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A systematic literature review on the software requirements elicitation issues

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***Abstract*— Software requirements elicitation is an important and essential pre-requisite to the subsequent phases in software development lifecycle. There is an increasing focus on how industry performs elicitation as this has a direct influence on the overall project success. Researchers and practitioners have consistently observed poor requirements elicitation to be one of the key causes for project failure. Hence, it is important to understand broader elicitation issues and challenges, and address them on a large-scale, especially on geographically distributed software development framework, on which current project execution trend lay. There are studies focusing on requirements elicitation, but they are relatively small. There are also studies that focus on specific parameters related to elicitation that are discussed in a generalized manner. There is no substantial research in this specific area that provides a comprehensive view of elicitation issues along with its causes and effects. This paper attempts to provide a summary of the systematic literature review (SLR) findings from 81 papers. The findings are based on causes of poor elicitation, elicitation issues and challenges, consequences of poor elicitation, advisable practices and classification of elicitation issues. The authors have leveraged cause-and-effect diagrams to draw conclusions on SLR.**

Keywords- software requirements engineering, software requirements elicitation, elicitation issues, systematic literarture review, cause-and-effect

I. INTRODUCTION

Requirements elicitation (RE) is an essential and an important pre-requisite for subsequent phases in any software development project [18]. As identified, it is the most critical activity of software development; poor execution of RE will almost certainly draw projects to a failure [1].

RE is a practice [19] that aids in determining customers, users and stakeholders needs' in building systems and software that can result in a high probability of satisfying such needs. It is, probably the most complex part of requirements engineering and demands attention, especially in Global Software Development (GSD) framework, so as to minimize the impacts of failures [57]. A flowchart of elicitation activities in GSD scenarios is depicted in Figure 1. Since failures are uncontrolled, it is likely that improving how industry performs elicitation would have dramatic effects on project success [16]. It becomes imperative to understand potential elicitation issues, so that preventive measures can be taken to overcome, avoid or plan to address them in a manner that minimizes the negative effect on the product quality and overall project success.

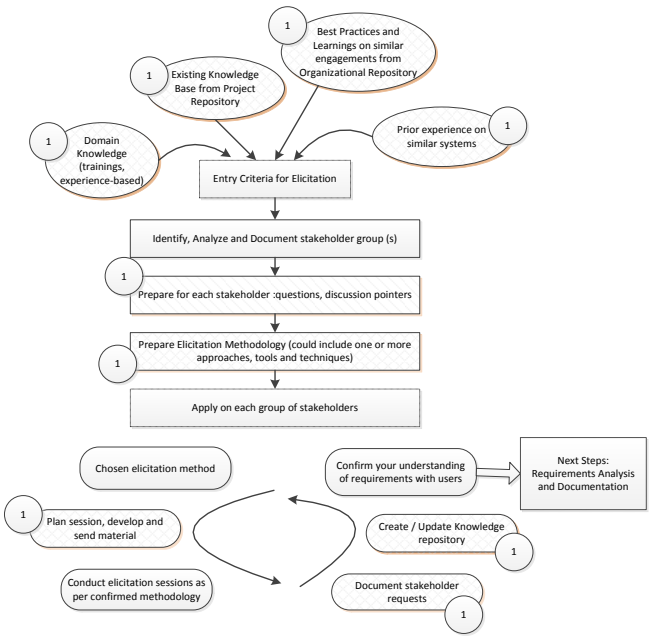

Figure 1. Customized RE approach on GSD Model [57]

Researchers and industry practitioners are cognizant about most project failures being attributed to poor requirements [57]. There have been several mechanisms designed to overcome critical elicitation issues. Despite such effort, issues persist and continue to impact project quality

and success. Theoretical and empirical investigations in RE have exposed related problems that one encounters in certain projects types [16, 14, 21, 1], but there is no comprehensive study that discusses RE issues, challenges, causes, effects and best practices which can guide researchers and practitioners to perform elicitation in an effective manner. Bridging this gap makes the study unique.

There is not any comprehensive study on elicitation issues done or documented that can support researchers and practitioners in conducting effective elicitation or enhancing their current processes that can aid in elicitation. This study is an attempt to bridge this gap through five stages.

- Firstly, the aim is to identify the problems that cause poor elicitation through the theoretical and empirical studies that have been reported;
- Secondly, to provide an insight into the root causes of such problem that surface throughout the execution of elicitation;
- Thirdly, extract the effects or consequences as reported for such causes as it exist in current literature;
- Fourthly, determine the best practices and recommendations for an effective elicitation; and
- Lastly, summarize taxonomy of elicitation issues and challenges.

The author has reviewed similar studies to make an effective presentation on the SLR process and its results [16, 76]. This study is also part of an academic research and an extension to the author's work presented in the WICT 2013 [88]; the related research framework is discussed in [57].

The rest of the paper is structured as follows. Section II discusses related work done in this field and emphasizes the need for a systematic review. Section III describes the research methods adopted for conducting the SLR. The outcomes of this systematic review are discussed in Section IV. Section V is discusses in detail on the about the classification of the elicitation issues following by the limitations of this study in Section VI. The conclusions and future work are highlighted in Section VII.

II. BACKGROUND

A. Related work

There is neither any substantial literature available that determines the overall RE issues nor the presence of a comprehensive collection of cause-and-effects of poor RE through systematic reviews. The absence of such a study is the primary factor driving the need for an SLR in this specific area of requirements engineering. There are, however, studies in specific dimensions or parameters that influence elicitation such as requirements, stakeholders, communication, scope, human factors, change, etc. some of which are briefly discussed in the remaining section. Researchers have focused on these dimensions for better understanding of related issues and challenges in RE. They have also been able to furnish advisable practices and recommendations on what, in their view, may help overcome similar issues and challenges. The focus of these practices and recommendations might be contextual, dealing with specific nature of projects. In such cases, a generalized view may be overlooked or missing.

Scope

There is an increased understanding on requirements scoping and its impact on the overall requirements engineering process and project success. The influence of poor scoping exercise and its drastic impacts on the overall project quality is understood. Research has reflected avenues of achieving more realistic scope by means of their empirical studies [14, 28].

Stakeholders

Stakeholders have played critical roles in global RE and researchers have focused in providing guidance on their identification, role, participation that can improvise elicitation [11, 22]. Global RE problems have been studied and methodologies have been constructed to minimize related challenges as discussed in [34, 53, 58, 65, 67].

Communication

Understanding communication problems [5, 14, 24, 28, 31, 32, 33, 61] and measuring communication gaps has been studied [3], given the level of importance communication demands in RE. Multiple types of communications and their influence on the overall project performance are also theoretically and empirically examined.

Tools, techniques and methods

Davis et.al, [1] conducted systematic reviews on empirical studies concerning effectiveness of elicitation techniques. Several researches present meaningful insights into the features of different types of techniques and methods, based on which a practical guideline for method selection is also suggested [6, 9, 10, 15, 18, 25, 29, 38, 40, 53, 54, 60, 68, 75].

Human Factors

Viller et.al [66] reviews human sciences when working as groups, individuals and organizations. This reflects requirements engineering and in turn elicitation, as social a process that can impact system failures through varied human behaviors.

Requirements

RE revolves around capturing requirements. This is an area that poses major challenges as there are several aspects to capturing requirements effectively. Poor requirements can encompass, for example, bad requirements, lack of domain expertise resulting in poor understanding of requirements [2], poor consultation with users [2], requirements not completely known at the start of development cycle [8] and mis-interpreted requirements [8]. This is a parameter that significantly influences the elicitation process and the

overall quality of the software. Project failures are largely attributed to this parameter.

Based on the nature on projects

RE is a sensitive activity and can have varied influence on projects depending on its nature. For example, web-based RE [48, 50, 59, 82], RE in legal projects [47], market-driven RE [49, 78, 80], contextual RE [71], etc. require specific methods to be adopted for conducting effective elicitation and dealing with related issues.

B. Need for a systematic literature review

RE consumes a fraction, but an impactful percentage of the software development lifecycle. Increased and continued focus on RE demonstrates the need for its effectiveness because of its strong (positive or negative) influence on product quality and project success. A detailed, comprehensive view of RE issues, challenges, causes, effects, etc is therefore, necessary, which can serve practitioners as a guide in pursuing elicitation in an effective manner. This will also support related processes defined in elicitation to be improvised that can overcome or minimize or even eliminate occurrences of issues. The better known approach to achieve the objective was to adopt an SLR.

As discussed in [16], each approach is limited in scope and researchers need to rigorously and systematically locate, assess and aggregate outcomes from all significant theoretical and empirical studies related to a particular topic of interest, in order to provide an objective summary of the relevant evidence. This has been addressed in this study through the process of SLR. Adopting this approach discussed in [16] to conduct the literature review provides the researcher much more confidence about locating and gathering as much information as possible pertaining to the topic under study.

III. Research Method

By adopting the guidelines described in [85, 86] and also related papers [16, 76]; the guidance for the research method was identified for this review. The main goal of this systematic review was to identify and classify various natures of elicitation issues. To ensure proper focus on the review, a set of research questions were necessary. With the underlying goal to providing support to the software quality and overall project success, the high-level question addressed by this review was

"*What are the cause-and-effects of poor RE and how can the RE issues be classified?"*

Attempting to answer this question was the main objective of the systematic review. The high level research question was decomposed into five specific research questions, which guided the literature review. The author collected and summarized this evidence in order to know what the problems and issues in software requirements elicitation and what aspects need to be understood and adapted in order to improve the software requirements elicitation process.

A. Research questions

Following are the five research questions that emerged from the high-level question.

RQ1. What are the issues reported in literature on RE?
RQ2. What are the causes for poor RE?
RQ3. What are the consequences of poor RE on software quality or project success?
RQ4. What are the advisable practices for performing effective RE?
RQ5. How can RE issues be classified?

Figure 2 depicts how the five research questions are related and provide a comprehensive view on the systematic review. The summary of the research questions and the motivations to find answers in literature for the same is highlighted in table I.

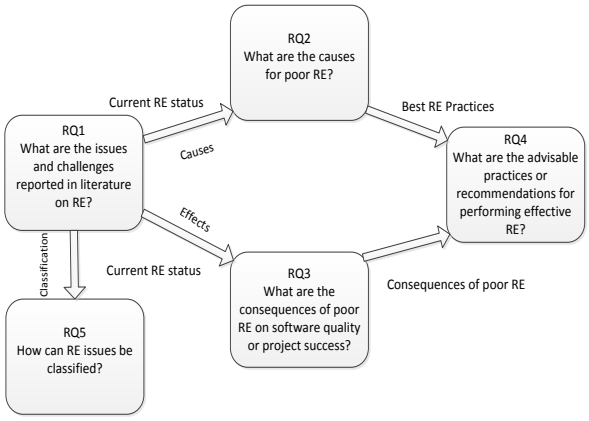

Figure 2. The relationship between the five research questions

TABLE I. Summary of research questions and motivations

#	*Research Questions*	*Motivation*
1	What are the issues reported in literature on RE?	Identify types of issues and challenges reported in software engineering literature as an input to classify the issues and prepare a taxonomy for the same
2	What are the causes for poor RE?	Identify the root causes for reported issues and challenges as an input to the cause-and-effect of poor RE
3	What are the consequences of poor RE on software quality or project success?	Identify the effects or consequences for reported issues and challenges as an input to the cause-and-effect of poor RE
4	What are the effective practices for effective RE?	Identify the best practices and recommendations that can be adopted in conducting effective RE
5	How can RE issues be classified?	Organize the issue information into a taxonomy

B. Search terms

The following keywords were derived based on research questions: *"Requirements Engineering, Requirements Elicitation, Elicitation Issues and Challenges, Elicitation Effective practices, Effects of Poor Elicitation."* Table II summarizes the searches performed.

