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A Systematic Stakeholder Selection Model in Requirements Elicitation for Software Projects: A Systematic Mapping Study

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ABSTRACT

Context. The appropriate stakeholder selection for software engineering is an essential stage and the precondition of software requirements elicitation. However, the stakeholder analysis hasn't get enough attention in the requirement elicitation field as it was commonly recognized as a self-evidence process in practice.

Objectives. In this study, we investigated the current status of this area. Collated the affecting factors which influence the appropriate stakeholder selection on Software Engineering (SE) with respect to the requirement elicitation purpose. On the basic of this objective, we investigated a systematic conceptual model which aims to guide the appropriate stakeholder selection of software projects. Finally, we evaluate the meaning to practice of our model.

Methods. We conducted the systematic mapping study for the first objective. The objective of selecting affecting factors is on the basic of the first objective. The objective to evaluate the meaning to practice is realized by interviewing 10 experienced software product managers.

Results. The recent studies on this area have been classified according to their different focuses. We described the methods of each included papers on systematic mapping study. We collected 12 factors used by previous studies and select 6 factors for our model. And we generated our model by six steps. The interview to ten practitioners is used to evaluate our model.

Conclusions. We extracted six factors according to previous studies, then proposed a systematic stakeholder selection model for software projects on the basic of analysis to those factors. Generally, our model's meaning to practice has been confirmed by interviews with experienced practitioners.

Keywords: Stakeholder identification, stakeholder prioritization, requirements engineering

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The requirements engineering is widely concerned with the elicitation, analysis, specification, and validation of software requirements. If any of these activities are performed poorly, software engineering projects will failed easily. [1] This study belongs to the elicitation stage. The requirements elicitation deals with the issue where software requirements come from and how to collect them for a particular software system [1]. The requirements gathering is the first and the most important phase of software development process [2][3]. The understanding to software's problems is necessary, which needs identifying stakeholders and establishing relationships between development team and customer [1]. In software requirement engineering, wrong requirements would rise numbers of consequences such as delay system delivery, overruns in budget, unexpected maintenance [4]. Thus, the project will fail as the poor requirements elicitation.

As requirements elicitation is critical for a SE, there are many requirements elicitation techniques have been investigated, which applied to various context. Requirement elicitation can be divided into primary stakeholders identification and proper elicitation techniques selection [4]. Relatively, studies concerning stakeholder analysis are few. Requirements Elicitation (RE) is known as the interaction between customer's business domain knowledge and development team's software domain knowledge [5]. The good communication between these two groups is a fundamental tenets of good software engineering [1]. Requirements elicitation techniques concentrates on making stakeholders articulate their thoughts accurately [1]. Stakeholder analysis acts as the prerequisite, supporting the correctness of RE. Efforts on wrong stakeholder is meaningless.

This study focuses on stakeholder analysis rather than requirements elicitation techniques. Stakeholder analysis is a common elicitation technique which needs analyze stakeholder fully, for example, find out whom they are, what their attitudes and interests are [6, Sec. 8]. The stakeholder selection means selecting appropriate stakeholders to elicit requirements for a certain software project. According to the existing studies related to stakeholder analysis, the stakeholder selection process can be explained as identifying all potential stakeholders, then prioritizing them which help deciding included stakeholders for certain projects. Previous studies show that incorrect stakeholder selection often leads to unsuccessful requirements elicitation processes. And the stakeholder selection process has a big impact on software requirements quality. [7] Therefore, proper stakeholder selection is the key to accurately elicit requirements.

Although selecting candidate stakeholders is crucial for RE, many projects didn't pay enough efforts on it. The inherent obstacle will cost certain time to communicate with stakeholders. For example, stakeholders are not mentally prepared; stakeholders might lack of time, knowledge or interest; discussion may not be fruitful, etc. [6, Sec. 8] Moreover, actual projects always have limited time and budget, which may drive them selecting stakeholders under insufficient decision. To be more

specific, they may miss some important groups of stakeholders or spend too much time with stakeholders be of less significance, which will influence accuracy of requirements elicitation. Stakeholders are an significant and necessary requirements source, identify primary stakeholders and obtain their views or potential needs to the project under various constrains is critical [1].

In industry, this process is viewed as self-evident task, which include end user and the development team merely [8]. A systematic stakeholder selection model would be very helpful to select appropriate stakeholders. Previous studies related to this area mostly focused on how to identify all potential/primary stakeholders, classify stakeholders or prioritize stakeholders.

Pacheco and Garcia [8] reviewed the stakeholder identification (SI) methods which dated from 1984 to 2011. They analyzed the status of SI and the aspects need to improve. They found SI methods are few and unstructured, lacking a common framework and a uniform description. And the focus of SI methods varies a lot which is result by the fact that the SI methods were proposed according to their certain application contexts.

Anwar and Razali [4] found the elements which are used to identify stakeholders are separately, namely, stakeholder's role, knowledge, interest and communication skills. Studies related to Stakeholder Prioritization (SP) concern the different significance between stakeholders. Only few studies investigated the model or framework of stakeholder selection, and all those models are not structured well. Anwar and Razali [5] proposed a conceptual model for effective stakeholder selection through reviews of related work. They collected the elements that affect stakeholder selection, then established their conceptual model with those elements. There are three phases defined on the basic of the four above mentioned elements, namely, Identification, Filtering, and Prioritization. On their new paper [4], Anwar and Razali verified the effect of elements used in [5] through quantitative data collection and analysis [4]. Although this framework was a little bit of rough and hasn't been assessed through empirical work, it provided the perspective that establish systematic stakeholder selection model starting from the elements analysis.

By reviewing related works, we found an elaborate stakeholder selection model is needed, a systematic and comprehensive method would be valuable in practical requirement elicitation.

Babar Muhammad Imran, et al. [9] published a systematic literature review as well. Although that study was in value-based software development context, the extraction of stakeholder attributes is in line with our goal. However, in [9], the purpose finding the stakeholder attributes is calculating the frequency of each attribute that used in studies which with respect to SI. Then, the different frequency is recognized as the only criteria by the study to determine different stakeholder attributes' importance. And, only 15 papers were included in their review. Regardless of whether that outcome is meaningful or not, the investigation towards each attribute was missing.

Pacheco and Garcia mapped the SI methods between 1984 to 2011, they investigated the application of SI methods. The various application context makes

the SI methods various as well, this paper adapted a categorization which classify SI studies into three categories, namely, studies that exclusively describe stakeholders, studies focusing on the interaction between stakeholders, studies that include an assessment of stakeholders. This categorization is good at classifying various SI studies and suits our study as well. Also, they present the issues which can be useful to improve SI methods, such as taking into account the project type. However, our study is more on investigating the elements/factors of the SI. The factors represent stakeholder's attributes or characteristics. There is a need to conduct a systematic mapping study to view the current status of this area and investigate the used factors by related studies.

This paper is organized as follows: Section 2 presents the overview of related literatures; Section 3 describes our methods and the results are present in Section 4; in Section 5, we analyze and discuss the results; and finally, we present our conclusions and further research in Section 6.

2 RELATED WORK

2.1 Stakeholder Definition

Stakeholder is an essential notion to software engineering, they might participate in any stage of software life cycle. Stakeholder has already been defined by various researchers. Mitchell, et al. [10] collated many definitions to stakeholder on 1997. Definitions are more about the support to organization, or on whom the organization is depending for its existence. Stakeholders might be interest to the project as the matching between their needs and project's objectives, in other words, they might concern the achievement of the project's objectives. Stakeholders might benefit from or harmed by the project's achievement. On other hand, individuals or groups who can impact the achievement of project's objectives are stakeholders as well. The project will fail directly without supports from some individuals or groups [4]. In addition, individuals or groups interact with the project to support its operation or create values are stakeholders as well. [10]

The most commonly used definition comes from Freeman, et al., which was defined on 1983 (while not available from internet currently). The definition is extracted from its citations:

> *"Can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives"*

Generally, to a software project, stakeholders are individuals or groups who can affect or be affected by the achievement of project's objectives.

2.2 Stakeholder Analysis

The stakeholder notion on software engineering had been paid much attention since the stakeholder is the primary source of requirements of software projects. To improve the quality of software requirements elicitation, many researches were done to analyze software stakeholder. Most of studies in this area is about identifying all potential stakeholders, especially key stakeholders.

McManus [11] investigated the stakeholder involvement and the key stakeholders identification. Since stakeholder involvement is generally context-specific, for a given software project, he suggested to identify stakeholders by considering the definition of stakeholder. For example, thinking who might be affected by project accomplishment; who can contribute financial and technical resources; etc. Expect for identification, McManus present a taxonomy which classify stakeholders by four types, namely, primary stakeholder, secondary stakeholder, external stakeholder and extended stakeholder.

Mitchell, et al. [10] defined a notion "salience" to describe stakeholders. They proposed a new normative theory of stakeholder identification by gathering two existing attributes "power" and "legitimacy" with another attribute "urgency" which is proposed by themselves [9], [11]. "Power" to a stakeholder means the power he possesses to impose his will on the project. "Legitimacy" to a stakeholder specify his

relationships with the project. They defined "urgency" as *"the degree to which stakeholder claims call for immediate attention"* [10]. By analyzing these three attributes to stakeholders, their saliences are easily displayed which is positively related to the involved number of attributes. For example, stakeholders only have "legitimacy" belong to low salience classes, while stakeholders have both "power" and "legitimacy" belong to moderately salience classes and the definitive stakeholders own all three attributes to the project.

2.2.1 Stakeholder identification

Recent studies concerning software stakeholder identification are more about other attributes of stakeholders, such as role, influence, interest, etc. Razali, et al. [5] collated important elements concerning appropriate stakeholder identification by using content analysis based on relevant studies. Type, interest, knowledge are the three elements selected. Firstly, selecting stakeholder by classifying all possible stakeholders into types which has different importance, this classification is conducted on the basic of project definition (goal, type and domain). Then, filtering stakeholders by analyzing their knowledge and interest. This stage involved both stakeholder identification and prioritization. One critical problem is they didn't specify how to determine the possible stakeholders. Helen Sharp, et al. [13] identified stakeholders into several self-defined types, namely, baseline stakeholder, client stakeholder, supplier stakeholder, and satellite stakeholder. As well, they didn't specify the identification of all potential stakeholders.

