Contextual attributes impacting the effectiveness of requirements elicitation Techniques: Mapping theoretical and empirical research

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A B S T R A C T

Background: Software engineers can utilise a myriad of elicitation techniques to capture relevant informa- tion in order to specify requirements. The effectiveness of these techniques varies depending on the con- text in which the elicitation takes place. So, it is important to identify the attributes that represent this context. *Objective:* This paper aims to match theoretical to empirical research on contextual attributes that influence elicitation technique effectiveness. *Method:* We conduct a systematic mapping study to identify proposed attributes (by theoretical works) and attributes studied empirically. Then we map empirical re- sults with theoretical proposals. Results: 60% of theoretically proposed attributes have been studied em- pirically. There seems to be some degree of coordination between theory and empiricism. However, there is empirical confirmation of the impact of only a third of the theoretically proposed attributes. Conclu- sions: These results call for more empirical research in order to evaluate beliefs with respect to elicitation techniques.

1. Introduction

Software requirements are often elicited by means of interviews [1,2]. However, more elicitation techniques are likely to be necessary to gather the full range of requirements for most software systems. There are a variety of elicitation techniques that can be used. Some reviews account for tens of elicitation techniques [3–5]. Many of these techniques have been imported from fields like cognitive psychology, anthropology, sociology and linguistics [6].

Elicitation techniques are of different kinds [7], and they may therefore be more effective in some situations than in others. Each type of problem, development team or stakeholder group outlines a context that fits, to a greater or lesser degree, the conditions under which certain elicitation techniques get its highest performance. The contextual attributes describe such conditions. Contextual attributes characterise aspects of the environment in which the elicitation process takes place, such as characteristics of participants or problem. The values of the contextual attributes may or may not match the characteristics required by the elicitation techniques, determining whether or not they are suitable for use in a particular situation. For instance, if there is a set of stakeholders, group techniques fit better; People per Session is a contextual attribute. Such contextual attribute assesses whether exist groups or individuals and the matching between context conditions (number of stakeholders) and technique adequacy (appropriate for group conditions) allows to choose the most promising elicitation technique. If there are different points of view among stakeholders, techniques that facilitate convergence will be more appropriate; Consensus among informants is the attribute that describes whether in the context exist agreement or not across stakeholders. Again matching among context conditions and contextual attributes identifies appropriate techniques. If stakeholders have difficulty expressing their thinking, structured techniques will perform better, and the contextual attribute Articulability allows to identify such context condition. If the elicitor has low experience, simpler techniques may be more suitable, since contextual attributes such as Elicitation Experience or Experience with Elicitation Techniques allow to match techniques suitable for the condition elicitor's low experience. If the problem domain is complex, cognitive techniques may work while others do not, and so on. In other words, some contextual attributes of the project may influence the behaviour of elicitation techniques, and thus their effectiveness [8]. So, it is critical to understand which values of contextual attributes get the best of a technique. For example, the open

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interview will perform well for gathering information in the form of declarative knowledge. However, eliciting procedural knowledge using open interview will get poorer results that using protocol analysis, since this last technique was envisaged to elicit such type of knowledge [9].

The influence of the context on the effectiveness of the elicitation techniques has been repeatedly discussed in the requirements literature [8,10–14]. We call effectiveness a measure of the performance of techniques in capturing more and better information (per elicitation session). For example, if in a given situation the technique questionnaire gathers more requirements unambiguous, complete and verifiable than the technique open interview, then questionnaire is more effective than open interview for the specific conditions of such situation, although in other situation (with other conditions) open interview will be more effective than questionnaire. The claims about with regard to which technique is better suited to a particular context often rely on the experience and knowledge acquired by each researcher. Few claims have been empirically evaluated by means of experiments comparing the behaviour of elicitation techniques in different contexts [15].

Which contextual attributes may influence the effectiveness of elicitation techniques is a need on two grounds: (1) frameworks and procedures for selecting the most effective elicitation technique for an elicitation session, (2) knowledge on the contextual attributes, irrespective of whether or not they have an influence, provides directions for empirical research. This first ground was the aim of our previous research [16], which proposed a technique selection framework based on the most promising contextual attributes from both an operational viewpoint and in regard to consensus in the requirements engineering community.

In the research reported here, we address the second of the grounds mentioned above, that is, we conduct a literature review in order to empirically confirm the influence of contextual attributes on the effectiveness of elicitation techniques. We have reviewed contextual attributes impacting the effectiveness of elicitation techniques that have been studied empirically and proposed in theoretical research.

In short, our research identifies all contextual attributes discussed in the literature and checks which theoretical and empirical studies have addressed such contextual attributes. We aim to understand how well aligned theory and empiricism are in requirements elicitation and to identify the beliefs with respect to the effectiveness of elicitation techniques that have not yet been empirically evaluated. To do so, we use the systematic mapping study method.

The results suggest that there are 27 contextual attributes addressed in 26 theoretical works and 28 empirical studies. Almost half of the contextual attributes proposed theoretically, as having an influence on elicitation technique effectiveness, still require empirical research to verify whether or not they have a bearing. There was strong confirmation of the influence of nine out of 27 contextual attributes. So, more empirical research needs to be undertaken to provide practitioners with guidelines based on empirical evidence about which elicitation technique select.

There are very few empirical studies per technique and attribute. Therefore, we have not been able to focus on individual elicitation techniques, as there is not enough empirical evidence to perform a matching of attributes to techniques. We have focused on attributes having an individual impact on any technique since at such level there is barely information enough.

In the rest of this paper, Section 2 discusses the background of this research. Section 3 describes the design of the mapping study. Section 4 reports the primary studies found. Section 5 uses the extracted data to answer the research questions. Section 6 discusses the findings of our work. The limitations of the study are described in Section 7. Finally, Section 8 outlines the conclusions.

2. Related work

There are no previous systematic mapping studies analysing theoretical and empirical works on contextual attributes influencing requirements elicitation. The systematic review by Dieste and Juristo [15] is the only review that reference the attributes addressed in empirical studies. That paper takes into consideration only the empirical studies for the purpose of evidence aggregation. However, contextual attributes are explicitly mentioned, although possibly not with this name, in several proposals for selecting requirements elicitation techniques. These proposals are generally based on comparing technique characteristics and context characteristics.

Maiden and Rugg [17] presented a framework for selecting elicitation techniques which matches 12 techniques with six facts or attributes, such as purpose of requirements, internal filtering of knowledge, knowledge types, observable phenomena, acquisition context and method interdependencies.

Hickey and Davis [18] built two ontologies for matching purposes: one characterises the requirements elicitation techniques and the other characterises the context in which this activity takes place. The first ontology defines ten dimensions: physical co-location, temporal co-location, record-keeping, analyst role, convergence/divergence, anonymity, stakeholder count, tool based, product/human focus and direct/indirect. The second defines about twenty characteristics of the problem domain, solution domain, stakeholders, solution builders and bridge-builders.

Batista and Carvalho [19] proposed a set of 11 parameters or attributes to characterise the contexts for which the requirements elicitation techniques are best suited and reported matches for three techniques. The proposed parameters attributes are: stakeholder role, application categories, organizational environment, requirements source, techniques applicable in different phases, developer's technique training/knowledge level, required developer skills, cost of the technique, purpose of the gathered information, quantity of gathered information, and user participation level.

We conducted an opportunistic search of attributes for the purpose of instantiating the proposed elicitation technique selection framework [16]. The attributes proposed in that work had to meet the requirements of theoretical justifiability (possibility of finding a justification for the attribute influencing elicitation technique effectiveness), instrumentability (possibility of assigning a value to the attribute during a development project), and assessability (possibility of establishing ratings for the different attribute values). We also proposed new attributes that, we believe, influence elicitation technique selection.

Besides from the above proposals, several papers in the requirements field state contextual attributes and surmise what influence they have on elicitation technique effectiveness. For example, a characteristic like ability to improve communication, as a property of some technique, does not provide any clear indication as to the conditions under which it can be used. On the other hand, the contextual attribute problems of communication among participants [20] can be used to decide which techniques will be best: interview in the case of fluid communication or protocol analysis if the verbalization of tacit knowledge is troublesome.

The stock of contextual attributes used in the above papers, as well as their effect on elicitation techniques is bereft of any empirical groundwork and obeys either the expert opinion of their authors or is based on general literature (e.g., cognitive psychology) or previous research, most of which has no empirical foundation either and can again be regarded as expert opinion.