There were not significant work published that directly represents responses to the research questions. Overcome this gap and to extract as much literature on the questions, searchers were adopted on other key words like "Requirements Engineering, Stakeholders, Communication, Scope, Requirements, Users, Globally distributed requirements elicitation". This helped retrieval of further information and relevant details had to be studied from these papers to ensure accurate and appropriate responses to the research questions.

C. Source selection

Prior reviews [16, 76, 84] supported our study to obtain an exhaustive source list. Table II summarizes the sources.

With guidance from [76], the inclusion and exclusion criteria for paper extraction are as follows:

Inclusion criteria:

- Papers that explicitly discussed RE issues, challenges
- Theoretical and empirical studies that discuss issues, causes and effects of poor RE
- Papers that discuss requirements engineering challenges with focus on RE
- Papers that focus on specific elicitation issues
- Surveys that discuss elicitation issues in SDLC
- Papers with focus on categorizing elicitation issues

TABLE II. SEARCH STRINGS

Search strings		
#	***High-level search string***	***Detailed search string***
1	Software requirements elicitation issues OR problems OR challenges	((elicitation OR obtaining OR gaining OR extracting OR acquisition OR discovery OR capture) AND (issues OR challenges OR problems))
2	Software requirements elicitation root causes	((elicitation OR obtaining OR gaining OR extracting OR acquisition OR discovery OR capture) AND (causes OR reasons OR root causes)) OR ((poor elicitation))
3	Effects OR Consequences of poor requirements elicitation	((elicitation OR obtaining OR gaining OR extracting OR acquisition OR discovery OR capture) AND (effects OR consequences))
4	Software requirements elicitation best practices OR effective practices OR advisable practices	((elicitation OR obtaining OR gaining OR extracting OR acquisition OR discovery OR capture) AND (best practices OR effective practices OR advisable practices))
5	Software requirements elicitation issues OR problems OR challenges classification OR taxonomy	((elicitation OR obtaining OR gaining OR extracting OR acquisition OR discovery OR capture) AND (taxonomy OR classification OR grouping OR categorization OR organization OR systemization OR factors)).
6	Software requirements engineering issues OR problems OR challenges	((requirements engineering) AND (issues OR challenges OR problems))
7	Poor requirements engineering OR project failure reasons	((requirements engineering) AND (causes OR reasons OR root causes OR project failure)) OR ((poor requirements engineering))
8	Issues pertaining to Stakeholder OR Scope OR Requirements OR Users OR Globally distributed requirements elicitation OR Communication	((stakeholders OR user OR scope OR communication OR globally distributed requirements elicitation) AND (issues OR challenges OR problems))
9	Software requirements elicitation findings	(elicitation AND (thesis OR systematic literature reviews OR SLR OR surveys OR reports OR findings OR research))

Exclusion criteria:

- Slide-ware
- Tutorials, lecture notes, expert opinions, views
- Studies not in English
- Studies with findings that are unclear and ambiguous
- Studies not related to any research question

TABLE III. SOURCE SELECTION

#	***Sources***	***Source name/ link***
1	Databases	ACM Digital Library, IEEE.org, ScienceDirect.com, Springer, Wiley Online Library, Google Scholar
2	Journals	Journal Of Systems And Software, Journal of Defense Software Engineering, Journal of Information Technology Theory and Application, Malaysian Journal of Computer Science, Journal of Computer Information Systems, Requirements Engineering Journal, International Journal of Reviews in Computing, Internal Journal of Computer Applications, International Journal of Information and Electronics Engineering, Journal of the Association for Information Systems
3	Additional Sources	Books, Thesis documents, Technical Reports

D. Document retrieval

4988 papers were extracted from identified databases and 204 represented full versions of papers. Based on inclusion and exclusion criteria, 81 papers were finally selected for the systematic review. From the below graph, 9%

of "Others" include thesis work and technical reports. The collection included papers that covered 56% empirical studies and 34% theoretical studies.

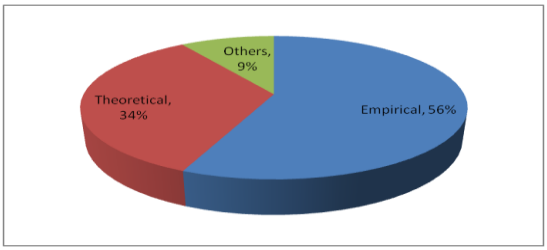

Figure 3. Research method of selected papers

E. Publication Year

The reviewed papers were published between 1993 and 2012. Approximately 53% of papers span 2009 to 2012. There has been significant focus in the last five years of research study towards software requirements elicitation and related issues. This is an indication of the growing awareness in the importance of elicitation as it affects project success directly. This is a reflection of the recent trends in the related research. This also gives confidence in the presenting this study. Figure 4 represents the selection of papers based on years of study.

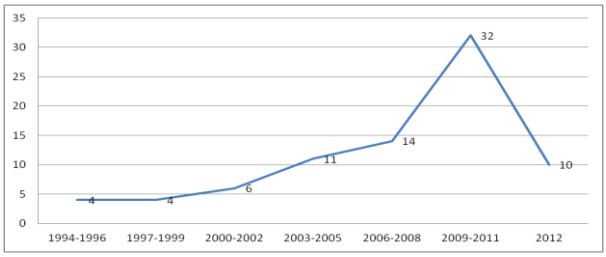

Figure 4. Number of papers included in the review by a 3-year interval

F. Paper Distribution

The table IV provides a statistical view of the sources from which the papers are validated and confirmed to gather relevant information on requirements elicitation issues.

TABLE IV. PAPER DISTRIBUTION

Sources	*Count*	*%*
IEEE Xplore	25	309
SpringerLink	8	9.9
ACM Digital Library	7	8.6
Others	5	6.2
ScienceDirect	4	4.9
Journal Of Systems And Software	2	2.5
International Journal of Advances in Computing and Information Technology	2	2.5
SEI Technical Report	2	2.5
KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS	1	1.2
JOURNAL OF ADVANCES IN COMPUTER RESEARCH	1	1.2
Proceedings of the First Westminster Conference on Professional Awareness in Software Engineering	1	1.2
International Conference on Concept Mapping	1	1.2
Journal of Software Maintenance and Evolution : Research and Practice	1	1.2
International Conference on Software Engineering Advances	1	1.2
Malaysian Journal of Computer Science	1	1.2
Australian Journal of Information Systems	1	1.2
International Conference on Automated Software Engineering	1	1.2
International Journal of Computer Applications	1	1.2
Journal of Computer Information Systems	1	1.2
International Journal of Computer Science and Network Security	1	1.2
Conference on Software Engineering Research and Practice	1	1.2
SDIWC Digital Library	1	1.2
Middle-East Journal of Scientific Research	1	1.2
CLEI ELECTRONIC JOURNAL	1	1.2
Proceedings of REFSQ	1	1.2
Indian Society for Education and Environment (iSee)	1	1.2
Issues in Informing Science and Information Technology	1	1.2
Journal for Information and Software Technology	1	1.2
International Journal of Software Engineering & Applications	1	1.2
Conference on Evaluation & Assessment in Software Engineering	1	1.2
International Journal of Software Engineering (IJSE)	1	1.2
International Conference on Software Engineering and Knowledge Engineering	1	1.2
International Requirements Engineering Efficiency Workshop	1	1.2
Total	**81**	**100**

G. Quality assessment

Quality assessment was done on identified papers as adopted in [76]. The outcomes indicated high quality papers being identified for review (Table V) and results of which are in Table VI.

TABLE V. QUALITY ASSESSMENT QUESTIONS

Category	*Assessment questions*
Experiment -al studies	• Does the evidence support the findings? • Was the analysis appropriate? • Does the study identify or try to minimize biases and other threats? • Can this study be replicated?
Observation -al studies	• Do the observations support the conclusions or

Category	*Assessment questions*
	arguments? • Are the comparisons clear and valid? • Does the study identify or try to minimize biases and other threats? • Can this study be replicated?

TABLE VI. STUDY QUALITY ASSESSMENT

Quality Scores	*Poor < 26%*	*Fair 26-45%*	*Good 46-65%*	*V. Good 66-85%*	*Excellent >86%*
# of studies	1	5	43	12	20
~ %	1.2%	6.2%	53.1%	14.8%	24.7%

H. Data extraction and synthesis

A data extraction template was created for consistent and accurate extraction of information. Data items include identifier, author name, publication year, title, source, article type, reference, study aims, context, data collection methodology, data analysis, concepts. The guidance on this has been obtained from [76, 85, 86]. The details extracted from the identified papers are described in table VII.

TABLE VII. ITEMS EXTRACTED FROM ALL PAPERS

Data items	*Description*
Identifier	Unique identifier for the paper
Bibliography	author, year, title, source
Source	Journal, article, conference, technical report, thesis, book
Article type	Theoretical/empirical
Study aims	The aims and goals of the study
Context	Primary focus of the research paper.
Data Collection	How was the data collected? interviews, questionnaires, observations, documents
Control group	Yes, no: If yes, number of groups and size per group
Data analysis	How was the data analyzed? Qualitative, quantitative, mixed forms
Concepts	The primary concepts in the studies
Study findings	Key findings, conclusions and limitations from the study

IV. RESULTS

A. RQ1. What are the issues reported in literature on RE?

Brief grouping was identified for ease of categorization and documentation. Critical issues studied as part of the literature review was identified and documented.

1) ***Change-related****:* management and political rules [7, 61], acceptance criteria changes [7], unstable requirements [67], changes in nature of requirements overtime[74], user needs and understanding changes [52]

2) ***Communication-related****:* articulation related [63, 24, 67] ,unaware of needs [63, 24, 8, 40, 74], mis-understanding amongst stakeholders [63, 3], verbal and presentation skill [61, 67], requirements-related [2, 61, 67], culture and perspective related [8, 9, 33], language barriers [8, 65], change related [43]

3) ***Human factors-related****:* conflicts, ambiguities amongst stakeholders [63], intra-group conflicts [27], communication, participation, cognition errors [64]

4) ***Knowledge-related****:* understanding needs [39], domain related [63, 52, 72, 5, 43, 59, 79, 59], problem analysis [74], knowledge sharing mechanisms [63, 83]

5) ***Requirements-related****:* issues related to documentation [51, 20, 70, 49], knowledge [51], practice [25] , prioritization [54, 26, 44], process [25, 39, 53, 61, 45, 48, 6, 22, 60, 16, 65, 52, 31, 36, 50, 18, 58, 81, 71, 59, 76], quality [25], requirements related [8], schedule [52] , skills [12, 52, 17, 69, 41, 27], technical [63], traceability [5], uncertainity [81, 46, 42], understanding [8, 12, 40, 52, 55, 59, 62, 67, 74]

6) ***Social, organizational-related****:* legal [47], policy and structure changes [8, 67], complexity [8], cultural issues [65, 33, 67], time-factor issues [67]

7) ***Scope-related****:* ill-defined scope [25, 31, 30, 8, 59], overscoping [14]

8) ***Stakeholder-related****:* user-participation [46, 42], stakeholder [25, 22, 33, 74, 16, 37,56, 50, 41, 69, 59, 8], staffing [61, 22, 37, 52, 27]

9) ***TTM-related****:* tools [45, 41], techniques [24, 75, 71, 29, 10,12, 52, 18, 59, 66, 79], methods [77, 69, 1]

B. RQ2. What are the causes of poor RE?

The general causes of poor elicitation are depicted in Figure 5. These causes are outcomes of the issue classifications. The detailed view of these parameters is described in section V. Causes of issues from RQ1 are described using cause-and-effect diagrams. Figures 6-8 represent cause-and-effects (fishbone) diagrams for problems of understanding, volatility and scope respectively. The categorization of elicitation problems is based on [19].

