JOURNAL OF SOFTWARE ENGINEERING & INTELLIGENT SYSTEMS
ISSN 2518-8739
31st August 2016, Volume 1, Issue 1, JSEIS, CADMEI Copyright © 2016
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Identification of challenges and attributes for value-based software stakeholder analysis

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ABSTRACT

Value Based Software Engineering (VBSE) deals with the development of economic driven software systems. In such systems, a business idea is implemented in order to gain the market leverage. For the realization of an idea, the requirements must be highly valuable. The valuable requirements can only be obtained from a key set of valuable stakeholders. Researchers presented different stakeholder identification and quantification (SIQ) approaches. The current approaches do not provide low level details in order to carry out the SIQ process, and most of these approaches deal at a very high level of abstraction. This paper focuses on the problems of existing SIQ process and identifies the key stakeholder attributes in order to streamline the SIQ process. In this research, a survey is conducted in the software industry of Pakistan and Malaysia. The survey reports the problems faced by the software industry in the SIQ process. Moreover, the key stakeholder attributes are also reported which may be used to solve the key problems of the SIQ process.

Keywords: value-based software; stakeholders; stakeholder problems; stakeholder attributes; requirements engineering; software process;

1. INTRODUCTION

In the value-based software (VBS) development process, an innovative idea is implemented in order to get an economic leverage. The high uncertainty exists related to the outcome of an innovative idea after its implementation. The level of uncertainty is very high in developing such systems. For the achievement of desired results, the involvement of relevant stakeholders is highly desirable in the development process of such systems [1]. The financial or cash-flow streams in case of VBS systems provide the comprehensive financial scenarios of the system in terms of investment and outcome [2].The financial streams make the VBS systems different from other traditional software applications.

Value Based Software Engineering (VBSE) processes, have a significant impact on the quality of the VBS software development. The value-based methodology, integrates the value considerations with the existing and evolving doctrines of software engineering (SE) and in the development of a new framework all these doctrines support each other [3]. Stuart Kaufman is the founder of the buzzword VBSE [4]. Barry Boehm and his mates define VBSE as "the explicit concern with value concerns in the application of science and mathematics by which properties of computer software are made useful to the people" [5]. In VBSE, the first and the foremost problem is the realization of an innovative idea. There is no earlier realization of an innovative idea by the industry, and the profitability estimation is impossible before implementation of the idea [6]. Researchers define the word value in terms of economic or monetary value of something however, with the passage of time "the scope of VBSE research expanded to include aspects of value other than economic and monetary" [5].

The success of value-based paradigm is based on valuable requirements. Requirement engineering (RE) plays a vital role in the development of innovative or VBS systems [7-9]. RE is a process that is difficult to handle, and it is not associated with the size of the industry directly or indirectly [10]. Innovation is the cause of complexity, so it becomes hard to develop such software [11]. Complexity is the result of unclear objectives that affect the overall quality of system design. It is difficult to develop such software. Such complexities can be controlled by giving due consideration to the stakeholder values at all levels for managerial decisions and elicitation of the valuable requirements [5]. Stakeholders are the key candidates who add value to the RE process by providing success critical

requirements [12]. A clear, complete and consistent requirement set helps in improving the software design and quality. The clear requirements and objectives can only be achieved by applying systematic RE approaches.

Software industry adopts different software quality assurance standards to enhance the productivity and the quality of the software applications [13-15]. This research focuses stakeholders for the development of high quality VBS systems. Researchers have presented different SIQ approaches. Most of the approaches are impractical for stakeholder analysis due to the lack of implementation details. Stakeholders are divided into different value propositions i.e. critical, important and those who may add some value in the quality and innovation of the system. There is no proper consideration of these value propositions for VBS systems. However, in spite of all these research contributions there is a need to find out key stakeholder attributes that are essential for the SIQ process.

The stakeholder is a common term in the business community and the researchers define it in different ways. The stakeholders are the participants who may be the individuals, groups, and organizations and are influenced by the system or they influence the system directly or indirectly [16]. Tom Gilb defines a stakeholder as "any person or organisational group with an interest in, or ability to affect, the system or its environment" [17]. The definitions of the stakeholders mostly delineate the same meanings and the notable differences between them are the usage of words like influence, stake, interest, and the job alteration due to system usage. Sharp et al. state that in practical scenarios, it is hard to find out all the key stakeholders with the help of these stakeholders' definitions, and most of the examples are imprecise, so it is difficult to find out a success critical set of stakeholders [18].

This research is in continuation of the systematic literature review by Babar et al. (2014) [19]. This paper has two main research themes. The first one explores the problems of different existing SIQ techniques. The second theme of the research paper covers a survey of software industries of Malaysia and Pakistan to find out the key challenges faced by the industry related to SIQ process. The second key purpose of the survey is to find out the key stakeholder attributes, which should be considered essential for the SIQ process, as reported by the industry experts.

The paper is divided into 7 main sections. Section 1 is about introduction. Section 2 describes the different existing SIQ approaches. Section 3 gives an overview of the main research questions of the study. Section 4 describes the research process in order to complete this study. Section 5 describes the results of this study. Section 6 is a description of the stakeholder attributes reported by the industry experts during this survey. Section 7 presents a discussion and the conclusion.

2. SIQ APPROACHES: AN OVERVIEW

Mitchell's theory is the most famous theory also called as Stakeholder Salience Theory. The stakeholder salience theory focuses on the power, legitimacy and urgency attributes of the stakeholders. Based on these attributes it divides the stakeholders into eight categories of *dormant stakeholders, discretionary stakeholders, demanding stakeholders, dominant stakeholders, dependent stakeholders, dangerous stakeholders, definitive stakeholders and non-stakeholders* [20]. A research study conducted by Sharp et al. has some similarity with Mitchell's theory in terms of different categories of the stakeholders. However, the study can also be termed as a pioneering study in the domain of SIQ for different software systems. The reported categories of the stakeholders are *satellite stakeholder, supplier stakeholder, client stakeholder* and the *base stakeholder* who serve in the center of the whole SIQ game [18]. The study focuses on the interactions between satellite stakeholders and baseline stakeholders. The baseline stakeholders are going to deliver products with the support of supplier stakeholders. The proposed stakeholder model by Helen et al. is shown in Figure 1.

