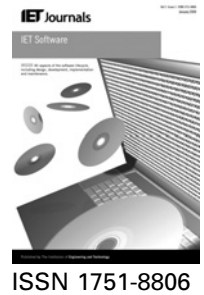


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# Stakeholder management in value-based software development: systematic review

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**Abstract:** In the value-based software (VBS) development, an innovative idea is realised in order to gain an economic leverage. The VBS systems deal with financial streams and this thing make them different from the conventional systems. The success of a VBS system is associated with a valuable set of requirements. The valuable requirements can only be gathered from success critical stakeholders. To select a set of success critical stakeholders, different stakeholders identification and quantification (SIQ) approaches are presented by the researchers. The current approaches cannot be adopted as a standard as different methods and processes are adopted in different approaches. In this study, the aim is to find out the reported evidence based attributes or characteristics of the stakeholders and their usage context in terms of their application in different domains, stakeholders' quantification metrics, the reported stakeholder types and the reported issues of VBS development. The standard systematic literature review guidelines are used as given by Barbara Kitchenham. The literature evidence shows that there is a need to explore all the possible stakeholders' attributes. The stakeholders' metrics can be derived by using the stakeholders' attributes and a new SIQ framework can be proposed for the VBS systems.

## 1 Introduction

Value-based software (VBS) system is designed based on economic perspectives. The processes, adopted in the VBS engineering (VBSE), which are value-based requirements engineering (VBRE), system analysis and design, testing and maintenance, have a significant effect on the overall quality of the VBS systems. 'The value-based approach to software development integrates value considerations into current and emerging software engineering principles and practices, while developing an overall framework in which these techniques compatibly reinforce each other' [1]. In the VBSE, the first and the foremost challenge is the implementation of an innovative idea that has not been realised earlier by the industry [2]. The economic value of the idea is associated with the clear objectives in the form of the requirements. For a successful implementation of the idea, the requirements must be correct and in accordance with the innovative idea. The value of any VBS system is defined in terms of its economic leverage.

The VBSE was introduced by Kauffman [3]. After Kauffman, huge volumes of research were introduced in this area by Barry Boehm and different new perspectives of VBSE were introduced [1, 4–10]. In the VBSE context, the value is defined in terms of financial or monetary benefit. Boehm [6] defines the 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'. The VBS systems normally deal with financial matters and this peculiarity makes them different from the other traditional software systems. In the

case of the VBSE, the uncertainty level is very high and either the innovative idea will yield the required economic worth or not. In the VBSE, the selection of valuable stakeholders is highly critical in order to yield potential results after the implementation of the innovative idea.

Requirements engineering (RE) plays a vital role in the development of any software system, and especially requirements elicitation is an important phase in the RE [11]. However, for the VBS system, the value of the RE is crucial because of the financial risks associated with the development of the system. The RE is a critical and challenging process [12] that deals with the identification of the stakeholders and the documentation of their needs that are analysed and later implemented [13]. The stakeholders are the key entities in the elicitation of the requirements, and their identification before requirements elicitation phase (REP), is highly desirable [14]. According to the 'plangauge' parameters of Tom Gilb (2005) a stakeholder is 'any person or organisational group with an interest in, or ability to affect, the system or its environment' [15]. The two major categories of the requirements are the functional requirements (FRs) and the non-FRs (NFRs). Different approaches are adopted to gather and store the FRs and the NFRs or the knowledge of different engineering projects and the stakeholders are considered as the key entities that are related to all the activities [16]. The main problem with the developed software application is that normally it does not meet the usage standards, the policies of the department and the understood norms, although the customer needs are satisfied [13]. The purpose of this SLR is to find out all the relevant attributes of the stakeholders, the usage context of

the stakeholder attributes which means the domain for which they are used, the stakeholders' quantification metrics, the reported stakeholders' types and the focused issues of the VBS systems development. The main purpose to explore the focused issues of the VBS systems development is to find out the importance given to the stakeholders identification and quantification (SIQ) process. However, the focus of our research is based on the stakeholder attributes and their usage context in terms of the domain, the stakeholders' quantification metrics, the stakeholder types and the reported importance of the stakeholders in the VBSE research.

## 2 Related work

Still no integrated SLR exists on the stakeholder attributes and their usage context in terms of the domain, the stakeholders' quantification metrics, the stakeholders' types and the reported issues of VBS development. However, there is a research conducted by Carla Pacheco and Ivan Garcia on 'A Systematic Literature Review of Stakeholder Identification Methods in Requirements Elicitation' [17]. The research published by Pacheco and Garcia divides the SIQ approaches into three different categories. The first category of the studies exclusively describes the stakeholders, the second category focuses on the interaction between the stakeholders and the third category focuses on the studies that include an assessment of the stakeholders.

There are different SIQ approaches which present different methods under different circumstances. The purpose of all these approaches is to manage the stakeholders in a successful way. A successful software project is the result of collaborative activities among different stakeholders including technical persons and all others who have stakes in the project such as clients [18]. The identification of the key stakeholders is vital for an elicitation of the valuable requirements. The success of a project is directly associated with the selection of the key stakeholders. Normally, stakeholders reject a project if the software system is not going to meet the key needs and this normally happens because of an improper identification of the requirements, and it results in longer schedules and over budget [19]. The problems of scheduling and over budget result in the abandonment of a software project. It is stated that 'one of the most difficult management issues that can arise in connection with IT projects is deciding whether to abandon or continue a project that is in trouble' [20]. Project abandonment is a routine practice in the industry for failed software development projects [21].

The SIQ approaches normally focus on different domains such as strategic management approaches, stakeholders' approaches for Information Systems (IS) and stakeholders' approaches for engineering and scientific businesses [22]. The stakeholder theory by Freeman deals with strategic management in order to identify and map the stakeholders [23, 24]. The stakeholder analysis approach for the inter-organisational stakeholders presented by Ballejos mainly focuses on the roles and the types of the stakeholders [25–27]. The key disadvantage of this technique is that there is no way to measure the importance of a given stakeholder for the system. The proposed approach is also not cost effective in terms of time. Clear guidelines are not given in order to initiate the SIQ process. The technique is based on the stakeholders' profiles and as a result different stakeholders possess the same profiles

which are also problematic in terms of the stakeholders' quantification.

It is stated by Pacheco and Garcia that 'there is still no stakeholder identification process (SIP), framework or uniform description' [17, 28, 29]. Hence, the selection of a best stakeholders' identification approach is difficult [28, 29]. Ken Power has presented a hybrid approach for stakeholders in which Mitchell's model [30] and Freemans' method [23] are used in agile environments [31]. Mitchell's model divides stakeholders into seven major categories. Power has not given indepth details of the SIQ process. However, instead of quantifying the stakeholders Freeman's method divides the stakeholders into two main categories of primary stakeholders and secondary stakeholders.