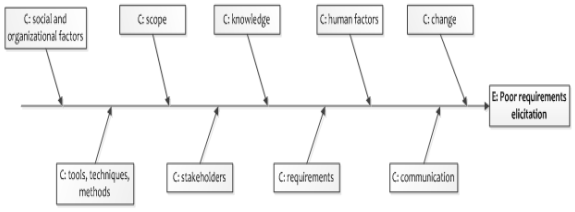

Figure 5. Causes for poor elicitation

Problems of understanding

Problems of understanding categorize issues within groups as well as between groups such as users and developers [19]. Causes for ***problems of understanding*** are consolidated from various studies [10, 13, 16, 31, 33, 34, 40, 59, 62, 65, 67, 74, 77, 22, 24, 25, 32, 38, 47, 48, 69, 87]. In the GSD scenario where projects are executed, a large number of elicitation issues fall in this category. The cause-and-effect diagram in Figure 5 provides a skeletal view on the causes for poor elicitation in this category.

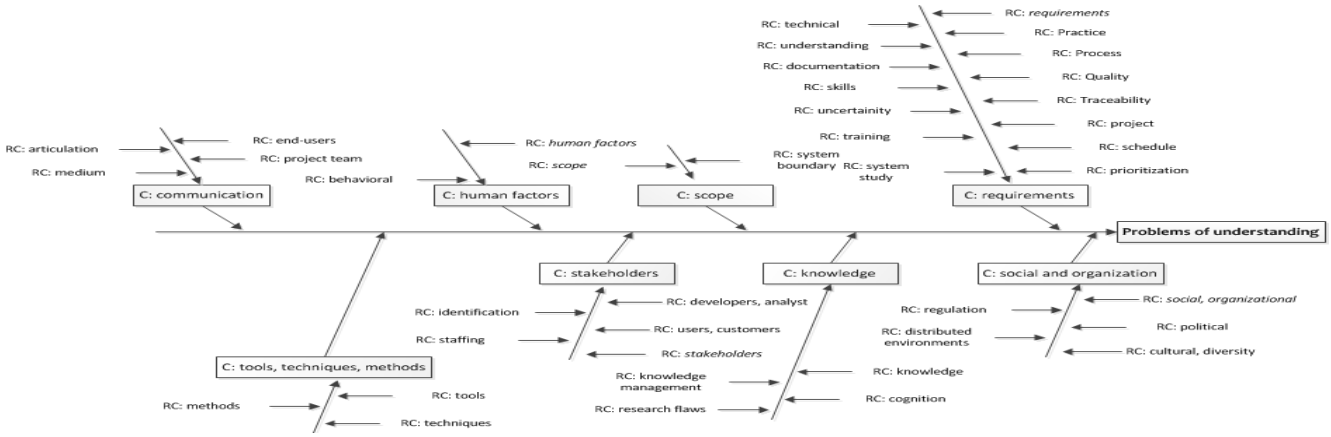

Figure 6. Causes for "problems of understanding"

Problems of volatility

Problems of volatility describe the changing nature of requirements [19]. In today's world, given the dynamic nature of business and the need for the business to have a competitive edge in the market, changes are inevitable. Causes for ***problems of volatility*** are consolidated from some critical studies related to change [25, 82, 67, 74]. The cause-and-effect diagram for the same is depicted in Figure 6.

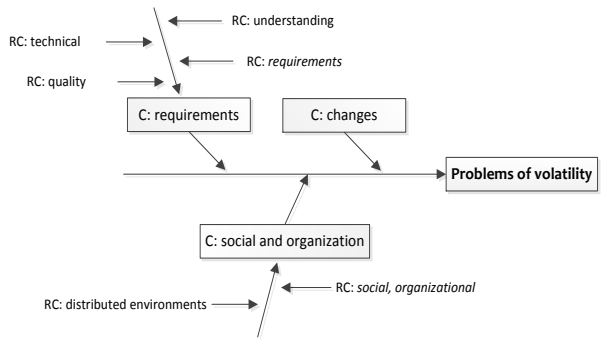

Figure 7. Causes for "problems of volaitility"

Problems of scope

Problems of scope refers to a category where-in the requirements may address too less or too much information [19]. Causes for ***problems of scope*** are consolidated from studies that have focused on scope or have discussed scope-related issues in detail [14, 25, 74]. The cause-and-effect diagram in Figure 7 provides a skeletal view of the causes for this category

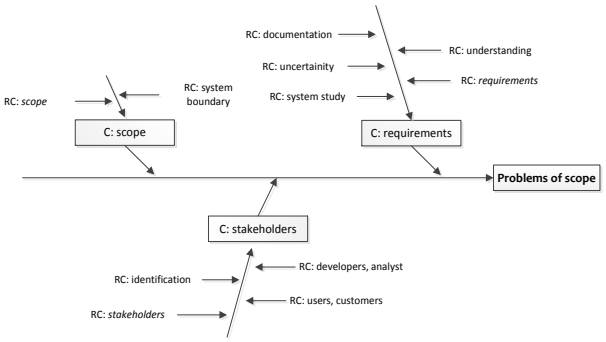

Figure 8. Causes for "problems of scope"

C. RQ3. What are the consequenses of poor RE on software quality or project success?

While the major consequence of poor elicitation is project failure, there are several others that impact the overall project quality and lead to unsuccessful project execution. The primary consequences of poor RE are highlighted below.

1) ***Change-related****:* process overheads, re-work [22] impacted project cost, quality, failure [7], requirements inconsistency, unusable [74]

2) ***Communication-related****:* system failure, budget overruns, project failure [3, 5, 61], co-ordination issues [22], misunderstanding, poor definition of needs [3], broken communication links [52], imperfect specification [4], scope creep [3], abstract communication [5], low motivation, waste [13]

3) ***Human factors-related****:* withholding information [63], recognition failures [66], sabotage efforts [63]

4) ***Knowledge-related****:* project failure [52], low quality specifications,, domain knowledge [72]

5) ***Scope-related****:* requirement changes, quality issues, project delays and cancellations, customer expectations not met, communication gaps, wasted effort, requirements specifications not updated [14]

6) ***Social, organizational-related****:* communication barriers [23], wait time, delays in GSD [67], legal consequences, affects trust [47]

7) ***Stakeholder-related****:* poor specification correctness, completeness, consistency [16], risks [16], inefficiencies and duplication, communication problems, re-work, project delays, cost overruns, project failure [56]

8) ***TTM-related:*** loss of information, requirements [77], delays in delivery, increased costs, descreased success rates [29], disorganized efforts [12], late discovery of requirements [12], lack of detailed approach [41], significant gap in RE theory, practice [18], requirements inconsistent and expectation mismatch [66].

9) ***Requirements-related:*** repeated errors [25], re-work cost, budget overruns, poor quality systems, stakeholder dissatisfaction, project failure [16, 18, 61], process and tools mis-alignment [22], errors, uncertainities [54], poor requirements [74], high maintenance costs, frequent changes [31], conceptual inconsistency [72], incomplete domain knowledge [51], flaws in resultant system [73].

D. RQ4. What are the advisable practices for performing effective RE?

Researchers have been able to provide guidance on some of the critical issues that constantly surface during elicitation. These advisable practices listed below are generic in their descriptions and the nature of projects significantly contributes to how these practices are implemented. The primary practices captured as part of this study are listed below.

1) ***Change-related****:* proactive in RE process, predict potential changes , future requirements [52]

2) ***Communication-related****:* maintain communication lines amongst stakeholder roles, inform and monitor progress on defined artifacts [22]

3) ***Knowledge-related****:* domain knowledge and prototypes as necessary [52]

4) ***Social, organizational-related****:* define organization structure, communicating responsibilities [22], peer-to-peer links [22], partially synchronize inter-organizational processes, perform frequent iterations and deliveries [22], frequent validation of artifacts [25], establish cultural liaisons [22], make customers feel ownership, responsibility to requirements and future system [52]

5) ***Stakeholder-related****:* supporting interorganizational structures, communication structures [22], use of "Collaborative Tools" [22], establishment of constructive stakeholders interaction [16], classify requirements elicited according to evaluation of priorities, project goals [16]

6) ***Requirements-related****:* elicit distribution to represent expert's knowledge, summarize basis for knowledge, impart training, record elicitation exercises [35], improve project management process, communication, documentation, change control, management [52]

E. RQ5. How can RE issues be classified?

This section summarizes findings on derived RE factors. Table VIII describes the importance of issues related to *requirements* (69% of study) impacting overall elicitation. RE, being most critical in driving project success rate, has significant issues reported in literature. 76 papers discussed RE issues, either in general or related to specific factors like stakeholders, communication, over-scoping, etc. Based on findings, categories for these issues were identified. RE issues are categorized under problems of scope, understanding and volatility [19]; Table IX represents categories of issue *factors* identified.

TABLE VIII. PAPER STATISTICS: FOCUS ON ELICITATION FACTORS

Factors**	***F1***	***F2***	***F3***	***F4***	***F5***	***F6***	***F7***	***F8***	***F9***
Paper count*	14	33	8	14	4	17	59	23	22
~ Primary study (%)	**17**	**29**	**9**	**17**	**5**	**20**	**69**	**27**	**26**

*** F1: Change; F2: Communication; F3: Scope; F4: Social and Organizational; F5: Human factors; F6: Knowledge; F7: Requirements; F8: Stakeholders; F9: Tools, techniques, methods*
** Papers overlap on discussions of some of the elicitation factors*

TABLE IX. ELICITATION ISSUES : FACTOR GROUPING

Elicitation issue factors	***Problems of scope***	***Problems of understanding***	***Problems of volatility***
Changes			√
Communication		√	
Human factors		√	
Knowledge		√	
Requirements	√	√	√
Scope	√	√	
Social, organizational		√	√

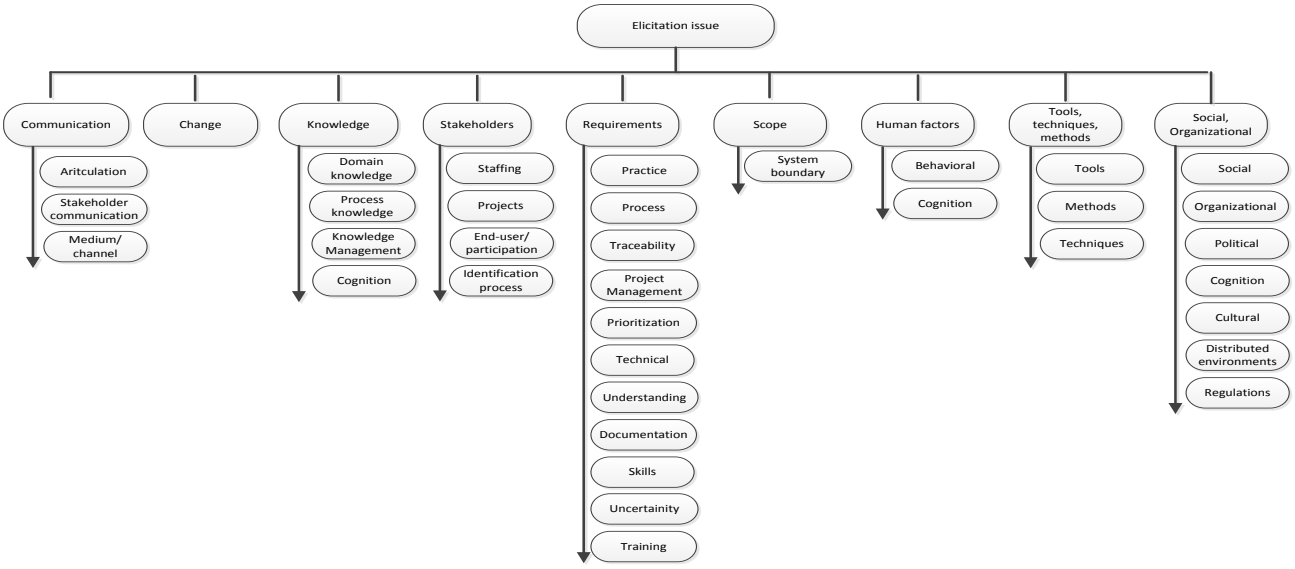

Figure 9. Elicitation Issue Taxonomy

Elicitation issue factors	*Problems of scope*	*Problems of understanding*	*Problems of volatility*
Stakeholders	√	√	
Tool, techniques and methods (TTM)		√	

SLR draws specific classification of RE issues as represented in Figure 9. These classifications have been derived through multiple levels of iterations based on the information gathered through sources described above. A broad classification of the same is depicted below.

