Before searches are performed, the expressions must be adapted to the standard established in each digital library chosen.

[2]Open source code is made available with licenses assigned by the code's developer that establish the degree of freedom for possible adaptations, sharing, and commercial use of these adaptations by other developers (Laurent, 2004).

Phase (2), *Conducting*, begins with activity (2.a), *defining the study selection criteria*. First, inclusion criteria (IC) and exclusion criteria (EC) are defined. IC are applied to select the primary studies that provide direct evidence on the RQs, whereas EC are applied to exclude articles that do not meet aspects established in the protocol (e.g., articles written in other languages, not available in full, published outside the considered period, duplicates, and grey literature). After these definitions, library search is performed, resulting in the initial sample of articles. Filters provided by the libraries should be recorded in the protocol if they are considered during the searches.

The study selection process in activity (2.a) occurs in two stages. In the preliminary selection stage (1st filter), after applying the defined criteria and reading the title, abstract, and keywords of each article in the initial sample, the articles that fit the research scope are selected. In the final selection stage (2nd filter), the articles selected in the 1st filter are read in full using the same selection criteria, resulting in the preliminary final sample of articles. This preliminary sample can be supplemented with the optional snowballing procedure (Wohlin, 2014), which involves searching the references or citations of the selected articles. This procedure aims to identify articles that are potentially eligible for the study and were not returned in the digital library search.

Additionally, one can also perform activity (2.b), *study quality assessment*, which consists in an optional quality check of the articles in the preliminary final sample. This activity aims to determine the rigor of the study selection and the relevance of the identified primary studies. Items such as descriptive validity, theoretical validity, generalizability, and interpretive validity (Petersen *et al*., 2015) can be analyzed. Articles that do not meet any defined item are excluded, resulting in the final sample of articles.

Next, activity (2.c), *data extraction*, aims to obtain general information about the articles in the final sample (e.g., title, authors, country, and year of publication) as well as necessary information to address the SQs. In this activity, an extraction form is designed so that data listing is performed in the same way for all articles. Then, in activity (2.d), *data analysis*, the results are presented in tables and graphs and considerations about the SQs and the main RQ are made.

Phase (3), *Reporting*, involves writing up and disseminating the SMS protocol and results and should provide conditions for their repeatability and replication.

3 Related Works

This section presents some works related to this study.

3.1 Searching for Grey Literature

The inclusion of GL in SMSs in software engineering has only recently been formalized. Garousi *et al*. (2019) developed a protocol for GL search called multivocal literature reviews (MLR) based on an SMS methodology which considers regular search engines as databases. In this protocol, the identified GL is classified into three levels according to

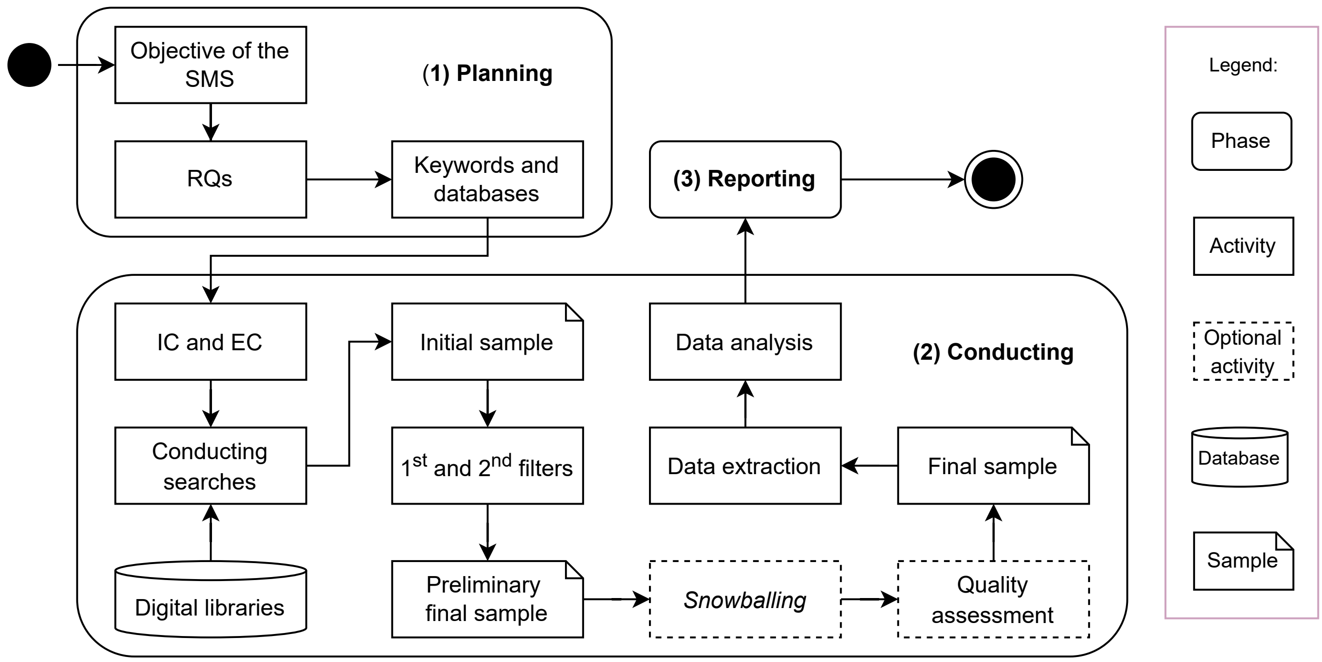

Figure 1. Overview of Petersen *et al.*'s (2015) SMS protocol.