Larr W. Smith [14] outlined a stakeholder analysis method identifying project stakeholders by brainstorming activities with members appropriately selected. The project context is the basic of brainstorming. However, the identification of internal and external stakeholders might be too rough to conduct in especially large-scale project. S. Ling Lim, et al. [15] proposed a stakeholder identification method based on project scope, discover stakeholder by considering project boundary. Muhammad I. B., et al. [16] established a framework for value-based software systems which aim to contribute the gap of missing low level implementation details for stakeholder identification process. They set several stakeholder metrics for quantification on the basic of several stakeholder attributes such as personality, skills, communication, etc.

Luciana C. B., et al. [16], [17] analyzed the relation between stakeholder's interest, project goals and requirements. An equation is present to calculate stakeholder's influence to projects. Model of this study takes into account the impact to stakeholders' interest and influence by the changes of interorganizational projects. Luciana C. B., et al. [19] proposed four criterion to classify stakeholders into different types, namely, functional criterion, geographical location criterion, knowledge/abilities criterion and hierarchical level criterion. Mohd Sadiq, et al. [20] set similar criterion based on Luciana's study. Classifying stakeholders from those aspects helps understanding stakeholders. A stakeholder matrix is used to analyze stakeholders' importance based on interest and influence analysis. For example, stakeholders with high influence and interest to project are most important.

The communication skills are also useful to select appropriate stakeholders. Md. M. Rahman, et al. [21] investigated the essential skills for project stakeholder identification. They used an inductive approach for relevant papers and finally conclude several essential skills for both internal stakeholders and external stakeholders. Although all these skills are suitable to stakeholder identification, the communication skills are the most commonly acknowledged.

2.2.2 Stakeholder prioritization.

McManus [11] developed a strategic view of situation to view relationships between stakeholders. And clarify stakeholder interests and roles to prioritize identified stakeholders. While, he didn't research in deep to the strategic view. Alexander, et al. [22] did a survey about the difficulty of stakeholder involvement. They list five categories represent the source of difficulty, then the results show 38% participants replied that the difficulty is result by stakeholders' skill which indicates the ability to communicate or explain their needs. 34% participants replied the difficulty is result by limited time or budget. This research has a validity threaten that participants didn't considered the issue of stakeholder identification, or, recognize this issue as communication problems.

Several attributes were found frequently used by related studies to prioritize stakeholders. Namely, type, interest, influence/impact, knowledge (educational background, and experience), interpersonal skills, relationship. Razali, et al. [5] investigated filtering stakeholders by analysis of knowledge and interest, then prioritizing by interpersonal skills evaluation. Larr W. Smith [14] combined interest and impact analysis to estimate relative priority. He proposed to estimate impact level for each interest of a certain stakeholder, then estimate relative priority based on the addition of all impact estimations of a certain stakeholder. Mohd Sadiq, et al. [20] prioritized stakeholders based on influence and interest matrix.

M. Sherkat, et al. [23] proposed a stakeholder identification method which prioritize stakeholder by against project's owners' objectives with stakeholder needs. They firstly calculate the goal's importance via an equation based on each owner's weight to the goal. Then, calculate the importance of stakeholder accordingly.

2.2.3 Stakeholder interaction

There are few literatures addressed stakeholder interaction issues since the interaction involved people is so hard to handle, not only on SE. S. Ling Lim, et al. [15] used social networks techniques to analyze stakeholders of large-scale software projects. Their proposed method establishes the networks between initial set of stakeholders. Ask for involved stakeholders' recommendations to other roles of stakeholders which might have claim to the project. This step is repeated as a snowballing way to discover additional roles. Web 2.0 technologies are suitable to facilitate that method [24]. The limitation of this method is involved individuals' passive response which might result by lack of knowledge, time, interest, etc. In

addition, projects with no enough stakeholders such as small-scale software projects might make that method meaningless for the limited participation.

Regardless of the interactions between stakeholders and project, the interactions amongst stakeholders might be more difficult to handle. The conflicts of requirements between stakeholders in software requirements engineering is widely known. V. Kulkarni [25] locate the conflicts via a stakeholder and requirements matrix, which contribute few to this gap. The stakeholder prioritization could handle this issue indirectly [17].

3 METHODOLOGY

Our study aims to find out the current research status about stakeholder analysis in software project. Then, we propose a model on the basic of review and analysis to related literatures. The model is supposed to help selecting appropriate stakeholders for software projects, which ensure that software engineer could extract requirements from right person, hence, ensure the requirements quality and make requirement elicitation more efficient.

In section 3.1, we present our aim and objectives in detail; three research questions are present in section 3.2 based on aims and objectives; in section 3.3, we state the chosen methods, and we elaborate the motivation of these methods in section 3.4; in section 3.5, we explain the method Systematic Mapping Study which is used to review related literatures; in section 3.6, we present the aim and plan of our interview; the validity of our study is discussed in section 3.7.

3.1 Aim and Objectives

Our ultimate goal is to propose a model to help improving the requirement elicitation's quality and efficiency of software projects. For the aim of this goal, we decide to investigate the affecting factors which can influence beneficial stakeholder selection in the requirements elicitation phase of software engineering. Based on the review and analysis to the affecting factors, we establish a systematic stakeholder selection model.

To achieve the aim of this study, we defined several sub-objectives as follow:

a. Investigate the existing affecting factors with respect to stakeholder selection in software projects.
b. Identify and chose the affecting factors with respect to Stakeholder Selection for our model on the basic of the result of sub-objective a.
c. Evaluate the meaning to practice of our model.

3.2 Research Questions

According to the above objectives, we need to analyze the stakeholders in detail, so we define the following issues:

- RQ1: What factors should be taken into consideration when selecting appropriate stakeholder of software projects to elicit requirements?

This question is corresponding to the aim of finding out all affecting factors which can influence beneficial stakeholder selection. For example, during the phase of stakeholder prioritization, namely, certain groups of stakeholders are involved to extract requirements, stakeholders' communication skills are an important factor. In other words, when taking the communication skills into account, software engineer will pay more attention to stakeholders who are easier to communicate. The analysis of involved factors is the foundation of establishing our model to select appropriate stakeholders.

- RQ2: Which factors are suitable to apply to our model?

We identify the affecting factors when answering RQ1, then we plan to investigate how could we make use of them to select stakeholders for software projects. Which needs to review related studies and sufficient analysis to generate the systematic stakeholder selection model. The point to answer this research question is determine the adopted factors.

- RQ3: Is our proposed model meaningful in practice?

For this systematic stakeholder selection model, it's expected to be valuable for software requirements elicitation in practice. However, it's difficult for us to apply our approach in real software projects, we decide to interview several senior experts in this area, which aims to evaluate this model under their rich experience, in practitioner perspectives.

3.3 Chosen Research Methods

To answer the RQ1 and RQ2, we conduct systematic mapping study. Systematic mapping could determine the coverage of a research area [26]. The overview of current research status is the first and necessary stage of our study.

In our study, we analyzed related studies concerning the factors that influence appropriate stakeholder selection. RQ1 could be answered by this process. In addition, we analyze how related studies conclude their affecting factors. This process could help us answering RQ2. By answering RQ1 and RQ2, we establish our systematic stakeholder selection model.

Based on the results of systematic mapping study, then we conduct interview with experienced practitioners to evaluate whether our model is valuable in practice. The overall of our chosen methods are shown as follow:

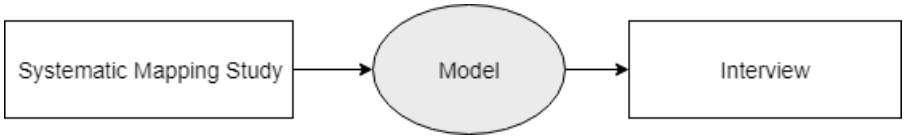

Figure 3.1: Overall methods

3.4 Discussion of Alternatives

We select systematic mapping (SMS) study rather than systematic literature review (SLR) or literature review as we can use systematic mapping studies to structure and show an overview of our research area [27]. SLR focuses on collection and comprehensive evidence [27]. In our study, one of the objective is determine affecting factors to appropriate stakeholder selection, then put forward a systematic stakeholder selection model on the basic of analysis to the determined factors. Thus, we firstly need to review the existing results of affecting factors concerning stakeholder selection. The amount of related studies will make it unrealistic to research in deep for all of them. In addition, some literatures are included because they partly referred to the "stakeholder" which are valuable to our study. Reading in-depth to those studies is unnecessary and time consuming.

We select interview rather than case study or experiment as our aim in this phase is to find that whether the model has the practical value. Gathering practitioners' attitudes towards our model could be important. Case study research the contemporary SE phenomena in its real-life context [28]. While it's unrealistic for us to apply our model into real software projects. In addition, it is very difficult for us to use the survey to evaluate our model. The desired participants of survey should be those populations who have relevant experience such as software development practitioners or researchers in this area. We can't find enough desired participants to perform such a survey.

3.5 Systematic Mapping Study

As we found there are not much literatures concerning this research area, we decide to conduct snowballing combined with systematic mapping to review related literatures.

3.5.1 Research Questions of SMS

To help answering RQ1 and RQ2, we set several research questions for SMS, which can facilitate getting the overview of this research area. In addition, this measure can contribute the following works such as paper screening, data extraction and mapping, etc.

- SMS_RQ1: When and where are the stakeholder investigation papers published?
- SMS_RQ2: What application context do these papers researched?
- SMS_RQ3: What are the techniques used in stakeholder selection?
- SMS_RQ4: Which papers are published to investigate affecting factors related to stakeholder selection?
- SMS_RQ5: Which affecting factors related to stakeholder selection have been studied in the literature?
- SMS_RQ6: How are these affecting factors studied?

When take these questions into mind, the following works would be much clearer. Also, the results are structured according to those questions.

3.5.2 Conduct Research

As shown in Figure 3.2, to conduct research, we need to prepare the prerequisites in advance.