- ***Communication*** - articulation, requirements, global context, organizational, communication channels
- ***Change –*** management and political rule changes, acceptance criteria changes, unstable requirements, user needs' and understanding, incomplete requirements, poor change management, changing nature of requirements
- ***Knowledge*** – research flaws, global context, requirements, human cognition errors, domain errors, knowledge management
- ***Stakeholders*** – requirements, users, project teams, global context, communication, process and organizational
- ***Requirements*** – practice, process, project, quality, schedule, skills, traceability, training, uncertainty, understanding, documentation, technical, prioritization, system study
- ***Scope*** – system, process, requirements, organizational, communication, stakeholders
- ***Human factors*** – communication, behavioral, participation, human cognition, management
- ***Tools, techniques, methods*** – tools, techniques, methods, requirements, processes
- ***Social, organizational*** – legal, global context, organizational, stakeholders, communication

V. DISCUSSIONS

This section summarizes the principal findings of the literature review, highlights the detailed causes and effects of primary factors that govern the effectiveness of RE and the contribution of findings on RE issues in the software engineering research and practice community.

A. Principal findings

The primary goal of this systematic review was to identify the causes of poor elicitation in the requirements phases of the software development life cycle and classification of elicitation issues. A systematic review was conducted to confirm the RE issues and categorically determine the factors that influence the effectiveness of RE and thereby, the overall product quality and project success. The principle findings of the review are:

- A description of the elicitation issues reported in literature and their contributions in identifying elicitation issues in the software development life cycle
- A description on the cause and effects of generalized issues in elicitation, such as, problems of scope, problems of understanding and problems of volatility
- An elicitation issue taxonomy that classifies the all of the elicitation issues uncovered during the systematic review
- A description of factors that determine effective elicitation, the cause and effects that influence the

project outcome along with other significant impacts to the development life cycle

B. Influencing factors in RE

The objectives of classifying the elicitation issues, depicting the cause and effects the systematic review have been achieved. There is an interesting view of these classifications here. As groups categorically emerged as issues were uncovered during the review, the order of focus of these categories was also studied. This implies that there were certain factors that drew more attention than the others. Table VIII provides a view of the percentage of papers that discussed these factors. A good percentage of papers discussed multiple factors rather than just focus on one.

The findings in described in this section significantly contribute to the software engineering body of knowledge in the field of requirements engineering. This section discusses in detail, the first four research questions for every factor that determine effective RE. RQ5 is not relevant in this context and is omitted from this discussion.

Requirements

According to IEEE standards [90, 91], a requirement is defined as

"(1) A condition or capability needed by a user to solve a problem or achieve an objective.

(2) A condition or capability that must be met or proposed by a system or system component to satisfy a contract, standard specification, or other formally imposed document.

(3) A documented representation of a condition or capability as in (1) or (2)."

Capturing requirements in an essential part of RE. This factor has a significant influence on elicitation and determines the overall project success. If requirements are not captured properly or captured incorrectly, it is highly likely that the project will fail. Researchers and practitioners confirm this observation in all their discussions pertaining to RE. We attempt to answer the four research questions with respect to "*requirements*".

RQ1a. What are the issues reported in literature on RE pertaining to *requirements*?

The requirements related issues have been uncovered through this systematic review. The list covers the following:

- Inexperienced analyst to perform detailed modeling
- Reluctance to spend money
- Pressure for greater details as control gets higher
- Inappropriately skilled analysts and users assigned due to availability rather than capability
- Prototyping effort not managed properly
- Process inherently imprecise
- Requirements elicited not be feasible, cost-effective, or easy to validate
- Vague, lacking specifics, and not represented in a manner that can be measured or tested.
- Requirements defined at different and in insufficient levels of detail
- Requirements incorrect, incomplete, inconsistent, and not clear to all stakeholders
- System goals and users' needs susceptible to change
- Process adopted cause requirements volatility and affect the requirements quality
- Lack of sufficient awareness, understanding, and expertise in elicitation practice
- Large gaps between elicitation theory and practice, and between novice and expert analysts
- Poor execution of elicitation
- Inability of stakeholders to analyze impact of systems on society
- Requirements change over time, scope changes
- Software and hardware technologies changing rapidly
- Lack of awareness of all relevant sources of requirements
- Nature or novelty of system imposes constraints on elicitation
- Distributed environment
- Expectation mismatch between software engineers and stakeholders to explicitly provide requirements to them in a ready-to-use form
- Communication
- Coordination
- Travel cost
- Ambiguity
- Redundancy
- No formal techniques to support prioritization
- Cannot progress with unsatisfied responses on requirements
- Process differences inherent in inter-organizational partnerships
- Inability to understand and interpret requirements clearly
- Ambiguous understanding of processes
- Inconsistency within a single process by multiple users
- Lack of standardized domain data definition and system-environment interface
- Requirements decision-makers lack of technical and domain expertise
- Incomplete requirements
- Misconception of requirements
- Incorrect requirements
- Ill-defined system scope
- Ambiguous requirements

- Stakeholders' inability to validate and conclude system needs
- Unimportant requirements part of scope
- Documenting requirements
- Conflicts in stakeholder views, perceptions and goals
- Information overload
- Inadequate stakeholder input
- Biased prioritization of requirements
- Social issues
- Technical issues
- Ignoring organization's contextual issues
- Environmental factors
- Vague needs from incorrect or irrelevant stakeholder
- Poor understanding of capabilities and limitations of computing environment
- Incomplete understanding of problem domain
- Lack of good requirements leading to failure
- Adversarial relationships between designers and stakeholders
- Process sensitivity to forces that shape organizational life.
- Politics of resource allocation and legitimacy of decision-making within organizational environments
- Poorly established specifications and design
- Poor preparation
- Poor participant selection and training
- Poor use of enabling technology
- Lack of analyst's creativity, impertinence, impartiality, flexibility, and attention to details
- Poor interpersonal interaction
- Poor problem solving
- Poor decision making
- Unclear goals
- Poor quality controls
- Poor expectations management
- Unrealistic schedules
- Unrealistic cost estimates
- Non-functional requirements are not considered
- Integration of non functional requirements with functional requirements
- Conflicts of requirements
- Lack the skills and abilities necessary to carry out the tasks
- Insufficient training to students
- Time difference in GSD environments
- Non-compliance of documents with standards
- Lack of requirements understanding in user community
- Constrained schedules to allow sufficient interaction and learning period between customer and development team
- Traceability issues of requirements to business strategy
- Use of conflicting concepts to achieve goals
- Usability
- Abundance of Choice
- Nature, the domain complexity, the variety of methods and notations and the interdependency of partial requirement make it very difficult to establish total consistency
- Unfamiliar notations between user and developer groups
- Inability to track requirements to human sources
- Information that is thought to be "common domain knowledge" is omitted
- Ranges of satisfaction
- Crucial constraints implicit in domain as "domain phenomena"
- Domain expertise difficult to acquire
- Generating strategies for converting vague goals
- Lack of attention
- No availability of right people with adequate experience, technical expertise, and language skills
- Coding begins as soon as information is gathered
- Unstructured elicited requirements from operational domain difficult to manage and model
- Detailed specification with low coupling counterproductive for reuse, understandability and comprehension aspects
- Heavily dependent on experience and expertise of participating analyst
- Critical, complex, and potentially expensive activity in the majority of cases is performed in an adhoc manner without a defined process or methodology
- Lack of systematic methods with situational process guidance, and experience reports
- More training and tools are required to support novice analysts during the process of requirements elicitation
- Lack of transparency
- Unorganized bulky information source
- Unstructured data
- Unable to integrate information
- Incorrect assumptions
- Requirements Engineering considered as an overtime activity
- Bias towards one customer
- Working on information that's obsolete
- Potential requirements not known to both user and analyst
- Potential requirements known to analyst, not known to user and vice-versa

RQ2a. What are the causes for poor RE are attributed to *requirements*?

- Vast array of options and decision
- Communication
- Socially rich nature
- Geographic distribution of stakeholders
- Familiarity of users with software systems
- Informal nature of elicitation process
- Context in which requirements are elicited
- Process inherently volatile
- Organizations resistant to investing appropriate time and effort

- Unorganized and large amount of requirements
- Poor understanding of requirements
- No direct contact of developers with customers
- Assumptions by developers
- Misunderstanding of system
- Stakeholders unable to express real needs
- Developers gathering requirements don't know the problem domain
- Knowledge and cognitive limitations
- Omitting obvious information
- Knowledge of novice users, professionals recently graduate centered on theory
- Current trends of development and their effect elicitation not considered
- Minimum availability of stakeholders with required knowledge on system

A cause-and-effect diagram illustrated in Figure 10 depicts cause and effects of poor requirements in the context of elicitation.

RQ3a. What are the consequences of poor RE on software quality or project success that is attributed by *requirements*?

- Repeated errors from practitioners with respect to elicitation
- Practitioners do not acknowledge real issues and their subsequent effects

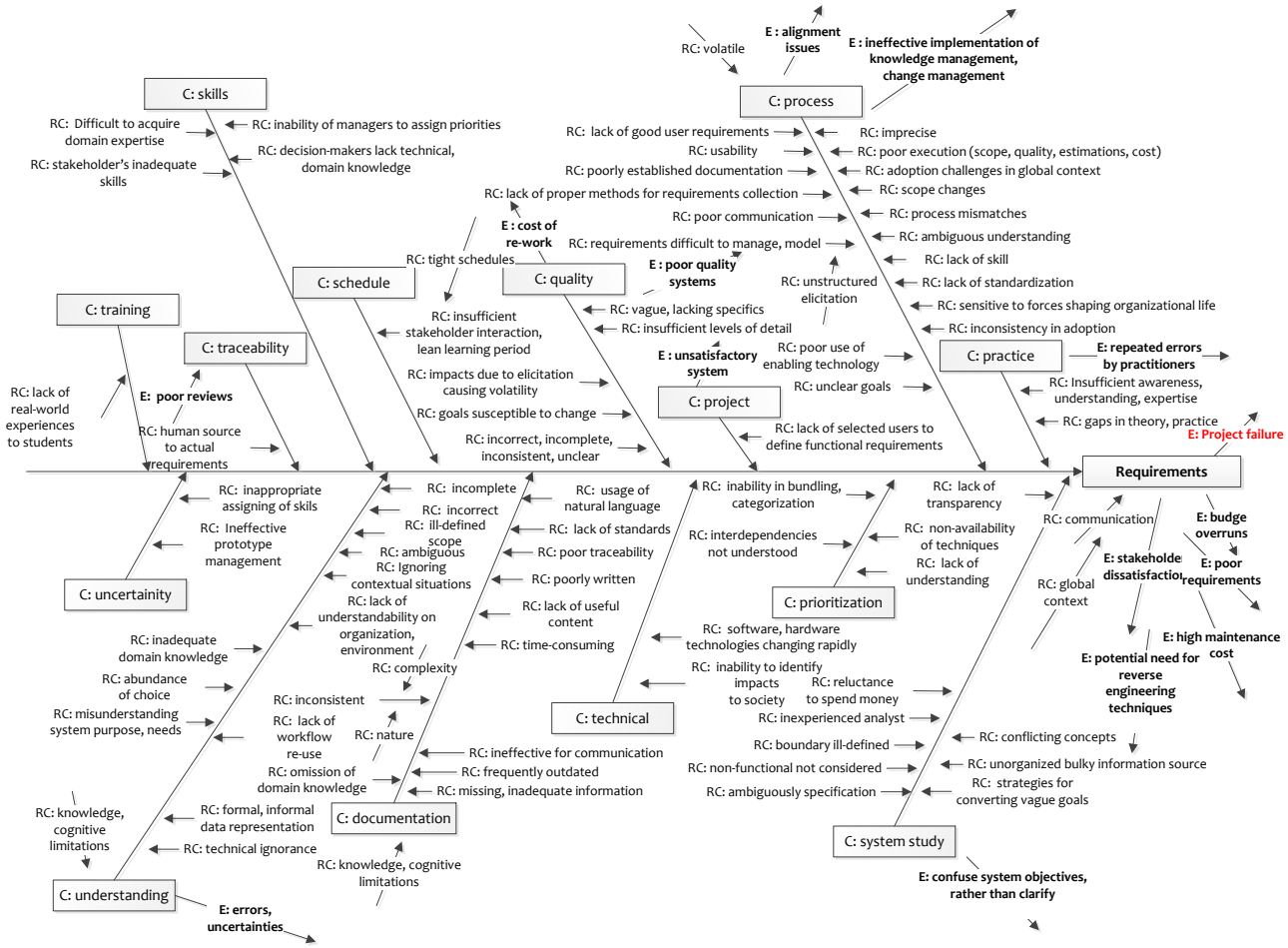

Figure 10. Cause-and-effect diagram for "Requirements"