The PisoSIA<sup>®</sup> approach is applied for stakeholders' identification in the IS. The approach focuses on the identification of new stakeholders when a change is applied in the existing IS. The approach is presented in combination with Mitchell's model. The expectations of better results are associated with correct early findings. In case of incorrect early findings, the PisoSIA<sup>®</sup> will be less effective in finding new stakeholders [32]. This reason makes it impossible to measure the efficiency of PisoSIA<sup>®</sup>. The approach presented by Boonstra [33] is applied in the domain of Enterprise Resource Planning (ERP) when there is the need to incorporate a change in the existing ERP project. The approach is applying Mitchell's model in order to discover the new stakeholders after a change in the ERP project. However, the approach is not presenting any new SIQ process.

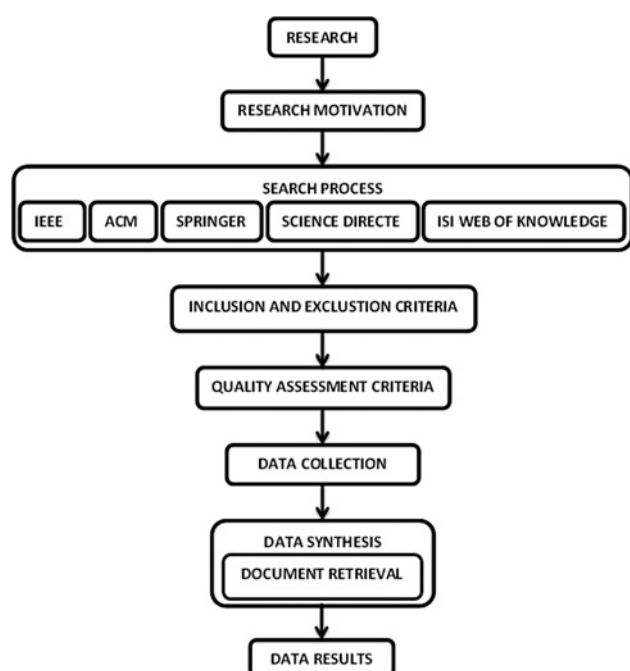
The identification of the stakeholders before the initiation of the RE process is highly essential and there is the need to know 'who they are and how important they are' [34]. Glinz and Wieringa have divided stakeholders into three main categories which are critical, major and minor. The research is unable to provide a description of the low level activities of the SIQ process. The SIQ framework presented by Razali and Anwar [35] consists of three main stages which are 'identification', 'filtering' and 'prioritisation'. The framework is not applied in any domain and this conceptual framework 'may not be conclusive as it needs to be confirmed and refined further' [35]. Some research studies discuss stakeholders as an essential part of the research like [36–41] but these studies do not focus on the SIQ process directly.

In a nutshell, the current SIQ approaches are not systematic and difficult to initiate. Hence, they are also not suitable for the VBS developmental process. The main purpose of this research is to find out the key stakeholders' attributes that are used to quantify them, the usage context of the attributes in terms of different domains, the stakeholders' quantification metrics, the different reported types of the stakeholders and the reported issues in the VBSE research. The VBSE issues will help us in finding out when due importance is given to the stakeholders of a VBS system. The published literature for this research is selected and reviewed very carefully in order to analyse the different viewpoints of this research in a holistic way. The research will help us to learn the different dimensions that may help to streamline the SIQ process.

## 3 Research method

The method, which is followed in order to conduct this research, is an SLR. An SLR is 'a means of evaluating and

interpreting all available research relevant to a particular research question or topic area or phenomenon of interest' [42]. An SLR is an Evidence Based Software Engineering (EBSE) practice. The EBSE research method is normally used in education, psychiatry and social policies [43, 44]. The SLR guidelines of Kitchenham [42] are adopted in order to analyse the research problem thoroughly. Initially a review protocol is designed in order to initiate the research. Fig. 1 describes the review protocol. The review protocol consists of the following six research stages: (i) research motivation; (ii) formulation of research questions; (iii) search process; (iv) inclusion and exclusion or the study selection criteria; (v) the quality assessment criteria; and (vi) data assessment. The research motivation is associated with the main problem domain of the VBSE and the stakeholders. The formulation of the research questions is based on a research motivation. These research questions help to explore the different dimensions of the published research in order to support the problem domain. The search process is a way to find out all the relevant published research in the domain of the focused area. In the search process, different search strings are used based on the keywords of the focused problem domain. Two different types of search strings are used which are based on the keywords of the VBSE and the SIQ processes. The search engines used for the search process are IEEE, ACM Springer Link, Science Direct and the ISI Web of Knowledge. Later, Google Scholar, CiteSeerX and Metapress were also used to find out the related research. The study selection criteria help in finding out the most relevant studies which may be used to support the research. The study selection criteria proved useful to narrow down the research process in order to find out the most relevant facts about the focused problem domain and then to propose a suitable solution and future research directions for the said problem. The quality assessment criteria helped in assessing the suitability of the research studies for the SLR.



**Fig. 1** *Review protocol*

### 3.1 Research motivation

Different SIQ approaches are the motivation of this research. The existing approaches proposed by researchers cannot be adopted as a standard because of the issue of non-uniformity. Most of the existing techniques are applied in different domains, hence they are not feasible for all the domains. It is stated in one study that ‘there is still no SIP framework or uniform description’ [28, 29]. Mitchells’ theory also known as the ‘stakeholder salience theory’ is considered as a base of the whole research in the domain of the SIQ. The three main stakeholder attributes that are considered in Mitchells’ theory are ‘power, legitimacy and urgency’. The eight categories of stakeholders that are defined based on these three attributes are ‘dormant stakeholders, discretionary stakeholders, demanding stakeholders, dominant stakeholders, dependent stakeholders, dangerous stakeholders, definitive stakeholders and non-stakeholders’ [30]. The research evidence shows that the current SIQ approaches have certain drawbacks. They cannot be adopted, for the VBS system design in order to identify and select stakeholders, because of the stated problems. In the VBS, the main focus is on the financial streams and the risk is very high. There is no guarantee in the VBS development whether the realisation of an innovative idea will yield the required financial output. The existing SIQ approaches are complex and do not provide the low level descriptions of the stakeholders’ analysis process. The importance of the stakeholders is accepted, however, the existing SIQ approaches present the stakeholders’ analysis process at a higher level of abstraction without clearly defining the low level details of the SIQ approaches. Some of the approaches evaluate the stakeholders wrongly because of the incorrect early findings like [32] and correct early findings are highly desirable for a correct stakeholder evaluation. The existing approaches are not uniform and cannot be adopted as a framework [17]. The existing SIQ approaches are costly, and time consuming [25, 27]. Mostly, the research studies are applying the existing approaches to find out new stakeholders when a change is required in the existing system [32, 33]. Owing to these reasons, the existing SIQ approaches are not suitable for the VBS development where the level of uncertainty is very high. The current techniques cannot be adopted as a framework and are not the state-of-the-art for the VBS requirements elicitation and the developmental phases. The SLR is conducted in order to find out all the reported stakeholders’ attributes and stakeholders’ quantification metrics that may contribute to propose a uniform and standard framework. Moreover, the existing studies have divided the stakeholders into different types and categories based on the key characteristics. This research also reports the different types of the stakeholders that have been reported so far. The main purpose in reporting the different types is to find out the extent of the contribution of these stakeholder types in the SIQ process.