criteria about output control and credibility. The protocol includes checklists to verify the need for these searches in a study, to indicate when to end the searches, and to evaluate the quality of the GL found. The present study also adapted an SMS protocol but considered the application and source code repositories as the databases and the software solutions in those repositories as GL.

3.2 Searching for Health Applications

Works with different approaches for searching health applications in repositories are found in the literature. Formagini *et al*. (2017) conducted searches in the App Store and Google Play Store (GPS) repositories to identify smoking treatment support apps. The authors selected 14 applications after searching in these repositories, applying IC and EC, and categorizing and analyzing the applications' functionality.

Brown *et al*. (2020) conducted a search for pregnancy and nutrition information apps for pregnant women on GPS. 76 free English-language apps were deemed eligible for the study. A quality scale was assigned to the apps with an analysis of the Mobile Application Rating Scale (MARS) tool (Stoyanov *et al*., 2015).

Marcelo *et al*. (2020) performed searches on GPS to identify and categorize apps about diabetes mellitus. The searches identified 222 applications, of which information such as description, functionality, number of downloads, version, and developer were cataloged, as well as an overview of user comments in the repository.

Silveira *et al*. (2020) searched for applications about hypertension on GPS. The initial search resulted in the identification of 364 applications. Paid applications and the ones that did not fit the topic were excluded, resulting in 267 in the final sample. The applications were categorized according to their functionality.

Partially using Kitchenham and Charters's (2007) SMS protocol, Querino *et al*. (2020) searched for apps about anxiety and depression on GPS and App Store. Two keywords were defined for the searches, which resulted in the identification of 274 applications. The final sample was composed of 57 free Portuguese-language applications that had been recently updated. The analyses were conducted with the applications in use.

Scotini *et al*. (2021) searched for applications used to support the learning of children with autism spectrum disorders, using the keyword "autism" in the App Store and GPS repositories. The first 100 applications resulting from the searches were pre-selected. After this pre-selection, only Brazilian applications that had at least one free functionality were considered for analysis. 18 applications met the criteria and were categorized and subjected to an accessibility evaluation.

Of these works, only Querino *et al*. (2020) cite the use of an SMS protocol, but with a partial adaptation and without the snowballing and quality assessment steps. The present study differs from these ones in that it considers all the steps involved in an SMS for searches in repositories.

3.3 Search for Applications and Secondary Studies

Searches in repositories are also performed as a complement to secondary studies. Souza and Silva (2016) conducted searches on GPS as well as in SciELO and MedLine digital libraries to identify apps that contribute to the elderly daily activities. The keywords used in the libraries were also used individually in six searches in the repository, resulting in the identification of 1244 applications. The final sample consisted of 46 applications.

Morais *et al*. (2020) conducted searches in GPS and IBECS, LILACS, Science Direct, SciELO, PubMed, Scopus, MedLine, and Google Academic libraries to identify applications on children's oral hygiene education. The library searches resulted in the selection of 12 articles and the repository searches resulted in 284 applications. The protocol employed in the libraries does not indicate the changes made to it for the repository search.

Trecca *et al*. (2021) searched for ENT applications in the GPS and App Store repositories and in the PubMed library. The same keywords were used in these searches, and the term "mobile application" was added to the library searches. The final sample consisted of 1074 English-language applications identified in the repositories. Applications that did not fit the scope, were duplicates or educational, promoted a business, and required specific separate hardware were excluded. The quality scale of the applications was assigned with the MARS tool. Library searches returned 636 publications, of which 193 were included in the study.

These works highlight that searches for applications in repositories associated with secondary studies can generate more comprehensive results. This fact can be indicated as one of the motivations for the present study, whose proposal can also be used as a complement to secondary studies.

4 The SMNAR Protocol

The proposed SMNAR protocol was based on Petersen et al.'s (2015) SMS guidelines. Similar to the protocol used as a basis, our SMNAR protocol is structured in the three aforementioned phases and their respective activities. Some activities remained the same as in the SMS protocol while others were adapted for the context of the repositories. Some adaptations drew on our own previous experiences using application and source code repositories and were based on health applications search approaches identified in related works (Section 3). Since the SMNAR protocol focuses on identifying health applications, the adaptations made in the protocol are aimed at its use by healthcare professionals and software developers. Figure 2 presents an overview of the SMNAR protocol and highlights the adapted activities, namely, activities (1.c), (2.a), (2.b), and (2.c). The other activities as well as phase (3), Reporting, remained unchanged and should be conducted as described in Section 2.