- Mistakes in elicitation leads to missing the customers' real needs
- Difficult knowledge-intensive processes to model
- Ill-defined scope
- Scope barriers due to abstraction level gathering and requirement sources
- Cost of rework
- Budget overruns
- Poor quality systems
- Stakeholders' dissatisfaction
- Projects failure
- Inability to align processes and supporting tools

- Ineffective implementation of knowledge management and change management practices in GSD environment
- Ambiguity of interpretation
- Complicating requirements modeling
- Cause errors and uncertainties
- Narrow or broad scope of system due to requirements unfinished, unverifiable, unnecessary and unstable and collected information
- Unable to explore all needed knowledge from stakeholders
- Inability to transform wrong decisions and actual needs of user
- Confuse, rather than clarify, overall system objectives
- Cost of the rectification impacting latter SDLC stages
- Product quality suffers
- Serious flaw in the resultant system because many stakeholders' preferences and their specifications are not fully addressed
- Cancellation of system development
- Poor requirements
- system produced that is judged unsatisfactory or unacceptable
- High maintenance costs
- Frequent changes
- Conceptual inconsistency
- Incomplete domain knowledge produced
- Reverse engineering techniques may be necessary

RQ4a. What are the advisable practices for performing effective RE with respect to *requirements*?

- Elicit a distribution to represent the expert's current knowledge, and it is useful to have a summary of what that knowledge is based upon
- Impart training to familiarize the expertise
- Record should be kept on elicitation exercises. This should ideally set out all questions that were asked by the facilitator together with the expert's responses
- Improve project management process, to facilitate communication, documentation, change control and management

Tools, techniques and methods

According to [29], RE process is resource-intensive and this requires to be accomplished through the support of pre-determined techniques. There are various tools and techniques available that can facilitate elicitation effectively, to a large extent. The adoption of tools, techniques and methods (TTM) are critical for this activity and prior knowledge about these are important so that the right TTMs can be adopted for specific types of project.

This section discusses the research questions with respect to TTM. While this area has gained focus in research, the adoption of available TTM for elicitation may not be applied directly to projects. There is a certain degree of customization that will be required to have them utilized effectively for RE.

RQ1b. What are the issues reported in literature on RE pertaining to *TTM*?

- Budget constraint to adopt tools
- Fail to address the less conspicuous and often more tacit requirements, priorities, and issues that analysts do not know to ask about and that users do not or cannot readily identify and articulate
- Traditional techniques unable to fully diagnose how such contextual issues will affect system requirements, system development, and system evolution
- Difficulties in selecting most suitable techniques
- Important aspects and hidden details are difficult to capture with conventional techniques
- Lack of systematic guidelines leading to poor application of contextual methods
- Limited number of target customers
- Limited expression of customers' opinions
- Difficulty in collecting the customers' opinions continuously
- Inappropriate requirements engineering techniques
- Interaction obstacles
- Language difficulties
- Existing techniques don't provide a scalable solution for large requirements
- Results are faulty or error prone
- Results don't recall
- Complexity associated with prioritization technique
- Techniques can be time-consuming due to lack of exposure
- Non-professional engineers likely to use a single technique
- Reuse existing design in wrong context and environment
- Constraints arising from systems' political and organizational environments are hard to discover and document
- Difficulty of using complex tools and diverse methods due to lack of knowledge or experience
- General unwillingness to adopt TTM
- Lack of ability to select the optimal technique
- Lack of ability of available techniques to address different project types
- Inability of models to provide theoretical basis for understanding 'regularly patterned' human activity
- Stakeholders' needs and desires shift when exposed to early prototypes
- Inability to model and represent domain knowledge
- No appropriate method to predict elicitation effectiveness
- Techniques are not interchangeable

RQ2b. What are the causes for poor RE are attributed to *TTM*?

- Lack of effective elicitation techniques

- Availability but poor use of effective elicitation techniques
- Lack of skills of practicing analyst
- Increasing its costs
- Poor product utilization
- Decreasing its success rate

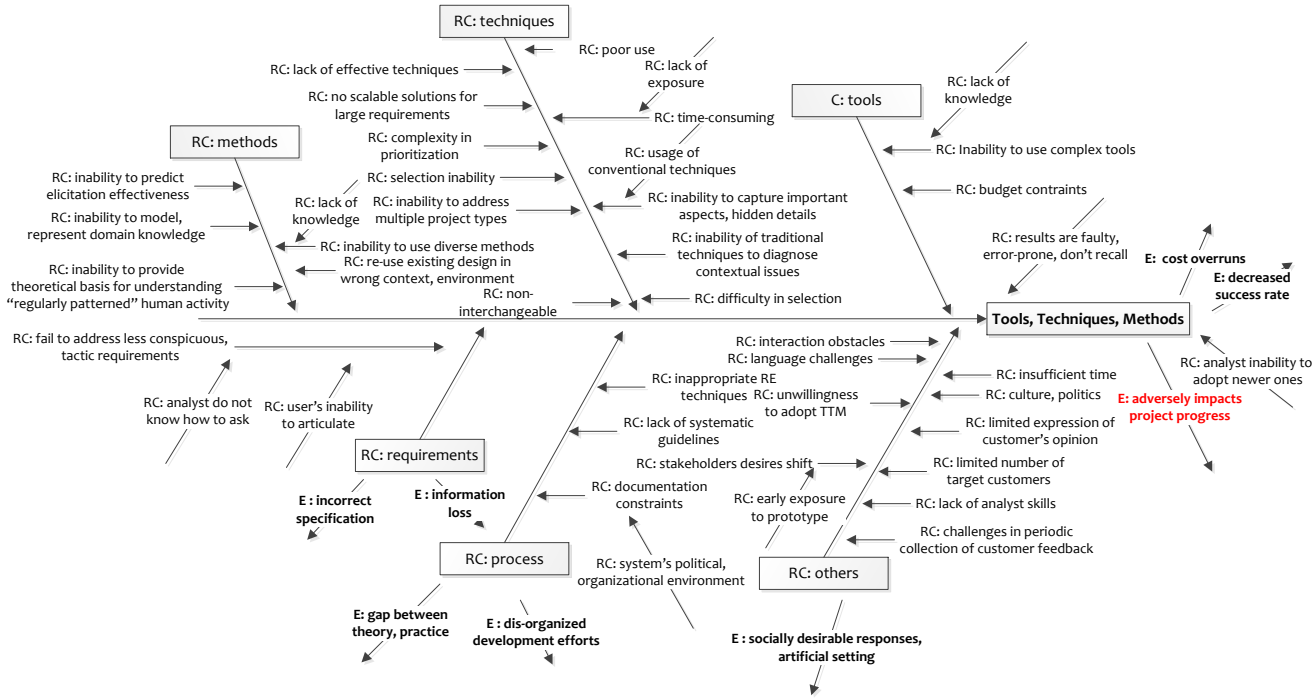

Figure 11. Cause-and-effect diagram for "Tools, techniques and methods"

- No effective technology transfer
- Techniques' inherent complexity
- Insufficient time
- Temporal and spatial constraints
- Sample customer groups may not represent the entire customer population
- Culture and politics
- Terminology issues
- Analysts' lack of interest in new techniques
- Lack of analysts' ability to approaches/ scenarios to adopt appropriate techniques

A cause-and-effect diagram illustrated in Figure 11 depicts cause and effects of TTM in the context of elicitation.

RQ3b. What are the consequences of poor RE on software quality or project success that is attributed by *TTM*?

- Reduction of abandoned applications due to less coverage of functions
- Induces a socially desirable response, resulting in artificial setting of questions
- Potential loss of additional information and requirements.
- Delay in product delivery
- Missed deadlines
- Disorganized development efforts
- Late discovery of architecturally significant requirement
- Negate benefits of a complete and detailed approach
- Significant gap between requirements elicitation theory and practice
- Requirements specified project documentation may differ markedly from what is actually needed or expected

RQ4b. What are the advisable practices for performing effective RE with respect to *TTM*?

No significant best practices have been reported for this factor. However, there have been recommendations for TTM that are listed below.

- Improving elicitation first requires understanding it
- Better technique selection improves quality of process and increase project success"
- Improve average analyst's ability to select elicitation techniques, this will improve records of successful products
- Use of a tool has some impact on the rate of completeness of requirements document

- Facilitated workshops fit in the general tendency to increase the involvement of stakeholders in elicitation
- Selection of suitable technology
- Knowledge Engineering can be used to address elicitation technique effectiveness

Stakeholders

According to [37], requirements emerge in a highly collaborative and social process that involves many stakeholders: users and the users and the customers, the domain experts and the developers, sales, marketing, and management. Stakeholders play an important role in the requirements engineering phases and especially in elicitation. Studies have recorded that stakeholders' influence on elicitation is high and significantly contributes to the success of the project. The research questions with respect to stakeholders are discussed below.

RQ1c. What are the issues reported in literature on RE pertaining to *stakeholders*?