### 3.2 Research questions (RQs)

The principal goal of this research is to review the existing literature holistically in order to analyse the different reported stakeholder attributes for the SIQ process. The research also focuses on the significance of the existing approaches for the VBS systems. The following questions are addressed in this paper:

- RQ1: Which stakeholder attributes have been reported for the SIQ?
- RQ2: What are the usage contexts of these stakeholders attributes?
- RQ3: Which types of different stakeholders and metrics are reported?
- RQ4: Which issues are addressed in the VBS development?

The reported stakeholder attributes from RQ1 will help in analysing the cause of non-uniformity of the existing SIQ approaches. The main interest in this research question is to find out whether the reported attributes are sufficient for evaluating the stakeholders of a VBS or not. Meanwhile, by using RQ2, the usage context of the stakeholders' attributes can easily be judged in order to analyse the different scenarios under which these attributes are used. RQ3 is designed to find out the reported stakeholders' types in order to differentiate the key stakeholders and the stakeholders' quantification metrics. The reported stakeholders' metrics in the studies will help to evaluate the value of a stakeholder in the REP. RQ4 is designed to find out the issues handled in the research of the VBS development. Such findings will help in gaining an insight into the interest of the researchers in the valuable SIQ process and the stakeholders' involvement in the development process.

### 3.3 Search process

The search process is performed very carefully in order to find out all the relevant studies. Well-known digital libraries are used for research papers such as the ISI Web of Knowledge, the IEEE Computer Society Digital Library, the Springer link, ACM and Science Direct. Google Scholar, Metapress and Citeseer were also taken into account for a complete collection of the relevant literature. Some of the studies were not accessible, and they are not a part of this SLR. Table 1 lists the links of the different database sources and these databases are chosen to select the research of a higher effect. The search strings are based on the proposed research questions related to the SIQ process and the VBS development. The keywords used in the search string are shown here. The search strings are applied in a versatile manner in order to find out all the related studies.

- stakeholder identification
- stakeholder quantification
- stakeholder attributes

**Table 1** List of the sources

Source ID	Name	Web Link
1	ACM portal	<a href="http://www.portal.acm.org/portal.cfm">http://www.portal.acm.org/portal.cfm</a>
2	CiteSeerX	<a href="http://www.citeseerx.ist.psu.edu">http:// www.citeseerx.ist.psu.edu</a>
3	Google scholar	<a href="http:// www.scholar.google.com">http:// www.scholar.google.com</a>
6	IEEE Xplore	<a href="http:// www.ieeexplore.iee.org">http:// www.ieeexplore.iee.org</a>
7	ISI web of knowledge	<a href="http://www.isiknowledge.com">http://www.isiknowledge.com</a>
8	Sciencedirect	<a href="http://www.sciencedirect.com">http://www.sciencedirect.com</a>
9	Springer link	<a href="http://www.springerlink.com">http://www.springerlink.com</a>
10	Wiley InterScience	<a href="http://www.interscience.wiley.com">http://www.interscience.wiley.com</a>
11	Metapress	<a href="http://www.metapress.com/home/main.mpx">http://www.metapress.com/home/main.mpx</a>

- stakeholder characteristics
- stakeholder types
- stakeholder metrics
- stakeholder analysis
- VBS development
- VBS engineering
- issues of the VBS

We have used simple search terms. The search terms are expanded based on the keywords used in the well-known research papers in the domains of the SIQ and the VBSE such as [1, 4, 6–8, 10, 27, 30, 31, 45]. All the search terms are derived from the existing studies in order to find out the answers of the proposed research questions.

### 3.4 Study inclusion and exclusion criteria

The primary studies related to the stakeholders' analysis and the VBS development are evaluated based on the empirical evidence and the proposed criteria. However, the filtering of the research studies is performed based on the empirical evidence. The inclusion and the exclusion criteria are defined as follows.

**3.4.1 Inclusion criteria:** The inclusion criteria for the different research papers are defined based on the titles and the abstracts:

- Studies which discuss the stakeholders and the VBS.
- Research studies written in the English language.
- Research studies discussing the issues of the VBSE.
- Research studies discussing the different SIQ techniques.
- Research studies that are based on expert opinion.
- All those studies which discuss the notion of the stakeholders with respect to software development.
- Research studies published in the domain of the SIQ from the year 1992 [The research study [54] published in 1992 is selected as a baseline for the SIQ research studies and is the first study of its kind that focuses on the identification of an acknowledged expert in the domain of the knowledge-based systems.] to 2011.
- Research studies published in the domain of the VBSE from the year 2000 to 2010.

**3.4.2 Exclusion criteria:** The exclusion criteria are based on the following key points:

- Website articles.
- The studies published in languages other than English.
- The duplicate studies.

The duplicate studies are those studies which have the same title and are retrieved from different databases. These duplicate studies are not included in the SLR without compromising the loss of any valuable data. However, there are some studies which are presented in different versions and these studies are evaluated very carefully and the most suitable version is considered as a valuable asset for this SLR such as [25–27].

### 3.5 Quality assessment criteria (QAC)

The study of the QAC helps in interpreting the results and to elaborate the value or the strength of the conclusions [46]. The QAC is designed to ensure the quality of the primary



**Table 2** Quality assessment criteria

ID	QAC	Feedback	Score
1	does the study focus on the related problem domain?	yes = 2/partially = 1/no = 0	
2	does the study explicitly focus on the stakeholders' identification process?	yes = 2/partially = 1/no = 0	
3	is the study about the software development process?	yes = 2/partially = 1/no = 0	
4	is the study about the VBSE?	yes = 2/partially = 1/no = 0	
5	does the study discuss the software stakeholders' attributes?	yes = 2/partially = 1/no = 0	
6	is the study about the problems of the stakeholders' identification process?	yes = 2/partially = 1/no = 0	

studies which is based on a checklist. The checklist is used to assess the quality of the studies as proposed in [47, 48]. The QAC checklist is formulated based on generic questions that are related to the problem domain. The purpose of these questions is to find out the most relevant studies, and to include them in the SLR. Table 2 describes the QAC checklist.

The QAC is applied in order to find out the key reported evidence based studies in the domains of the SIQ and the VBS development. We have analysed the studies based on the proposed questions and if a study answers the questions in yes then two points are given to this study. On the other hand, if a study answers the questions partially then 1 point is awarded to that study. The study which does not answer the questions is awarded with 0 points. The main purpose of the QAC is to find out the relevance of the study with the intended research questions of this SLR. Initially, we found 373 studies and after the application of the QAC we have found 4.02% of the studies suitable for the SIQ process and 6.97% of the studies were found suitable for the VBS development. Hence, a total of 10.99% of the studies are found appropriate for this SLR.