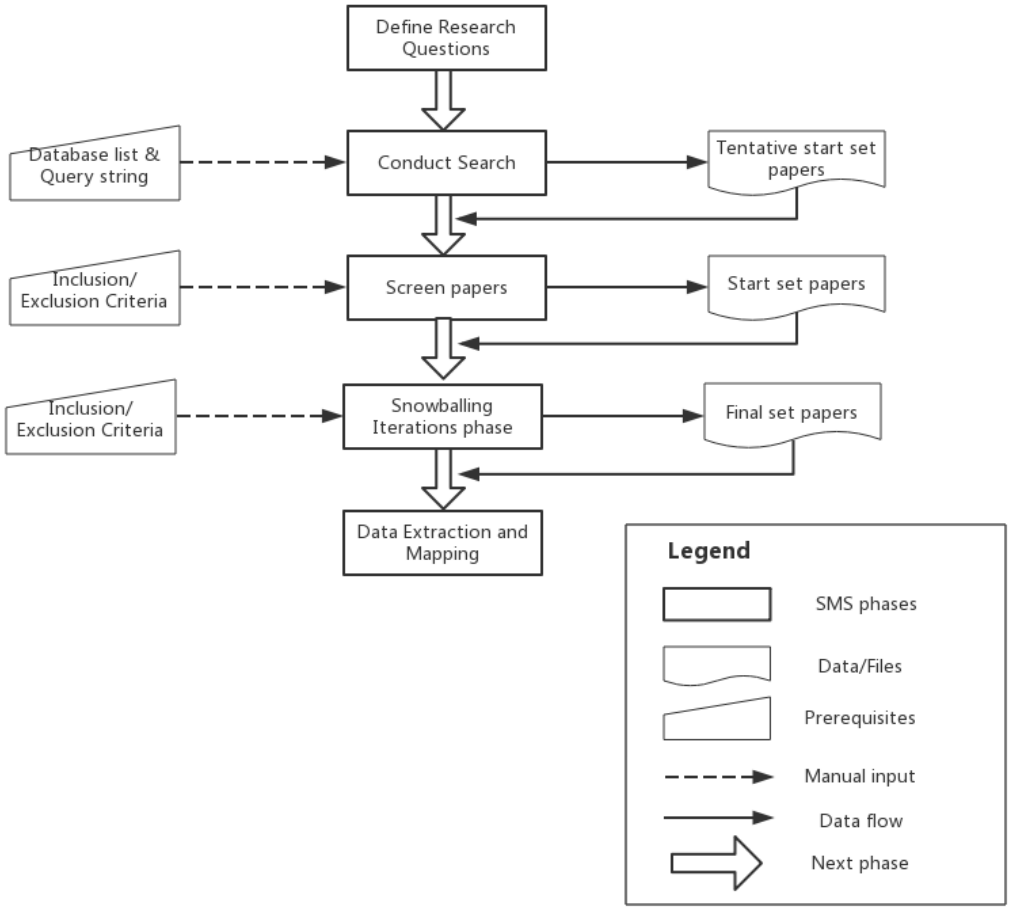

Figure 3.2: Overview of SMS combined with Snowball Sampling

- Database

We finally chose these digital databases to search related papers: Scopus, Springer, Inspec, ACM DL, IEEE Xplore, Web of Science, Science Direct. They are the most commonly used digital databases for software engineering publications.

- Query String

According to the research questions and our knowledge to this area, we firstly identified the keywords to formulate query strings. Our study actually belongs to stakeholder analysis in software engineering, the keywords “software engineering” or “requirement elicitation” are necessary since the querying results contain many studies in other domain.

The studies we searched are supposed to investigate how to choose appropriate stakeholders for the aim of improving the quality and efficiency of software requirements elicitation. According to our previous knowledge to this area, we found the desired studies are most about (primary) stakeholders identification or groups of stakeholders’ prioritizations in a certain application context. Hence, we think “stakeholder identification” and “stakeholder prioritization” are proper keywords. By viewing several desired studies, we found the “classification” and “selection” appeared several times as synonyms.

To formulate the query string, we need to applied the specific rules for each database. Most of the basic rules are similar, there still are several differences. For example, we need to search the studies that contain terms “stakeholder” and “identification” near or adjacent to each other. The operators “W/n” and “NEAR/n” are used in different database.

During the query strings formulation, we found some studies use “identify” rather than “identification”, thus, the wildcards “*” is useful to the formulation. By using the basic operators and wildcards, we formulate query strings as follow:

Table 3.1: Query strings formulation

Database	**Query String**	**Result number**
Scopus	TITLE-ABS-KEY (((stakeholder W/3 select*) OR (stakeholder W/3 identif*) OR (stakeholder W/3 priorit*)) AND ("software engineering" OR "requirement elicitation"))	146
Springer	((stakeholder NEAR/3 select*) OR (stakeholder NEAR/3 identif*) OR (stakeholder NEAR/3 priorit*)) AND ("software engineering" OR "requirement elicitation")	307
Inspec	((stakeholder NEAR/3 select*) OR (stakeholder NEAR/3 identif*) OR (stakeholder NEAR/3 priorit*)) AND ("software engineering" OR "requirement elicitation")	104
IEEE Xplore	(("stakeholder" NEAR/3 "select*") OR ("stakeholder*" NEAR/3 "identif*") OR ("stakeholder*" NEAR/3 "priorit*")) AND ("software engineering" OR "requirement elicitation")	51
Science Direct	TITLE-ABSTR-KEY(((stakeholder W/3 select*) OR (stakeholder W/3 identif*) OR (stakeholder W/3 priorit*)) AND ("software engineering" OR "requirement elicitation"))	7
Web of Science	((stakeholder NEAR/3 select*) OR (stakeholder NEAR/3 identif*) OR (stakeholder NEAR/3 priorit*)) AND ("software engineering" OR "requirement elicitation")	33
ACM DL	(("stakeholder" AND "select*") OR "stakeholder identification" OR "stakeholder prioritization") AND ("software engineering" OR "requirement elicitation")	54

3.5.3 Screen Papers

Figure 3.2 shows that we have to judge inclusion either exclusion for each paper twice when screening papers. Namely, we exclude papers by reading title, abstract, and keywords. Then, again, we do the judgement by reading full text. Start set papers are determined by these procedures.

To make the screening work more efficient, we list several Inclusion/Exclusion criteria as follow:

Table 3.2: Inclusion and Exclusion criteria for paper screening

No.	**Description**
IC1	The title, keywords or abstract indicate that this paper is related to

	stakeholder selection of software project
IC2	The paper investigates the affecting factors of stakeholder selection of software project
IC3	The paper proposes a method/approach/framework of stakeholder selection of software project
IC4	The paper investigates the stakeholder identification of software project
IC5	The paper investigates the stakeholder prioritization of software project
EC1	The paper is not latest studies
EC2	The paper is not write in English
EC3	Can't download the paper's full text
EC4	The paper is already selected on another database
EC5	The paper is not in the scope of software engineering or software requirements elicitation
EC6	The title, keywords or abstract show that this paper totally not or just mentioned a little bit software project's stakeholder selection
EC7	Publications not in journals, conferences, thesis, book chapter or technical reports

Table 3.1 shows we found 702 papers from seven digital databases by corresponding query string. Which means the **tentative start set** has 702 papers. Obviously, papers in the tentative start set are searched by the formulation of query strings within several presetting items. All desired papers are supposed to be contained there. While, most of papers in that set are going to be excluded even if they meet the query string. To exclude these irrelevant papers, paper screening is necessary.

The next step is screen papers by reading title, abstract, keywords, which is clearly shown in Figure 3.2. This screening work is conduct manually under the inclusion/exclusion criteria. Thirty-one papers remain after this step. Actually, the main reason of most papers excluded in this step are not relevant with our study, a few papers seem suitable while not available for us. The left papers in this step are collected as the **middle set papers**. Preliminarily, papers in this set are recognized as the desired papers.

Then, we read the full text of each paper in the middle set papers. By applying the criteria which listed on Table 3.2 during screening, only eleven papers are found suitable for our SMS. And, after discussion, all these papers are decided as the start set papers.

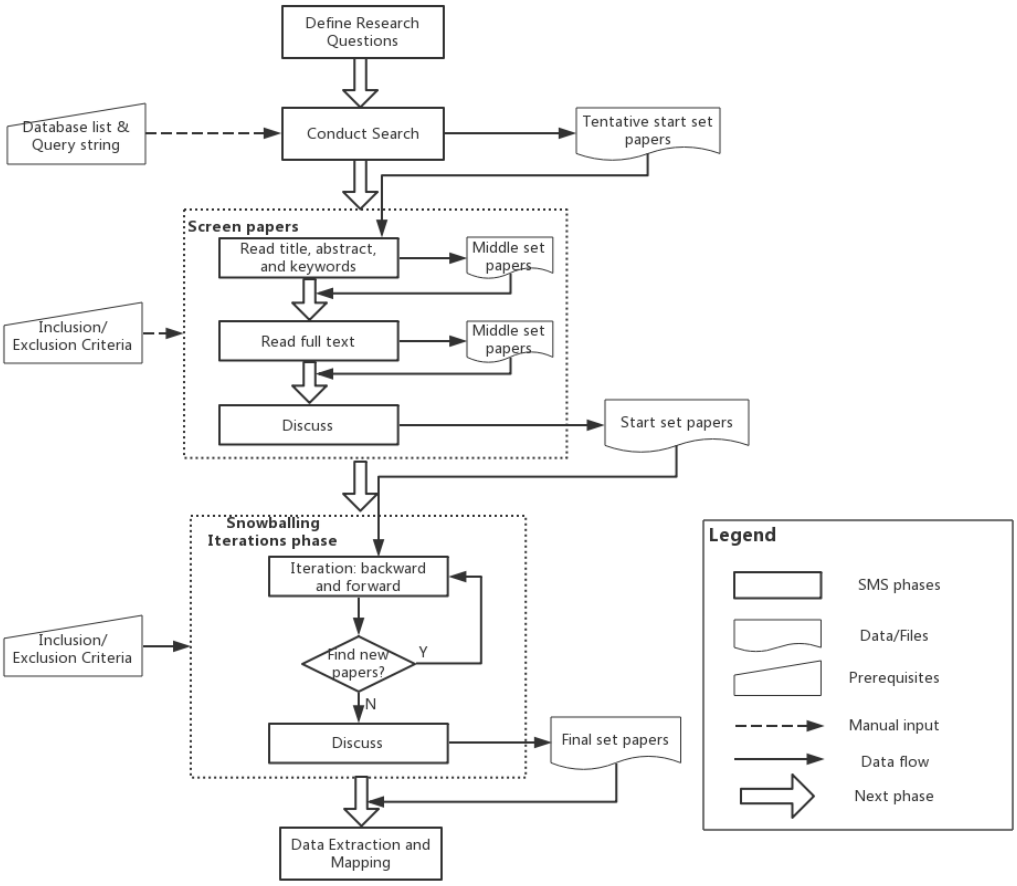

Figure 3.3: Detailed procedures of SMS & Snowball Sampling

3.5.4 Snowball Sampling

Snowballing is acknowledged as identifying additional papers by using the references of a paper and citations to the papers. The usage of references and citations are recognized as backward and forward snowballing respectively [29]. Snowballing could also be applied by looking at where the paper is referenced or cited. Although this approach could make our searching more correct, it's impossible to conduct it entirely since some papers have too much references or have been cited too much times. According to the guideline for snowballing proposed by Wohlin, et al., we decide to conduct the screening work as we identified before. To be specific, for each paper in a certain paper's reference list and citation list, we firstly read its title, abstract, keywords to determine whether exclude it or not. This step let us exclude irrelevant paper quickly. Then, determine whether include the paper or not by reading its full text. Papers can be determined as start set paper only if we viewed its full text. The inclusion or exclusion criteria are the shown as Table 3.2. Figure 3.4 shows the detailed procedures of our snowball sampling phase.