- Desirable users unavailable
- Lack of co-operation and open hostility between users and developers
- Conflicts between stakeholders and requirements
- Not willing to compromise or prioritize requirements
- Lack of analyst' ability to prepare or perform effective requirements elicitation including appropriate technique selection and identification of relevant requirements sources
- Changes of staff
- Lack of cooperation
- Lack of commitment and participation
- Less tolerance
- Lack control of work burden
- Inability to effectively handle conflicts
- Complicated set of communication channels for effective knowledge sharing between stakeholder groups
- Lack of collaboration among stakeholder groups due to problems cultural, language, and process differences
- Lack of trust among stakeholder
- Lack of developers' direct interaction with end-users
- Group cognitive-type evaluation
- Changing requirements over time with maturation of stakeholders ideas
- Resistance to change
- Poor stakeholder identification process
- Miscommunication, misunderstanding, misalignment leading to conflicts
- No dedicated personal for requirements related tasks
- Difficulties to facilitate the active participation of relevant and required stakeholders
- Lack of available skill, knowledge and expertise
- Contradicting and conflicting requirements
- Diverse nature due to project type; key stakeholders hard to identify for Web applications

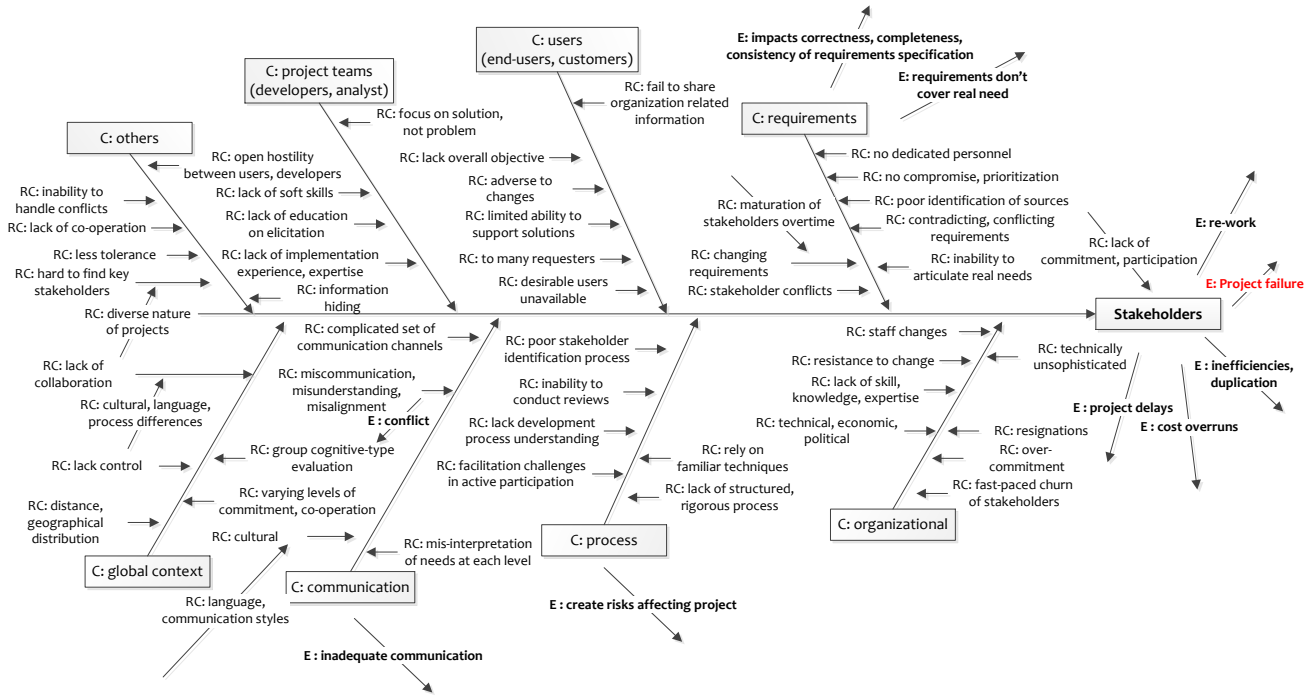

Figure 12. Cause-and-effect diagram for "Stakeholders"

- Technically unsophisticated
- Lack of development process understanding
- Inability to conduct reviews
- Resignations
- Over (unnecessary) commitment
- Information hiding
- Too many requesters

RQ2c. What are the causes for poor RE are attributed to *stakeholders*?

- Inability to understand or articulate real needs
- Limited in their ability to support investigation of possible solutions
- Adverse to changes a new system may introduce
- Varying levels of commitment and cooperation
- Lack of understanding of overall objective and concerned with factors that affect them directly
- Change about requirements as a result of elicitation or other reasons
- Technical, economic and political
- Analysts not be equipped with sufficient implementation expertise and experience
- Lack of education in terms of theory behind techniques and approaches, or the practice of using soft skills such as listening, communicating, and questioning
- Analyst from traditional software engineering backgrounds focus on solution and not problem"
- Lack of structured or rigorous processes adoption to address elicitation
- Fast-paced churn of stakeholders in the newly created inter-organizational relationships
- Higher chance of introducing misinterpretations of stakeholder needs at each communication level
- Users fail to share information about the client organization's priorities, standards, and policies
- Developers fail to reveal accurate information on estimates and priorities.
- Cultural factors such as language or communication styles
- Analysts rely on techniques that they are familiar with for elicitation rather than adopt what is relevant

A cause-and-effect diagram illustrated in Figure 12 depicts cause and effects of stakeholders in the context of elicitation.

RQ3c. What are the consequences of poor RE on software quality or project success that is attributed by *stakeholders*?

- Impacts correctness, completeness, and consistency of requirements specification
- Include requirements that do not cover real need
- Create risks affecting project
- Inefficiencies and duplication
- Communication problems
- Rework
- Project delays
- Cost overruns
- Project failure

RQ4d. What are the advisable practices for performing effective RE with respect to *stakeholders*?

- Supporting inter-organizational structures and supporting communication structures - interactive ways of communication and coordination during the project life cycle, for the purpose of successful relationship building and expectation management
- Use of "Collaborative Tools
- Identify and consult with the stakeholders of the system
- Identify user classes and their characteristics- assign appropriate roles to stakeholders through an analysis of skills, behavior in group dynamics and personality tests; aspects that would render the SI repeatable and verifiable.
- Establishment of constructive interaction between stakeholders during requirements gathering process, and with systems to avoid conflicts and problems of communication arising from different points of view.
- Classify requirements elicited from the stakeholders according to an evaluation of their priorities in relation to the project goal, in order to define the interactions between the stakeholders and with projects, enabling validation of initial project goals.

Communication

Communication is the important factor that governs the success of elicitation. Written and verbal communications are equally important in any requirements gathering activity and especially in the GSD framework. The findings for the research questions also support this fact.

RQ1e. What are the issues reported in literature on RE pertaining to *communication*?

- Difficulty articulating requirements
- Unaware of actual needs
- Lack of technological know-how
- Fear of articulation
- Different notations and terminologies
- Inability in decision-making
- Limited view on future systems
- Poor communication
- Language barriers
- Diversity of communities
- Lack of face to face communication
- Time difference
- Cultural diversity

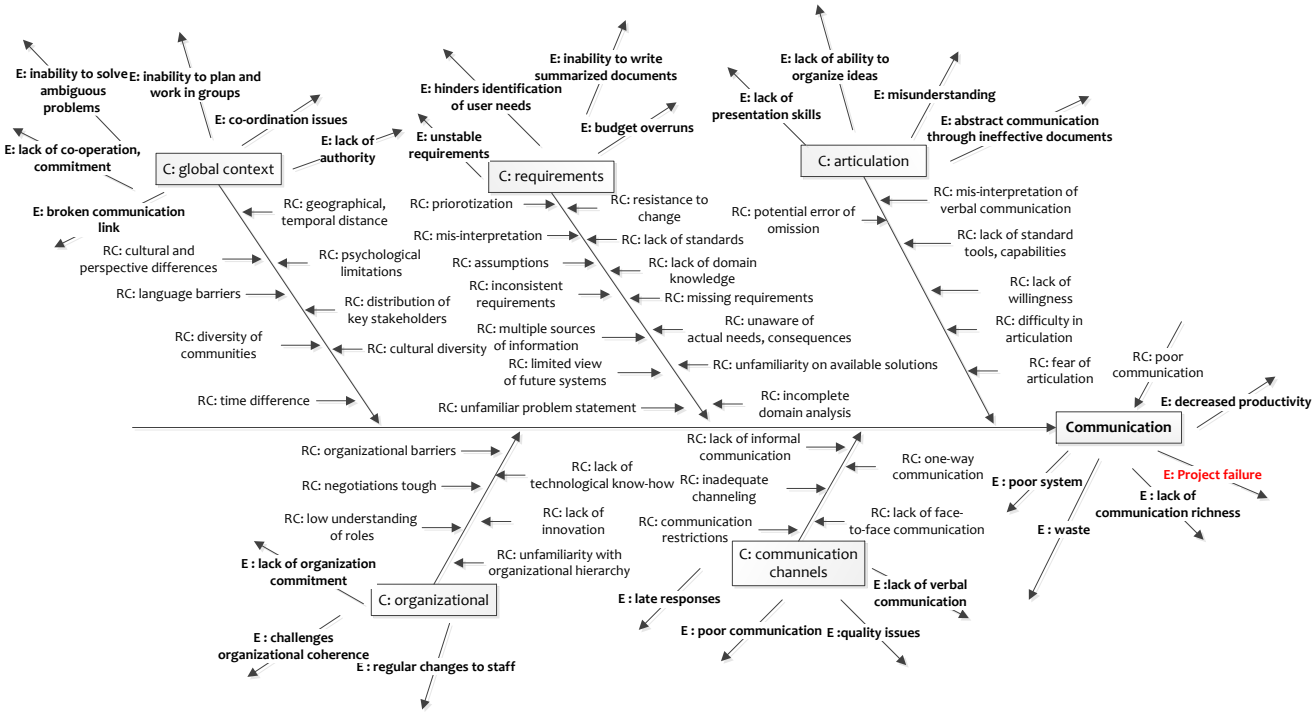

Figure 13. Cause-and-effect diagram for "Communication"

- Large amount of information originating from different sources
- Incomplete Domain Analysis
- Missing requirements
- Inconsistent Requirements
- Lack of Domain Knowledge
- Lack of Willingness
- Culture & Perspective Differences
- One-way communication channels (over the wall requirements)
- Organizational barriers
- Assumptions
- No influence on choice of methods and notations to represent requirements
- Negotiations tough in GSD environments
- Mis-interpretation of requirements
- Resistance in responding to change
- Distribution of stakeholders geographically
- Multiple views on prioritization
- Potential for error of omission
- Lack of informal communication
- Inadequate channeling of requirements change information across sites
- Standard tools and techniques limit the user's capacity to fully identify and articulate needs
- Psychological limitations

RQ2e. What are the causes for poor RE are attributed to *communication*?

- Lack of common understanding of concepts and terms
- Unfamiliar of problem statement
- Lack of innovative
- Lack of knowledge on consequences of requirements
- Unfamiliarity on available solutions
- Focus on solutions rather than requirements
- Misinterpretation of verbal communication
- Misinterpretation of nonverbal communication
- Lack of communication
- Decreased productivity
- Misunderstandings due to communication restrictions
- Source of misunderstandings caused by the use of ambiguous words, expressions that can be misunderstood, body language that gives a wrong impression
- Geographic and temporal distance
- Cultural differences
- Lack of awareness
- Low understanding of roles
- Unclear vision of overall goals
- Unfamiliar with organization hierarchy

A cause-and-effect diagram illustrated in Figure 13 depicts cause and effects of communication in the context of elicitation.

RQ3e. What are the consequences of poor RE on software quality or project success that is attributed by *communication*?

- Poor system

- System failure
- Budget overruns
- Coordination issues
- Project failure
- Hinders identification and definition of user's needs
- Misunderstanding of required information
- Information requested is too detail
- Inability to plan and work in groups
- Inability to solve ambiguous problems
- Lack the (verbal) communication skills
- Lack of presentation skill
- Lack of authority
- Lack of the ability to write summarized documents
- Lack of the ability to organize ideas
- Regular changes of staff
- Lack of cooperation
- Lack of commitment
- Lack of tolerance
- Emotional
- Lack of the ability to handle conflicts
- Lack of work commitment
- Lack of organization commitment
- Lack of work knowledge in the domain area
- Lack of management skill
- Lack of interpersonal skill
- Lack of skill for problems
- understanding and problem solving
- Lack of ability to make decision
- Late responses
- Misinterpretation
- Unclear pronunciation
- Informal information
- Unrecorded information
- Regular interruption (phone, guest)
- Information not recorded
- Customer expectations not always met
- Low motivation on requirements work
- Unclear requirements coverage
- Quality Issues
- Waste
- Unstable requirements
- Distance
- Broken communication links between stakeholders
- Yielding imperfect specification, scope creep, ultimately dissatisfaction with project
- Notations used difficult to understand and validate
- Complicated synchronous communication
- Loss of communication richness
- Loss of identity within team
- Uncertainties propagate and multiply with information exchange
- Abstract communication through documentation

RQ4e. What are the advisable practices for performing effective RE with respect to *communication*?