### 3.6 Data collection

The data collection stage in the SLR is highly critical. For the data collection and the referencing we have used the Endnote software [49]. Furthermore, for data collection we have analysed each study fully in order to find out the relevant information which may help in answering our proposed research questions. To answer *RQ1* we have collected the data from those studies that focus on the stakeholder identification process based on the key attributes of the stakeholders. The studies which focus on the stakeholders directly or indirectly based on the key stakeholder attributes are included in this SLR. For *RQ2* those studies are covered which focus on the application of the stakeholders attributes in the different domains of the software systems. All those studies are also covered which focus on *RQ3* and a due consideration is given to the studies based on the reported stakeholders' types and metrics. The study of the reported metrics will help in finding out the significance of the existing metrics and will also pave the way for a derivation of the new metrics. For *RQ4* all those studies are considered that discuss the different issues of the VBS systems in order to find out how much importance is given to the SIQ process in the existing studies. Different VBSE

studies are considered based on the stakeholders' attributes, the reported stakeholders' types, the metrics and the issues of the VBS development.

### 3.7 Data synthesis

Data synthesis describes the results, in a summarised way, collected from the primary studies [42]. In the data synthesis part, the evidences are collected in order to answer the proposed research questions. The data is synthesised both quantitatively and qualitatively in this SLR. Initially, the research studies, related to the SIQ process, are analysed based on the reported stakeholders' attributes, their usage context and the reported stakeholders' types. Table 4 describes the overall summary of the SIQ research in Section 4. Based on this initial scrutiny of the stakeholders' studies *RQ1*, *RQ2* and *RQ3* are answered. *RQ1* answers all the reported stakeholders' attributes in the selected primary studies of the SIQ process. *RQ2* answers the usage context of the reported stakeholders' attributes and Table 5 describes the detailed summary of the usage context of the attributes. *RQ3* answers the reported stakeholders' types and the proposed metrics for a stakeholders' analysis. The studies related to the VBSE are also analysed thoroughly in order to find out the reported issues. The issues of the VBSE are evaluated in order to find out the extent to which due importance is given to the stakeholders. Table 7 represents the summary of the reported issues of the VBSE. Based on the results given in Table 7 *RQ4* answers the different reported issues of the VBSE in detail and the studies are categorised based on these reported issues.

### 3.8 Document retrieval

During our search process, we have found 373 papers in the initial stage. In the first stage, we have rejected 265 studies based on the title and the abstracts. Initially, we have analysed 108 papers very carefully and a total of 41 studies were selected out of which 15 are related to the stakeholders and 26 are related to the VBS development. Those studies are selected in the domain of the stakeholders which mainly cover the SIQ process in the domain of software development or present a stakeholder analysis approach.

The initial assessment is performed by two researchers on 108 research studies. The primary researchers initially selected 42 papers including both the domains of the SIQ process and the VBS development. Dr. Dayang, Head of the Software Engineering Department, UTM, Malaysia, served as an independent researcher and she has analysed

**Table 3** Data retrieval steps

Data retrieval steps	Total papers
initially retrieved research papers	373
papers rejected on the basis of the titles and the abstracts	265
papers analysed by the primary researchers	108
papers selected by a primary researcher	42
papers analysed by an independent researcher	18
papers rejected by an independent researcher	1
papers selected for the SIQ process	15
papers selected for the VBS development	26
total selected papers	41

**Table 4** Summary of the SIQ techniques

Study #	Year	Reference	Context/domain/principle	Stakeholders' type	Reported stakeholders' attributes
1	2011	[50]	IS	group	role, influence in terms of power, activity and interest
2	2010	[38]	Generic Software Engineering		activity
3	2008	[27]	Inter-organizational systems	stakeholders' with same characteristics, internal and external	role, function, geographical position, knowledge, abilities, hierarchy in the organisation, importance and influence
4	2001	[51]	generic software engineering/systems science	goal stakeholder for a suprasystem, means stakeholder for a suprasystem, goal stakeholder for the system under consideration and means stakeholder for the system under consideration	interest in the behaviour of the suprasystem, interest in the way the suprasystem achieves its behaviour in terms of its structure, interest in the perceived behaviour of the system under consideration and interest in the way the system under consideration achieves the behaviour in terms of the internal structure
5	2006	[33]	ERP/effect of change	used the types defined by Mitchell's model [30]	power, legitimacy and urgency
6	1997	[30]	who and what really counts?	dormant stakeholders, discretionary stakeholders, demanding stakeholders, dominant stakeholders, dependent stakeholders, dangerous stakeholders and definitive stakeholders	power, legitimacy and urgency
7	1999	[52]	IS/managing change	driver stakeholders, influencer stakeholders	influence in terms of power
8	2005	[53]	IS/failure		Freeman's framework [23] is used and the reported attributes are potential interest, stakeholders' coalition with shared objectives or interests, roles and inter-relationships
9	1997	[22]	IS		the spring model is applied [54], and the relationship between the past and the current situations is used based on expert perceptions
10	1992	[54]	knowledge-based systems/spring model		the relationship between the past and the current situations is used based on expert perceptions
11	2004	[18]	Generic Software Engineering	primary stakeholders, secondary stakeholders, external stakeholders and extended stakeholders	influence, power and interest
12	2007	[34]	Generic Software Engineering		use of interest, responsibility, roles and risk
13	2011	[35]	Generic Software Engineering	mandatory stakeholders, optional stakeholders and nice-to-have stakeholders	role, education, experience, job scope, interest inventory and personality test
14	2010	[31]	Agile Software Product Development		power, legitimacy and urgency
15	2010	[55]	Social Networks, Recommender Systems		roles and influence/power

the 18 papers chosen randomly from a list of accepted and rejected papers. However, she has rejected 1 paper. Finally, 41 papers were added in this research. The data retrieval steps are described in Table 3.

**Table 5** Attributes usage context

Attributes' usage context	Studies	Total
IS	[22, 50, 52, 53]	4
Generic Software Practices	[18, 34, 35, 38, 51]	5
knowledge-based systems	[54]	1
ERP	[33]	1
ASDP	[31]	1
inter-organisational systems	[27]	1
social networks and recommender system	[55]	1

## 4 Data extraction results

The research conducted by different researchers, on the SIQ process, focuses on the issue differently under different circumstances for different domains. Numerous studies are reported by the researchers on the stakeholders, and there are few which focus on the SIQ process. To conduct our research, we have found only 15 most relevant studies which focus on the SIQ process or the attributes of the stakeholders and 26 studies are selected which focus on the VBS development and the associated issues. The included studies about the SIQ were published in the time bracket of 1992–2011 whereas the selected VBSE studies are published in the time frame of 2000–2010. The specific studies are selected to support our research questions. Fig. 2 shows the yearly publication statistics of the published research in the SIQ domain. Fig. 3 shows the yearly publication statistics of the published research in the VBSE

in order to find out the different reported issues. The selected studies of the VBSE will help us in finding out that when due consideration is given to the stakeholders of the VBS. Most of the research in the VBSE was conducted in the years 2006–2010.