The evidence gathered from expert opinion based on theory is at the bottom, whereas empirical studies are at the top of evidence hierarchies [21]. It is worthwhile, therefore, exploring which contextual attributes have been proposed in theoretical studies and

the extent to which their influence on elicitation techniques has been confirmed empirically.

3. Mapping study design

3.1. Research questions

We aim to evaluate the match between theoretical and empirical research with regard to the contextual attributes that play a role in the selection of techniques for an elicitation session. Our research questions are:

RQ1: What contextual attributes have been proposed by theoretical research and/or empirically evaluated by empirical research as influencing the effectiveness of elicitation techniques?

RQ2: Which theoretically proposed attributes have been empirically studied?

RQ3: Which theoretically proposed attributes have been empirically confirmed as having an influence on the effectiveness of elicitation techniques?

RQ4: Have attributes affecting effectiveness of elicitation techniques been sufficiently empirically researched?

We have selected systematic mapping as the method for answering the research questions. Systematic mapping studies (SMSs) are an alternative to systematic literature reviews (SLRs) applicable if there is not enough empirical evidence or the topic is too broad for a systematic review to be feasible. The granularity level of a mapping study is coarser, and it aims to identify research gaps and clusters of evidence in order to direct future research [22]. A SLR is a means of identifying, evaluating and interpreting all available empirical research relevant to a particular question focusing on quantitative and empirical studies, while SMS intend to 'map out' the research undertaken rather than to answer a detailed research question. A systematic mapping study structures the type of research reports and results that have been published by categorizing them. It often gives a visual summary, the map, of its results [23].

From the findings of the review by Dieste and Juristo [15], we can presume that it will be difficult to corroborate the influence of contextual attributes for each elicitation technique because there are not enough replications of empirical studies. Only a few empirical works study the same attribute for the same technique. Therefore the appropriate research method here is SMS rather than SLR. Our SMS focuses on attributes, even if studied for different elicitation techniques, since there is not enough evidence to focus our research on attributes impacting a specific technique.

3.2. Search strategy

The information pursuit was based on a search of research papers and books related to requirements elicitation techniques. We searched three bibliographic databases with an unspecified start date and an end date of December 2014 (inclusive): Scopus, IEEE Xplore and ACM DL.

The searches accounted for four aspects (linked by AND):

- focus of our research (framework, comparison, study, empirical, experiment, case study, survey),
- research area (requirements, knowledge),
- type of activity (elicitation, acquisition, gathering) and
- type of instrumentation (techniques, methods).
- The strings used to search the specified databases were:
- Scopus: TITLE-ABS-KEY((framework OR comparison OR empirical OR study OR experiment OR case study OR survey) AND (requirements OR knowledge) AND (elicitation OR acquisition OR gathering) AND (techniques OR methods)) AND SUBJAREA (comp OR Undefined)
- IEEE Xplore: Metadata: ((framework OR comparison OR empirical OR study OR experiment OR case study OR survey) AND (requirements OR knowledge) AND (elicitation OR acquisition OR gathering) AND (techniques OR methods)) AND SUBJECT: Computing & Processing (Hardware/Software)
- ACM DL: ((Title:framework OR Title:comparison OR Title:empirical OR Title:study OR Title:experiment OR Title:case study OR Title:survey) AND (Title:requirements OR Title:knowledge) AND (Title:elicitation OR Title:acquisition OR Title:gathering) AND (Title:techniques OR Title:methods))OR ((Abstract:framework OR Abstract:comparison OR Abstract:empirical OR Abstract:study OR Abstract:experiment OR Abstract:case study OR Abstract:survey) AND (Abstract:requirements OR Abstract:knowledge) AND (Abstract:elicitation OR Abstract:gathering) AND (Abstract:techniques OR Abstract:methods)).

Apart from these formal searches, we applied backward snowballing (i.e. searching based on the references listed in the retrieved papers) and opportunistic searches of grey literature.

3.3. Inclusion/exclusion criteria

To identify relevant papers, we took into account the following aspects considered as inclusion criteria:

- Although the focus is on SE elicitation techniques, we included studies on other areas where elicitation techniques are applied (like economics or marketing). This, since we aim to study the performance of the technique itself regardless of the use of tools in the application of a technique. Additionally, the techniques may be individual or group, that is, we included techniques used to elicit information from both one and more than one stakeholder.
- The focus is on attributes that are related to the elicitation process. Some of the attributes proposed in the literature may influence other requirements activities but not elicitation. For example, the requirements volatility and number of requirements attributes cannot be established until after the requirements have been captured, and therefore their influence is confined to post-elicitation activities, such as requirements specification and management [24].
- Empirical studies may measure the effectiveness of elicitation techniques differently [15]. Such diverse measurements of technique adequacy may have a bearing on the aggregation of the results of the experiments but is not critical for deciding whether an attribute is capable of differentiating techniques, that is, irrespective of how the effectiveness of the elicitation techniques is measured, a difference in the results of applying the techniques under the attribute conditions is sufficient for it to be considered to have an influence.

We considered exclusion criteria as follows:

- Studies on requirements elicitation support tools, like software for automating elicitation techniques, were not considered because they may endow the evaluated techniques with differentiating features that bias their behaviour, and therefore their effectiveness. The problem with using tools is that the comparison would be unfair: Some techniques do have tools that implement them (even some techniques have several tools), others do not. Then the research would not be any more about which technique intrinsically fits better certain circumstances but about efficiency of the techniques due to the tools that implement it not due to the suitability to the context.
- Studies on elicitation technique characterization, like [3], have generally been excluded as they consider aspects that are intrinsic to, or descriptive or prescriptive of the nature of tech-

Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attribute Values (discussed in the primary study)	Excerpt/Results	Primary Study Category

Fig. 1. Data extraction form.

niques but do not consider aspects of the context in which the techniques can be applied. Such type of works refer to the class of technique, such as, for example, it is "administered orally or in writing" instead of aspects referred to contextual attributes like "whether or not stakeholders are online" [25]. It is the aspects of context, availability or location, that may vary from one elicitation context to another and even between elicitation sessions, whereas the intrinsic characteristics of the techniques are unchanged (mode of questionnaire administration). Even though it is the intrinsic features that underpin the merits and adequacies of technique, they, by themselves, are unable to differentiate whether techniques are adequate for one context or another. A technique will be adequate for a scenario when its intrinsic characteristics fit in with the contextual circumstances of an elicitation session.

- Not all the empirical studies on effectiveness provide useful information for this research. Strictly speaking, we focus on studies that compare more than one elicitation technique and also take into account some condition or contextual attribute as variable. The results of comparative experiments indicate whether technique effectiveness varies, thereby detecting the influence of an attribute. It is impossible to ascertain from a study of a single technique whether the considered attributes make the difference between technique effectiveness. Therefore, they may not necessarily influence the selection of elicitation techniques for a context. For example, Roth and Wood [26] study the Delphi method as a technique for comparing the information gathered from individual and group stakeholders. Although the results showed that more information of better quality is gathered from groups, this relative effectiveness may be similar across all elicitation techniques, meaning that the attribute referred to the number of informants would have no bearing on technique selection, for the case of techniques that can be applied to both individual and group stakeholders.
- Note that a study of the effectiveness of several techniques is out of the scope of research unless it tests a specific contextual attribute [27–30]. For example, Jones, Miles and Read [27] evaluated three knowledge acquisition techniques in order to build a prototype expert system. However, they did not define any contextual variable to study the effect of context on the treatment. It is precisely such context variable that provides the key decision-making information on which technique is likely to be more effective in a particular elicitation session.

3.4. Data extraction strategy

Once we identified the primary studies, we proceed to gathering relevant information about the contextual attributes. We defined the data extraction form shown in Fig. 1. Important information is whether the studies are theoretical or empirical.

Theoretical papers discuss the authors' proposals without empirical validation. Most often they are works about models or roadmaps. The main information that we wanted to retrieve from these proposals are:

- Type of proposal
  - Frameworks, which group papers dealing with models, methods, approaches and frameworks addressing a wide range of general aspects of the elicitation process.
  - Taxonomies, which include typologies, ontologies and taxonomies per se, following a faceted classification.
  - Guidelines, which account for comparisons of techniques and guidelines for use.
- Excerpts specifying the argument of authors with respect to the attribute influencing elicitation technique effectiveness.

In the case of empirical studies, our interest focused on the type of method used (experiment, case study, survey, etc.) and the results obtained.