In this stage, we use Google Scholar to search papers since it includes papers from all those chosen databases. In addition, it's very useful to find all citations to a certain paper.

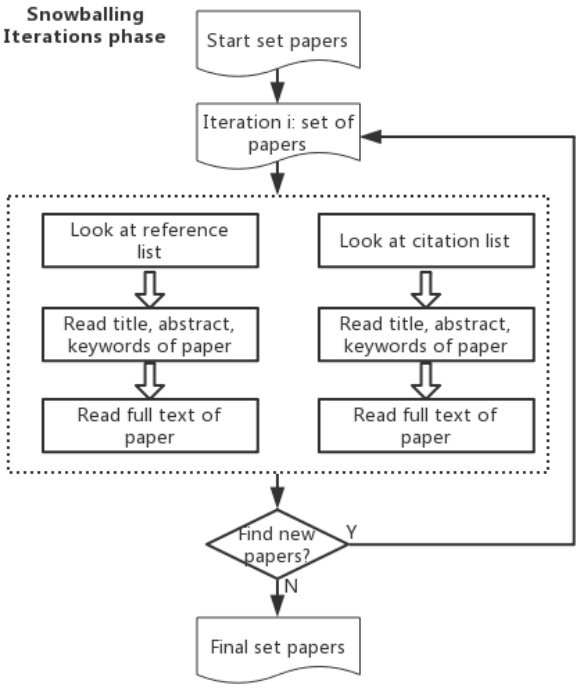

Figure 3.4: Procedures of Snowballing

- Start set

As we mentioned before, snowballing is the paper searching based on a certain set of papers, namely, start set papers. The identification of start set paper is the first challenge of snowballing [29]. A bad start set could make snowballing work inefficient or even meaningless. In our study, the combination of SMS and snowballing ensure the quality of start set. According to the characteristics of a good start set identified by Wohlin, et al. [29], we found the volume of our start set paper may not up to the expected standard. We think it's result by the less attention to this research area compared to other area such as software requirements elicitation techniques.

- Iteration 1

As the identified procedures in Figure 3.4, we did both backward and forward snowballing to the 10 papers in start set. As shown in Table 3.3, we signed the start set papers from P1 to P10. We count the number of references of each paper and citation to them, while numbers in parenthesis represent the amount of new papers we included.

In summary, 252 references have been examined for these eleven papers, and seven of them are included. 555 citations to these papers have been examined, and eight of them are included. Most of the excluding reason is not relevant to our study, some papers are examined and included already, and a few papers are excluded for other reasons. In addition, the 14 found papers in iteration 1 are signed from P11 to P24.

Table 3.3: Results of iteration 1

ID	Reference	Citation
P1	4(0)	7

P2	26(3)	9(2)
P3	31(0)	0(0)
P4	25(2)	10(0)
P5	30(1)	60(2)
P6	24(0)	99(2)
P7	24(0)	320(2)
P8	32(0)	13(0)
P9	26(0)	8(0)
P10	30(0)	29(0)
Total	252(6)	555(8)

- Iteration 2

After viewing papers on reference lists and citation lists of 10 papers in iteration 1. We found two new papers finally. Their sources are shown in Table 3.4. We neglect the papers from which we extracted none paper.

In summary, 107 references have been viewed, one paper is added in the final set. 39 citations have been viewed, one paper is added in the final set. We signed the two papers from P25 to P26.

Table 3.4: Results of iteration 2

ID	**Reference**	**Citation**
P14	78(0)	8(1)
P22	29(1)	31(0)
Total	107(1)	39(1)

- Iteration 3

Two papers are newly added. However, none paper is included in this iteration. Thus, the iteration is ended.

3.5.5 Classification Scheme

Pacheco and Tovar identified [30] identified three attributes related to papers of SI. The first category is studies that exclusively describe stakeholders. Paper in this category provide a list of potential stakeholders and analyze wishes from these stakeholders. Many factors are overlooked such as effort, time, money cost from stakeholder. Hence, studies in this category can't be regarded as SI. While, contributions of these papers could also be consultative to our study.

The second category is studies focusing on the interaction between stakeholders. The basic interactions between different stakeholders or between stakeholders and system have been identified by these studies. The third category is studies that include an assessment of stakeholders [29][30]. Which means diverse groups of stakeholders' importance or priority should be involved in these studies.

According to our reviews, for the aim of classify studies more clearly, we decide to add one classification to classify included papers. Namely, analysis refer to stakeholder selection.

a. Analysis refer to stakeholder selection: The main goal is not stakeholder selection, or its study partly involved stakeholder selection. Generally, studies in this category is not sufficient.
b. Exclusively describe stakeholder
c. Focus on interaction between stakeholders
d. Focus on assessment of stakeholder

3.5.6 Data Extraction

The data extraction is in line with the systematic mapping study research questions defined in section 3.5.1. The data extraction is structured by answering those questions.

3.6 Interview

3.6.1 Design

As we know the desired participants are relevant researchers or practitioners, and we found it's hard to include enough desired participants. We select interview rather than survey to evaluate our model.

On the basic of the results from SMS, we determine the suitable factors for our model. And the model is generated on the basic of the determination of those factors.

After the generation of the systematic stakeholder selection model, we performed semi-structured interview [31] to 10 experienced product managers from five game companies. To ensure the credibility, all of the ten interviewees have rich software development experience. We list the collated factors from SMS, then ask for their opinions and scores to all factors respectively. Finally, we asked for the evaluation of the processes of the models, the criteria of the evaluation are based on the model practical value's evaluation. Those results are discussed on result discussion.

3.6.2 Semi - structured interview

We conducted semi-structured interview to product managers from five game companies. The aim of the interview is to verify the importance of 12 factors that we summarized in Systematic Mapping Study, in the practical perspective. In addition, this semi-structured interview asked respondents for the evaluation to our model, to be more specific, the chosen factors and the defined procedures of the model. Those evaluations are supposed to be made according to their rich experience and knowledge. Thus, evaluate our model's practical value. Also, research question three is answered by this result.

We interviewed 10 product managers from five different game companies in China. They all have more than five years' experience and had monitored many software projects. Because of the commercial privacy, it is allowed to provide their real information.

Our interview was carried out in the form of a symposium. We met with 10 product managers from 5 companies for 30 to 40 minutes, and we divided the interview into 5 steps.

STEP 1: Introduce the topic, the purpose and the main content of the interview. 5~10 min.

STEP 2: Ask questions to the interviewees. 10~20 min. The defined problems are as follows:

Table 3.5: Questions of Interview

No.	Question
Q1	In previous projects, how do you choose stakeholders?
Q2	We analyzed the topic before the interview, and we summed up 12 factors which influence the choice of stakeholders. Do you think these factors have an impact on the choice of stakeholders?
Q3	In addition to these 12 factors, what factors do you think are missed?
Q4	Please score the 12 factors from 1 to 5 points in your opinion.
Q5	We use these factors to create a model for stakeholder selection. Can you give us your evaluations and suggestions?

STEP 3: discussion with interviewees. 5~10 min

STEP 4: Respond to interviewees

3.7 Validity

We have discussed the threat of potential effectiveness in our study, based on the experience of Wohlin Claes, et al. [32, Sec. 5.4.3]. We discussed in four aspects: construct validity, conclusion validity, internal validity, and external validity.

3.7.1 Construct validity

Constructive validity refers to the extent to which the concepts or qualities of the theory can be measured in the experiment. Construction validity is based on the appropriateness of the inference based on observation or measurement (usually test scores), specifically whether the test is to measure the expected structure. To avoid this threat to validity, in our study, we interviewed 10 software project managers with years of experience. These people have certain abilities and domain knowledge to further mitigate the threat, and those who are not familiar with the field has been excluded already.

3.7.2 Conclusion validity

Conclusion validity is the conclusion that the conclusion of the relationship between variables based on data is correct or reasonable. Its threats are usually errors that occur on the source of the data. In order to avoid this threat, after modeling, we interviewed ten product managers who have many years of software development experience. We firstly asked them to evaluate the 12 factors summarized from SMS, then verify the 6 factors we applied in the model. Finally, we asked them to evaluate

our model. For the interviewees, direct evaluation might be hard to given, thus, threat the validity of this evaluation.

3.7.3 Internal validity

Internal validity refers to the causal relationship between the independent variable and the dependent variable provided by the Institute. In interviews，our research and views might affect respondents' thinking. Therefore, to avoid and reduce the impact of our research on the expression of respondents' opinions, we only provide respondents with the goals and basic explanations of our research. There is a threat that whether the chosen factors can sufficiently reflect stakeholder's significance. We think the carefully review to the analysis to those factors from included paper can mitigate this threat. What's more, if we missed many related papers which result by poor searching strategy, the review to those papers might be far away from sufficient. Considering this threat, we combined the snowball sampling with SMS to discover related papers.

3.7.4 External validity

External validity refers to the generalization of the results of a particular study. The study has the external validity, which shows that the results can be extended to other situations. The review to relevant studies is on the basic of academic databases, while, the interview is performed in China. Those results might not reflect the condition all over the world. We think this threat is acceptable as our model is generated mainly based on the review to relevant studies, and the data collected from China act as a supplement to that process as well as the evaluation.

4 RESULTS

4.1 Results of SMS

As shown in Figure 4.1, the selection of relevant papers is conducted in five steps. By choosing databases and setting query strings, we found 702 papers at this step. The second step is screen papers by reading title, abstract, and keywords within inclusion/exclusion criteria mentioned in section 3.5.3. In this step, we included 55 papers which seems relevant to our study. Most of the paper can be excluded by title, abstract will be read when information from title is not enough to judge whether include a paper or not. Some papers have been recorded by several academic databases and be searched by us. In addition, some papers are not available somehow. We excluded 17 duplicated papers and 7 unavailable papers in the third step.