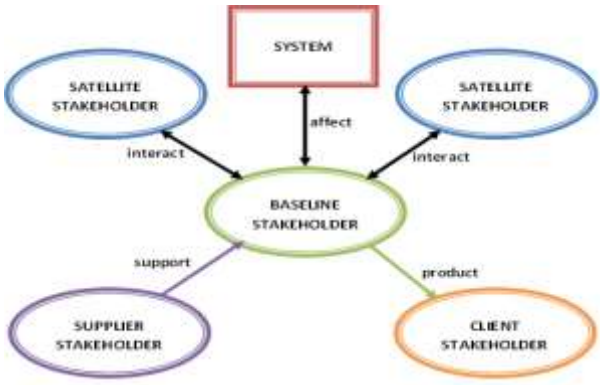

Figure. 1 Stakeholder Model by Sharp et al. [18]

The research reported by Escalona and Koch on value-based web systems presents different modelling approaches for value-based web applications [21]. These modelling approaches focus on the functional and non-functional requirements and do not focus the SIQ process. The success of VBS systems is possible only with the selection of valuable stakeholders who have an immense influence on valuable RE process. Researchers have proposed different SIQ processes, but they are not uniform. It is difficult to adopt them as a standard process especially in the case of VBS systems. The VBS systems are more critical than traditional software systems. If the requirements are not correct, it may result in severe financial losses. The research reports the different problems of the SIQ approaches. It also reports the stakeholder attributes that are essential for VBS software development.

Pacheco and Garcia state that, "there is still no Stakeholder Identification Process (SIP), framework or uniform description" [22-24]. It is difficult to select the best approach among the existing approaches [22, 23]. Most of the approaches focus on stakeholder identification and do not focus on the quantification or prioritization of the stakeholders. Different approaches have used the stakeholder attributes like influence, roles and relationships for stakeholder identification [20, 25-27]. There are some approaches that do not focus the attributes of roles, relationships and influence [18, 28]. Such a scenario delineates that there is not a common set of key stakeholder attributes for stakeholder evaluation. Different techniques focus different stakeholder attributes and lack in uniformity. Ken Power presented an approach that focuses the stakeholders in an agile environment [29]. It is a hybrid technique comprised of Freeman's method [30] and Mitchell's model [20]. There is no in depth description of stakeholder attributes that should be considered in order to identify and quantify the critical stakeholders.

Ballejos et al. presented a technique that focuses inter-organizational stakeholders based on stakeholder roles and their types [31-33].The key stakeholder attributes in the technique are knowledge, hierarchy or position, function and geographical position. The technique is beneficial, but the main issue is how to measure the relevant importance of each stakeholder. There is no proper guidance about SIQ process specially using the given stakeholder attributes. It is a profile based technique and the four above stated attributes help in the development of different stakeholder profiles. The main problem with the technique is that various stakeholders possess the same profiles with different requirements. The technique is time consuming due to its focus on identification of all possible stakeholders instead of the most critical stakeholders. The implementation of the technique is costly in terms of time consumption.

PisoSIA® (Stakeholder Identification and Analysis) technique is an extended form of PISO® (Process Improvement for Strategic Objectives) technique and is presented for information systems [34]. In PISO® framework, the stakeholders are only considered as important, and an extension is proposed to support stakeholder identification. PisoSIA® is applied, when a change is required in the development process of an information system (IS). The impact of change is then analyzed, and the new stakeholders are identified for an existing IS. Mitchell's model [20] is integrated with PisoSIA® and it is also expected that the early finding must be correct for better results. If the early findings will be correct, then PisoSIA® will work effectively and vice versa. The effectiveness of the PisoSIA® is not measured due to the lack of correct initial findings. Boonstra presented a technique for Enterprise Resource Planning (ERP) based on Mitchell's model [35]. The technique is for ERP projects and is applied when a change is required in the existing ERP projects. The impact of change is measured on the stakeholders, and the change helps to find out new stakeholders. The technique does not focus the issue of SIQ process and is not considered as a standard for SIQ process.

Babar et al. have presented a STAR Triangle in which it is shown that the software quality mainly depends on three main factors of stakeholders, requirements and testing [36]. The stakeholders are given the high priority and are placed at top in the STAR Triangle. A stakeholder identification model is proposed and the stakeholders are divided into two main categories of *functional* and *non-functional* stakeholders. The stakeholders are identified based on the factors of *business process understanding*, *experience* and *training*. The research still lacks in providing low level details and the reported factors or attributes are not sufficient for all scenarios. The solution relies on heavy expert judgement without use of stakeholder metrics. Baber et al. have also forced in systematic literature review that there is the need to explore all possible key stakeholder attributes in order to derive stakeholder metrics for quantification purposes and to propose a comprehensive framework [19, 36].

Wagner and Durr presented a five step method for value-based planning and monitoring of systems engineering projects. The main focus of the research is to solve the issues of project management. The research motivates that presently the SE practices exist in a value neutral fashion, and all the artefacts have equal importance [37]. The concept of equal importance is not viable for VBS systems. The research deals with the identification of Success-Critical Stakeholders (SCS). Researchers have used a range of techniques and tools for identification of success critical stakeholders for VBS development. Researchers have not stated the names of applied techniques for stakeholder analysis. The stakeholders are divided into two main categories of internal and external stakeholders. Figure 2 describes the internal and external stakeholders. The external stakeholders are the primary stakeholders who have an interest in the software development and are the main financiers of the project. The internal stakeholders are the secondary stakeholders who are IT experts and have an interest in a clear understanding of all the stakeholder requirements for system realization. This research focuses only primary stakeholders who have an interest in the development of the system.

Figure. 2 Project Stakeholders [37]

Glinz and Wieringa state that the "stakeholder identification precedes any other RE activity: we must first determine who they are and how important they are" [38]. There is a need to apply the statement of Glinz and Wieringa in a practical way. The features that should be considered for stakeholder identification are stakeholder interest in the system, involvement in management, introduction of the system, operation of the system, maintenance of the system, involvement in the development, their business responsibilities, the interest in terms of finance, role as a regulator in order to constrain the system and the negatively affected stakeholders [38]. The proposed process lacks in giving elaborated stakeholder attributes and SIQ activities. Razali and Anwar presented the SIQ framework comprised of three stages of *identification, filtering and prioritization* [39]. The framework is a conceptual overview of the necessary attributes that must be considered essential during SIQ process and to make RE process effective. The proposed framework provides a very high level picture and "the framework may not be conclusive as it needs to be confirmed and refined further" [39]. A technique introduced in [40] quantifies the stakeholders based on proposed

attributes using nominal and ordinal scales for stakeholder quantification. The ranking criteria are highly conflicting due to use of vague terms like high, absolutely high, moderate high, and very high. The application of these terms along-with ordinal ranking makes the whole process obscure even for few stakeholders and probably impractical for a large number of stakeholders. In a study conducted by Lindsey and Mark [41] an approach is presented for stakeholder value prioritization in order to solve the plight of "what to implement" instead of the SIQ process. There are many research contributions in which the stakeholders are part of the whole research scenarios, but the research itself does not focus the issue of SIQ process [42-47]. In these research contributions, the stakeholders are considered only in a casual way.