Some papers include both theoretical and empirical studies. In these cases, the studies are catalogued according to the contribution they make to our research. For example, Fowlkes et al. [31] report an empirical study on a single technique: event-based elicitation. As discussed above, this mapping study does not include studies of single techniques. On the other hand, the authors state that some elicitation techniques depend on contextual attributes such as domain knowledge and process time. Thus, for the purposes of our research, we consider this to be a theory paper, as we use the theoretical section of the above paper as a source of information.

Additionally, we had to establish the contextual attribute or attributes that pinpoint the effectiveness of the elicitation techniques, as well as their possible values.

4. Study execution

We applied two consecutive filters to each database search in order to select the primary studies. First, we screened the title and abstract of each identified paper (F1: First Filter in Fig. 2) by means of which we were able to reject most of the articles and identify candidates. Later, we scan the full text of the candidate papers to rule out some papers and leave the selected primary studies (F2: Second Filter in Fig. 2).

As shown in Fig. 2, Scopus search and backward snowballing were the most productive screenings, as most of the studies of interest were identified there. We selected 28 papers out of a total of 2340 from Scopus. Through backward snowballing, we identified 18 papers of interest out of a total of 114 publications. The other searching engines did not identify a sizeable number of new publications despite the large volume of papers screened: 7 out of 428 in IEEEXplore and 1 out of 261 in ACM DL. Generally, the selected studies account for books, journal publications, conference papers, dissertations, etc.

Out of the 54 selected primary studies, 26 are theoretical and 28 are empirical. Table 1 details the studies, identifying each publication with a code and its bibliographic reference. Both theoretical

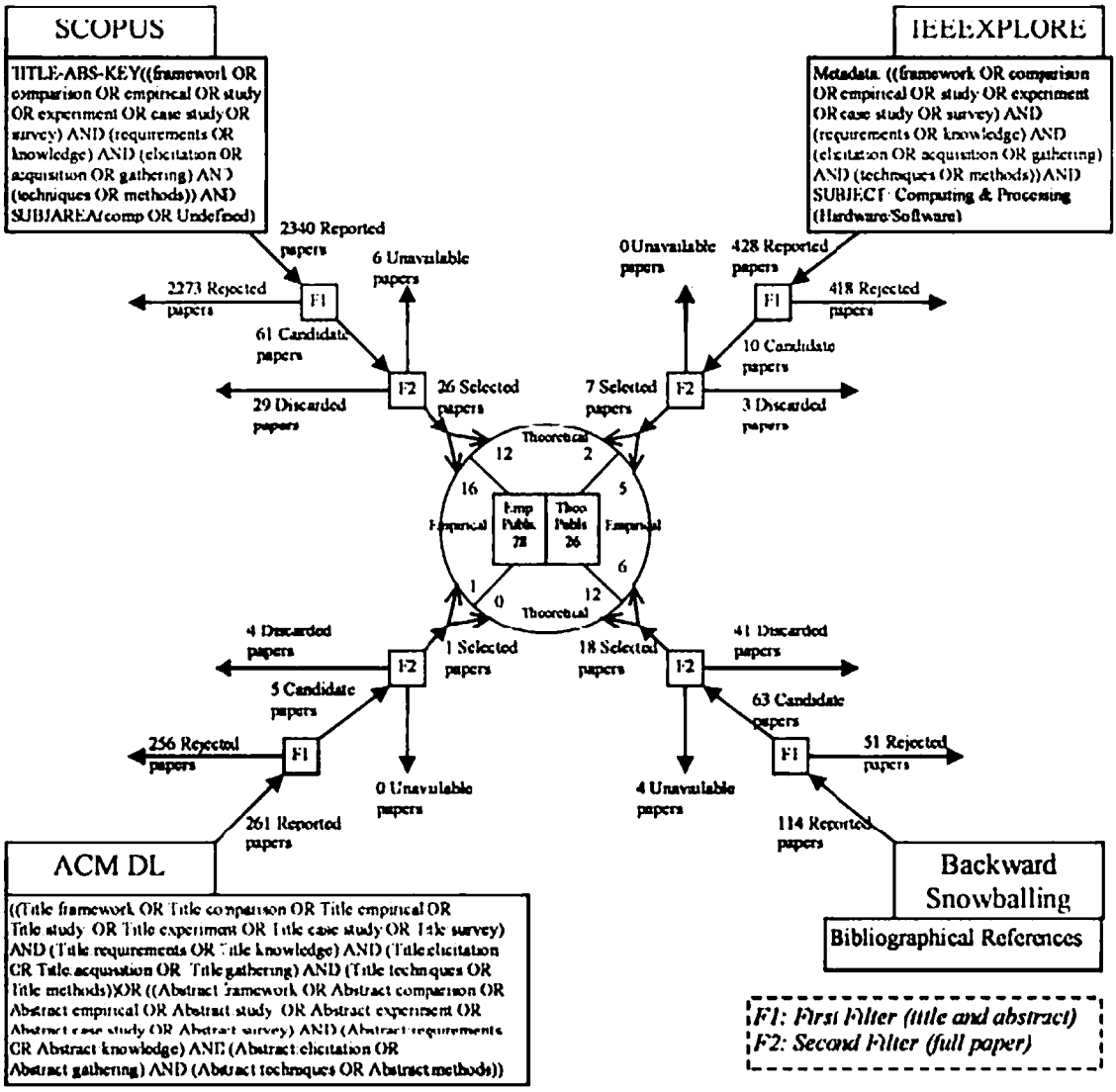

Fig. 2. Search method.

proposals and empirical studies are distributed equally across the search period. In other words, neither paper type seems to takes precedence over the other.

The publications are sourced from different areas: knowledge engineering (20: 8 theoretical, 12 empirical), software engineering (27: 16 theoretical, 11 empirical), information systems (5: 2 theoretical, 3 empirical), knowledge management (1 empirical) and product design (1 empirical).

Some publications represent a group of studies or proposals related (for example, Davis and Hickey [18] and Burton et al. [64]).

The extracted data are compiled in a table shown in Appendix.

5. Results

We aim to identify contextual attributes proposed to influence the effectiveness of the elicitation techniques, as well as to study the extent to which the influence of such attributes has been empirically confirmed. So, we first classified the contextual attributes proposed in theoretical works and studied in empirical studies (Section 5.1). Then we matched the theoretically defined attributes with empirically evaluated attributes (Section 5.2). Finally, we studied which attributes have been empirically confirmed to influence elicitation technique effectiveness (Section 5.3).

5.1. Attributes proposed in the literature

This section addresses the response to research question RQ1: What contextual attributes have been proposed by theoretical research and/or empirically evaluated by empirical research as influencing the effectiveness of elicitation techniques?

We screened 54 primary studies and identified 127 contextual attributes that had been proposed or evaluated as having an influence (see Appendix). Some attributes were proposed in more than one paper. For example, articles T03, T26, T20, T24, T17, E06 and E15 propose Knowledge Types as impacting attribute. We grouped other attributes that were called differently but shared definition and were of the same type within the same category. Some degree of generalization was necessary to make the matching possible. For example, we clustered under Domain Familiarity (on the grounds of the similarity in their definition) Domain Knowledge and Experience in the Problem Domain (T19, T22) and Application Type (E08, T06). This reduction is based on the definitions of the attributes not on their names. For example, the generic attribute

Table 1
Primary studies.