The aim of step 4 is determine papers included in start set, prepare for the snowball sampling. According to the definition of start set papers from [29], every papers included in start set should be read full length papers. Hence, we read full text of the 31 papers left by step 3, by applying the inclusion/exclusion criteria in Table 3.2, we got 10 papers included in start set.

In the last step, we extend the relevant papers by snowball sampling, namely, found relevant papers by searching the included papers' reference list and citation list. After this step, we add 16 papers in the result set. The 26 papers included in result set would be the base of our analysis.

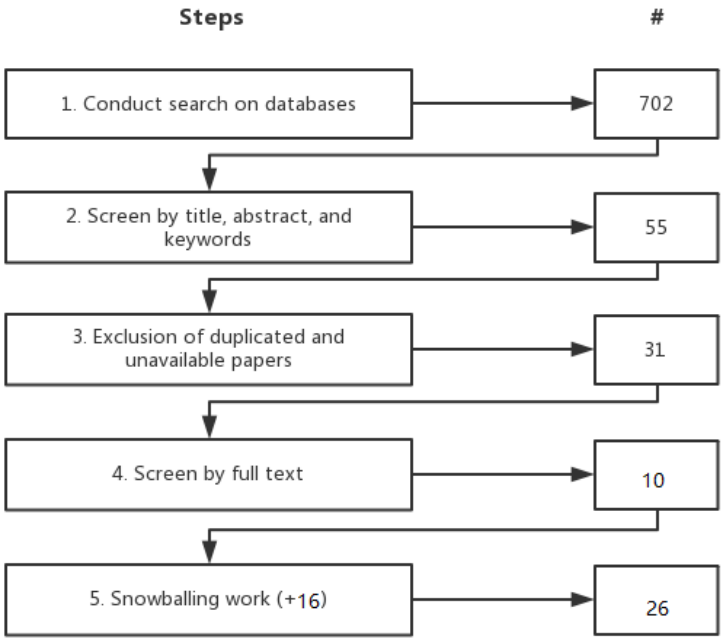

Figure 4.1: Steps of search and selection of the relevant papers

The Table 4.1 show the details of 26 included papers from SMS. We denoted them from P1 to P26, then added their corresponding reference index. The full information of those papers is shown in Appendix A.

Table 4.1: Result papers after snowballing

ID	Title	Author(s)	Year	Ref.
P1	A conceptual model for capturing stakeholders' wish list	Mrs. Vasundhara Kulkarni	2008	[25]
P2	A Stakeholder Model for Interorganizational Information Systems	Luciana C. Ballejos, Silvio M. Gonnet, and Jorge M. Montagna	2008	[17]
P3	Does it Fit Me Better? User Segmentation in Requirements Engineering	Mohammadhossein Sherkat, Tim Miller, and Antonette Mendoza	2016	[23]
P4	Effectiveness of stakeholder identification methods in requirements elicitation: experimental results derived from a methodical review	Carla Pacheco, Ivan Garcia	2009	[39]
P5	Method for stakeholder identification in interorganizational environments	Luciana C. Ballejos, Jorge M. Montagna	2008	[19]
P6	StakeNet: using social networks to analyse the stakeholders of large-scale software projects	S. L. Lim, D. Quercia, and A. Finkelstein	2010	[15]
P7	Stakeholder identification in the requirements engineering process	Helen Sharp, Anthony Finkelstein, and Gala1 Gala1	1999	[13]
P8	Stakeholder identification method in goal-oriented requirements elicitation process	Mohd Sadiq, S. K. Jain	2014	[20]
P9	Using Web 2.0 for Stakeholder Analysis: StakeSource and Its Application in Ten Industrial Projects	S.L. Lim, D. Damian, F. Ishikawa, and A. Finkelstein	2013	[24]
P10	Who is the advocate? Stakeholders for sustainability	Birgit Penzenstadler, Henning Femmer, and Debra Richardson	2013	[33]
P11	Understanding project sociology by modeling stakeholders	Ian Alexander and Suzanne Robertson	2004	[22]
P12	Stakeholders Selection for Interorganizational Systems: A Systematic Approach	Luciana C. Ballejos and Jorge M. Montagna	2006	[18]
P13	Project Clarity Through Stakeholder	Larry W. Smith	2000	[14]

	Analysis (2000)			
P14	Stakemeter: Value-based stakeholder identification and quantification framework for value-based software systems	Muhammad Imran Babar, Masitah Ghazali, Dayang N. A. Jawawi, Kashif Bin Zaheer	2015	[16]
P15	Who are the players? Finding and characterizing stakeholders in social networks	Cristina Chuva Costa and Paulo Rupino da Cunha	2010	[34]
P16	Contextual- and Behavioral-Centric Stakeholder Identification	Alejandro Salado, Roshanak Nilchiani	2013	[36]
P17	Thorny Issues of Stakeholder Identification and Prioritization in Requirement Engineering Process	Shariful Islam Majumdar, Md. Saidur Rahman, Md. Mijanur Rahman	2013	[35]
P18	A Stakeholder Perspective within Software Engineering Pro	J. McManus	2004	[11]
P19	Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts	Ronald K. Mitchell, Bradley R. Agle and Donna J. Wood	1997	[10]
P20	Stakeholder discovery and classification based on systems science principles	Otto Preiss, and Alain Wegmann	2001	[37]
P21	Selecting the right stakeholders for requirements elicitation: a systematic approach	ROZILAWATI RAZALI,FARES ANWAR	2011	[5]
P22	Essential Skills for Project Stakeholders Identification: Sustainability Perspective	Md. Mashiur Rahman, Madad Ali, Naveed Malik, Muhammad Salman Ahmad, Fahad Asmi	2017	[21]
P23	Stakeholder identification methods in software requirements: empirical findings derived from a systematic review	Pacheco, Carla & Garcia, Ivan	2008	[38]
P24	Stakeholder Identification in Requirements Engineering: Comparison of Methods	Edmundo Tovar, and Carla Pacheco	2006	[38]
P25	Stakeholder Identification as an Issue in the Improvement of Software Requirements Quality	Carla Pacheco and Edmundo Tovar	2007	[30]
P26	Stakeholders Selection Model for Software Requirements Elicitation	Fares Anwar and Rozilawati Razali	2016	[4]

4.1.1 Frequency of publication (SMS_RQ1)

The included papers were published between 1997 and 2017, and Figure 4.2 shows the distribution of those publications. It's obvious that the included studies were published more frequent on these time spans: 2006 to 2010, 2013 to 2016. This may reflect the focus change on this area as well. For example, to the 26 included papers, only seven papers were published before 2006, which might reflect the less focus on this area on that time period.

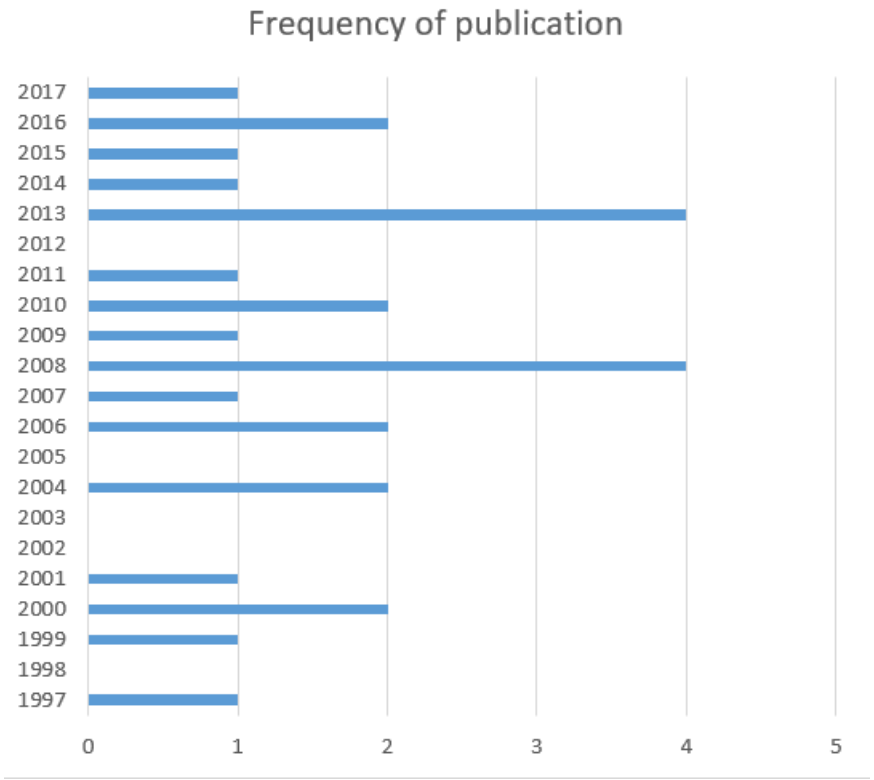

Figure 4.2: Number of included papers from 1997 to 2017

4.1.2 Application context (SMS_RQ2)

We recorded the application context of each included papers. Although our study aims to propose a model/approach to help software engineer selecting proper stakeholders to elicit requirements, and we didn't specify the application context which means general context, the studies investigate stakeholder selection in other software application context are valuable to our study. There must be many differences between various application context, but the analysis to stakeholder would be useful to us, i.e., characterize stakeholder. There four papers applied the interorganizational context, one author participated all of those papers. One paper applied value-based software engineering. Another paper focus on the Goal-Oriented software engineering. The rest papers are all about the general software engineering context. Generally, most of the included papers didn't specify their application context, which is result by the fact that most of publications in this area were investigating the "stakeholder" such as characterize stakeholder, analyze the nature

of stakeholder. The studies to a specific application context were based on the stakeholder's analysis as well.