- Maintain open communication lines between well-defined stakeholder roles
- Frequently inform and monitor progress on commonly defined artifacts

Social and organizational factors

In GSD model, social and organizational factors play an important role in elicitation. According to [67], most development projects fail because of inadequate elicitation which involves social, political and cultural differences associated with the projects. As we study the social and organizational aspects that influence the project, its relevance and importance become obvious in the GSD environments. The responses to the research questions for social and organizational factors confirm this observation.

RQ1f. What are the issues reported in literature on RE pertaining to *social and organizational factors*?

- Eliciting and managing legal requirements
- Information extraction from law given the imperfection and vagueness,
- Different sources from which information needs to be captured,
- Changing dynamics and
- Time consuming analysis that is error-prone
- In GSD environments, increased distance between originating requirements changes and those with decision-making and execution power
- Cultural mediation
- Social, political and cultural differences associated with the projects.
- Communication challenges in GSD environments
- External factors
- Lack of communication and coordination effectiveness
- Poor group decision-making and team performance
- Lack of trust and mutual understanding
- Potential conflicts of interests
- Evasive behaviors (shadowboxing)
- Stakeholders with diverse backgrounds and using different domain terminologies
- Limited user participation
- Lack of trained personnel
- Cultural differences posing formidable challenges for achieving shared understanding of requirements
- Organizational complexity
- Changes in policies, structure
- Changing organizations goals
- Psychological factors
- Unforeseen situation
- User needs evolve over time

RQ2f. What are the causes for poor RE are attributed to *social and organizational factors*?

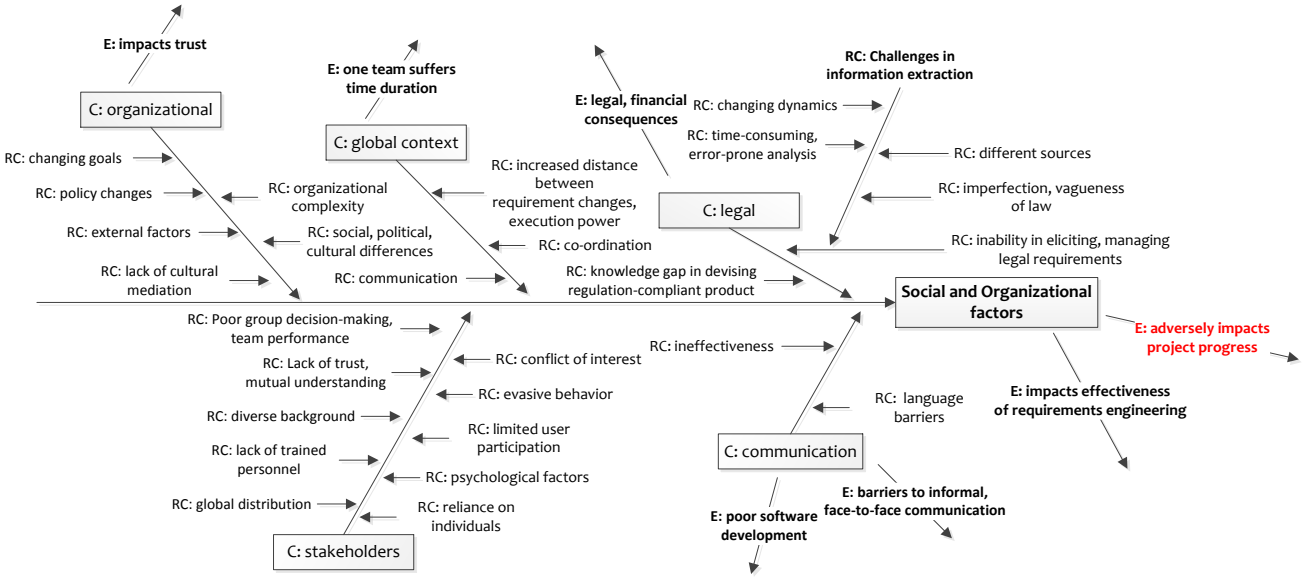

Figure 14. Cause-and-effect diagram for "Social and organizational factors"

- Knowledge gap in devising regulation-compliant product as software designers that do not have legal education
- Language barriers

A cause-and-effect diagram illustrated in Figure 14 depicts cause and effects of social and organizational factors in the context of elicitation.

RQ3f. What are the consequences of poor RE on software quality or project success that is attributed by *social and organizational factors*?

- Organization may be administratively sanctioned
- Person who has suffered damage because of deviation from norms may claim compensation"
- Legal incidents have legal and financial consequences
- Affects trust people feel towards organization"
- In global distributed environments, one team has to suffer time duration causing increased wait time
- Less communication across developer and customer sites, which results in poor software development
- Affects change of demands
- Barriers to informal and face-to-face communication
- Impact effectiveness of requirements engineering

RQ4f. What are the advisable practices for performing effective RE with respect to *social and organizational factors*?

- Define a clear organization structure with communicating responsibilities for the distributed project
- Peer-to-peer links at all management, project, and team levels across distributed sites"
- Partially synchronize inter-organizational processes and perform frequent iterations and deliveries
- Frequent validation of these artifacts gives the teams visibility into the progress of stakeholders' work at remote sites and consequently aids expectation management
- Establish cultural liaisons
- Making customers feel their ownership and responsibility to requirements and future system

Scope

According to [89], project scoping of features and functionalities required to meet the system objectives is critical for project success. An accurate determination of the system boundary to develop software has long been identified as a challenge that practitioners have been attempting to overcome. This is emphasized through the responses consolidated for the research questions pertaining to scope.

RQ1g. What are the issues reported in literature on RE pertaining to *scope*?

- Initial scope not sufficiently defined making it open to interpretations and assumption
- Over-scoping - large amount of features weakly prioritized leading to change management
- Lack of balanced scope and satisfying relevant stakeholders
- Insufficient inputs from stakeholders
- Fluctuating requirements
- Continuous acceptance of additional requirements
- Ill-defined system boundary
- Over-ambitious in elicitation
- Objectives of system not well-understood
- Not adhering to user or organization's true goals
- Scope and deadline dictated
- Communication gap

A cause-and-effect diagram illustrated in Figure 15 depicts cause and effects of scope in the context of elicitation.

RQ3g. What are the consequences of poor RE on software quality or project success that is attributed by *scope*?

- Constant/ many requirements changes
- Quality issues

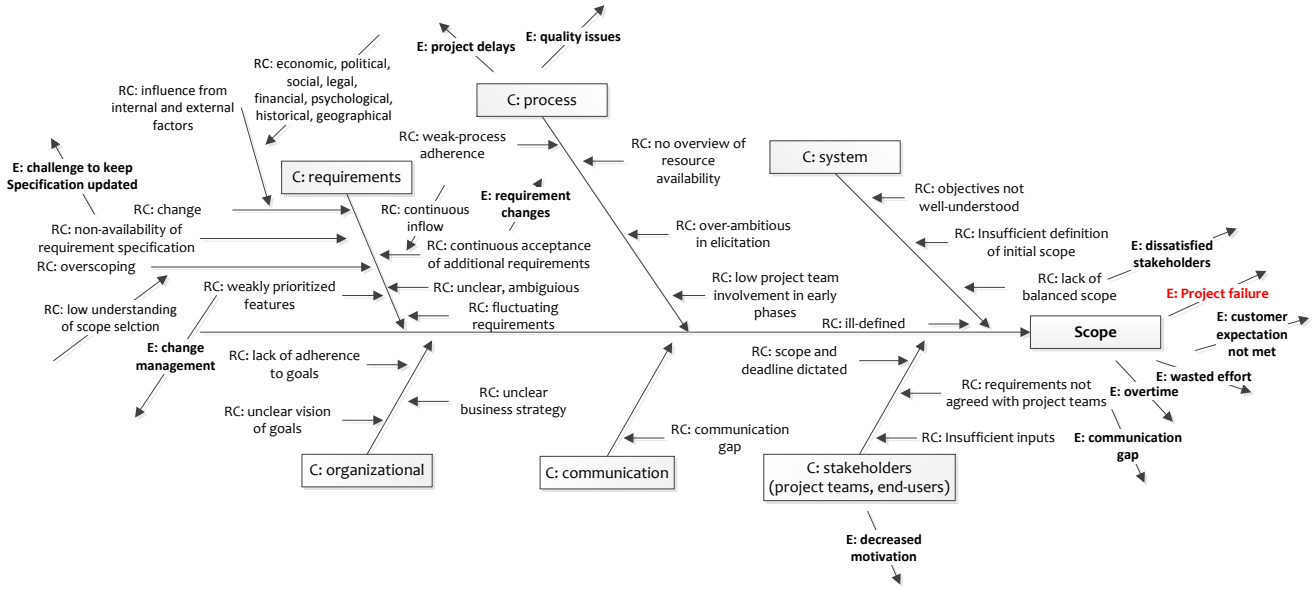

Figure 15. Cause-and-effect diagram for "Scope"

RQ2g. What are the causes for poor RE are attributed to *scope*?

- Subject to change and influence from internal or external factors including economic, political, social, legal, financial, psychological, historical and geographical
- Continuous requirements inflow
- No overview of resource availability
- Low project team involvement in early phases; Requirements not agreed with development teams"
- Non-availability of detailed requirements specification produced upfront
- Unclear vision of overall goals
- Weak process adherence
- Unclear business strategy
- Unclear, ambiguous requirements
- Low understanding of scope selection
- Project delays; product plans changed/ cancelled
- Customer expectations not met
- Communication gaps
- Overtime
- Wasted effort
- Decreased motivation
- Challenge to keep requirements specifications updated

RQ4g. What are the advisable practices for performing effective RE with respect to *scope*?

There are no significant advisable practices or recommendations reported in literature.

Knowledge

According to a survey results reported in [52], it is confirmed that level of business and technical knowledge has great impact to the quality of requirements elicitation and management process. As business analysts and requirements engineers, it is imperative to have the required

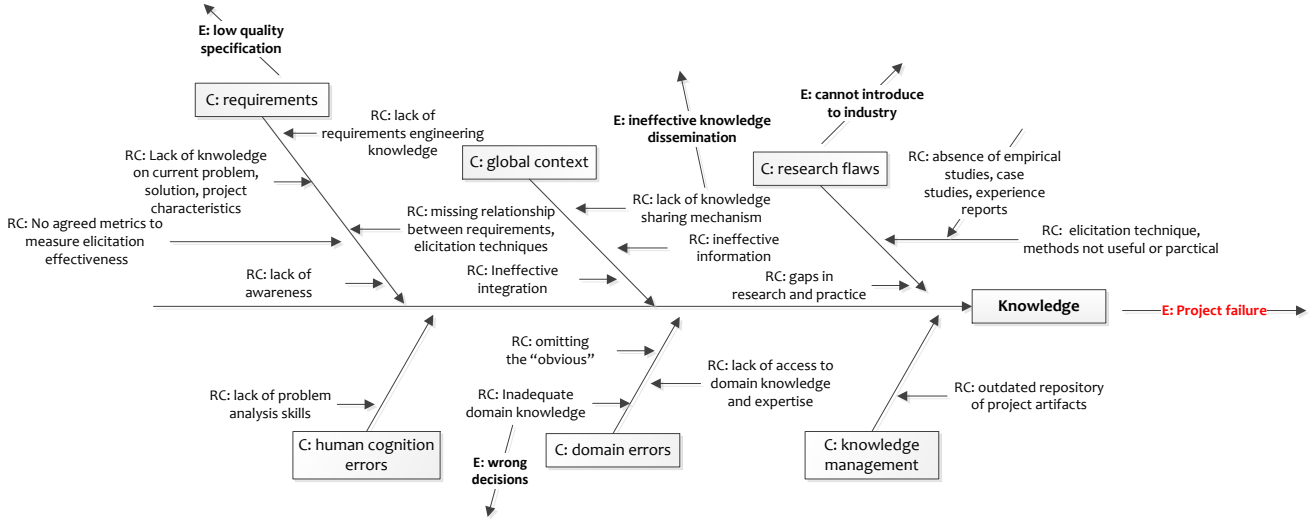

Figure 16. Cause-and-effect diagram for "Knowledge"

domain knowledge prior to participating in the elicitation process. The responses to the research questions pertaining to knowledge focus on the need for having the right knowledge for conducting effective elicitation.