The current SIQ approaches focus on different stakeholder attributes with respect to different environments or domains. There is a lack of uniformity in terms of attribute selection, and few stakeholder attributes are reported in the literature. Different approaches focus differently. These approaches do not provide stakeholder metrics for their identification and selection. For the formulation of metrics, it is essential that all possible stakeholder attributes must be at hand. Different cost estimation models are proposed to calculate the investments and outcomes. Too much research is carried out on cost estimation models for VBS systems. The proposed models are mainly algorithmic and non-algorithmic. The major algorithmic models are Waslton-Felix Model [48], Nelson Model [49] and power function models like COCOMO and COCOMO II [50]. The non-algorithmic models are Price to Win, expert judgment, cost analogy, Parkinson, Top-down and bottom-up models [49-52]. However, this research does not focus on the cost estimation models. The main focus of this research is on the SIQ problems faced by the software industry in VBS domain and the exploration of all key stakeholders' attributes.

3. RESEARCH OBJECTIVES AND GAP

In each approach, the stakeholders are identified and quantified based on some stakeholder attributes. These attributes describe the technical and the non-technical characteristics of a stakeholder. Some of the attributes that are reported in different research approaches are *roles, types, influence, relationship, power, legitimacy and urgency*. However, these attributes are not sufficient for SIQ process, and there is a need to explore all essential attributes for the SIQ process. In order to know more about the challenges of the SIQ process and the stakeholder attributes, an industrial survey is conducted with respect to the VBS systems. The survey addresses two main goals. The first goal is to find out the SIQ process problems faced by the industry. The second goal is to explore all the relevant stakeholder attributes that must be considered during the SIQ process. These attributes may help to derive metrics for stakeholders. The research questions that are designed for this study are stated as follows:

The goals of this research study are stated as follows:

a) *To find out the problems faced by the industry in the stakeholder identification and quantification process for value based software systems.*
b) *To find out the stakeholders' attributes that should be considered as vital in stakeholders' identification and quantification process for value based software systems.*

The objective one is designed to find out the main problems faced by the software industry related to the SIQ process. The analysis of these problems will help to find out a way for a new SIQ framework. The objective 2 is designed to identify the key stakeholder attributes in order to formulate the stakeholder metrics. The derived stakeholder metrics will help in stakeholder quantification. The above-mentioned two main research questions are followed by the survey questionnaire and interview in order to collect the comprehensive data from industry experts. The full details, of the questionnaire and interview, are given in the research process.

4. RESEARCH PROCESS

In this research, a survey is conducted. The survey samples are chosen from Malaysian and Pakistani software industry in order to generalize the results. The samples are chosen only from these two countries due to the financial and geographical restrictions. The two major types of sampling techniques are probability sampling and non-probability sampling. In this research, the sampling approach is based on the non-probability sampling, and the convenience sampling approach is adopted for this survey. The coverage of the software industry of all countries is impossible due to financial and geographical problems. The sampling data is based on the convenience non-probabilistic approach. The survey is a two-step research survey. The first phase is comprised of a questionnaire, and the second phase is a semi-structured telephonic interview. Figure 3 shows this two steps research process.