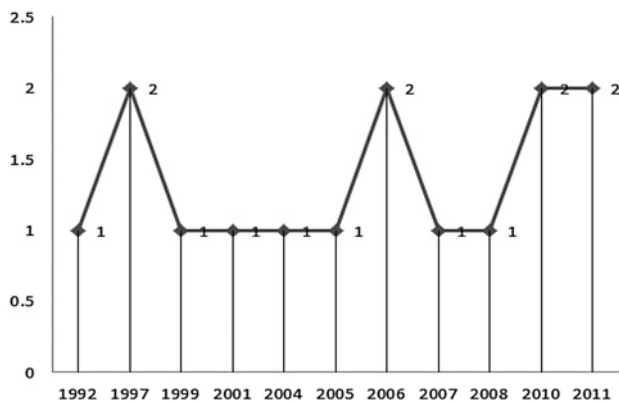


Fig. 2 Selected stakeholders' identification studies

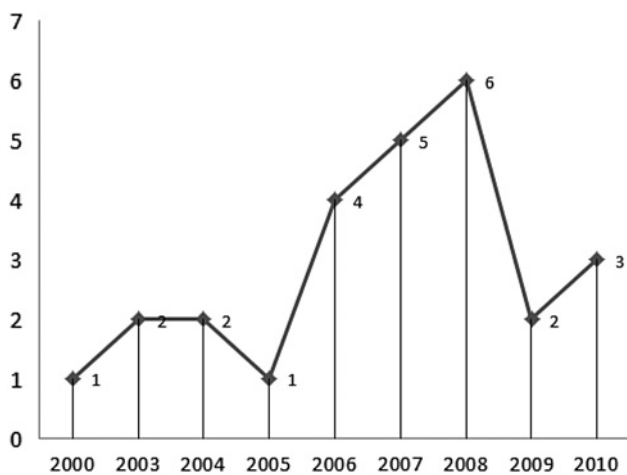


Fig. 3 Selected VBSE studies

#### 4.1 Stakeholders' identification and the quantification techniques

Table 4 describes a summary of the reported proposed techniques with respect to the reported stakeholders' attributes and types in different contexts. Here, the aim is to find out all the reported attributes of the stakeholders that are used in the SIQ process under different contexts. The identified research papers exclusively focus on the identification of the stakeholders. The identification process mainly deals with the suitability of the stakeholders for a given software project in the REP. In the generic stakeholder web, there are two major types of stakeholders that are called internal and external stakeholders. The subcategories of the stakeholders all come in the domain of these two main stakeholders' types. Table 4 deals with *RQ1* and *RQ2*, and it reports the attributes, the context or the domain of the research, the principle applied, the meaningful subcategories or the types of the stakeholders.

#### 4.2 RQ1 reported stakeholders' attributes

The research questions *RQ1* and *RQ2* focus on the two main areas of the stakeholder attributes and the context in which these attributes are applied. The main purpose in finding out the stakeholder attributes is to identify the frequency of the different attributes that are used in the different SIQ approaches. The frequency of an attribute tells the importance of an attribute that is used in different methods and domains. The two words influence and power are used alternatively as an attribute but they are same in meaning. Hence, the word power is taken into account. It is evident from the research that the four most important attributes are power, interest, role and urgency. The other reported attributes are few and are used in few studies along with the four most important attributes. Fig. 4 depicts the usage of the different attributes in different studies. If we move in a clockwise direction, it is observed that the frequency of the other attributes reduces quickly. Most of the studies just report the usage of these attributes in their proposed research frameworks and do not describe the evaluation of these attributes for the stakeholders. The attribute of power has a usage frequency of 7, the attribute of interest has a usage frequency of 6 and the attributes of role, urgency and

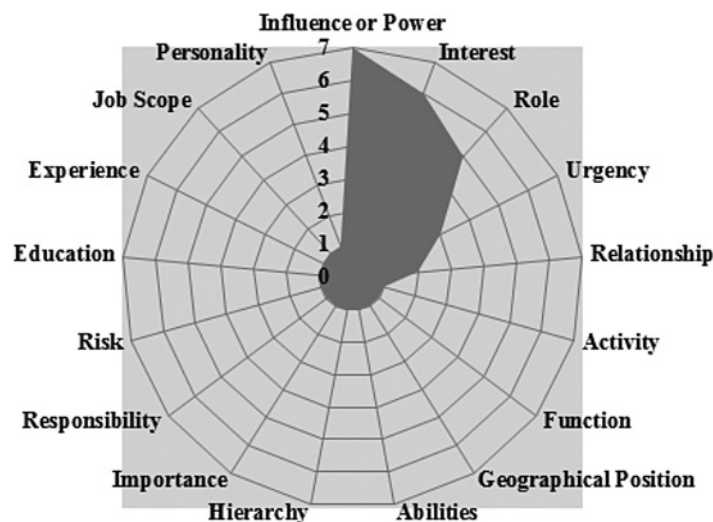


Fig. 4 Stakeholder attributes

relationship have usage frequencies of 5, 3 and 2, respectively, whereas all the other attributes have usage frequency 1.

The reported attributes of the stakeholders are divided into two main categories which are 'emphasised attributes' and 'non-emphasised attributes'. The emphasised attributes are those attributes that are used frequently in different studies such as power, interest, role and urgency, whereas the usage of the non-emphasised attributes is not frequent and is rare. The reported emphasised and non-emphasised stakeholder attributes, in the existing SIQ frameworks, are very limited. Mitchell's model is one of the initial models for the stakeholders, and in it the attributes of power, legitimacy and urgency are used in order to identify and quantify the stakeholders [30]. Mostly, in the existing studies, the researchers have adopted Mitchell's model as a whole or partly in order to support their research. From the statistics, we can conclude that the attribute of power is the focus of 46.6% of the techniques. The attribute of interest is the focus of 40% of the techniques. The attribute of the role is focused on by 33.3% of the techniques. The attribute of urgency is focused on by 20% of the techniques. The attributes of activity and relationship are focused on by 13.3% of the techniques whereas all the other attributes are focused on by 6.6% of the techniques.

The reported attributes are used in the research studies without defining a precise usage criterion. The studies do not report how to apply these stakeholders' attributes under different circumstances. There is no description of any standard way in order to assess the value of the different stakeholders by using the reported attributes. Some of the attributes are used in a few studies or in a single study, and it is difficult to find out the generalisation of the results after using these attributes. Most of the techniques use these attributes at a very high level of abstraction, and they do not provide the different detailed activities in order to apply the different chosen attributes. The reasons for the chosen attributes or the existing methods are not given.