Type	Code	Authors	Discipline
THEORETICAL	T01	Fazlollahi and Tanniru, 1991 [32]	Software engineering
	T02	Christel and Kang, 1992 [33]	
	T03	Maiden and Rugg, 1996 [17]	
	T04	Lauesen, 2002 [34]	
	T05	Batista and Carvalho, 2003 [19]	
	T06	Davis and Hickey, 2003 [18]	
	T07	Tsumaki and Tamai, 2005 [35]	
	T08	Aranda et al., 2005 [36]	
	T09	Zowghi and Coulin, 2005 [13]	
	T10	Jiang and Eberlein, 2007 [24]	
	T11	Zhang, 2007 [37]	
	T12	Thew and Sutcliffe, 2008 [38]	
	T13	Proynova et al., 2010 [39]	
	T14	Kausar et al., 2010 [40]	
	T15	Tiwari, Rathore and Gupta, 2012 [41]	
	T16	Serna, 2012 [42]	
	T17	Kim and Courtney, 1988 [43]	Knowledge engineering
	T18	Byrd, Cossick and Zmud, 1992 [44]	
	T19	Dhaliwal and Benbazat, 1990 [45]	
	T20	Skidmore, 1994 [46]	
	T21	Moody, Blanton and Will, 1999 [29]	
	T22	Fowlkes et al., 2000 [31]	
	T23	Coulin, Zowghi and Sahraoui, 2006 [47]	
	T24	Hua, 2008 [48]	
	T25	Davis et al., 2006 [49]	Information systems
	T26	Eva, 2001 [50]	
EMPIRICAL	E01	Keil and Carmel, 1995 [51]	Software engineering
	E02	Moore and Shipman, 2000 [52]	
	E03	Damian and Zowghi, 2002 [53]	
	E04	Lloyd, Rosson, and Arthur, 2002 [54]	
	E05	Vale, Albuquerque and Beserra, 2011 [55]	
	E06	Boulila, Hoffmann and Herrmann, 2011 [56]	
	E07	Zapata et al., 2012 [57]	
	E08	Hadar, Soffer and Kenzi, 2012 [58]	
	E09	Ahmad, Tahir and Kasirun, 2012 [59]	
	E10	Niknafs and Berry, 2012 [60]	
	E11	Todoran, Seyff and Glinz, 2013 [61]	
	E12	Grabowski, 1988 [62]	Knowledge engineering
	E13	Crandall, 1989 [63]	
	E14	Burton et al., 1990 [64]	
	E15	McCloskey, Geiwitz and Kornell, 1991 [65]	
	E16	Massey and Wallace, 1991 [66]	
	E17	Rugg et al., 1992 [67]	
	E18	Corbridge et al., 1994 [68]	
	E19	Holsapple and Raj, 1994 [69]	
	E20	Chao and Salvendy, 1995 [70]	
	E21	Wagner, Chung and Najdawi, 2003 [71]	
	E22	Holsapple, Raj and Wagner, 2008 [72]	
	E23	Tan et al., 2010 [73]	
	E24	Agarwal and Tanniru, 1990 [74]	Information systems
	E25	Browne and Rogich, 2001 [75]	
	E26	Scapolo and Miles, 2006 [76]	
	E27	Sauer, Schramme and Rüttinger, 2000 [77]	Others
	E28	Chiravuri, Nazareth, and Ramamurthy, 2011 [78]	

Problem Domain Categories identified in T18 looked like it might be associated with the Domain Types attribute. However, when we reviewed Byrd et al.'s paper, we found that the Problem Domain Categories referred to the classes of contextual information in the problem domain and not to specific application domains. Therefore, it was associated in the end with the Information Types attribute.

We grouped the 127 attributes proposed in the literature as 27 contextual attributes. The match between the attributes proposed in the primary studies and the 27 attributes that we identified can be seen in Appendix.

The 27 attributes are very diverse, but they are relatively easy to classify by their type or source for the purposes of categorization. Table 2 shows this classification and attribute clustering. We identified five factors or contextual attribute types [79]:

- Elicitor, member of the development team that elicits key information for requirements specification.
- Informant, person or persons from whom information is gathered.
- Problem domain, problem aspects that the software system under development is to address.
- Solution domain, aspects of software product being developed to address the problem.
- Elicitation process, aspects related to the management of the project as part of which the elicitation is conducted.

For example, Information Gathering Experience, Elicitation Technique Training, Domain Familiarity and Cognitive Aspects refer to the agent acting as the requirements engineer in the elicitation process, generically denoted as the Elicitor.

Table 2
Classification of attributes by aspect.

Aspect	Attribute
Elicitor	Information gathering experience
	Elicitation technique training
	Domain familiarity
	Cognitive aspects
Informant	Number of informants
	Stakeholder participation
	Geographical aspects
	Information source
	Articulacy
	Personal aspects
Problem Domain	Information types
	Domain types
	Uncertainty
	Task types
	Problem size
	Complexity
Solution Domain	Product types
	Criticality
	Problem-solving methods
Elicitation Process	Purpose of requirements
	Deliverable
	Project environment
	Elicitation project type
	Communication type
	Process constraints
	Process time
	Methodologies

5.2. Matching between attributes proposed in theory and evaluated in empirical studies

This section addresses the response to research question RQ2: Which theoretically proposed attributes have been empirically studied?

Researchers used different metrics to represent elicitation techniques effectiveness (for example, number of requirements, quality of requirements, productivity, etc.). Note that, irrespective of how effectiveness is represented, we aim to find out whether or not an attribute influences such elicitation technique effectiveness. This calls for some generalization of the elicitation technique effectiveness or performance construct.

The five aspects, according which we classified contextual attributes, have not received the same attention either theoretically or empirically. As shown in Fig. 3, Problem Domain is the aspect that has awoken most interest, and Solution Domain is the least researched aspect. Note that the focuses of theoretical and empirical papers match closely and are highly correlated ($r = 0.97$), that is, the aspects that are most researched in theory are also the empirically most studied issues. Therefore, theoretical and empirical interests in the contextual attributes that influence elicitation technique effectiveness are aligned at aspect levels.

We also found that experiments are the most common method (75%) for empirically studying almost all aspects (with the sole exception of solution domain, where the number of case studies is greater). Note that the totals for both (theoretical and empirical) work types do not add up to the vertical sum because some publications deal with more than on attribute type.

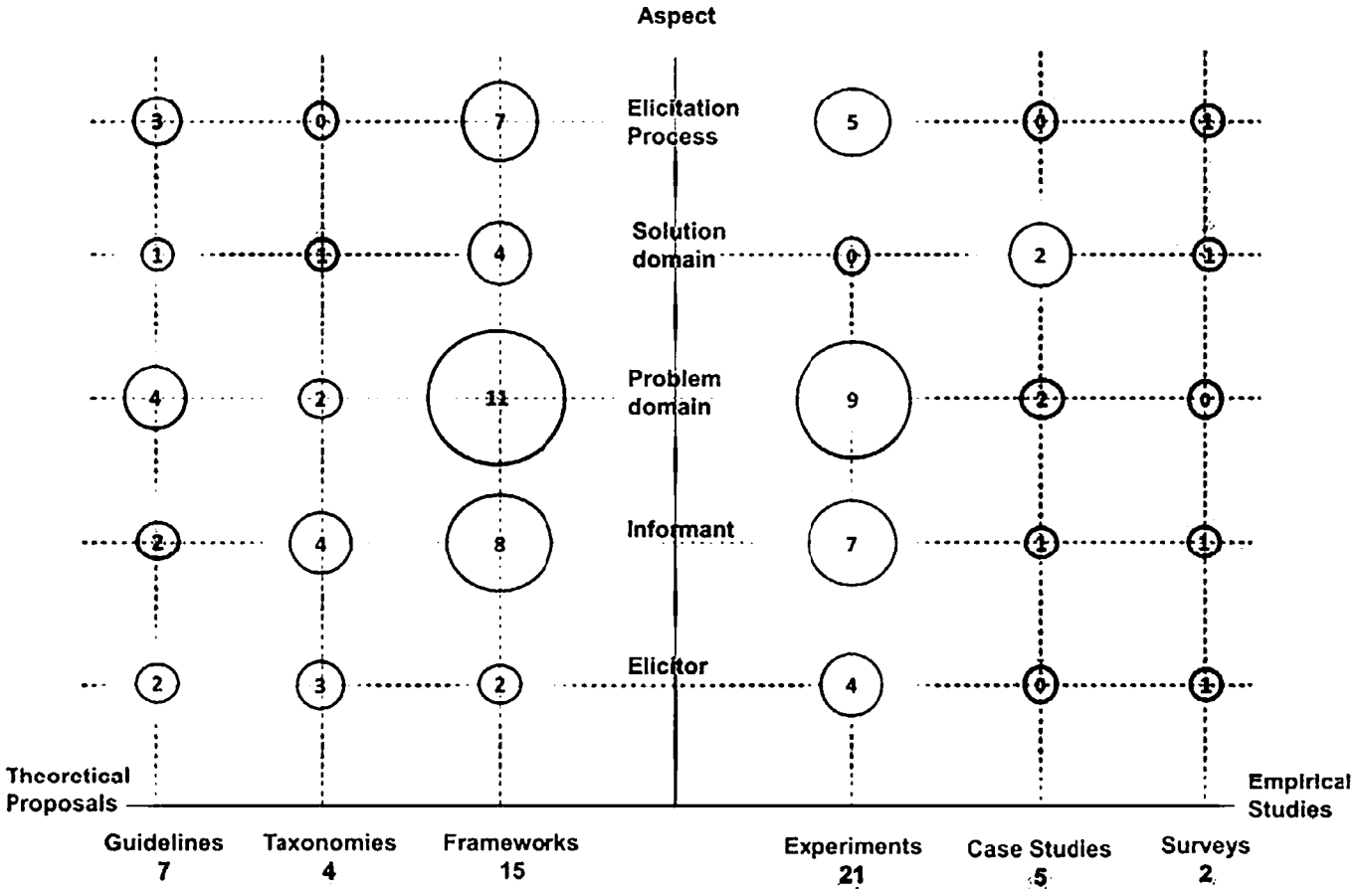

Fig. 3. Types of theoretical and empirical works by contextual aspect.