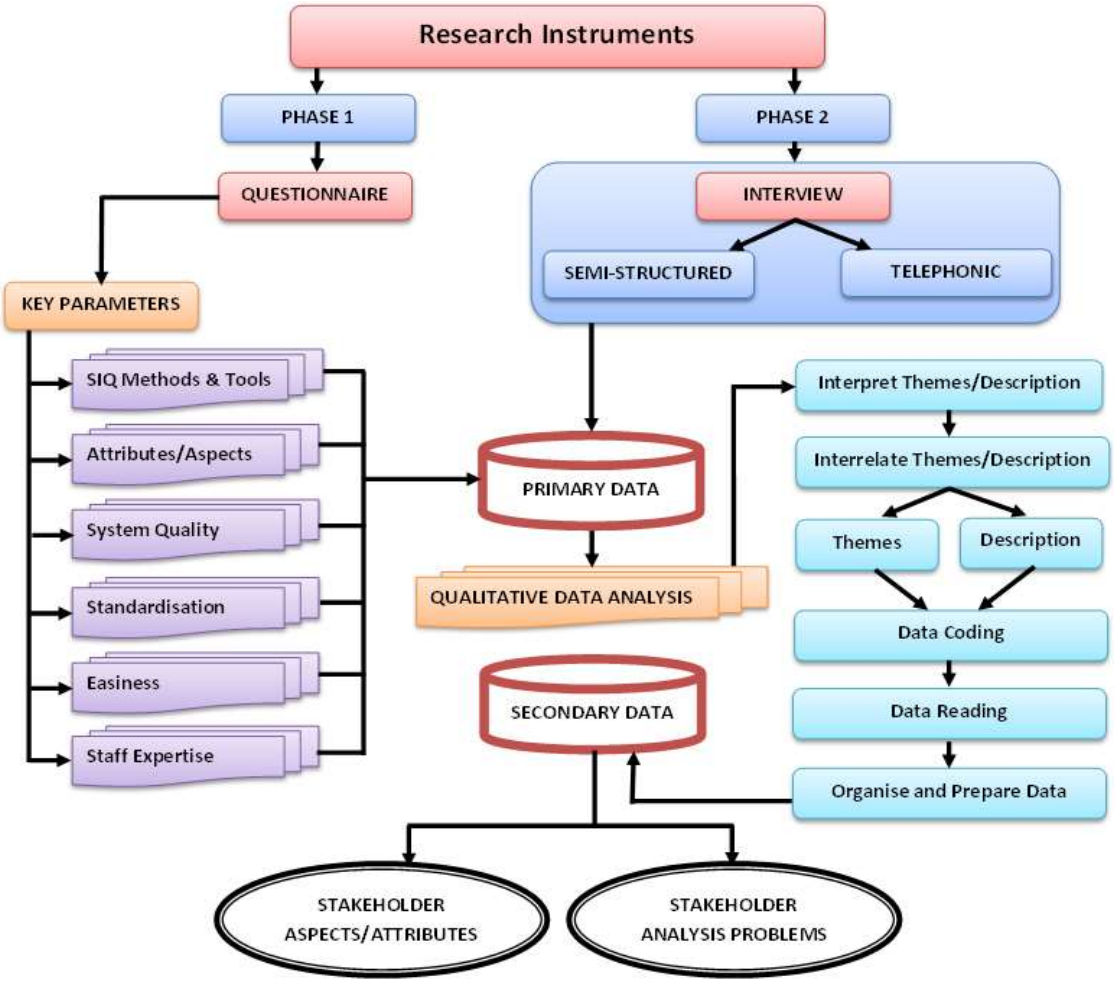

Figure. 3 SIQP Survey Research Process

The questionnaire is important in order to know the knowledge of the industry experts about the existing approaches of the stakeholders' analysis and the problems faced during application of the SIQ approaches. Furthermore, few stakeholders' attributes are reported in the literature. The questionnaire and interview will prove to explore more attributes. In the questionnaire, a variety of questions is asked in order to get a clear understanding of the experts about the key issues. Interview is used in order to know more about different issues of SIQ approaches and attributes. The interview conducted was a semi-structured interview.

4.1. Phase 1 Questionnaire

Phase 1 of this study consists of a questionnaire. The design of the questionnaire is derived from the literature and the output of the discussion with some industry experts. Some key points are used in the survey in order to know an in-depth detail of the actual SIQ practices in the industry. The points that are focused in the questionnaire are *analysis methods and tools, stakeholders' attributes, system quality, standardization, easiness,* and *staff expertise.* These factors are considered in the study in order to understand the current industrial scenarios regarding stakeholders. The questions in the questionnaire are open ended questions that are designed purposely for detailed analysis of the issue. Due to the open ended questions this research survey focuses on qualitative research instead of quantitative research methodology. The selected questions cover the following key points or parameters as shown in Figure 3.

4.1.1. Analysis Methods and Tools

In the questionnaire, the question numbers 5, 6, 7, 8, 13, and14 are based on the analysis methods and tools used in the industry for the SIQ process. This point helps to evaluate the stakeholders' analysis methods and tools that are used in the industry in the SIQ activities. These questions are used to know about clarity of the processes adopted by experts and how much understanding they possess about the critical issue of the SIQ. Furthermore, it is also focused on identifying the role of the SIQ methods and tools in managing the stakeholders and what problems are faced by the industry experts.

4.1.2. Stakeholders' Attributes/Aspects

In the questionnaire, some questions are designed to focus on the stakeholders' attributes. These attributes are essential to find out the different characteristics of the stakeholders. The key stakeholders' attributes can also be used for the stakeholders' metrics that may help in the identification and quantification of the stakeholders. These questions are made to find out all possible stakeholders' attributes for the SIQ process.

4.1.3. System Quality

These questions focus on the SIQ process with respect to the quality of the system. These questions focus system quality to find out in depth knowledge about the key attributes of the stakeholders. These questions are helpful in exploring the key problems of the SIQ process related to the system quality. The questions also help to find out the impact of key stakeholders on the quality of the software system.

4.1.4. Standardization

Some of the questions are designed to cover the issue of standardization. The point of standardization focuses on whether any standard of the SIQ process is adopted by any software organization or not. The main purpose of this question is to get an acquaintance about the existing standard SIQ processes for development of VBS systems. In an interview, the follow-up questions helped to find out the key activities of the standard SIQ process.

4.1.5. Easiness

In the questionnaire, question number 8 implicitly and question number 15 deals explicitly with the easiness of the initiation and adoption of SIQ process. The point of easiness is added in the questionnaire in order to find out the problems of SIQ process in detail. These questions also help to assess that which practices are easy and are not easy to perform in the SIQ process.

4.1.6. Staff Expertise

These questions are designed purposely in order to know the skill set of the people who handle the SIQ process. The staff expertise will help to know about the different procedures adopted by them in order to initiate the SIQ process and the problems faced by them. The questions deal with the level of expert judgment of the team. The main purpose of these questions is to explore the practices that are based on expert judgment of the team.

4.2. Study Sample Size

A hard copy of the questionnaire was sent to a total population of 123 industry experts of 57 different companies of Malaysia and Pakistan. All participants from 57 companies have an experience of more than 5 years and the experience range is between 5 to 13 years. Most of the participants included in the survey have a related experience of system analysis and design and RE practices. With respect to participants, 28% were female, and 72% were male participants. The companies are selected randomly in order to generalize the results. The sample consists of companies of smaller and larger size. The standardization of companies is also not taken into account purposely that either they are CMM, CMMi or ISO certified. Out of 123 participants a total of 87 participants responded the survey warmly and the rest were unable to respond. It was also difficult to reach 5 of the participants due to their busy schedules and geographical problem. So the total response rate for the survey was 73.73% and the sample size is comprised of 87 participants. The total response rate is calculated using the following equation [53].

$$total\ response\ rate = \frac{total\ number\ of\ responses}{total\ number\ in\ sample - ineligible} \quad (1)$$

The names of the companies cannot be shown in the demographic analysis due to the issue of data privacy. Most of the participants included in the survey possess senior positions in their organizations. The demographic analysis presented in the Table 1 shows that there are 8 Project Managers, 7 System Analysts, 9 Software Tester, 11 Software Developer, 9 Software Engineer, 12 Software Architect, 8 Requirements Engineer, 7 Business Head, 6 Team Lead, 5 Project Delivery Head and 5 Project Lead. Thus, there are 87 participants in total. Table 1 describes the profiles of the participants with respect to their experience. Figure 4 shows the percentages of the different participants.