In activity **(1.c)**, ***defining the search strategy***, the repositories for the searches are chosen. For the healthcare professional profile, Google Play Store[3], the official repository for Android, is suggested since Android is the most widely used operating system for mobile devices nowadays (Garg and Baliyan, 2021). Among other repository options for this profile App Store[4] for iOS devices and F-Droid[5] for Android devices are highlighted.

For the software developer profile, Github[6] is suggested, which is currently the largest repository for source code management, hosting, and versioning (Ye *et al*., 2021). Other options of source code management and hosting repositories for this profile are SourceForge[7], Gitlab[8], Google Code[9], and Bitbucket[10].

In activity **(2.a)**, ***defining the study selection criteria***, the search for applications is performed. The suggested repositories usually do not allow the use of search expressions; therefore, an individual search must be performed for each defined keyword to obtain the initial sample of applications. This strategy is used by Souza and Silva (2016), Formagini *et al*. (2017), Marcelo *et al*. (2020), Silveira *et al*. (2020), Morais *et al*. (2020), Querino *et al*. (2020), and Trecca *et al*. (2021). The technical specifications of the device used for the searches (desktop or mobile) should be cataloged, as variations can influence the analysis of the applications. To select the preliminary final sample of applications, the use of IC and EC is proposed in two selection filters: in the 1st filter, information about the application provided in the repository is analyzed; in the 2nd filter, the source code or the application in use is analyzed after it is installed on the device. This selection process is used by Querino *et al*. (2020). Inclusion criteria may consider, for example, the application of meta-analyses (Rosenthal and DiMatteo, 2001; Field and Gillett, 2010). Optionally, snowballing can consider the applications indicated as related to those that make up the preliminary final sample when such function is available in the repositories.

Considering the healthcare context, the use of quality assessment guides (Kiatake *et al*., 2020; Lima *et al*., 2020) or frameworks with parameters for evaluating health applications (Stoyanov *et al*., 2015; Henson *et al*., 2019) is suggested to define the quality items in activity **(2.b)**, ***study quality assessment***. This evaluation strategy is used by Brown *et al*. (2020). Applications that do not meet any defined item are excluded from the sample. In activity **(2.c)**, ***data extraction***, information about the applications in the final sample is cataloged with a data extraction form adapted for the chosen repositories. Data extraction can consider in-development or running applications and also be conducted directly from the application, source code, software documentation, or other repository artifacts available in the repositories, such as revisions and version control messages.

4.1 The SMNAR User Guides

After all adaptations, two guides[11] were developed for planning and conducting an SMNAR. These guides were designed for the two user profiles defined in the protocol. The guides initially indicated the user profile and suggested repositories for searching applications. Then, the guides presented the phases and activities of the SMNAR in a structured way, with short instructions about the procedures for each activity. Tables were proposed for each activity to help catalog the protocol and the results obtained. Regarding the guide for the healthcare professional profile, some adaptations were made to the suggestions and the information about the repositories as well as to the instructions for analyzing the identified applications.

[3] https://play.google.com
[4] https://www.apple.com/pt/ios/app-store
[5] https://f-droid.org
[6] https://github.com
[7] https://sourceforge.net/
[8] https://about.gitlab.com
[9] https://code.google.com
[10] https://bitbucket.org
[11] The SMNAR guides are licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. Based on a work at https://zenodo.org/record/5256159#.YfqqDTpv_IU.