Table 3
Matching between theory and empirics.

Aspect	Attributes	Theoretical Works	Empirical Works
Elicitor	Information Gathering Experience	T19	E04, E24
	Elicitation Technique Training	T19, T06, T05	-
	Domain Familiarity	T19, T22, T25, T06	E08(2), E10
	Cognitive Aspects	T05, T15, T06, T07	E05
Stakeholder	Number of Informants	T03, T14, T06	E16
	Stakeholder Participation	T07, T14, T05	E04
	Geographical Aspects	T06(2), T11	E03(2), E04
	Information Source	T19, T16, T15(2)	E14, E11
	Articulacy	T25	E13
	Personal Aspects	T19(2), T12(3), T13, T11, T18, T08,	E18, E20, E23, E28
Problem Domain	Information Types	T03(3), T04, T26, T18, T20, T24, T21, T11, T17	E25, E26, E12, E15, E02, E06
	Domain Types	T23, T07	E14
	Uncertainty	T19, T06, T25, T16, T11, T17, T01,	-
	Task Types	T19	E21, E16
	Problem Size	T17, T10, T07	-
	Complexity	T17, T10, T06	E22, E19
Solution Domain	Product Types	T10, T06, T15(2), T14(3)	E01, E11
	Criticality	T10	-
	Problem-Solving Methods	T21, T19	-
Elicitation Process	Purpose of Requirements	T03, T16	-
	Deliverable	T23	-
	Project Environment	T15	-
	Elicitation Project Type	T23	E07
	Communication Type	[redacted]	E18, E17, E09, E27, E11
	Process Constraints	T03, T14(3), T16, T10(2)	E11
	Process Time	T09, T22, T02	-
	Methodologies	T15, T19	-

With respect to the individual attributes, Table 3 shows the number of theoretical and empirical works covering each of the 27 generic attributes. There exist three scenarios: attributes are studied in both theoretical and empirical works (white cells); attributes are studied only in theoretical papers (light grey cells), and attributes are investigated only in empirical studies (dark grey cells). There is a moderate positive correlation between the number of theoretical and empirical papers per attribute ($r = 0.5$).

Fig. 4 shows the attribute distribution by theoretical/empirical coverage. Both theoretical and empirical works were found for 16 out of the 27 generic attributes (59.3%). There are more often more theoretical papers proposing than empirical papers studying an attribute (11 out of 16 cases). The attention that some attributes received differs by study type. For example, Information Types is the most researched attribute, appearing in nine theoretical proposals and six empirical studies. On the other hand, Task Types is investigated in only two empirical studies and one theoretical work.

10 out of the 27 generic attributes (37%) are proposed in theoretical works but have not yet been studied empirically. Uncertainty and Process Constraints attributes are a case in point; they appear in seven theoretical works but are not subject of any empirical study. Finally, only one attribute, Communication Type, appeared in empirical studies but has not been addressed in theoretical works (3.7%).

5.3. Match between theoretical and empirical results

This section addresses the response to research question RQ3: Which theoretically proposed attributes have been empirically confirmed as having an influence on the effectiveness of elicitation techniques?

In order to learn whether the influence of an attributes on the effectiveness of elicitation techniques is confirmed, we studied the match between theoretical proposals and empirical results for each contextual attribute. In other words, we compared the proposals of the theoretical literature against the results of empirical studies that investigate the same attribute than the proposals.

For the purposes of theoretical/empirical verification, we need to decide whether or not an empirical study provides support for the influence of a contextual attribute. To do so, we classified the conclusions of the empirical studies into two types:

- in favour of the influence (FI) of an attribute, that is, evidence is found that the attribute influences the effectiveness of elicitation techniques, or
- against the influence (AI), that is, no evidence is found that an attributes have an influence.

For example, looking at the Domain Familiarity attribute, E08 were able to reject the hypothesis that "There is no difference between analysts with and without domain knowledge in terms of the amount of specific questions in an interview" because they found the difference to be a statistically significant ($p = 0.01$). In

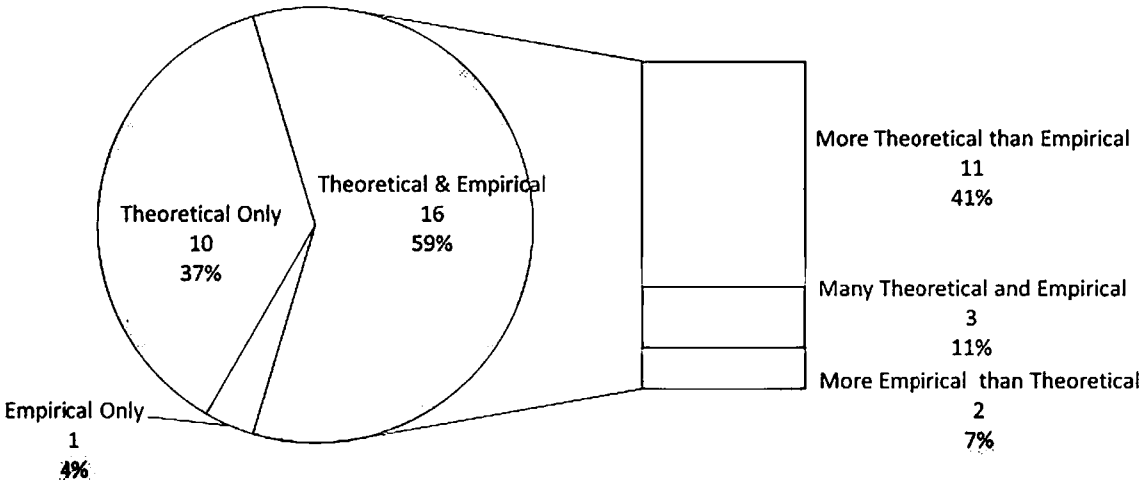

Fig. 4. Distribution of attributes by theoretical/empirical coverage.

Table 4
Match between contextual attributes and empirical study results.

Aspect	Attributes	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24	E25	E26	E27	E28
Elicitor	Information Gathering Experience				FI																				AI				
	Elicitation Technique Training																												
	Domain Familiarity								FI		FI																		
	Cognitive Aspects					FI																							
Informant	Number of Informants																FI												
	Stakeholder Participation				FI																								
	Geographical Aspects			FI	FI																								
	Information Source											FI			FI														
	Articulacy													FI															
	Personal Aspects																		AI		FI			FI					FI
Problem Domain	Information Types		FI				FI						FI			FI			FI							AI	FI		
	Domain Types														AI														
	Uncertainty																												
	Task Types																FI					FI							
	Problem Size																												
	Complexity																			FI			FI						
Solution Domain	Product Types	FI										FI																	
	Criticality																												
	Problem-Solving Methods																												
Elicitation Process	Purpose of Requirements																												
	Deliverable																												
	Project Environment																												
	Elicitation Project Type							FI																					
	Communication Type									FI		FI						AI	FI									FI	
	Process Constraints											FI																	
	Process Time Methodologies																												