Table. 1 Demographic analysis of respondents

Participants	Experience	Frequency
Project Manager	5-13 years	8
System Analyst	5-11 years	7
Software Tester	5-7 years	9
Software Developer	5-9 years	11
Software Engineer	5-11 years	9
Software Architect	5-9 years	12
Requirements Engineer	5-6 years	8
Business Head	8-13 years	7
Team Lead	5-6 years	6
Project Deliver Head	5-8 years	5
Project Lead	5-9 years	5
Total Participants		**87**

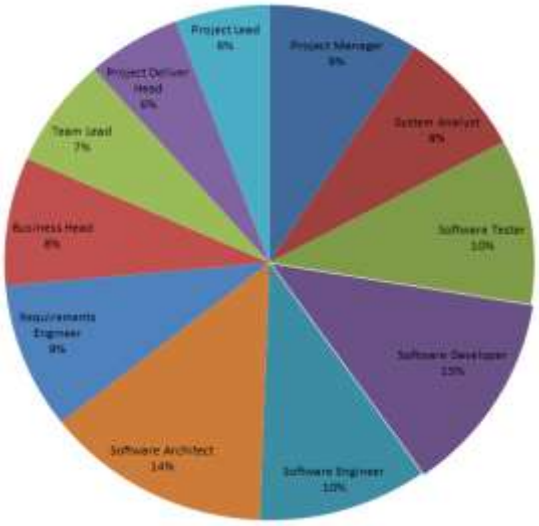

Figure. 4 Percentage of respondents

4.3. Phase 2 Semi-Structured Interview

Phase 2 of the research was a semi-structured interview from the 28 IT experts. The interview was taken from 11 IT experts of Malaysia and 17 IT experts of Pakistan. The length of the interview was from 20 to 30 minutes. These experts are selected based on their experience in the domain of requirements analysis and handling of the stakeholders. The access to these interviewees was also easy, and the interview was conducted to know more about different issues of SIQ process and stakeholders' attributes. The interview has played a vital role in documenting the core context of the problem.

4.4. Qualitative Data Analysis

In this research, a qualitative data analysis approach called thematic analysis is used which is based on the concept of themes and description [54]. The two major themes of data are SIQP problems and stakeholder attributes. The themes are interpreted, interrelated and are presented in the form of headings and subheadings. The data is analysed and coded into different categories based on themes and description. For categorisation, an open coding process is used [55]. A code is actually a data representation of an item or instance [56]. The data is thoroughly analysed and categorised based on key themes.

5. PROBLEMS OF THE SIQP

Stakeholder evaluation is essential before initialization of requirements elicitation phase. This section deals with results which are derived from the questionnaire which is the first step in the research methodology. The focal points of this activity are discussed in the previous section. Six factors are focused in order to find out the key problems of the SIQ process and to find out the key attributes of the stakeholders. We obtained the responses from 87 respondents out of 123 participants. The problems of the SIQ process that are reported by these respondents are *lack of standardization, lack of expertise, difficult to understand, unclear stakeholder attributes, time consuming, lack of automation,* and *ambiguity or uncertainty.* Figure 5 shows the problems of the SIQ process.

Figure. 5 Problems of the SIQ Process

5.1. Lack of Standardization

Out of 87 respondents, 83 have reported that the current practices that are related to the SIQ process are brainstorming and expert judgment. From this number, about 95.40% of the respondents reported the expert judgment. The evidences show that most of the practices are non-standard practices. Out of 57 companies 40 consider financiers as their key stakeholders because the information, of all the budgetary constraints, helps in managing the project scope. Some consider key positions as key fortune tellers. The views of the companies vary from entity to entity. The results depict that most of the time the key requirements are gathered from key users of the system. These users help to find out key requirements that may add economic leverage due to the innovation. In the follow up questions of the interview it is found that there is a dire need of a standard.

5.2. Lack of Expertise

It is observed that the lack of expertise is associated with the non-standardization of SIQ process directly or indirectly. About 81.61% of the respondents reported a lack of expertise in the domain of stakeholder analysis. It is

reported that usually the initiation is difficult due to the lack of standard analysis methods and tools of the SIQ process. In most of the small size companies, it is found that there is a lack of expertise in the domains of stakeholders' analysis and RE. It is usual that the RE practices are also the responsibilities of the software engineers. There is a lack of expert staff or specialized manpower, and mostly the experts do the work in different domains at the same time. However, out of 57 companies, 7 have reported that they are taking the services of a third party for stakeholders' analysis and RE. A percentage of the companies, who are outsourcing the stakeholders' analysis and requirements analysis processes, is about 12.28%. The rest of the companies follow the expert judgments or practices.

5.3. Easiness

The discussion about existing SIQ processes reveals that it is not easy to adopt any existing process quickly. The practices given in these techniques are not easy to adopt. More than 80% of the respondents reported that the lack of uniformity, in the existing SIQ processes, is the main cause of making the decision making process difficult. The practices of the current techniques are insufficient, and the VBS systems require highly sophisticated way. The existing techniques are presented for different environments and different project scenarios. The variation in the implementation scenarios makes the SIQ process controversial, and it becomes difficult to apply an existing process easily.

5.4. Stakeholders' Attributes

About 90.80% of the respondents have reported that the existing stakeholders' attributes need to be expanded, and the current attributes are insufficient. Stakeholders' attributes reflect a stakeholder both in terms of professionalism and personality. The professionalism is a key need in the software industry for economically driven applications. Professionalism is associated with some key attributes of a stakeholder, and these attributes may help in avoiding risks associated with the stakeholders. The evaluation of a stakeholder becomes easy with the presence of some key attributes and metrics. The derivation of the metrics also depends upon attributes. The current practices use different attributes under different circumstances, and this induces confusion. Industry experts urge that there is the need of a complete range of attributes for stakeholders' analysis.

5.5. Time

There is no empirical evidence of the existing techniques in the industry. The main reason of non-availability of empirical evidence as reported by 78% of the industry experts is time consumption. The application of these approaches is not in compliance with the VBS systems, where industry experts normally apply agile practices. It is reported that for agile practices industry focuses on the existing indoor procedures in order to save time. However, time is no doubt a critical factor in each and every project either it is a VBS development project or a traditional software development project. The time problem may be solved after presenting a standard automated SIQ process.

5.6. Lack of Automation

Automation of any process is directly linked with the standardization of industry practices. The 88% of the respondents reported that the industry experts follow their expert practices that are manual. Some of the organizations use standalone applications in order to manage the stakeholders manually. They have their checklists to characterize the stakeholders. However, the presence of a standard SIQ process can easily pave the way for automated decision making tool.

5.7. Ambiguity or Lack of Clarity

Out of 87 respondents 63 have reported that the current approaches are unclear and ambiguous. The ambiguity is reported in terms of the types of stakeholders, use of different stakeholders' attributes and different processes. The existing approaches have focused on different stakeholders based on their interests. Some of the stakeholders have a financial interest, some in the usage of the system, and some in automation of the existing processes. It is reported that the suitability of the current practices for VBS systems is not obvious. Table 2 lists the reported problems and response rate in percentages by the respondents.