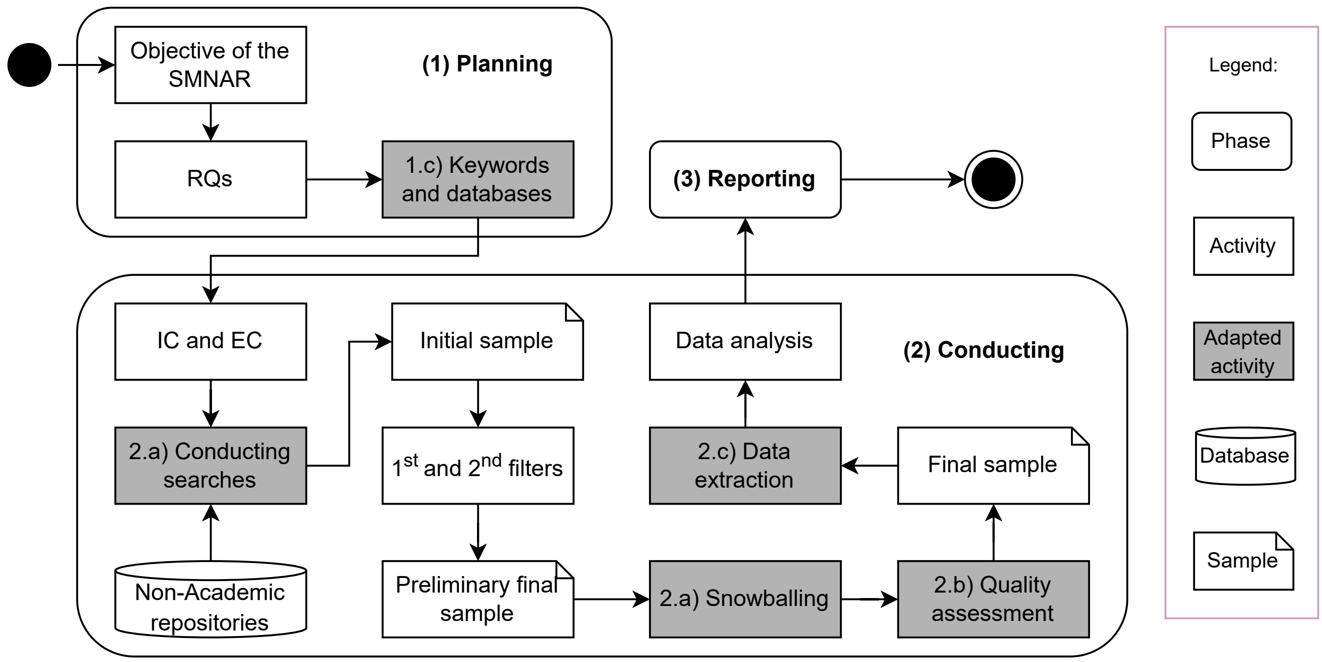

Figure 2. Overview of the SMNAR protocol.

5 Feasibility Study

A feasibility study is a first experimental study conducted to evaluate a new technology. As such, it does not intend to obtain a definitive answer, but rather data to refine a solution and generate hypotheses related to its use (Corbin and Strauss, 2014). Based on Wohlin *et al.*'s (2012) methodology for controlled experiments in software engineering, the present study was carried out aiming to evaluate the feasibility of the developed SMNAR protocol user guides.

5.1 Selection of Participants

The study participants were selected by convenience and consisted of one representative of the healthcare professional profile (a medical student) and two representatives of the software developer profile (masters students in computer science). Before the study began, the participants signed an Informed Consent Form (ICF), which aims to ensure voluntary and consensual participation and guarantee the anonymity and confidentiality of the collected data.

5.2 Selection of Determinants

This study aimed to evaluate the determinants of perceived ease of use, perceived usefulness, and intention to use of the Technology Acceptance Model (TAM) (Davis, 1989; Venkatesh and Davis, 2000). The TAM is commonly used to assess the acceptance of new technologies and is compatible with the objective of the present study. We formulated statements and open-ended questions about the TAM determinants and general aspects of the SMNAR user guides' organization, such as structure, content, and wording. For the analysis of qualitative data, we opted for the Grounded Theory (GT) coding process (Corbin and Strauss, 2014).

5.3 Materials

To help conduct the study, the following materials were prepared and made available online to the participants: (i) slides about the SMNAR; (ii) materials with the study instructions, containing the procedures for its conduction and links to the forms; (iii) the ICF; (iv) the SMNAR protocol user guides, which are the objects evaluated in this study; (v) an online participant characterization form[12]; and (vi) an online post-study form[13].

5.4 Preparation

The study was conducted remotely due to the COVID-19 pandemic at the time of research. It was divided into two moments—synchronous and asynchronous—following a predefined script. The synchronous moment was held by video conference on the BigBlueButton[14] platform. Before the study began, the researcher ran audio, video, and screen-sharing tests on this platform. In addition, all the materials described in Subsection 5.3 were sent to the participants in advance.

5.5 Method

The study was conducted between August 20 and September 10, 2021. In the synchronous meeting, the SMNAR protocol and study procedures were presented to the participants, who were also asked to read, sign, and submit an ICF. During the presentation, the participants were informed that the study consisted of partially conducting an SMNAR on a topic of their choice and that the post-study form should be filled in during the data extraction activity, indicated in the guides.

[12]https://forms.gle/BiiwVN4vhKdrQ11E6
[13]https://forms.gle/7gUArDAR1J3ndCDw8
[14]https://bbb.c3sl.ufpr.br

There was a moment after the presentation to answer possible questions from the participants. The deadline initially suggested to finish the study was seven days, but it was later extended to 21 days.

The asynchronous moment consisted in the participants conducting an SMNAR by themselves based on the instructions given in the synchronous meeting. During this moment of the study, the participants exchanged emails and messages with the researcher in order to ask any questions. After finishing the SMNAR, the participants reported their impressions of the guide through a post-study form. Later, for documentation purposes, they sent the SMNAR protocols developed in the study to the researcher. They also answered a characterization form asynchronously.

No personal data from the participants was collected. The characterization form was limited to the aspects mentioned in Subsection 5.6. The post-study form was limited to questions about the TAM determinants and other open-ended questions about the guides. The results obtained with this form are presented in Sections 6 and 7.

5.6 Characteristics of the Study Participants

In the characterization form, the participants reported their experiences of: (a) using application repositories; (b) using source code repositories; (c) conducting or reviewing secondary studies (SMSs or SLRs); and (d) conducting or reviewing systematic mappings in repositories. Table 1 shows the answers from this form. The participants are indicated by "P", i.e., "P1" indicates "participant 1", while their experience levels in the aforementioned activities are indicated by no experience (N), low experience (L), medium experience (M), and high experience (H).