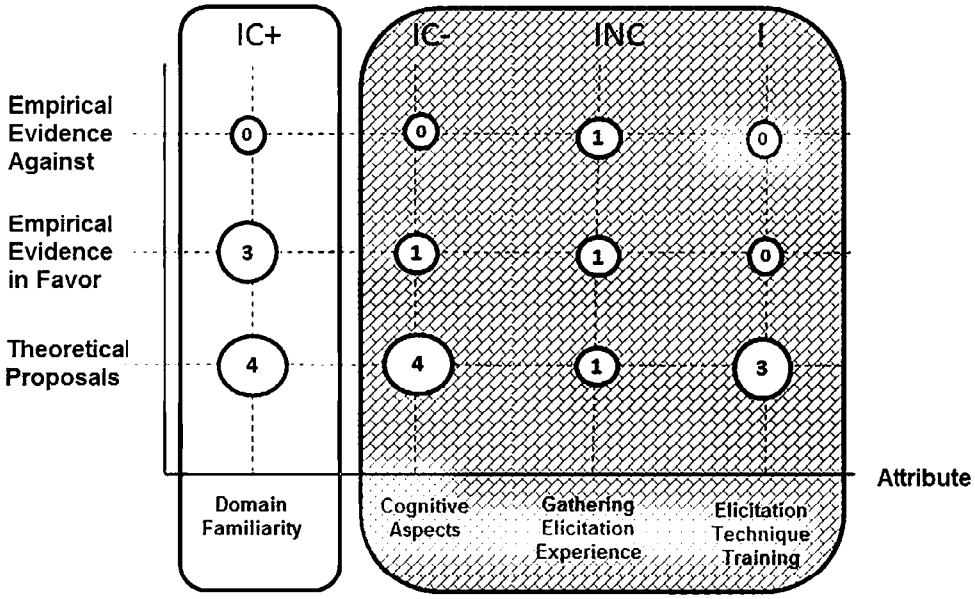

Fig. 5. Results for the Elicitor aspect.

Table 5
Designed synthesis procedure.

Code	Dictum	Description
IC+	Strong confirmation of influence	2 or more pieces of FI than AI evidence
IC-	Weak confirmation of influence	1 more piece of FI than AI evidence
INC	Influence is not confirmed	Equal or greater number of AI than FI results
!	Influence is not confirmed	There are no empirical studies

this case, the study provides evidence in favour of the influence of the Domain Familiarity attribute on the effectiveness of the interview technique.

In another case, E17 compared the Information Types elicited using different types of sorting techniques and did not find a statistically significant difference between techniques. Therefore, the influence of the Information Types attribute is not confirmed. Consequently, this empirical study is considered to provide a result that is against the influence of the Information Types attribute on the effectiveness of sorting techniques. Table 4 shows which empirical studies are in favour of or against the influence of a particular contextual attribute.

Predictably, empirical studies are not necessarily consistent with each other: some studies may be in favour of and others against the influence of one and the same attribute (e.g., E7 and E9 for Personal Aspects). On this ground, we need to establish some sort of aggregation procedure in order to determine whether or not each attribute really influences the effectiveness of elicitation techniques. The primary studies do not meet the requirements for quantitative aggregation (e.g., a meta-analysis). Therefore, we have no choice but to use less sophisticated procedures such as vote counting, which has been used for synthesis in the past [15]. Vote counting has the drawback of overestimating the negative influence of studies with low statistical power, which are very common in software engineering [80]. However, this drawback may be an advantage in this research, as the conclusions reached through vote counting tend to be conservative.

Table 5 illustrates the synthesis procedure that we use. We consider that there is strong confirmation of the influence of an attribute when there are at least two more results of empirical studies that are in favour of than against the influence. Likewise, we consider that there is weak confirmation of the influence of an attribute when there is one more result in favour of than against the influence. Finally, we consider that the influence of an attribute is not confirmed when there is an equal or greater number of results against than in favour of the influence.

Although stated in quantitative terms in Table 5, the synthesis procedure we followed actually emulates the reasoning of a human decision maker based on the information provided by primary studies.

For example, there are authors who suggest in their theoretical proposals that Elicitor Domain Familiarity is an influential attribute. For example,

- T19 state that "This attribute can be hypothesised to have a potential impact on the process of knowledge acquisition";
- T22 who suggest that "Interviews may require extensive domain knowledge" in their comparison of techniques;
- T25 claim that "Some technique allows analysts to elicit requirements in scenarios where they do not have business knowledge"; and
- T06 consider this attribute in their ontology, as "The match between the characteristics of the bridge-builders and the elicitation techniques used is essential".

On the other hand, we have empirical studies investigating this attribute:

- Empirical studies by E08 found significant confirmation that:
  - "Analysts who had domain knowledge posed more specific questions"
  - "Domain knowledge supports the communication between the analyst and the stakeholders"
  - "Domain knowledge can positively as well as negatively affect the formation of the analyst's deep understanding of the customer's needs".
- E10 also found evidence that "The mix of domain familiarities in a team affects the quality of the ideas generated by the team".

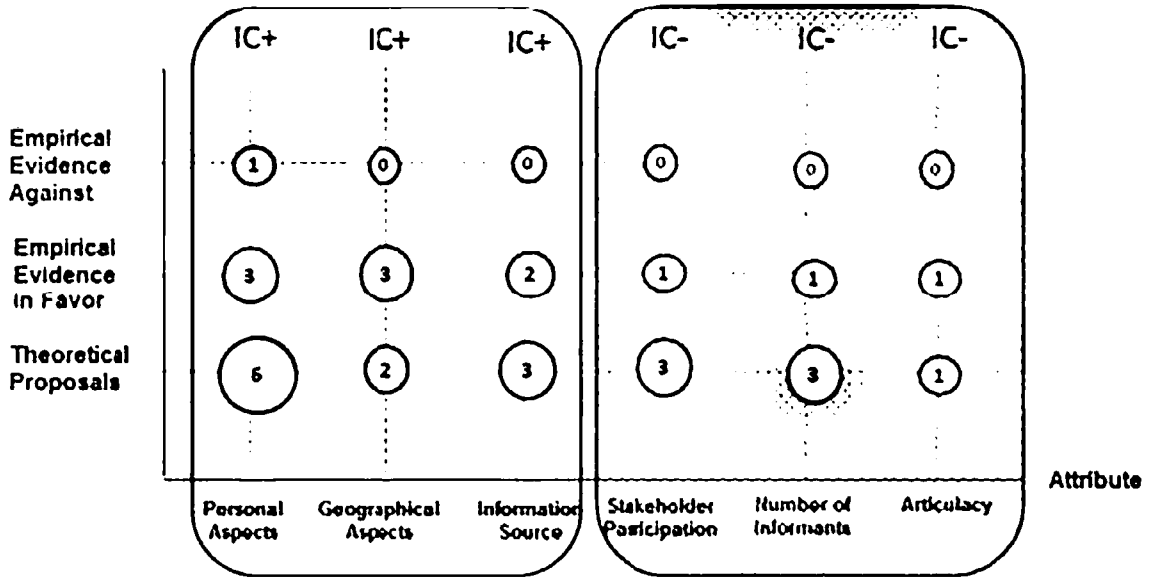

Fig. 6. Results for the Informant aspect.

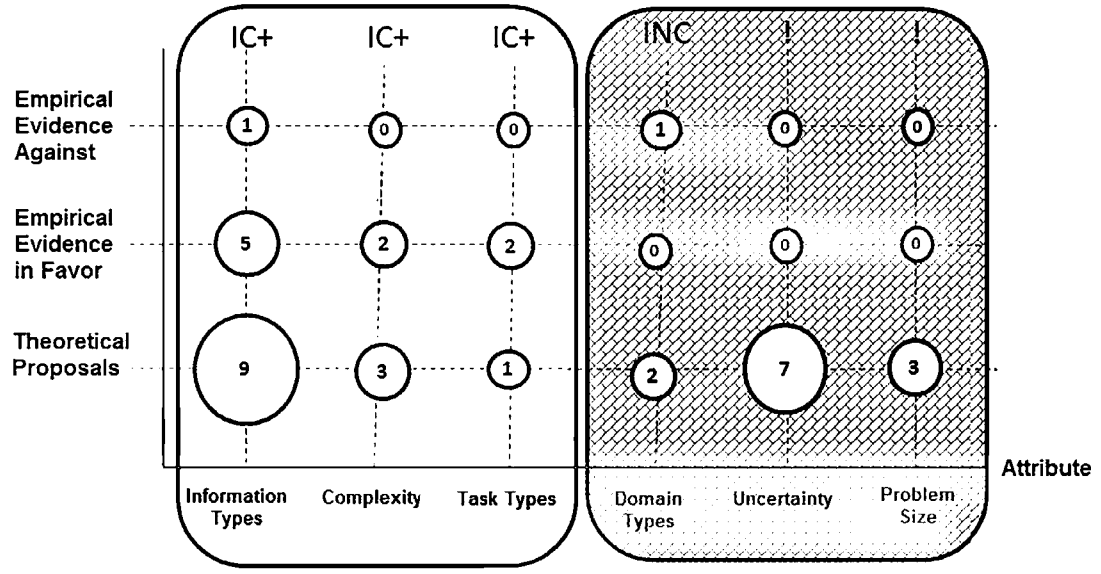

Fig. 7. Results for the problem domain aspect.