Table. 2 Response Rate of Reported Problems

Sr. #	Problem	Percentage of Response
1	Lack of Standardization	95.40%
2	Lack of Expertise	81.61%
3	Easiness	80%
4	Stakeholders' Attributes	90.80
5	Time	78%
6	Lack of Automation	88%
7	Ambiguity or Lack of Clarity	72.42%

6. REPORTED STAKEHOLDER ATTRIBUTES/ASPECTS

Different stakeholder attributes or aspects are discussed in the previous SIQ approaches like *roles, types, influence, relationship, power, legitimacy and urgency*. These attributes are vital for stakeholders' analysis. However, there is a need to explore stakeholders' attributes in more detail in order to make the SIQ process easy to understand and easy to implement. Many attributes are reported by industry experts that must be considered during the SIQ process for the VBS systems. The different percentages of the participants have reported different stakeholders' attributes. The more importance is given to the reported attributes instead of the response percentages. The reported stakeholder attributes are divided into four main categories of personality attributes, technical attributes, personality cum technical attributes and geographical attributes. The stakeholder attribute data is categorised by using open coding process. In open coding process, data is divided, examined and categorised into different clusters of closely related items [55]. The stakeholder attribute categories are shown in Figure 6. The main purpose of the categorization is to make the understanding of the attributes easy for the novel readers. These categories further elaborate the importance of a stakeholder based on the attributes.

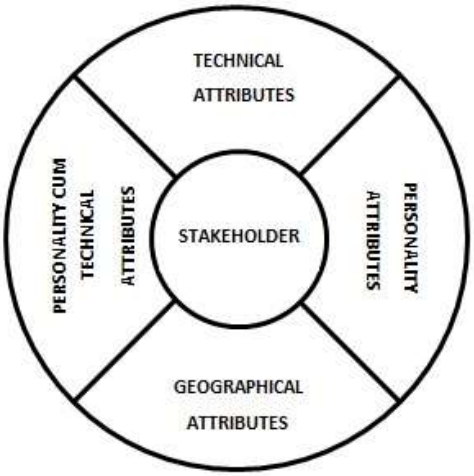

Figure. 6 Stakeholder Attribute Categories

These attributes are discussed with a team of five members of industry professionals, and based on their experiences the division of attributes is made. Out of five experts the three belongs to Pakistani software industry and two belongs to Malaysian software industry. The demographic analysis of the industry experts is shown in Table 3. The industry experts are selected based on their experience in the domains of stakeholder analysis and requirements engineering. The main purpose to select the experts from two countries is to generalize the categorization of the explored stakeholder aspects. The experiences of the experts are shown in experience column in the form of number of years in Table 3. Their industry association is shown with respect to the country in country column.

Table. 3 Demographic analysis of the industrial experts

Expert	Experience	Country	Domain
System Analyst	8	Malaysia	Stakeholders/requirements
Requirements Engineer	5	Malaysia	Stakeholders/requirements
System Analyst	7	Pakistan	Stakeholders/requirements
Business Head	10	Pakistan	Stakeholders/requirements
Team Lead	5	Pakistan	Stakeholders/requirements

Table 4 describes the frequencies of the attributes in a given data code. There are 24 technical attributes, 9 personality attributes, 8 personal cum technical attributes and 3 geographical attributes which are reported by the industry experts.

Table. 4 Attribute Frequency in Data Codes

	Technical Attributes	Personality Attributes	Personal cum Technical Attributes	Geographical Attributes
Total Attributes	24	9	8	3

6.1. Technical Attributes

The technical attributes of a stakeholder reflect the professionalism in terms of practicality and knowledge of the domain. The key significant reported technical attributes are *qualification, experience, domain knowledge, domain training, communication, interpretation, decision change, workload, system user, technical support, financial interest, practicality, authoritative, visionary, business knowledge, sub-areas expertise, problem solution finder, resource knowledge, domain scope knowledge, domain analyst, trainer, strategic executive (top level), managerial executive (mid-career),* and *operational executive (entry career)*. All these attributes deal with the technical attributes of a stakeholder and help in describing the professional maturity. The attributes mainly reflect the experiences and technical knowledge of the stakeholders about a given technical domain.

6.2. Personality Attributes

The personality attributes of a stakeholder depict the personality of a stakeholder in a number of different dimensions. These dimensions have a due weight to quantify the stakeholders. The reported attributes by the industry experts are *self-esteem, clarity, objectivity, self-confidence, immune to challenges, emotional, social impact, inspirer* and *role model*. The stated attributes reflect the extent of attractiveness of a stakeholder in terms of involvement in the RE process. Self-esteem represents the level of satisfaction of a stakeholder about his or her current job status. Self-esteem also reflects the stakeholders' satisfaction with the duties. Self-esteem paves the way to judge the consideration of a stakeholder for the given VBS software. Clarity attribute is vital in evaluating the understanding of a stakeholder about key needs. The clarity also depicts the understanding of the ideas of a stakeholder. The objectivity attribute is derived from clarity of a stakeholder. The clarity of ideas represents more objectivity and vice versa. The objectivity relates the importance of a given requirement with the intended outcome of the system. The attribute of self-confidence focuses on the confidence of the stakeholder that may be in decision making, taking some initiatives and in telling the critical needs. The attribute of *immune to challenges* describes the ability of a stakeholder to handle challenges in an effective way. Emotionalism describes the interest of the stakeholder in the project. Influence of the social factors and the ability to inspire others also help in the evaluation. The attribute of role model depicts the role of a stakeholder as a model for the other team members.

6.3. Personal cum Technical Attributes

These stakeholders' attributes reflect both personal and technical abilities of a stakeholder at the same time. The reported attributes are *managerial abilities*, *decision making*, *cognitive load*, *complexity*, *fatigue/exertion management*, *cooperative*, *performer*, and *knowledge sharer*. The dual nature of these attributes makes them special in the whole stakeholders' analysis process. The stakeholders possessing such attributes are highly important in the RE process. The managerial abilities and decision making both reflect the personality and technical know-how or grip of a stakeholder about a given technical domain.