Table 1. Characteristics of the study participants.

Participants	Application repositories	Source code repositories	Secondary studies	Mapping in repositories
P1	H	H	N	N
P2	H	H	M	N
P3	L	N	L	N

Regarding application and source code repositories, two participants reported having high experience with both, while another participant reported having low experience with application repositories and no experience with source code repositories. As for participation in secondary studies, one of the participants reported never having participated, and the other two reported low and medium experience. Regarding mappings in repositories, all participants reported that they had never participated in such studies.

6 Quantitative Results

Quantitative data were obtained in the post-study form through 14 statements based on the TAM determinants: perceived ease of use (PEOU), perceived usefulness (PU), and intention to use (IU). The answers to the statements followed the seven-level scale proposed by Venkatesh and Davis (2000): strongly disagree, moderately disagree, somewhat disagree, neutral (neither agree nor disagree), somewhat agree, moderately agree, and strongly agree. This scale was considered adequate because it offers intermediate values, thus providing participants with neutral answers when they are unsure.

6.1 Perceived Ease of Use

The PEOU determinant is defined as the degree to which the participant believes that using the technology is effortless. For this determinant, the following statements were defined:

- **(PEOU1)**: Reading the guide was clear and understandable;
- **(PEOU2)**: Using the guide does not require much of my mental effort;
- **(PEOU3)**: I find the guide easy to use;
- **(PEOU4)**: I find it easy to use the guide for planning the SMNAR;
- **(PEOU5)**: I find it easy to use the guide for conducting the SMNAR.

Figure 3 presents the participants' answers (P1, P2, and P3) about the PEOU determinant.

Concerning PEOU, P1 and P3 had more difficulties in using the SMNAR protocol user guides. A discrepancy is noted in the levels of acceptance of statement PEOU1: P3 strongly disagreed that reading the guide was clear and understandable, P1 somewhat agreed with this statement, and P2 strongly agreed. These difficulties in regards to PEOU1 may have contributed to P1 and P3 somewhat agreeing with PEOU2. Furthermore, the answers to PEOU4 and PEOU5 indicate that these difficulties can mainly compromise the planning of the SMNAR and, to a lesser extent, its conduction. Despite the difficulties indicated, the variations between moderate and strong agreement regarding statement PEOU3 indicate that, in general, the guides are easy to use.

6.2 Perceived Usefulness

The PU determinant is defined as the degree to which the participant believes that using the technology improves their performance in conducting the SMNAR. The evaluation of this indicator was performed according to the following statements:

- **(PU1)**: Using the guide has improved my performance when searching in repositories;
- **(PU2)**: Compared to traditional research methods in the literature, using the guide for planning and conducting the SMNAR may increase:
  - (PU2.1) productivity;
  - (PU2.2) effectiveness;
  - (PU2.3) criterion;
  - (PU2.4) reliability;
  - (PU2.5) rigor;
  - (PU2.6) auditing;
  - (PU2.7) repeatability;
  - (PU2.8) replication;
  - (PU2.9) impartiality;
- **(PU3)**: I find the guide useful for planning and conducting the SMNAR.

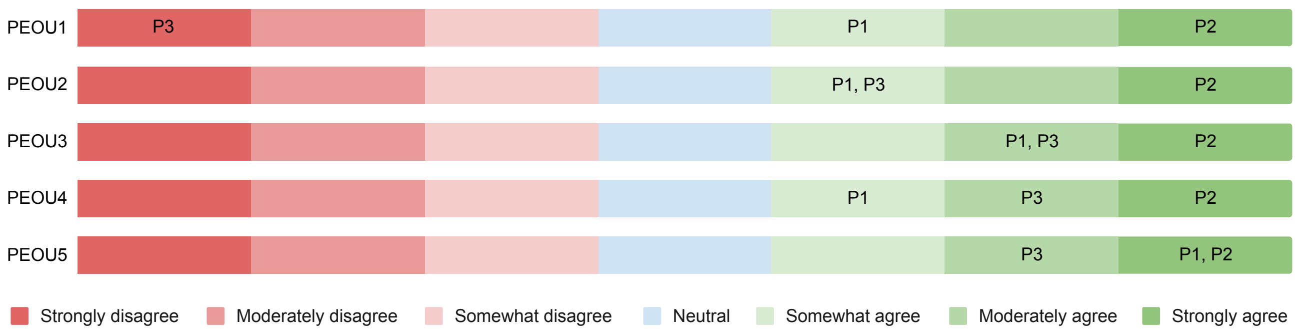

Figure 3. Participants' degree of acceptance regarding their perceived ease of use of the SMNAR protocol guide.

Figure 4 presents the participants' answers about the PU determinant.

About PU, P3 moderately agreed that using the guide improved their performance in the SMNAR (PU1), while the other participants strongly agreed with this statement. Subsequently, a large concentration of agreement can be seen from PU2.1 to PU2.9, which indicates that the guide contributed to increasing all aspects encompassed in the statements. Furthermore, the participants' complete agreement concerning PU3 indicates the guide's practical usefulness for conducting an SMNAR.