This favourable empirical evidence strongly confirmed the influence of the Elicitor Domain Familiarity on the effectiveness of elicitation techniques (IC+).

We applied such synthesis procedure to all attributes. Figs. 5–9 below show the match between theory and experience that we get after synthesizing empirical results. The attributes shaded light grey represent attributes that are well accounted for in empirical studies, and attributes filled pattern represent attributes that require further empirical research.

As Fig. 5 shows, the influence of two out of the four Elicitor attributes was confirmed: Cognitive Aspects and Domain Familiarity. For another attribute, Information Gathering Experience, the influence was not confirmed. Finally, no empirical studies were found for the Elicitation Technique Training attribute.

With respect to informants, six attributes have been proposed. As shown in Fig. 6, there is at least one empirical study for all attributes, and they were all confirmed to have an influence. Evidence for three was weak: Number of Informants, Stakeholder Participation and Articulacy. The influence of the other three – Geographical Aspects, Information Source and Personal Aspects – was strongly confirmed.

Problem Domain aspect is composed of six attributes, as shown in Fig. 7. In this case, its influence was strongly confirmed for three: Information Types, Task Types and Complexity. We found evidence against the influence of Domain Types, and no empirical studies were found for the other two attributes: Uncertainty and Problem Size. More empirical research is required for the last three attributes.

Solution Domain is composed of three attributes. As shown in Fig. 8, only one was confirmed as having an influence: Product Types. No empirical studies were found for the other two at-

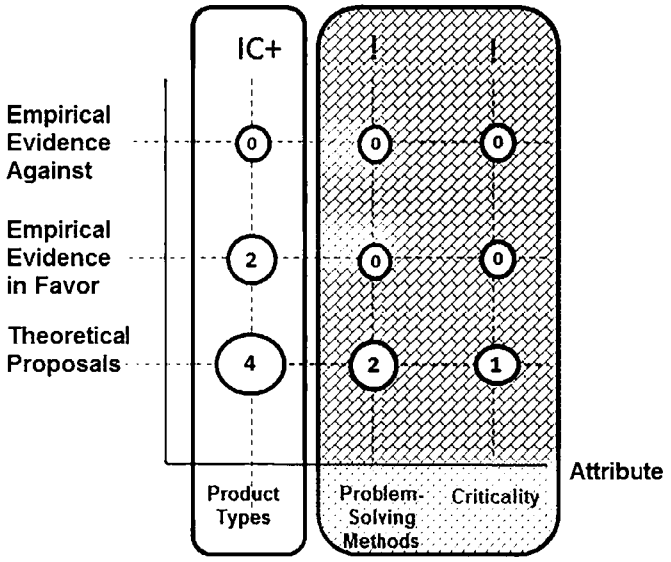

Fig. 8. Results for the solution domain aspect.

tributes: Criticality and Problem-Solving Methods. In other words, more empirical research is required for the last two attributes.

Finally, the Elicitation Process aspect has eight attributes. Only three were confirmed as having an influence: Type of Elicitation Project, Process Constraints and Communication Type. Note that Communication Type was the only attribute that did not appear in theoretical proposals. However, it was, as shown in Fig. 9, the empirically most studied attribute of this aspect. No related empirical studies were found for the other five attributes, which means that this is the elicitation aspect in greatest need of empirical research.

Summarizing, and as shown in Fig. 10:

- The influence of nine out of 27 contextual attributes (33%) was confirmed (IC+): Domain Familiarity, Geographical Aspects, Information Source, Personal Aspects, Information Types, Task Types, Complexity, Product Types and Communication Type.
- Six out of the 27 attributes (22%) were weakly confirmed (IC-): Cognitive Aspects, Number of Informants, Stakeholder Participation, Articulacy, Type of Elicitation Project and Process Constraints.
- There was not enough evidence of two out of the 27 attributes having an influence (8%) (INC): Information Gathering Experience and Domain Types.

Briefly, about half of the theoretically proposed attributes have been empirically confirmed as having an influence on the effectiveness of requirements elicitation techniques.

5.4. Result for theoretical-empirical alignment

Finally, this section addresses the response to research question RQ4: Has this topic been sufficiently empirically researched?

The results are summarised in Table 6 which classifies the empirical evidence in favour and against according to the type of empirical method used (EX: experiments; CS: Case studies; SU: Surveys).

Remember that, in some cases, there are more attributes than theoretical papers or more evidence than empirical studies because the respective papers proposed more than one version of the same attribute or gathered more than one piece of evidence with respect to its influence, respectively.

We can summarise the results with respect to their alignment between theory and empirics in Table 7. The coverage between theory and empirical investigation is good for attributes that are strongly confirmed ($\surd\surd$) (good alignment) while weak confirmation ($\surd$), no confirmation ($\times$), or lack of empirical studies (!) mean that more empirical research is required (poor alignment).

6. Discussion of findings

With respect to the research of attributes that influence the effectiveness of elicitation techniques we can state that there is some level of coordination between empirical research and theoretical proposals. In other words, the empirical researchers tend to study (with one exception) attributes proposed by theoreticians (whether consciously or otherwise). We even found a moderate correlation between how much attention both theoretical proposals and empirical research pay to every contextual attribute, which is unchanging over time.

Note that this research did not set out to corroborate the influence with respect to each particular technique since there are

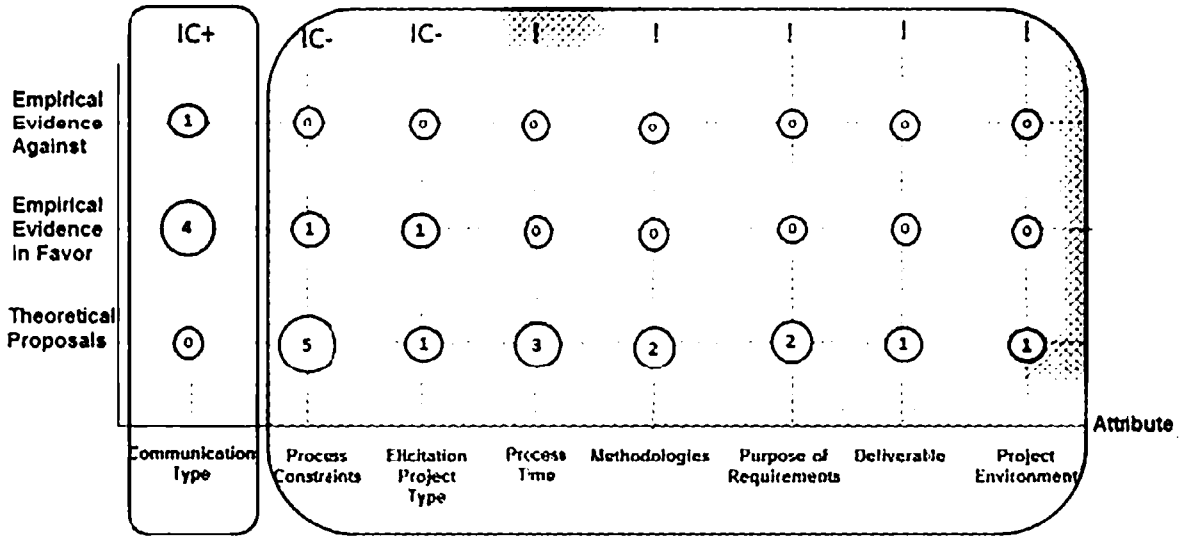

Fig. 9. Results for the elicitation process aspect.