#### 4.3 RQ2 reported stakeholders' attributes usage context

The application of the different SIQ approaches is not uniform and the reported approaches focus only on a few domains and different methodologies are applied. Out of the 15 studies, four focus on the domain of the IS. Five studies focus on the stakeholders' attributes in the generic software engineering practices. The rest of the studies focus on the diverse domains and are using the stakeholders'

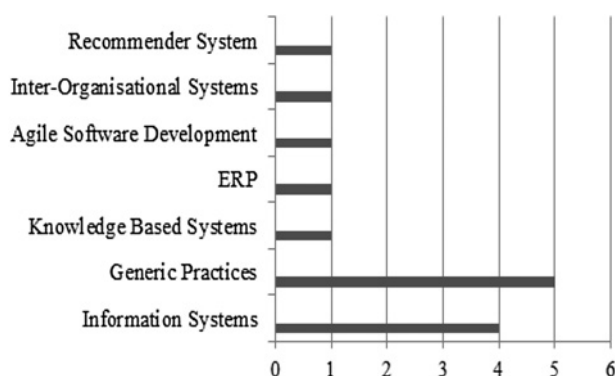


Fig. 5 Usage context of the attributes

attributes in different domains such as knowledge-based systems, ERP, agile software development (ASDP), inter-organisational systems and recommender systems. Two of the studies focus on the research based on some principles in order to find out the key stakeholders such as 'Who and what really counts?' [30] and the system science principle [51]. Table 5 describes the different studies with respect to their context.

Fig. 5 describes the frequencies of the studies focusing on the different usage contexts. The figure shows the total number of studies on the x-axis which covers the different reported usage contexts on the y-axis. The application of the different proposed SIQ approaches for the VBS systems is insufficient and not viable because of the lack of focused dimensions. The reported stakeholders' attributes are insufficient, and it is difficult to assess a large number of stakeholders based on a few attributes. There is a need to find out more key attributes of the stakeholders. The insufficient number of the reported attributes makes the SIQ process impractical and demands a high level of expert judgment. There is a huge diversity in the conducted research and most of the processes are not repeatable because of the vague guidelines. Such a diversity in the application is the cause of vagueness of the proposed SIQ techniques. There is no evidence of a single technique that is applied on more than two projects at the same time. The reported contextual information also delineates the insufficient experimentation of the existing SIQ approaches. This evidence makes the existing SIQ approaches impractical for the VBS development. The suitability of these approaches is challenging for the development of the VBS, where a high financial risk is associated with the developmental process.

#### 4.4 RQ3 reported stakeholders' types and metrics

The first part of RQ3 is related to the reported stakeholders' types. Eight papers report different types of stakeholders. These papers are mentioned in Table 4 along with the reported types. We have divided the reported studies into the following three main types:

1. Studies that do not present any stakeholder type.
2. Studies that present specific types of stakeholders.
3. Studies that report the stakeholder types in a generic way.

Fig. 6 describes the frequencies of the different studies with respect to the stakeholders' types. Most of the studies do not define the stakeholders' types and the stakeholders are treated in a casual way. Out of the 15 studies, seven do not report any type of stakeholders. The generic stakeholders' types are those types which define the stakeholders at a very high level of abstraction into two or three main categories, such as the internal and the external stakeholders, the primary or the secondary stakeholders and these are reported by four studies only. The specific stakeholders' types are those types of stakeholders that are defined based on the key characteristics of the stakeholders and they are also reported in four studies only. The reported stakeholders' types are not beneficial for the SIQ process. These types are not helpful in finding a critical set of stakeholders. When we use the term critical set of stakeholders then there is no need to categorise them into different types. The involvement of the key stakeholders is essential based on the particular functionality of the system. In the VBS development, there is no need to divide the stakeholders



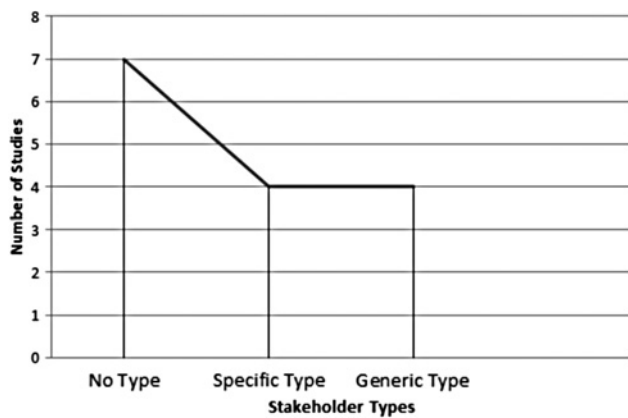


Fig. 6 Stakeholders' types

Table 6 Studies based on the stakeholders' types

Stakeholders' types	Studies	Total
no type	[22, 31, 34, 38, 53–55]	7
specific type	[30, 33, 51, 52]	4
generic type	[18, 27, 35, 50]	4

into different types. In the VBS development, a critical stakeholder is one who is considered important in gaining a small percentage of the market leverage. When we talk in terms of the market leverage the phenomenon of the stakeholders' types becomes useless.

Table 6 describes the different studies and their classification based on the types of the stakeholders.

The second part of *RQ3* is related to the reported stakeholders' metrics. From the literature, there is no evidence of the proposed metrics that may be used to identify and quantify the stakeholders. However, the reported few stakeholders' attributes may contribute in the formulation of the stakeholders' metrics. The metrics help in the judgment or a numerical evaluation of something and serve as a well-defined criterion.

#### 4.5 RQ4 addressed issues of the VBS development

The research conducted by different researchers, on the VBS systems, focuses on issues such as the realisation of an innovative idea, requirements or viewpoints clarity, business goals, QoS, value in terms of profitability, software process and system design, runtime issues, cost, time/schedule, value exchange, release planning, decision making, risk analysis, monitoring and control, business modelling, software architecture, uncertainty, communication and stakeholders, respectively. Table 7 shows the frequency of the research conducted on the different issues in order to design high quality VBS systems. The literature evidence shows that too much stress is laid on the requirements. The research which is conducted so far lacks in providing a proper framework for the inclusion and the exclusion of the stakeholders during the requirements gathering phase of the VBS systems. The works that focus on the stakeholders are few in number. The focus of the stakeholders is on a very high level of abstraction, and there is no quantification and categorisation of the stakeholders in the form of a framework or in the form of a refined stakeholders' analysis process. This research focuses on the analysis of the

Table 7 Problems addressed in the VBSE

Problem category	Problem addressed	Study	Total studies
1	innovative idea or competitive product problems	[2, 56, 57, 58]	4
2	requirements/viewpoints clarity/business goals problems	[2, 56, 58–70]	15
3	QoS problems	[58]	1
4	value/profitability problems	[1, 2, 8, 58, 59, 61, 62, 66, 68, 71, 72]	11
5	process design problems	[2, 56, 57, 73]	4
6	software design problems	[64, 74]	2
7	runtime issues	[58]	1
8	cost issues	[1, 9, 58, 60, 71, 72, 75]	7
9	value exchange problems	[58]	1
10	release planning problems	[59, 60]	2
11	decision making problems	[8, 59, 61, 65, 68]	5
12	risk analysis	[9, 63]	2
13	monitoring and control	[1]	1
14	business model	[61, 67, 76, 77]	4
15	SW architecture	[71]	1
16	uncertainty	[72]	1
17	communication	[74]	1
18	stakeholders	[2, 8, 9, 56, 59, 65]	6

stakeholders in a more rigorous way. There is a need to integrate the stakeholders' analysis with the VBS developmental process especially with the VBRE process.