6.3 Intention to Use

The IU determinant is defined as the degree to which the participant believes they can use the technology in the future. Two statements were defined for this determinant:

- **(IU1)**: Assuming that I have access to the guide, I intend to use it in my scientific research;
- **(IU2)**: Considering that I have access to the guide, I anticipate that I will use it again beyond this study.

Figure 5 presents the participants' answers about the IU determinant. The participants were interested in using the guide to conduct other SMNARs (IU1). Despite this, P1 moderately agreed that they might use the guide beyond this study (IU2).

7 Qualitative Results

Qualitative data were obtained through a post-study form and analyzed with procedures based on the GT method (Corbin and Strauss, 2014). The participants' answers were coded and then grouped by similarity of content, generating the following categories for analysis: positive points, benefits, difficulties, and suggestions for improvement. Below, participants' answers are quoted and indicated by "Q," i.e., "Q1" means "quote 1."

7.1 The Guides' Positive Points

As a positive point, some participants reported the structure of the guides (quote 1) while others indicated the description of the phases and the clarity of the guides (quotes 2 and 3). Finally, some indicated the fact that the guides fit the proposed context of use (quote 4).

> "*The [guide's] structure divided into steps and activities facilitates the conduction of the mapping.*" (Q1)
> "*The guide is very easy to use and well described, and it is very clear what should be done during the conduction of each phase. [...]*" (Q2)
> "*[...] it clearly points the steps that should be considered when conducting the guide [...]*" (Q3)
> "*The guide fine-tunes what is known as good practice in Systematic Mapping Studies [...]*" (Q4)

7.2 Benefits of Using the Guides

Some participants reported the protocol's contribution to conducting the SMNAR as a benefit (quote 5). Other participants believe that the guides helped with specific searches (quotes 6 and 7). Others still reported the support for searching in non-academic repositories as a benefit (quote 8).

> "*[...] Once everything was set, conducting the protocol was smooth.*" (Q5)
> "*Using the guide has improved my performance in searches for systems in my topic [...]*" (Q6)
> "*[The guide is a] Good way to refine/filter applications within a specific area or research problem.*" (Q7)
> "*[...] I find the guide useful to support the selection process in non-scientific databases.*" (Q8)

7.3 Difficulties in Using the Guides

The participants reported some difficulties in planning the SMNAR (quote 9). They associated these difficulties with a lack of prior knowledge in secondary studies (quote 10) and indicated that they were intensified by the lack of illustrative examples of the SMNAR phases in the guides (quote 11), as well as the language very specific to the field of computer science (quote 12).

> "*I found it difficult to define the protocol items [...]*" (Q9)
> "*[...] some people who do not know SMS, SLR, or any kind of secondary studies could have difficulties.*" (Q10)

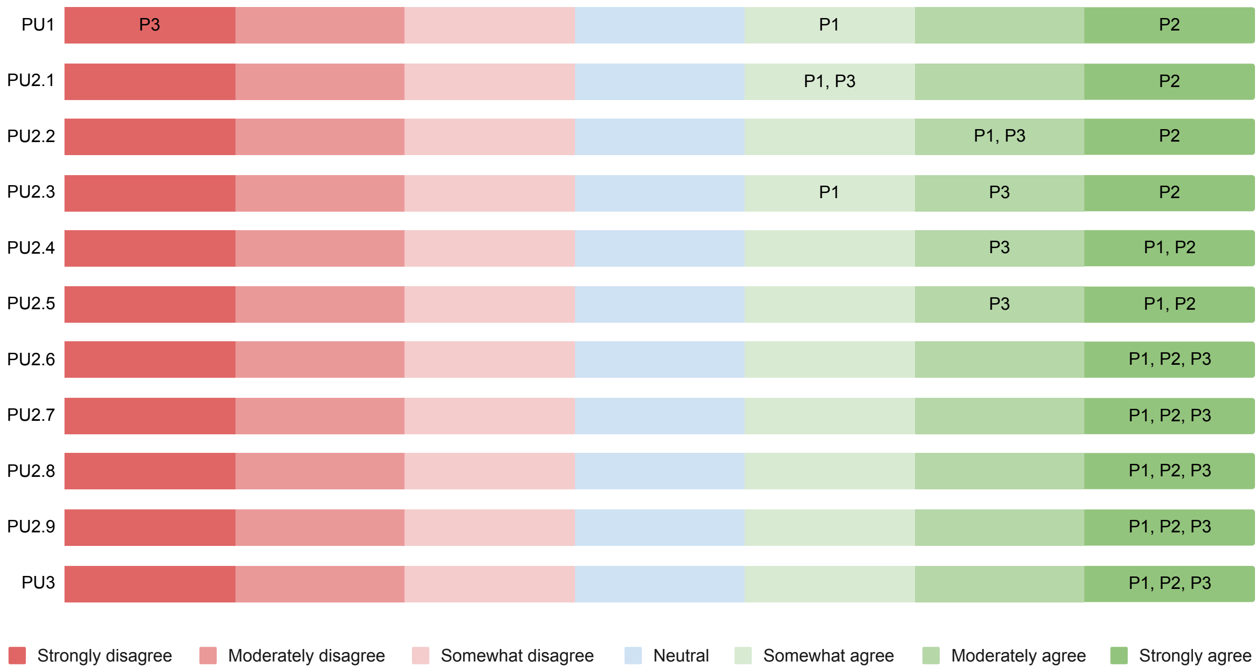

Figure 4. Participants' degree of acceptance regarding their perceived usefulness of the SMNAR protocol guide.