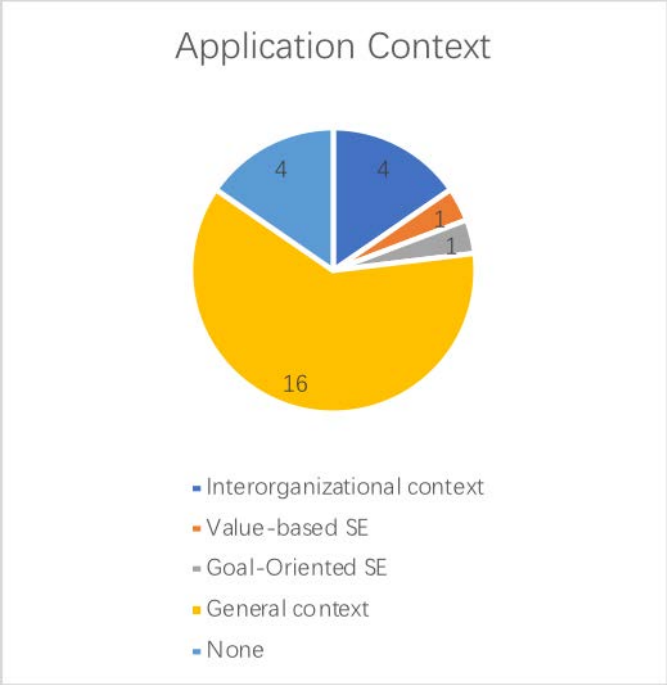

Figure 4.3: Application context

4.1.3 Technique (SMS_RQ3)

The third research question of SMS is "What are the techniques used in stakeholder selection?" We described the used techniques of each included paper. The result is shown in Table 4.2. The category in the Table 4.2 is defined in section 3.5.5.

Table 4.2: Descriptions of techniques concerning SI of software engineering

ID	Cat-eg-ory	Techniques description	Empirical evidence evaluation	Elaborate technique establish-ment
P1	a	Proposed a conceptual model to identify key stakeholders, then capture stakeholders' needs and prioritize them.	No	No
P2	b	Present a stakeholder model for interorganizational information systems, elaborately analyzed stakeholder to integrate stakeholder with requirements, design and implementation.	No	Yes
P3	a	Proposed a novel approach to segment potential and target users for the aim of provide a better insight for requirement elicitation.	Yes	Yes
P4	a	Present a methodical review of empirical	No	No

		studies which related to SI methods' effectiveness.		
P5	d	Proposed a method for SI in interorganizational environments, which take diverse stakeholder's attributes into consideration.	No	Yes
P6	c	Proposed a method for SI in software engineering, which identify and prioritize stakeholders. The social networks are used to extend stakeholder by ask predefined stakeholders recommend others.	Yes	Yes
P7	b	Proposed an approach to identify relevant stakeholders, which classify diverse groups of stakeholders into four categories.	No	Yes
P8	a	Present a method for SI in goal-oriented requirement elicitation process. This technique selects and classify stakeholders via fuzzy set theory, analyze stakeholder-based stakeholders' influence and interest to project.	No	Yes
P9	a	Identify and prioritize stakeholders via Web 2.0 technologies, such as social networking. Which is realized by asking predefined stakeholders recommend others.	Yes	No
P10	a	Identify stakeholders for sustainability of software project via four approaches. Which identify and classify stakeholders by instantiation of a generic stakeholder list	Yes	Yes
P11	b	Use an onion diagram to show different types of stakeholder and their relationships.	No	Yes
P12	d	Proposed a methodology to identify stakeholders of interorganizational software projects by taking into account the characteristics of that context.	No	Yes
P13	d	Present a stakeholder analysis method to identify and prioritize stakeholders by taking several stakeholder's attributes into account.	No	Yes
P14	d	Proposed a new stakeholder identification and quantification framework, which guides and helps the selection of significant stakeholders for value-based software systems. Used nines stakeholder factors and formulate them to help conducting its framework.	Yes	Yes
P15	c	Developed a novel approach to identify	No	Yes

		stakeholders by taking into account the specific demands of social networks.		
P16	d	Identify stakeholders in organizational fields by review existing methods, then proposed a model-based approach to overcome the limitations of previous methods by using systems thinking, as well as identifying stakeholders based on relationships between different stakeholders or between stakeholders and the system of interest.	No	Yes
P17	a	Analyzed the thorny issues of SI and SP in RE process by describing the critical phases of a successful software project.	No	No
P18	b	Examined and discussed the impact of stakeholders to software project, which include the analysis of stakeholder participation in project management process and the analysis of stakeholder's influence to the process.	No	Yes
P19	b	Generate a typology of stakeholders by contributing the analysis of three relationship attributes. Which could show the salience of stakeholders to software project manager.	No	Yes
P20	b	Based on the structure of a system, this study defined quality attributes as stakeholder-centric conditions, hence, quality attributes to software development can be handled more by discovery and classification of stakeholder.	No	Yes
P21	d	Proposed a systematic approach to identify and choose appropriate stakeholders for software project. The approach is based on analysis of elements that contribute the proper selection of stakeholders.	No	Yes
P22	a	Using literature review to investigated the essential skills that project leader needed to identify stakeholders of software project, which include skills of both internal and external stakeholders.	No	Yes
P23	a	Investigated the effectiveness of stakeholder identification methods based on review and aggregate previous empirical findings under a systematic review.	No	No
P24	a	Provided meaningful insights into the SI	No	Yes

		process in RE by conducting a comparison study to six current SI methods. And present some criteria to evaluate those methods.		
P25	b	Identify the type of papers concerning stakeholder identification.	No	Yes
P26	b	Proposed a model for selecting suitable stakeholders based on four stakeholder's attributes, then conduct case study to found the relevance of the used attributes.	Yes	Yes

According to the categories defined in section 3.5.5, ten papers referred to the stakeholder selection, although their main goal is not select appropriate stakeholder for efficient requirement elicitation. Eight papers exclusively describe stakeholder. Two papers focus on interaction between stakeholders. Six papers focus on assessment of stakeholder.

4.1.4 Affecting factors (SMS_RQ4&5&6)

Almost all the papers which in the category "Focus on assessment of stakeholder" analyzed the impact of several affecting factors to the efficiency of stakeholder selection. The affecting factors refer to the factors which are took into account when selecting appropriate stakeholders for software projects. Babar also collated the factors by conducting a literature review [9]. We followed the same pattern to collate our data. According to our in-depth review to each included paper of our SMS, for each paper, we extracted the used factors. Finally, we collated the result in Table 4.3.

Table 4.3: The focus of included papers on stakeholder's attributes

Factors	**Included papers**	#
Role	P2, P3, P5, P6, P8, P10, P11, P12, P21, P24	10
Knowledge	P5, P8, P11, P12, P21, P24	6
Influence/power	P2, P5, P13, P21	4
Interest	P2, P5, P13, P18, P20, P21	6
Relationship	P1, P6, P9, P15	4
Interpersonal skills	P14, P21, P22	3
Geographical position	P5, P8, P12	3
Abilities	P12, P14, P24	3
Hierarchy in the organization	P5, P12, P14	3
Risk	P14	1
Personality	P14	1
Responsibility	P8, P10, P14	3

Table 4.3 shows that five stakeholder attributes have been investigated more frequent relatively. Namely, role, knowledge, influence/power, interest, relationship. Limited by the number of included papers, this result can't indicate that the above five attributes are more significant than others. To realize this aim, we conduct in-depth study to the analysis of those attributes from included papers.

By reading in deep to the papers that include analysis of the above-mentioned attributes, we collated the results of valuable analysis.

- Role

In this area, role could be defined as an attribute that characterize a stakeholder population and its relationship with the software project [19]. Every stakeholder of a certain project must have specific roles, which is an important evidence to classify stakeholders [5][35]. For example, based on the roles stakeholders played, we can recognize stakeholders into different type (primary, secondary, external and extended). Stakeholders in different roles have different significance to the project, which could be judged by its participation, responsibilities, etc. The role identification that stakeholder played influence the appropriate stakeholder selection for requirement elicitation.

In addition, all papers from included papers which concerning stakeholder selection applied the role identification procedure, even if without corresponding analysis. For example, Sherkat, et al. [23] proposed an Owner Role Model to comprehensively analyze different owners' responsibilities, constraints and assumptions. This attributes could be useful to analyze stakeholders' significance [19], hence, the role could be an affecting factor to stakeholder selection.

- Knowledge

Stakeholders of a certain software project come from various backgrounds that reflect their specific knowledge [5]. According to stakeholder's knowledge, we can briefly classify stakeholder into two types: inner and outer. The inner specify person who own the software domain knowledge, these stakeholders may work in the development team or have relevant experience. On the contrary, the outer specify person who are unfamiliar to this domain. The outer stakeholders are involved may because of their business domain knowledge which bring certain values to the project.

- Influence/power

Stakeholder's influence/power indicates the stakeholder's impact to the project, to be more specific, the decisions amongst the project development [17]. Stakeholder with high influence can greatly facilitate the realization of certain tasks [19]. Ballejos, et al. [17] found that the determination of stakeholders influences should take into account the attribute "role".

- Interest

Stakeholders' interest may be built by the degree to which the desired project match their needs [5][14][16]. Stakeholder certain interest can promote zero or more project goals. This attribute is usually analyzed together with the attribute "Influence/power". Attentions to the stakeholders that have strong impact to project while hold negative interests may contribute the project's success a lot.

- Relationship

The factor "relationship" specify the interactions between stakeholders and projects or interactions amongst stakeholders [15]. The interactions between stakeholders and projects specify the particular way the stakeholder influences the

project or be influenced by the project. The interactions amongst stakeholders specify the relationships between stakeholders. Each stakeholder is socially related to others [15]. In the other way, the relationship between stakeholders can specify their needs' conflict. However, this study adopted the previous explanation since the solution to deal with that conflict beyond our thesis' scope. The social relationships could be used to discover potential stakeholders by asking existing stakeholders recommending others [15].

- Interpersonal skills

For a certain software project, stakeholders come from various backgrounds. There exist many barriers in requirements elicitation, which could be the obstacle to express stakeholders' need or explain what tasks they perform, stakeholders have conflicting views, etc. [6, Sec. 8.1]. Stakeholders are different respect to concern, responsibility, etc. [5]. The conflict always exists as the participation of multiple stakeholders. Thus, the interpersonal skills are important to remove those obstacles. On one hand, good communication skill could improve the efficiency of requirements elicitation process. On the other hand, necessary negotiation and collaboration skills could help handling those conflicts [5][35]. Requirements elicitation with the stakeholders who have poor interpersonal skills would absolutely bring more obstacles to RE process.

- Geographical position

The final representative of stakeholders may come from different place, or, the project need to collect requirements from different geographical places. Which take into account the differences of culture and preference [17][35]. In addition, since stakeholder's attitudes may change any time, this attribute should be considered when conducting face-to-face communication.