The literature evidence shows that the realisation of an innovative idea is based on the process of its exploration. The exposure of the innovative idea within a specific timeframe is considered as vital for business value. The realisation of this new idea is associated with the production and the introduction of a new software product in the market or industry. Different studies are conducted by the researchers on a value based paradigm in order to resolve the issues and to find out the new secrets of this domain. Most of the techniques focus on the issues of the requirements and the design in the VBSE domain. There are only a few studies in which the researchers tried their best to integrate the very notion of the stakeholders' analysis with the VBRE. In this section, the literature evidences are collected in order to find out when due consideration is given to the stakeholders for the VBS and the type of the problem domains.

The reported studies on the VBS development focus on a diverse range of problems. However, the studies which report the stakeholders in the usual manner are six in number. In the real essence, these studies do not focus on the SIQ rather in these studies the significance of the stakeholders is highlighted. The focused research areas in the different VBSE studies are highlighted briefly in the coming sections. We have divided the studies into different categories based on the issues handled in these studies such as innovative idea, cost and return on investment (ROI), issues of project management, issues of RE, software architecture, software design, value creation and stakeholders.

**4.5.1 Innovative idea:** Gordijn and his colleagues have presented a value-based approach  $e^3$ -value for the

exploration of an innovative idea in the domain of e-commerce and to estimate the benefits associated with it. The claim, made in the research is based on the argument that previously the analysis of the expenses or the cost incurred and the benefits regarding the innovative e-commerce ideas, is not sufficient. Based on this claim a value-oriented approach is presented that focuses on a requirements analysis and the design of the business process along with an analysis of the expenses and the benefits to all the actors regarding the innovative e-commerce idea. The approach e<sup>3</sup>-VALUE helps in a clarification of the business model decisions 'by modelling the end-to-end value activities and exchanges in the e-commerce stakeholder network' [2, 61].

**4.5.2 Project management:** The research conducted by Wnuk *et al.* [75] is based on the idea of the value of an individual feature of a product in the market. The model which is presented here is not supportive for dynamic environments. According to researchers 'the model presented here represents the decision-making criteria as temporal functions, not absolute values, which facilitate their use even in dynamic situations with uncertain scoping decisions'. The research focuses on the concept of COST and ROI. About the 'Earned Value Management System', Boehm and Guo state that it 'provides a useful technique for monitoring and controlling the cost, schedule and progress of a complex project. The technique has absolutely nothing to say about the stakeholder value of the system the project is developing. It serves a purpose, but needs to be incorporated into feedback control systems that focus on the real stakeholder value being earned' [1].

Wagner and Durr presented a five step method for a value-based planning and monitoring of the systems engineering projects. The main focus of the research is project management. The approach states the activities of project management for developing complex software-intensive systems. The main activities are 'to plan the project by selecting processes, methods and resources and to control the project by monitoring mainly cost and schedule, the so called earned values' [56]. A range of techniques and tools is used for the SIQ, and the description of the techniques is not given. The major consideration is on the brainstorming method for the SIQ. The stakeholders are divided into two major categories of internal and external stakeholders, and a list of the stakeholders is given.

**4.5.3 Requirements engineering:** Arnautovic and Kaindl conducted a research on the self-managed systems, and it is argued that the current self-managed or autonomic systems, which are highly complex, are not aware of the economic value. The research also deals with the QoS problems. It is argued that the current VBSE approaches for the RE are not feasible for the self-managed systems specifically with respect to the operations of these systems [58].

Ghada and Guy conducted a research on the development of the value driven e-commerce systems that require a business innovation and also a responsiveness because of the innovation. The traditional approaches for the analysis and the design of the e-commerce systems are problematic. The research focuses on the business processes, modelling the value-added services and their importance for the e-commerce systems. Moreover, there is also the need for the self-organising practices that may help in an

improvement of creative thinking and self-reflection for solving a given problem [57]. To handle these problematic situations, a new software RE methodology is proposed based on brainstorming sessions. Requirements volatility is a critical problem in the VBRE process especially for the web-based services. The volatility in the user requirements for the web-based services is highly dynamic and continuous even at the time of service [62]. Owing to this reason, the web companies always focus on satisfying or meeting the requirements of the users from the market. The REP is costly and longtime. The companies perform the REP in order to find out the situations where the users are not satisfied with the needs, and for it an effective REP can be advantageous. A model called the 'Value Gap Model' is proposed for the REP which helps in the selection of the user requirements. The model helps the requirements engineers on different key factors in order to find out the value keeping in view the intended users. The quality requirements of the stakeholders are described in a qualitative way, for example, 'the response time must be fast or, we need a highly available system' [63]. This qualitative representation of the requirements makes the requirements ambiguous because of which their verification is very difficult. The research by Glinz deals with the problems that are associated with the qualitatively represented requirements. The approach focuses on the risk associated with a system because of the unsatisfied stakeholders regarding the quality system requirements and the way to mitigate this risk at a low cost [63].

The RE, for the value-based web applications (VBWA), is an important discipline. The VBWA satisfy the needs of the different stakeholders along with some additional FRs and NFRs as compared with the other applications [67]. The innovative e-commerce applications are designed based on innovative solutions, hence the VBRE is extremely important in order to fully exercise the economic notion. The methodologies which are proposed for the development of the value-based applications mainly focus on the issues of system design and there are few that focus on the importance of the VBRE. In this approach, there is an integration of the VBRE with the WebML models and for this integration the VIP business modelling framework is used. The research by Escalona and Koch focuses on three main architectural viewpoints for which the stakeholders show their interest. The three viewpoints are the business value viewpoint, the business process viewpoint and the software architecture viewpoint, respectively. Moreover, it is found that no one has applied the said business analysis method in the VBWA development. A comparative study is performed and ten different approaches are analysed, and it is found that the major focus of these approaches is on the FRs and the NFRs [78]. The research presents a framework that integrates the system design models of the web modelling approaches with the value business models. Zarvic *et al.* conducted a research in which the business-IT alignment is discussed between the value web business models and the IS of the companies that want to implement the business model [76]. The traditional approaches of the business-IT alignment mainly focus on a single company, but the current approach for the value webs focuses on various independent businesses.