6.4. Geographical Attributes

These attributes represent the characteristics of stakeholders with respect to the geographical position. The three main reported geographical attributes are the *language barrier*, the *time difference* and *location*. The interviewees have discussed that the stakeholders in case of VBS systems are highly distributed across different geographical positions. The different geographical positions are the cause of lack of coordination between stakeholders and development team. Industry experts handle the time and language barriers seriously in order to avoid any dire consequences. The analysis and quantification, of distributed stakeholders, is difficult in the sense that it becomes difficult to evaluate the technical side of the stakeholders. It is reported by 57% of the respondents that requirements engineers and system analysts often visit the remote area for clear understanding of the key needs of the stakeholders. The facility of conference meetings is availed across the borders.

7. CONCLUSION

The analysis of stakeholders is highly significant not only in the case of VBS system development but also in the case of traditional application development. Stakeholders are essential characters in the whole development scenario of VBS system. The current SIQ approaches are complex and ambiguous in nature, and it is difficult to apply them in software development projects. Their application, in case of VBS systems' development, is not beneficial due to the reported problems. The adoption of these techniques is difficult in the sense that most of the techniques focus different projects under different circumstances. So the possibility of adoption of one technique or the other as a standard is not possible. There is the need of the state of the art automated framework that may help industry experts in quantification of the success critical stakeholders. Keeping in view the problems of the existing techniques software experts suggested that there is the need of a systematic SIQ framework. The reported problems of SIQ process usually address that there is a need to present a framework that may help to eliminate the current problems. However, the existing approaches do not focus vigorously on the stakeholders' attributes. The attributes covered in different approaches are few, and it is difficult to quantify the stakeholders based on these attributes. There is the need of more key stakeholders' attributes that may play a vital role in SIQ process. Most of the reported problems are associated with the stakeholder attributes that are essential to initiate the SIQ process. This study has reported four distinct categories of the attributes. These categories are highly significant because using these attributes different stakeholders' metrics may be defined. The derived stakeholders' metrics will help to apply expert practices vigorously for SIQ process and will help in the initiation of the SIQ process. The application of metrics is useful in the elimination of uncertainty. The metrics will help in easy identification and quantification of key stakeholders. Metrics will make SIQ process more mature and less ambiguous. For standardization of the SIQ process, the proposed attributes and derived metrics can be used. These attributes and metrics will serve as an initial step in the standardization process. Moreover, the metrics may be automated for quick results.

It is observed from the results of the survey that there is the need of an elaborated, easy, well-defined and an automated way to solve the issues of SIQ process. The future research is based on proposing metrics for SIQ process of VBS development. The proposed metrics will be designed keeping in view the problems faced by the industry and also based on the stakeholders' attributes reported by industry experts. The proposed metrics will help in making standard guideline for SIQ process. However, the implementation of an SIQ process requires a high level of professionalism.

ACKNOWLEDGEMENT

The current research for identification of valuable stakeholders for value-based software development is initiated at Universiti Teknologi Malaysia (UTM) by Software Engineering Research Group (SERG). The SERG at UTM is a place where the innovative research is on the way to solve different software engineering problems. The research is

also going on on different high profile embedded software applications at Embedded & Real-Time Software Engineering Laboratory (EReTSEL). The authors give special thanks to Sir Tom Gilb for his kind support and to the anonymous reviewers for their valuable comments.

REFERENCES

1. Emam, K.E., S. Quintin, and N.H. Madhavji, *User participation in the requirements engineering process: An empirical study*. Requirements engineering, 1996. **1**(1): p. 4-26.
2. Tockey, S., *Return on Software: Maximizing the Return on Your Software Investment*. 2008: Addison Wesley Publishing Company Incorporated.
3. Boehm, B. and L.G. Huang, *Value-based software engineering: A case study.* Computer, 2003. **36**(3): p. 33-41.
4. Kauffman, S., *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*. 1997, UK: Oxford University Press.
5. Biffl, S., et al., *Value-based software engineering*. Vol. 1. 2006: Springer. 399.
6. Gordijn, J. and R. Wieringa. *A value-oriented approach to e-business process design*. in *Advanced Information Systems Engineering*. 2003. Springer.
7. Gordijn, J. and J. Akkermans, *Value-based requirements engineering: Exploring innovative e-commerce ideas.* Requirements engineering, 2003. **8**(2): p. 114-134.
8. Gordijn, J. and R. Wieringa, *A value-oriented approach to e-business process design.*, in *Advanced Information Systems Engineering.* 2003, Springer. p. 390-403.
9. Brooks, F.P., *No silver bullet: Essence and accidents of software engineering.* IEEE computer, 1987. **20**(4): p. 10-19.
10. Lim, S.W., et al. *The Value Gap Model: Value-Based Requirements Elicitation*. in *Computer and Information Technology, 2007. CIT 2007. 7th IEEE International Conference on*. 2007. IEEE.
11. Babar, M.I. and S.A.K. Ghayyur, *A Review of Value Based Requirements Engineering for Value Webs.* International Journal of Reviews in Computing, 2009. **1**(1): p. 1-7.
12. Boehm, B., *Value-based software engineering: reinventing.* ACM SIGSOFT Software Engineering Notes, 2003. **28**(2): p. 3.
13. Wong, B., *Understanding Stakeholder Values as a Means of Dealing with Stakeholder Conflicts.* Software Quality Journal, 2005. **13**(4): p. 429-445.
14. Wong, B. and R. Jeffery, *A framework for software quality evaluation*, in *Product Focused Software Process Improvement*. 2002, Springer. p. 103-118.
15. Wong, B. and R. Jeffery, *Cognitive structures of software evaluation: A means-end chain analysis of quality*, in *Product Focused Software Process Improvement*. 2001, Springer. p. 6-26.
16. Pouloudi, A., *Stakeholder analysis as a front-end to knowledge elicitation.* AI & Society, 1997. **11**(1): p. 122-137.
17. Gilb, T., *Competitive engineering: a handbook for systems engineering, requirements engineering, and software engineering using Planguage*. 2005: Butterworth-Heinemann.
18. Sharp, H., A. Finkelstein, and G. Galal. *Stakeholder identification in the requirements engineering process*. in *Tenth International Workshop on Database and Expert Systems Applications*. 1999. IEEE.
19. Babar, M.I., et al., *Stakeholder management in value-based software development: systematic review.* IET Software, 2014.
20. Mitchell, R.K., B.R. Agle, and D.J. Wood, *Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts.* Academy of management review, 1997: p. 853-886.
21. Escalona, M.J. and N. Koch, *Requirements engineering for web applications-a comparative study.* Journal of Web Engineering, 2004. **2**: p. 193-212.
22. Pacheco, C. and I. Garcia. *Stakeholder Identification Methods in Software Requirements: Empirical Findings Derived from a Systematic Review*. in *The Third International Conference on Software Engineering Advances*. 2008. IEEE.
23. Pacheco, C. and I. Garcia. *Effectiveness of Stakeholder Identification Methods in Requirements Elicitation: Experimental Results Derived from a Methodical Review*. in *Eighth IEEE/ACIS International Conference on Computer and Information Science*. 2009. IEEE.