4.2 Results of Modeling

Based on the results of SMS, we determined to include six affecting factors to establish the systematic stakeholder selection model for software development.

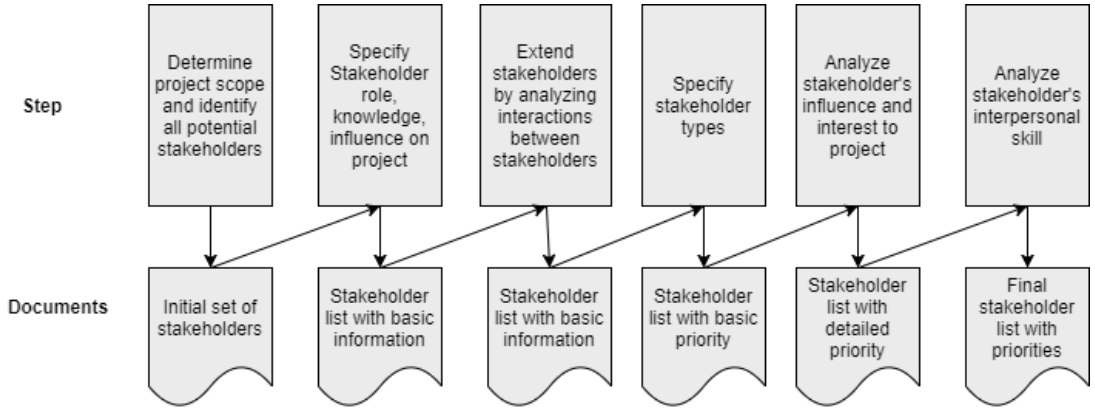

Figure 4.4: Overview of our approach

- Step 1: Determine project scope and identify all stakeholders of the project

The first step is list all stakeholders of the project by analyzing the project scope. When conducting the appropriate stakeholder selection in real software project, it's essential and necessary to identify all potential stakeholders of the project. Stakeholders of a certain project are determined by its scope, stakeholder selection is generally context-specific [11]. What's more, the rapid changing environment influenced the products' stakeholders. Thus, the actual condition may vary from project to project.

To handle this issue, Brainstorming could be very useful and convenient. To be specific, project manager can gather experienced persons in development team to discover all potential stakeholder based on analyzing the project scope. For example, discussing who will be affected (positively or negatively) by the realizing project goals? Who might offer financial or technical contributions?

- Step 2: Specify stakeholder's role, knowledge, influence on project

The aim of this step is providing fundamental information of all stakeholders. This aim is implemented by describing stakeholders' role, knowledge, influence to project. Stakeholders are grouped by role identification. That fundamental information could help systematically understanding stakeholders, as well as facilitate the following steps.

Table 4.4: Fundamental information of stakeholders

Option	**Description**
Name	Role name
Description	Briefly description of stakeholders in this role
Knowledge	Background description
Influence	Describe stakeholders' influence to project

- Step 3: Analyze relationship between stakeholders

This step aims to discover probably missed stakeholders and evaluate stakeholder's significance by means of social network technique [15]. According to investigation of [13][34], in large-scale software projects, stakeholder's significance can be reflected by applying the social network. Thus, this step can be conduct to help identifying all potential stakeholders and assess their significance in large-scale software projects. However, according to [15], the efficiency of this process is greatly influenced by stakeholder's response. Even in large-scale software projects, the involved stakeholders might respond negatively for the lack of knowledge, time or interest. Thus, this step is not supposed to applied to small-scale projects.

- Step 4: Specify stakeholder types

Based on step 1&2, step 3 specify stakeholder type to determine their different significances, which could be divided into four types: primary stakeholders, secondary stakeholders, external stakeholders, extended stakeholders [11]. Absolutely, primary stakeholders are much important than others, they are directly affected by the project implementation. For their great influence to project, any of them should be included. Otherwise, the project accomplishment will never be

sufficient. Primary stakeholders are so important because of their power, authority and responsibilities over the resources [11]. Secondary stakeholders are those indirectly affected by the project accomplishment. Although they are less important than primary stakeholders, their interest to the project should be managed well. External stakeholders come from outside the project, and they will have expectation to the project. It's important to recognize what values they can add to the project. Extended stakeholders could be those who assist other stakeholders reaching their visions.

- Step 5: Analyze stakeholder's influence and interest to project

As analyzed in SMS, influence and interest are two important attributes which have been investigated by many studies. In software development, they are also suitable to help analyze stakeholder' significance. For influence, the higher influence stakeholders own, the higher important they are. While, for interest, there is no evidence prove the same relation to stakeholder's significance. According to results of [4], some stakeholders should be selected because of their relevant knowledge even if they are not interested in the project.

In this step, these two factors are used together to analyze stakeholders' significance from a different aspect compared to step 3. We determined that stakeholders with high influence and high interest should gain most attention. The stakeholders with high influence and low interest or with low influence and high interest are less important, while, stakeholder with low influence and low interest are least important.

- Step 6: Analyze stakeholder's skill

This step takes into account the interpersonal skills. To be more specific, selection of internal stakeholders (project team) should assess their communication skills, which aims to remove the obstacle from oral communication. For the external stakeholder, except the communication skills, the negotiation and collaboration are necessary when dealing with the conflicts between stakeholders.

4.3 Results of Interview

First, we use the system mapping study to sort out the involved factors. The predetermined 12 factors are collated after SMS, those factors are investigated most frequent by previous studies. In section 4.1 "results of SMS", we selected 6 factors that we think is suitable for our model by calculating the research frequency and read in-depth to the previous analysis to those factors. However, the determination by our SMS might be insufficient as the limit of included papers' amount. Hence, in case of the big deviation which is result by that limitation, the result from interview is used to help determine the suitable factors for our model.

The semi-structured interview to 10 product managers are performed after our model's generation. To verify the importance of 12 factors from practitioner's perspective, then evaluate our model's practical value.

4. 3. 1 Results of Semi - structured interview

We have interviewed 10 experienced product managers from five game companies, all of them have worked for many years. We used this interview to ask their evaluation to 12 factors as well as our model. We defined five questions to discuss with them which are shown in Table 3.5, section 3.6.3. The details of the interview's content are recorded and attached in Appendix B.

Q1: In previous projects, how do you choose stakeholders?

All of the interviewees said the stakeholder selection is conducted on the basic of manager's experience, to be more specific, this determination is always finding who are relevant to the project. The developers and customers are always the only stakeholders. The small company even ignored this procedure.

Q2: We summed up 12 factors that influence the choice of stakeholder. Do you think these factors can impact the appropriate stakeholder selection?

According to their experience, they all agree that the analysis to factors can help selecting stakeholders. Some of the factors will be very helpful, while others are less important. Although those factors are enough to reflect stakeholder's importance, the impact of those factors depends on actual condition.

Q3: In addition to these 12 factors, what factors do you think are missed?

The following points are mentioned by them: character of stakeholders (e.g. sex and age), legality, applied development approaches, business strategies, restrictions (include contact and law), product's aims.

Q4: Please score the 12 factors from 1 to 5 points

They have different views on the 12 factors concerning their importance to select suitable stakeholders. The higher the score, the higher the importance of this factor has to stakeholder selection. The recorded scores are shown in the Table 4.3.6. We recorded the interview in text, and the content were attached in Appendix B.

Table 4.3.6: Factor score from experts

	Company1		Company2		Company3		Company4		Company5		Total (0-50)
Factor	PM1	PM2	PM3	PM4	PM5	PM6	PM7	PM8	PM9	PM10	
Role	5	5	5	5	5	5	5	5	5	5	50
Knowledge	4	3	4	5	4	3	4	3	5	4	39
Influence /Power	4	3	5	4	4	3	4	3	4	4	38
Interest	2	2	1	2	2	3	1	3	2	2	21
Relationship	3	4	3	4	4	4	3	3	2	2	32
Interpersonal skills	5	4	5	5	4	4	4	4	4	4	42
Geographical position	1	2	1	1	1	3	1	1	1	1	13

Abilities	3	3	3	4	5	4	3	4	3	3	35
Hierarchy in organization	3	4	4	3	3	3	3	3	3	3	32
Risk	4	3	3	3	4	4	3	3	4	4	35
Personality	2	1	2	2	2	1	1	1	1	1	14
Responsibility	4	3	5	2	3	3	4	2	4	3	33

From the table 4.3.6, four factors are given high importance respectively, namely, role (50), interpersonal skills (42), knowledge (39), influence/power (38). The role specifies the interaction of stakeholder to projects, it indicates the basic information of a certain (group of) stakeholder(s) which act as a name. This factor is applied by most of the included papers and recognized by all interviewees.

Most people think that interest, personality and geographical position is not important. The two product managers of a small company who usually develop some webpage games based on HTML5. They said they won't consider many factors for the small-scale projects. Instead, they only care the potential customers and the benefit. The other product managers from four big companies developed some large-scale games and published in the open market, so they will consider more factors to choose stakeholders. For example, on the basis of our 12 factors, they put forward some factors such as government, religion and race.

Q5: We used these factors to generate a systematic stakeholder selection model. Can you give us your evaluation and suggestions?

Generally, the six factors the model applied are accepted by them. They think the importance of those factors might depend on the actual condition. They suggest that we could propose a model to prioritize each stakeholder. They think our model should be more elaborate to make it practical.

In summary, the interviewees generally believe that there isn't a specific stakeholder selection standard currently. Ten interviewees have rich experience in developing software projects. They all are product managers. They believe that those factors are enough to analyze stakeholder, however, the selection to those factors depends on real conditions. They agreed that the appropriate stakeholder selection would be more accurate within a systematic stakeholder selection approach.

According to the interview, four large companies consider a more comprehensive way. They took into account many factors, and they mentioned several addition factors such as government, religion and race. The interviewed small company prefers delivering product quickly as they think their small-scale project don't need to cost too much efforts to requirements elicitation, not to speak of stakeholder selection.

5 ANALYSIS AND DISCUSSION

SMS: We carefully reviewed the stakeholder attributes investigated in included papers, the result is shown in Table 4.3. Twelve attributes are collated together with papers involved, and 17 papers referred to at least one attribute. Although we can't conclude the importance of those attributes, we initially determined six attributes that in line with our model's goals. By reading in deep of those papers, we determined those six affecting factors to software project's appropriate stakeholder selection: role, knowledge, influence, interest, relationship, interpersonal skills.