**4.5.4 Software architecture:** Ojala states that the software architecture is highly important for the companies which create the structures of highly competitive products. Companies mainly focus on the issues of cost, valuable

software development, higher productivity and cost-effectiveness. The work implements the process, the principles and the concept for assessing the value of a software architecture. It is concluded that the proposed method is useful in assessing the value of the product through a software architecture [71]. The major focus of the approach is to find out the valuable requirements for the intended system in order to meet the requirements of the stakeholders.

**4.5.5 Software design:** Cabrero *et al.* presented a value-based approach for 'choosing the best design strategy from requirements'. The existence of different software design solutions is helpful in satisfying the same software requirements. There is no method that may help in quantification of the value added by the selected software design solution. A new method is proposed in order to calculate the value of the selected software 'design strategy starting from requirements' [64].

**4.5.6 Value creation:** Value creation mainly deals with the value-creation criteria for software or product quality improvement. The VBSE is helpful for companies in order to gain a competitive market leverage in a global economy [65]. The VBSE associates the software development with the financial streams and the business objectives. On the other hand, the RE is used to add value to a software product. It is stated in the research that 'purchasers, users, software managers and developers all have different perspectives on what is valuable in a software release's functionality' [65]. These different perspectives are problematic for the decision criteria of the developers and the value-creation criteria of organisation which is interested in product development. After resolving these stakeholder conflicts, the companies can easily obtain a market leverage. The research focuses on how companies perceive a high value of the software by selecting the high quality requirements. The proposed VBSE methodology is based on the following three steps. The first step is given importance here which emphasises the SIQ process for the VBS system development. The research does not focus on the SIQ process exclusively, and the first step is only a part of the research process. The only issue, which is dealt with in this research, is associated with the conflicts of the different stakeholders regarding the decision and the value-creation criteria.

The 4+1 theory is an initial theory of the VBSE. The stakeholder win-win theory W is at the centre of this theory, and it addresses the two major research questions that are 'which values are important?' and 'how is success assured?' [8]. The 4+1 VBSE theory considers all the aspects of computer science and the 'managerial aspects of software engineering, plus considerations involved in the personal, cultural and economic value involved in developing and evolving successful software-intensive systems' [8]. Barney *et al.* conducted an empirical study in Australia in order to assess the software product value through a release planning by covering the concept of the software product lines. The RE process is used to understand the perception of the software industry professionals regarding value creation in release planning. The issues of the software product are considered with respect to the context such as the marketplace and the product age [59].

**4.5.7 Stakeholders:** The stakeholders are the main focus of this SLR. There are few VBSE studies that focus on the

stakeholders casually and these studies do not handle the stakeholders in terms of their identification and quantification. The studies such as [2, 8-9, 56, 59, 65] focus on the importance of the stakeholders, and do not discuss the SIQ process exclusively. As discussed, the VBS systems normally deal with the financial streams and this thing makes them distinctive from the other traditional systems. Hence, there is a need for a specific SIQ process that may help in gaining a market leverage.

## 5 Discussion

The research in the domain of the VBS development focuses on the importance of the success critical stakeholders. The importance of the stakeholders is accepted, but the available studies on the SIQ are not applied in the domain of the VBS development. The current available techniques on the SIQ are analysed in terms of their suitability for the VBS systems. It is concluded that the existing SIQ approaches are not suitable for the traditional software development, hence the suitability of these approaches for the VBS development is also not acceptable. The stakeholders have a deeper effect on the quality of the software. The software quality is measured based on the performance of the system, the services provided by the system and the acceptance of a system by the intended community. The software quality in terms of the VBS development is associated with the economic benefit obtained from the application. From the name VBS, it is evident that the system under development is of a very high value and quality for its intended users in terms of its services, acceptance by the stakeholders and economic value. If the system will reflect the minds of the stakeholders it will yield a high acceptance in terms of quality and high economic value.

The requirements are termed as the needs of the stakeholders who are interested in the development of the VBS. The empirical study shows that the existing stakeholders' attributes are insufficient for the VBS systems. There is a need to explore more attributes which may help in finding out a key set of the VBS stakeholders for the REP. From the literature, it is evident that the current stakeholders' analysis studies are non-framework based and provide a very high level picture of the SIQ process. To make a VBS project successful there is a need to properly look into the analysis of the stakeholders who can play a vital role in the RE and the design processes. There are certain characteristics of the stakeholders which must be taken into account before making their participation necessary in the VBS development process. The findings about the current stakeholders' analysis approaches show certain problems, as discussed before, because of which it is not possible to adopt them for the VBS development. There is a need to take the initiative to present a new SIQ framework for the VBS development.

The empirical study shows that the stakeholders play a vital role in the success of the VBS development. The participation of all the required and critical stakeholders is very essential in the developmental process of a VBS system. Without the support of the success critical stakeholders, it is not possible to develop a system of high quality. A sufficient range of the success critical stakeholders is needed for the innovative software projects. The software quality and the stakeholders are knotted with each other. If the stakeholders will be success critical in terms of their value then the

software quality will be high otherwise there will be a compromise on the software quality. There are few limitations of this research. The conducted review is holistic, however, the search process is manual and not automated. Hence, there is a possibility of missing some studies which focus on this research. The studies published in the languages other than English are not part of this research. The studies are selected based on comprehensive guidelines hence the studies published in the highly valuable databases are included in this research. Lot of research is conducted in the domains other than software development, hence the research about the SIQ of the other domains is not a part of this SLR.

The research results help in making the directions for the SIQ with respect to the VBS development. The existing stakeholders' attributes are not sufficient. The proposed SIQ approaches are not only suitable for the traditional system, but they are also not suitable for the VBS. Based on these key problems, there is a need to initiate a research in the following areas:

- To conduct a survey to find out the problems faced by the industry during the SIQ process.
- To conduct a survey to find out all the possible stakeholders' attributes that may be considered as critical for the SIQ process.
- To characterise the stakeholders based on the responsibilities.
- To propose the stakeholders' metrics to make the SIQ process easy.
- To propose an SIQ framework in easy steps.

## 6 Conclusion

The VBS development mainly focuses on the economics driven software applications. The VBS systems are characterised in terms of the commercial software products. The development of such products is a very difficult job. The innovative RE approaches are required for a value-centred business, and these approaches integrate the benefit with the application for the companies. Hence, for designing an innovative VBS application of good quality there is a need for a quantification of the values of the stakeholders and the information provided by them. The valuable stakeholders and valuable information have a deeper effect on the software design and ultimately on the overall quality of the software systems. The value is being taken as a principle, standard or quality considered worthwhile or desirable for software quality improvement. The current research on the VBSE focuses on the different problem domains, and there is almost no research on the identification and the quantification of the value-based stakeholders. In some of the research studies, the importance of the SIQ process is considered as vital but an effective solution is not provided for the problem. In this SLR, it is noted that there is a need to explore the problems of the SIQ faced by the industry and to explore more stakeholders' attributes. The explored attributes will help in a derivation of the stakeholders' metrics which can be used in the SIQ process.

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