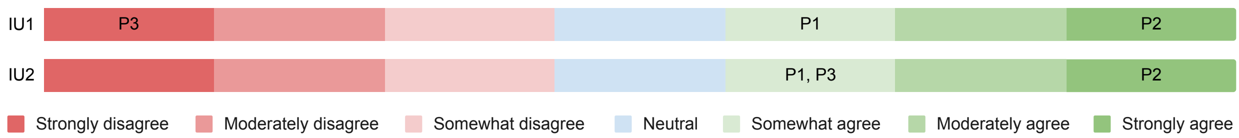

Figure 5. Participants' degree of acceptance regarding their intention to use the SMNAR protocol guide.

> "*I think some images were missing to illustrate the [guide's] phases with real examples [...]*" (Q11)
> "*The guide has a] Difficult language, practically inaccessible to computer science nonexperts*" (Q12)

7.4 Suggestions for Improving the Guides

Some participants suggested including examples of the SMNAR phases (quote 13). Others suggested the inclusion of illustrative examples designed for each user profile (quote 14) and also indicated the possibility of expanding the detailing of steps and activities in the guides (quotes 15 and 16). Still in terms of detailing, some participants suggested adaptations in the cataloging of the selection process (quotes 17 and 18). Others suggested more specificity in the terminologies used in the guides (quote 19).

> "*[It would be] better [to] exemplify each step with real examples.*" (Q13)
> "*Insert more illustrative examples covering different areas [...]*" (Q14)
> "*I believe that improving the description of what should be done in each activity and step would make it easier to understand the guide.*" (Q15)
> "*[...] maybe [the guide needs] images that demonstrate a more detailed step-by-step.*" (Q16)
> "*I think it is necessary for the guide to show the keywords used and how many applications each of them returned [...]*" (Q17)
> "*[...] The selection process also needs to show in numbers how many applications were included/excluded [...]*" (Q18)
> "*[The guide should] Use language adapted to each user profile.*" (Q19)

8 Discussion

The proposed adaptations to the SMNAR protocol focused on the Planning and Conducting phases and resulted in 4 adapted activities, which corresponds to about 57% of the activities in the SMS protocol used as a basis. The main adaptation in phase (1), Planning, refers to the choice of repositories according to the user profile: source code repositories were indicated for software developers and application repositories for healthcare professionals. Given these repository possibilities, Github and Google Play Store were suggested because of their reach and popularity, as well as the plurality of codes and applications from different fields of knowledge available in their databases.

Phase (2), Conducting, contains most of the adaptations made to the SMNAR: (i) individual searches in the repositories for each keyword; (ii) cataloging the search device's technical specifications; (iii) analysis of information about the repositories and in-development or running applications; (iv) snowballing procedure from indications of applications related to those returned in the searches; (v) definition of quality items based on health references; and (iv) adaptation of the data extraction form with specific information from each repository. We have not fixed some elements of the protocol, such as the inclusion criteria, so that the users can choose and define those elements that they consider most appropriate to the scope and knowledge of their study.

The feasibility study of the SMNAR protocol user guides was conducted for three weeks after the participants requested an extension of the initial deadline. As pointed out by Kitchenham and Charters (2007), searches performed in a systematic way may require more effort than informal searches. Therefore, they commonly involve more than one researcher, as they are conducted and reviewed by teams. Thus, the need for a deadline extension in order to complete the study can be attributed to: (i) the systematic bias of the searches performed in the SMNAR and (ii) the fact that the SMNAR was performed individually by the study participants. These factors were considered during the planning of the study and mitigated by the indicated time frame for the conduction of the SMNAR.

The quantitative results of the TAM determinants pointed out that using the guide contributed to planning the SMNAR and obtaining judicious, reliable, rigorous, auditable, and unbiased results. In addition, using the guide also favored increased performance, productivity, and efficiency for conducting a repeatable and replicable SMNAR. These results indicate that the protocol, adapted for the repository contexts described in the guides, has retained the benefits expected and inherent in the SMS methodology used for its development. In general, the participants showed interest in applying the guides in future scientific research beyond the present study, despite the difficulties reported about the clarity, comprehension, and effort for its conduction.

The reports in Section 7 showed some evidence of divergent opinions about the TAM determinants. First, the reported difficulties may be related to the fact that the SMNAR protocol is based on a SMS methodology oriented to the field of computer science; therefore, certain terminology used may not be familiar to the healthcare participant. Another possibility, reinforced in Subsection 4.6, refers to the participants' lack of previous experiences with secondary studies. Thus, the terms and methodology of an SMS may be unfamiliar to them, compromising their understanding of the SMNAR described in the guides. It is important to point out that the guides are designed to present the SMNAR protocol succinctly and comprehensively in light of possibilities of repositories and user profiles. However, the participants indicated that the main improvements for the guides involve the language used and detailing the SMNAR phases.