24. Pacheco, C. and I. Garcia, *A systematic literature review of stakeholder identification methods in requirements elicitation.* Journal of Systems and Software, 2012. **85**(9): p. 2171-2181.
25. Preiss, O. and A. Wegmann. *Stakeholder discovery and classification based on systems science principles*. in *Second Asia-Pacific Conference on Quality Software*. 2001. Hong Kong: IEEE.
26. Young, S.M., et al. *Quality and people in the development of situationally specific methods*. in *Second Asia-Pacific Conference on Quality Software*. 2001. Hong Kong: IEEE.
27. McManus, J. *A stakeholder perspective within software engineering projects*. in *IEEE International Engineering Management Conference*. 2004. IEEE.
28. Elayne, C. and E. Tony, *The role of the stakeholder in managing change.* Communications of AIS, 1999. **2**.
29. Power, K. *Stakeholder Identification in Agile Software Product Development Organizations: A Model for Understanding Who and What Really Counts*. in *Agile Conference (AGILE)*. 2010. IEEE.
30. Freeman, R.E., *Strategic management, a stakeholder approach*. 1984, Boston: Pitman.
31. Ballejos, L.C. and J.M. Montagna, *Stakeholders Selection for Interorganizational Systems: A Systematic Approach.* The Past and Future of Information Systems: 1976–2006 and Beyond, 2006: p. 39-50.
32. Ballejos, L.C., S.M. Gonnet, and J.M. Montagna, *A Stakeholder Model for Interorganizational Information Systems.*, in *Requirements Engineering: Foundation for Software Quality*. 2008b, Springer: Berlin / Heidelberg. p. 73-87.
33. Ballejos, L.C. and J.M. Montagna, *Method for stakeholder identification in interorganizational environments.* Requirements engineering, 2008a. **13**(4): p. 281-297.
34. Davison, J., et al., *PisoSIA® a stakeholder approach to assist change in information systems development projects and aid process improvement.* Software Quality Journal, 2006. **14**(1): p. 25-36.
35. Boonstra, A., *Interpreting an ERP-implementation project from a stakeholder perspective.* International Journal of Project Management, 2006. **24**(1): p. 38-52.
36. Babar, M.I., M. Ghazali, and N.A. Dayang, Jawawi, *Software quality enhancement for value based systems through stakeholders quantification.* Journal of Theoretical & Applied Information Technology, 2013. **55**(3).
37. Wagner, K.W. and W. Durr. *A Five-Step Method for Value-Based Planning and Monitoring of Systems Engineering Projects*. in *32nd EUROMICRO Conference on Software Engineering and Advanced Applications*. 2006. IEEE.
38. Glinz, M. and R.J. Wieringa, *Guest Editor's Introduction: Stakeholders in Requirements Engineering.* IEEE Software, 2007. **24**(2): p. 18-20.
39. Razali, R. and F. Anwar, *Selecting the Right Stakeholders for Requirements Elicitation: A Systematic Approach.* Journal of Theoretical and Applied Information Technology, 2011. **33**(2).
40. Majumdar, S.I., M.S. Rahman, and M.M. Rahman, *Stakeholder Prioritization in Requirement Engineering Process: A Case Study on School Management System.* 2014.
41. Brodie, L. and M. Woodman, *Prioritization of Stakeholder Value Using Metrics*, in *Evaluation of Novel Approaches to Software Engineering*. 2011, Springer. p. 74-88.
42. Al-Ani, B. and K. Edwards. *An Empirical study of a qualitative systematic approach to requirements analysis (QSARA)*. in *International Sysmposium on Empirical software Engineering*. 2004. IEEE.
43. Barber, K.S. and S.R. Jernigan. *Hybrid domain representation archive (HyDRA) for requirements model synthesis across viewpoints (poster session)*. in *22nd international conference on Software engineering*. 2000. ACM.
44. Fuentes-Fernández, R., J.J. Gómez-Sanz, and J. Pavón, *Understanding the human context in requirements elicitation.* Requirements engineering, 2010. **15**(3): p. 267-283.
45. Woolridge, R.W., D.J. McManus, and J.E. Hale, *Stakeholder risk assessment: An outcome-based approach.* IEEE SOFTWARE, 2007. **24**(2): p. 36-45.
46. Kasirun, Z.M. and S.S. Salim, *Focus group discussion model for requirements elicitation activity.*, in *International Conference on Computer and Electrical Engineering.*2008, IEEE. p. 101-105.
47. Williams, C., et al. *Supporting enterprise stakeholders in software projects*. in *ICSE Workshop on Cooperative and Human Aspects of Software Engineering*. 2010. ACM.
48. Walston, C.E. and C.P. Felix, *A method of programming measurement and estimation.* IBM Systems Journal, 1977. **16**(1): p. 54-73.
49. Nelson, E.A., *Management handbook for the estimation of computer programming costs*, 1967, DTIC Document.
50. Boehm, B.W., *Software engineering economics.*, 1981, Prentice-Hall.

51. Shepperd, M. and C. Schofield, *Estimating software project effort using analogies.* IEEE Transactions on Software Engineering, 1997. **23**(11): p. 736-743.
52. Parkinson, C.N. and R.C. Osborn, *Parkinson's law: and other studies in administration*. Vol. 24. 1957: Houghton Mifflin Boston.
53. Saunders, M., P. Lewis, and A. Thornhill, *Research Methods For Business Students*. 3rd ed. 2003, Edinburgh Gate, Harlow, Essex CM20 2JE, England: Pearson Education Limited.
54. Creswell, J.W., *Research design: Qualitative, quantitative, and mixed methods approaches*. 4th ed. 2013: Sage.
55. Strauss, A. and C. J., *Basics of Qualitative Research. Grounded Theory Procedures and Techniques*. 2nd ed.: Newbury Park, CA: Sage.
56. Lofland, J. and L. Lofland, *Developing analysis.* Analyzing social setting, 1995: p. 183-203.

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