The "interest" is the only one factor that has been given low importance to selecting appropriate stakeholders, according to the analysis of [4], those papers conclude that the interest didn't reflect stakeholder's significance directly. However, that conclusion doesn't means this factor is useless. It's suitable to analyze stakeholder together with another factor "influence". For example, stakeholders with high influence on project and high interest to project are generally seen as the most important stakeholders. Stakeholders with high influence and low interest should also been handled well as their might provide new ideas from their perspectives. The purpose of our model is understanding stakeholders by analyzing them from those six factors, but not prioritizing stakeholders directly. The understanding depends on real conditions which might result diverse conclusions.

Modeling: After determination of the six affecting factors, we referred relevant approaches, then generate our model applying to the general software development context. The first step didn't involve any above factors, instead, project scope is carefully discussed to help identifying all potential stakeholders by means of brainstorming. This step aims to avoid the missing of any primary stakeholders which might result by the misunderstanding of project scope. Actually, in real software projects, both previous studies and the communication with experienced experts told us that the stakeholder selection process is viewed as a self-evident task and performed by including direct users and development team merely [17][36][37]. Our model takes into account the relationship between stakeholders to extend stakeholders which may missed by the first step. Social network technique is used in this step, based on the premise that stakeholders with more interactions with other stakeholders are of more significant [15]. However, this technique works well in large-scale software project, which reflect the complex stakeholders. Project manager could jump over this step if the stakeholders of project are obvious enough.

Our model specify stakeholder types into four types according to McManus' definition [11]. Although the significances of these types vary from type to type, the significances of stakeholders in the same type are not determined via this step. To evaluate significance of each stakeholder, the factor "influence" combined with "interest" analysis to stakeholders are added. The aim of those above-mentioned steps is not only identified and prioritize stakeholders, but also help understanding all potential stakeholders. To be more specific, analyze stakeholder's impact to the

project; view the values that stakeholders can add to project; confirm the interactions between stakeholders and project; etc. Through those steps, project manager could have a clear view of all stakeholders, and the selection of appropriate stakeholder which for the aim of efficient requirement elicitation can be accomplished via taking actual project restrictions (time, budget, etc.) into consideration.

Our model finally assesses the interpersonal skills of involved stakeholders. This procedure is not only about compare the significance between different group of stakeholders (grouped by role). Also, if possible, it can be applied to the selection of different group stakeholders' representative.

Interview: To evaluate whether our model is practical, we performed interview with 10 experienced product managers from 5 companies. All of the interviewees said they used to conduct the stakeholder selection process according to their own experience, which is performed in a casual way. This phenomenon is in line with the analysis of our study. Namely, the software projects' stakeholder selection in practice need a systematic approach.

Next, we aimed to find how experienced practitioners think about those factors' importance. To avoid affecting their minds by our research, we firstly give them 12 factors that we summarized by SMS, then ask for their opinions to those factors' importance by ranking from 1 to 5. Consequently, only the factor "interest" is controversial. They affirmed our research results. They think our model can give a guidance about appropriate stakeholder selection to practitioners, especially those inexperienced practitioners. Our model provides an insight to analyze stakeholders, furthermore, guide how to prioritize stakeholder based on the analysis. In addition, they put forward their views on our model. Some product managers also put forward that we can classify the factors that we have summarized into internal factors and external factors. However, we think the classification concerning internal and external is redundant as we already specified whether stakeholders are internal or external. This process is included on step 2, which contains the knowledge description to each stakeholder.

According to the results of interview to those experienced practitioners, the chosen factors are in line with their previous self-evidence work [39]. The interviewees accepted our model, they think our model could help giving a guidance or providing a good insight for practitioners to systematically determine appropriate stakeholders. The systematic analysis to stakeholders can contribute to efficient requirement elicitation. Hence, our model is meaningful in real software development.

6 CONCLUSION AND FUTURE WORK

Our main objective is proposing a systematic stakeholder selection model for software projects. Systematic mapping study is used to have an overview of current status of this area and review in-depth relevant analysis from related literatures. We found there are not enough relevant papers. To extend related literatures, this study conducted systematic mapping study combined with snowball sampling which finally include 28 papers. Not all of those papers investigated the appropriate stakeholder selection for software projects. Some papers are about the identifying stakeholders as much as possible, while some papers are about the definition of stakeholders. However, all included papers are valuable to our study in some way.

We determined six affecting factors to generate our model based on the analysis to related works. The six selected affecting factors are determined from relevant analysis of included papers. Through the model, project manager can have a clear overview of all potential stakeholders for a certain software project. In addition, this model analyzes stakeholders' significances from several aspects. The evaluation of our model is performed by interviewing experienced practitioners. They have participated in many large-scale software developments. We think their estimations to our model are credible.

Our study is not going to determine which stakeholders to be involved for a certain software project. Instead, we proposed the model to discover potential stakeholders and then analyze their significances from several aspects. After those analysis, project manager should determine the appropriate stakeholders based on those analysis together with actual project restrictions. In addition, this study provides a thought to this area which may help later researchers or practitioners.

There still left many aspects that could be improved. For example, a big gap of this area is how to deal with the conflicts in stakeholders' requirements. An approach to address this issue might need analyzing stakeholder's relationship; The way to test the interpersonal skills is not determined in this thesis, that approach is meaningful in practice; The social network technique could be adjusted to large-scale software development; A practical model rather than theoretical guidance could be investigated for a certain application context; The application to real software projects could evaluate the model much more credibly; There is a need for a stakeholder selection model to a specific application context.

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APPENDIX A

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APPENDIX B

Company 1

Q1	PM1: In our previous projects, stakeholders are often chosen so long as they are related to the project. PM2: We often chose those who are involved in the project as stakeholders. But there is no systematic way of selecting them.
Q2	PM1: These factors may provide help of prioritizing different stakeholders, and the prioritization influences the choice. PM2: These factors indicate what characteristics a stakeholder has. Some factors are helpful, such as role, power, while some are not.
Q3	PM1: Restraints by contracts or laws, influences on the market, etc. PM2: Such as targeted user, aims of the product, and so on.
Q4	PM1: a-5, b-4, c-4, d-2, e-3, f-5, g-1, h-3, i-3, j-4, k-2, l-4. PM2: a-5, b-3, c-3, d-2, e-4, f-4, g-2, h-3, i-4, j-3, k-1, l-3,
Q5	PM1: Each element you list above can influences the selection. And the influence of each elements is different in different projects. Therefore, you may generate a general method of prioritizing different stakeholders based on different elements. PM2: The advice is that you could generate a assessing model to assess each stakeholder based on these factors.

Company 2

Q1	PM1: We often chose stakeholders based on their roles, such as developers, customers, clients, managers and so on. PM2: We often try to include as much stakeholders as possible.
Q2	PM1: These factors are helpful for categorizing different stakeholders based on their characteristics. PM2: Some of these factors are not so helpful, because stakeholders are of groups of people. Some factors are used to describe the personalities of a certain people, not a group of people.
Q3	PM1: Requirements, restraints and so on. PM2: Restraints, business strategies, development approaches…

Q4	PM1: a-5, b-4, c-5, d-1, e-3, f-5, g-1, h-3, i-4, j-3, k-2, l-5. PM2: a-5, b-5, c-4, d-2, e-4, f-5, g-1, h-4, i-3, j-3, k-2, l-5.
Q5	PM1: The idea is that you should generate an analyzing model to analyze different group of stakeholders. PM2: The advice is that you could find a way to assessing different groups of people, not a single person.

Company 3

Q1	PM1: In our previous practice, stakeholders were often chosen when the project involved them. PM2: I agree with him that the stakeholders are basically three categories, the owner, the development team, the user, and then the subdivision.
Q2	PM1: Some are helpful, such as role, power. While some are only valid under certain situations, e.g., geographical position could only be used when the project is distributed at different locations. PM2: I think it's mainly about roles, influence, power and knowledge, and other situations may consider interest, because the final product design is designed for the masses, so interest needs to be considered.
Q3	PM1: Other factors could be business strategies. PM2: I think it's very comprehensive.
Q4	PM1: a-5, b-4, c-4, d-2, e-4, f-4, g-1, h-5, i-3, j-4, k-2, l-3. PM2: a-5, b-4, c-5, d-1, e-3, f-5, g-3, h-4, i-3, j-4, k-1, l-3.
Q5	PM1: You could generate a prioritization model to prioritize all the stakeholders based on these factors. PM2: You could be more refined, because some of the small projects may not be considered.

Company 4

Q1	PM1: Because our company is small in size, this work is generally the subjective opinion of the game planning individual. PM2: We will list all the stakeholders of the project.
Q2	PM1: I think this is very comprehensive, but some of us can't really use it. For example, geographical location, the world today is no longer a problem. Now there are global software development, so this is not a problem at all.

	PM2:I agree that these factors can be considered in the choice of stakeholders.
Q3	PM1: Sex, age PM2: You can consider the scope of the law
Q4	PM1: a-5, b-5, c-4, d-2, e-2, f-4, g-1, h-3, i-3, j-4, k-1, l-4. PM2: a-5, b-3, c-3, d-3, e-3, f-4, g-1, h-4, i-3, j-3, k-1, l-2.
Q5	PM1: I think it ok, there is no opinion. PM2: If you have a chance, you can use your model to make a comparison with the analyst who has work experience.

Company5

Q1	PM1: It is divided into external stakeholders and internal stakeholders, and external stakeholders choose customers, investors and the like. A person who selects a developer, project manager, etc. directly related to the implementation of the project. PM2: I am also divided into external stakeholders and internal stakeholders, and I sometimes consider the external stakeholders of the government and the law.
Q2	PM1: I think it is sure that these factors will affect the choice of stakeholders. But to what extent you will have to see the actual project. PM2: According to our experience, these factors are enough to find the right stakeholders.
Q3	PM1: The character of the stakeholder should be considered. PM2: I agree with him that considering the personality of stakeholders, we can choose the right way to communicate with them, which will promote the progress of projects, so this is also important.
Q4	PM1: a-5, b-4, c-5, d-1, e-3, f-5, g-1, h-3, i-4, j-3, k-2, l-5. PM2: a-5, b-4, c-4, d-2, e-2, f-4, g-1, h-3, i-3, j-4, k-1, l-3.
Q5	PM1: You can classify these factors into internal and external factors PM2: Yes, adding internal and external classifications, your model will be more practical.