9 Second Version of the SMNAR Guides

Based on the participants' feedback and on our own perceptions during the study, some adjustments resulted in new versions of the guides[15]. The main adjustments were:

- (i) indications and examples of what the user should fill in in the guides, denoted by "<data>" (based on Q13, Q14, and Q16);
- (ii) inclusion of each SMNAR activity goal (based on Q15);
- (iii) expansion of the instructions for each activity, with more detail on its required procedures (based on Q15 and Q16);
- (iv) inclusion of an initial section, with a brief description of the protocol's objective, repository options oriented to each user profile, and the general structure of the guides (based on Q15 and Q19);
- (v) inclusion of tables to catalog the number of applications returned in the searches, and selected with the filters (based on Q17 and Q18);
- (vi) update of the snowballing description in the guide designed for software developers (based on Q18); and
- (vii) inclusion of a field for specifying software components (based on Q19).

10 Threats to Validity

Some threats to the validity of the feasibility study were identified. During the course of this study, we sought to minimize the influence of these threats and reduce possible risks related to them. The main threats identified were:

- (i) the preparation of the materials may influence the way they are understood and the study results. To minimize this threat, the materials were peer-reviewed and a moment during the synchronous meeting was used to clarify possible questions the participants may have had;
- (ii) the time required to conduct an SMNAR can cause fatigue and discourage the participants, negatively affecting their commitment to the study. To lessen this effect, the study was limited to partial conduction of the SMNAR;
- (iii) the synchronous moment of the study was done remotely and was thus prone to connection problems. Seeking to circumvent these possible situations, the presentation was uploaded, allowing it to be accessed at other times;
- (iv) the final part of the study was carried out asynchronously. During this period, the researcher was available to answer any questions the participants may have had;
- (v) the small number of participants may statistically compromise the identification of patterns in the data collected in the study. Therefore, the results obtained can be considered indications and not definitive conclusions; and
- (vi) study participants are not experts in SMSs or SLRs. However, despite this limitation, it was possible to eval-

[15]The second version of the SMNAR guides are licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. Based on a work at `https://zenodo.org/record/5948961#.YfqqNTpv_IU`.

uate the main aspects of the guide and obtain information for its refinement, thus achieving the main objective of a feasibility study.

11 Final Remarks

This article presented adaptations to an SMS protocol. These adaptations aimed to bring the benefits of secondary studies when searching for health applications in application and source code repositories. The SMS was considered as the basis for the proposal of the present study due to its expanded scope when compared to other types of secondary studies. Thus, the protocol for systematic mappings in non-academic repositories (SMNARs) was developed from a software engineering SMS methodology with consolidated guidelines and commonly used in computer science research. In addition, part of the adaptations was based on health applications search approaches found in the literature and on our own previous experiences using non-academic repositories.

From these adaptations, two SMNAR user guides were developed with specific settings in order to assist healthcare professionals and software developers in planning and conducting an SMNAR. Although the SMNAR protocol is aimed at the healthcare field, it can be applied in other areas as well. We hope that the SMNAR protocol can be applied as a complement to secondary studies in which identifying applications is important to the context of the study.

While the main focus of this work is to identify health applications, we hope that the SMNAR protocol can be used to identify software applications from other domains or transversal domains, with the necessary adaptations for each user profile. The main idea of this study is to propose a reasonably simplified protocol that can be used by researchers and non-researchers looking for health software applications for their needs. Thus, seeking this scope of use, we based the protocol definitions on a broader and less specific SMS protocol rather than a scoping review protocol.

The feasibility study of the SMNAR user guides was conducted from the viewpoints of healthcare and computer science students. The study participants indicated different levels of prior experience in using non-academic repositories and participating in secondary studies. This heterogeneity of the participants contributed to highlighting the aspects to be revised in the guides considering the different areas of knowledge associated with its use. The fact that no participant had participated in a previous SMNAR also allowed us to observe whether the content of the user guides was sufficient to make search in the repositories possible.

The quantitative results helped us obtain an overview of the participants' perceived ease of use, perceived usefulness, and intention to use the SMNAR guides in the future. Despite the reservations about the perceived ease determinant, the answers about the other determinants were mostly positive, indicating that the guides were, in general, well accepted. Although SMNARs demand more effort when compared to informal searches, the participants were able to obtain satisfactory results during the study. This evidence indicates that it is feasible to use the proposed guides to support the planning and conduction of an SMNAR. The qualitative results helped in the development of a new version of the SMNAR user guides, with greater detail of the protocol. The replication of the feasibility study considering the updated guides is suggested for further research.

Future works may adapt the SMNAR protocol using methodologies from other secondary studies, such as scoping reviews, as a basis. In addition, using other health references in these protocol adaptations can make the resulting guide more specialized in this application context. The replication of the feasibility study considering specialists in secondary studies as participants can be indicated as another possibility for future directions.

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