RQ1h. What are the issues reported in literature on RE pertaining to *knowledge*?

- Research issues pertaining to knowledge of elicitation methods/ techniques not useful or practical to introduce to industry
- Lack of awareness of known requirements and which need to be determined
- Lack of knowledge about current problem, solution and project characteristics
- Lack of knowledge of the relationship on the state of requirements to selection of elicitation technique
- Team of users and developers have no adequate domain knowledge and make wrong decisions
- Informal or intuitive statistics are frequently interpreted differently by different people due of their own experiences and biases
- Lack of generic knowledge on problem analysis
- Lack of Requirements Engineering Knowledge
- Software engineers do not have access to sufficient domain knowledge and expertise.
- Lack or incomplete domain knowledge
- Omitting "obvious" information; knowledge short falls
- Global context makes it difficult to seek and integrate necessary knowledge
- Lack of effective information and knowledge sharing mechanisms making global software delivery model ineffective

RQ2h. What are the causes for poor RE are attributed to *knowledge*?

- Absence of sufficient empirical research, case studies and experience reports on elicitation in literature
- No agreed metrics to measure performance of requirements elicitation process

A cause-and-effect diagram illustrated in Figure 16 depicts cause and effects of knowledge in the context of elicitation.

RQ3h. What are the consequences of poor RE on software quality or project success that is attributed by *knowledge*?

- Project failure
- Low quality specifications

RQ4h. What are the advisable practices for performing effective RE with respect to *knowledge*?

- Domain knowledge and prototypes necessary conditions of successful requirements engineering practice

Human factors

RE is a social process, so it involves human behavior [63]. Conflicts and ambiguities play a significant role in determining the success of elicitation. These cover sensitive aspects of the elicitation process that cannot be ignored at any point in time through the course of the development life cycle, not just the requirement engineering phases of the project. The degree of issues that can surface owing to human behaviors can be immense and it is important to pay special attention to these factors. The responses to the research questions pertaining to human factors support this view.

RQ1i. What are the issues reported in literature on RE pertaining to *human factors*?

- Communication-related issues
- Participation-related issues
- Human cognition-related issues
- Management -related issues
- Withhold information
- Recognition Failures - incorrect identification or non-identification of details
- Actively sabotage development effort

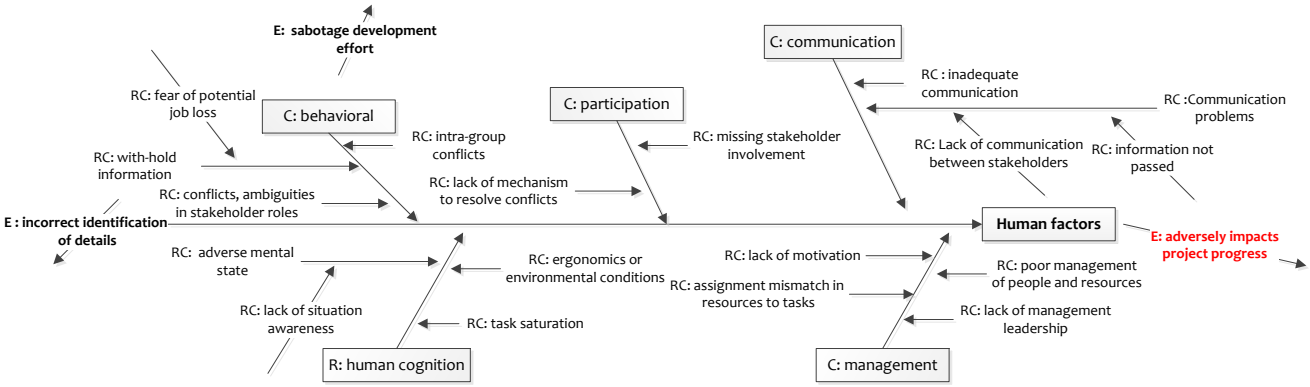

Figure 17. Cause-and-effect diagram for "Human factors"

- Behavioral -related issues

RQ2i. What are the causes for poor RE are attributed to *human factors*?

- Inadequate project communication
- Communication problems
- Lack of communication between stakeholders
- Conflicts and ambiguities in roles that stakeholders and developers play
- Development of a system to support an organization results in an expectation or fear that new system usage will necessitate changes in behavior of individuals and groups
- Potential loss of jobs
- Intra-group conflicts
- Information not passed between stakeholders
- Missing stakeholder information
- lack of mechanism in resolving conflicts
- Poor management of people and resources
- Lack of management leadership and necessary motivation
- Problems in assignment of resources to different tasks
- Mistakes caused by adverse mental state, loss of situation awareness
- Mistakes caused by ergonomics and environmental conditions
- Constraints on humans as information processors, i..e. task saturation

RQ3i. What are the consequences of poor RE on software quality or project success that is attributed by *human factors*?

A cause-and-effect diagram illustrated in Figure 17 depicts cause and effects of human factors in the context of elicitation.

RQ4i. What are the advisable practices for performing effective RE with respect to *human factors*?

There are no significant advisable practices or recommendations reported in literature.

Change

Requirements change over time. Given the nature of business in today's world, change is inevitable. These changes are broadly related to business or technological. Despite the nature of change, there is a significant impact owing to this parameter on the overall product quality and project success. The response to the research questions pertaining to change is highlighted.

Research questions:

RQ1j. What are the issues reported in literature on RE pertaining to *change*?

- Changes due to management and political rule
- Changes in acceptance criteria
- Poor change management
- Changes due to unstable requirements
- Changing nature of requirements overtime
- Incomplete knowledge of requirements at project start
- Volatile nature if users' needs and understanding

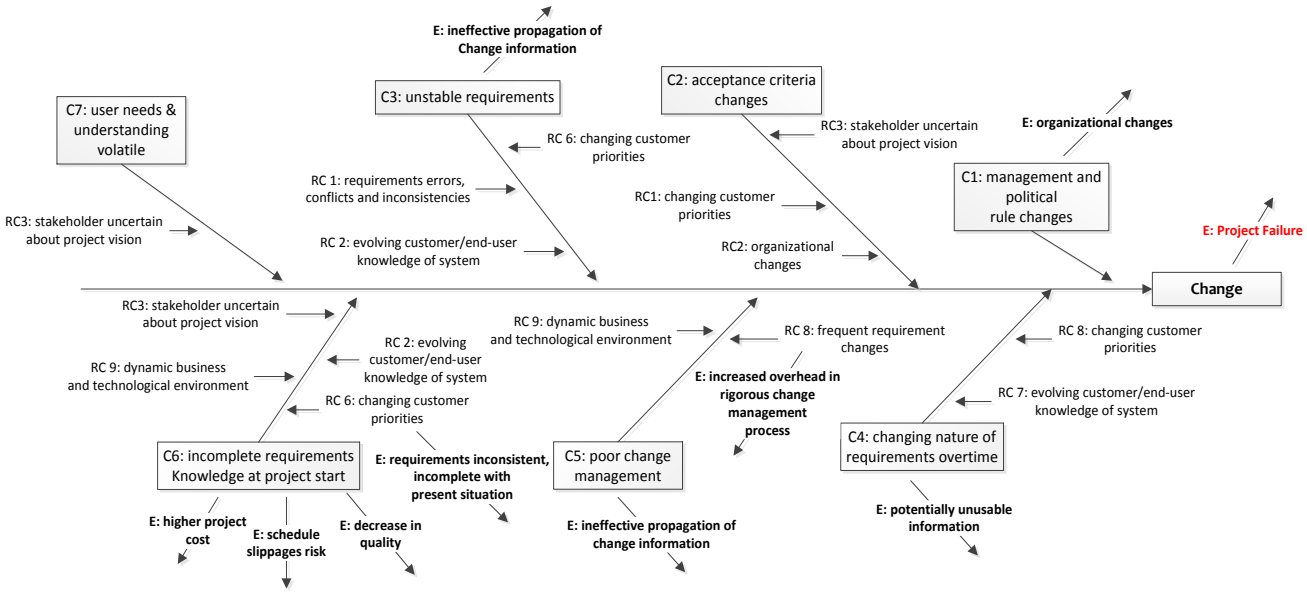

Figure 18. Cause-and-effect diagram for "Change"

RQ2j. What are the causes for poor RE are attributed to *change*?

- Unclear system domain
- Frequent requirement changes
- Stakeholders uncertain about project vision
- Dynamic business and technological environment
- Requirements errors, conflicts and inconsistencies
- Evolving customer/end-user knowledge of the system
- Technical, schedule or cost problems
- Changing customer priorities
- Organizational changes

A cause-and-effect diagram illustrated in Figure 18 depicts cause and effects of change in the context of elicitation.

RQ3j. What are the consequences of poor RE on software quality or project success that is attributed by change?

- Increased overhead in defining more rigorous change management processes
- Ineffective propagation of change information
- Increased development rework
- Higher project costs
- Risks for schedule slippage
- Decrease in quality
- Project Failure
- Requirements incomplete, inconsistent with present situation
- Potentially unusable as information becomes outdated

RQ4j. What are the advisable practices for performing effective RE with respect to change?

- Being proactive in requirements engineering process and predict potential changes and future requirements

C. Contribution to research and practice

This study provides a unique perspective on the overall requirements elicitation issues and the parameters that contribute to the activity. This work outlines, in detail, the issues and challenges, cause-and effects, recommendations and best practices and consequences of poor RE. A systematic review of literature in software engineering was conducted to identify and classify the RE issues. These classifications were further studied to provide a microscopic view of the cause-and effects pertaining to parameters that influence RE. The outcome of this study will be useful in providing guidance and enhance requirements elicitation processes, and thereby improving the overall project success factors and the quality of the product built.

This consolidated view is a significant contribution to literature as this was not documented in prior studies. This study will benefit the research and practice community. It will influence their preparedness for elicitation phases and also aid in decision-making. We believe that a constant study in this field will continue to uncover newer issues and challenges, and will provide constant guidance and support to the community, as there is always a constant struggle to improve the quality of the product.

VI. LIMITATIONS

Extensive work has been done during the last 5 years in the field of RE. While this study attempts to provide maximum coverage on RE issues, the author cannot guarantee all materials pertaining to RE has been captured. Materials in non-English language were excluded, which is a limitation for this study.

VII. CONCLUSIONS AND FUTURE WORK

This paper presents a systematic literature review of elicitation issues. The aim is to provide a consolidated view of RE issues, challenges, best practices and effects reported by researchers and practitioners. Practitioners have been constantly striving to produce good quality, low cost software. With RE gaining importance, related support will certainly help cost reduction along with ensuring better software to customers.

Further studies can be done integrating the information as part of the overall RE process so that risks and issues can be minimized. Models can be devised to understand probability of project success if RE issues are mitigated or overcome. As mentioned earlier, this work is part of academic research. The subsequent phases of this research attempts to build a structural equation model to statistically show impacts of RE issues on project success [57].

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