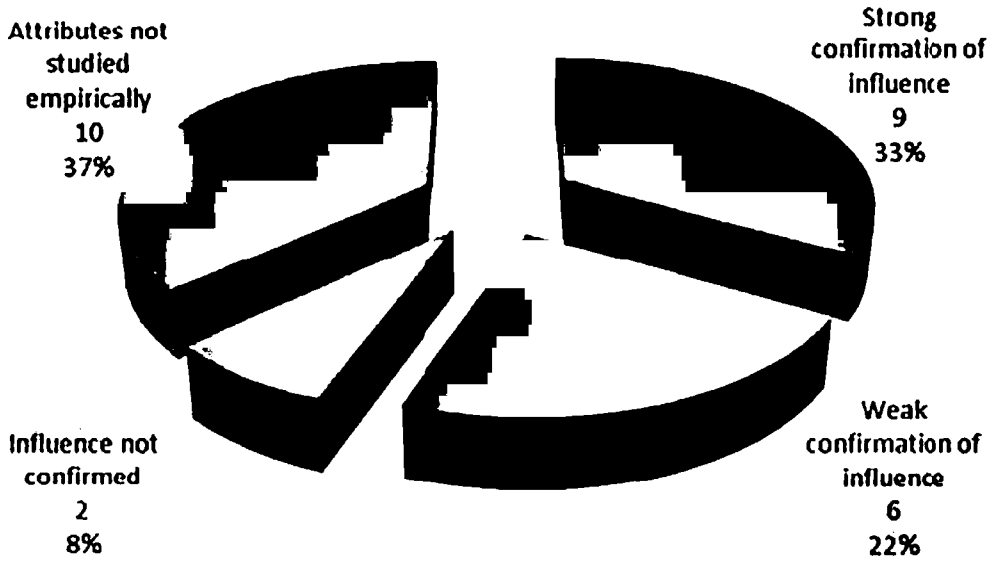

Fig. 10. Breakdown of the results.

Table 6
Match between theoretical and empirical works.

Aspect	Generic Attributes	Theoretical proposals (Number)		Empirical Studies (Number)									Dictum
				Total	FI Evidence				AI Evidence				
		Papers	Attributes	Papers	Total	EX	CS	SU	Total	EX	CS	SU	
Elicitor	Information Gathering Experience	1	1	2	1	1	0	0	1	1	0	0	INC
	Domain Familiarity	4	4	2	3	3	0	0	0	0	0	0	IC+
	Cognitive Aspects	4	4	1	1	0	0	1	0	0	0	0	IC-
Stakeholder	Number of Informants	3	3	1	1	1	0	0	0	0	0	0	IC-
	Stakeholder Participation	3	3	1	1	1	0	0	0	0	0	0	IC-
	Geographical Aspects	2	3	2	3	1	2	0	0	0	0	0	IC+
	Information Source	3	4	2	2	1	0	1	0	0	0	0	IC+
	Articulacy	1	1	1	1	1	0	0	0	0	0	0	IC-
	Personal Aspects	6	9	4	3	2	1	0	1	1	0	0	IC+
Problem Domain	Information Types	9	11	6	5	4	1	0	1	1	0	0	IC+
	Domain Types	2	2	1	0	0	0	0	1	1	0	0	INC
	Task Types	1	1	2	2	1	1	0	0	0	0	0	IC+
	Complexity	3	3	2	2	2	0	0	0	0	0	0	IC+
Solution Domain	Product Types	4	7	2	2	0	1	1	0	0	0	0	IC+
Elicitation Process	Type of Elicitation Project	1	1	1	1	1	0	0	0	0	0	0	IC-
	Communication Type	0	0	5	4	3	0	1	1	1	0	0	IC+
	Process Constraints	5	7	1	1	0	0	1	0	0	0	0	IC-

Table 7
Alignment between theoretical and empirical works.

Aspect	Generic Attributes	Findings	Alignment
Elicitor	Information Gathering Experience	×	Poor
	Elicitation Techniques Training	!	Poor
	Domain Familiarity	√√	Good
	Cognitive Aspects	√	Poor
Stakeholder	Number of Informants	√	Poor
	Stakeholder Participation	√	Poor
	Geographical Aspects	√√	Good
	Information Source	√√	Good
	Articulacy	√	Poor
	Personal Aspects	√√	Good
Problem Domain	Information Types	√√	Good
	Domain Types	×	Poor
	Uncertainty	!	Poor
	Task Types	√√	Good
	Problem Size	!	Poor
	Complexity	√√	Good
Solution Domain	Product Types	√√	Good
	Criticality	!	Poor
	Problem-Solving Methods	!	Poor
Elicitation Process	Purpose of Requirements	!	Poor
	Deliverable	!	Poor
	Project Environment	!	Poor
	Elicitation Project Type	√	Poor
	Communication Type	√√	Good
	Process Constraints	√	Poor
	Process Time	!	Poor
	Methodologies	!	Poor

not enough empirical studies at the technique level to do so. If, for a technique, an empirical study gathered evidence that different attribute values led to different technique effectiveness effects or two techniques were observed to have different effectiveness values for the same attribute value, then the hypothesis that the attribute influences the effectiveness of the elicitation techniques was accepted.

The results show that the influence of 15 out of 27 attributes was to some extent confirmed (55%), whereas we were unable to confirm the influence of two attributes (8%). So, the theoretical proposals were generally well founded. Only two theoretically proposed attributes have been empirically confirmed not to have an influence.

Note that the attribute values played a role in determining their influence. Attribute values were generally categorical. In some cases, they were nominal (non-hierarchical), and, in other cases, ordinal (values with an order, sequence or natural progression). Ordinal values might include a zero value for the attribute somehow representing that the attribute is non-existent (for example, no experience or no domain familiarity). The influence could be confirmed if there was an effectiveness difference between one or more techniques for different attribute values, irrespective of the direction of the effectiveness improvement. In other words, some techniques might perform better for zero attribute values, whereas others might yield better results for values other than zero. Alternatively, technique effectiveness for some attributes could upgrade or degrade the higher the respective values are in the hierarchy (or degrade or upgrade as the attribute values decrease).

We concluded that the amount of empirical research addressing which attributes influence the effectiveness of elicitation techniques is insufficient:

- Of the theoretically proposed attributes, 37% have not attracted any empirical research whatsoever.
- Of the proposed attributes, 26% were addressed only by one empirical study.
- Further empirical research is required for two-thirds (67%) of the attributes.

7. Limitations of the study

The mapping study that we have carried out aims to identify as much available information as possible in order to answer the research questions. However, even though we tried to cover as many publications as possible considering a broad search string, we are likely to have missed some, primarily empirical, works. There are several publications or scientific events that deal with empirical software engineering issues (e.g., Workshop on Requirements Engineering – WER – and Workshop Experimental Software Engineering Latin American Workshop – ESELAW –), which are not systematically indexed in the major databases taken into account in this study: Scopus, IEEE Xplore and ACM DL. To address this issue, we reviewed some of these scientific events manually. We also reviewed books and PhD theses in order to identify more primary studies.

A key aspect that may influence the results is related to the reduction and simplification of the contextual attributes defined in

the primary studies. As specified in Section 5.1, it was necessary to clean up the 127 attributes proposed in the literature by matching equivalent attributes. The result was a reduction of the number of attributes from 127 to 27. The 27 attributes of the study represent attributes that are very similar but with slight different names. There exist the threat that we might have misunderstood or made mistakes in the linkage we have done. However, we are quite confident in the coupling since names where mostly clear and meaningful and differences were mainly synonym terms. Besides decisions were discussed and agreed by the three authors, but we cannot rule out decision making being biased, though we expect not to.

Other threat of our study is that we obtain evidence at type of attribute level, rather than at attribute level as we would wish. Unfortunately very often there is only one study for every attribute so we can only get enough evidence if we generalize attributes: take into account evidence not for a specific attribute, but evidence from several studies of a type of attribute. Generalization of attributes to type of attributes is the strategy we have applied to overcome the small number of studies.

Another limitation of this study is the problem of associating a level of reliability with types of empirical methods. It is hard to determine how well empirically confirmed an attribute when empirical studies of different types yield contradictory results; for example, a survey with evidence in favour and an experiment with evidence against. Fortunately, whenever there was evidence against, the source was always an experiment (in fact, as Table 6 shows, there was no evidence against from case studies or surveys), and there were experiments in favour that we could use for comparison, and therefore there was never any question as to which decision to make.

Notice that to assess the reliability of each empirical study, a detailed analysis is required of how the method was applied in each case, of the philosophical stance adopted as empirical truth by the authors and, generally, of how validity threats are addressed. The evaluation of the quality of the empirical studies is beyond the scope of this research.

Likewise, the major decision with respect to the dictum for each attribute was whether or not the influence of the contextual attributes was confirmed. It is questionable whether a single piece of evidence in favour can confirm the influence of the respective attribute. Since our aim is to discover the alignment between what has been proposed theoretically and what has been studied empirically, it was more important to identify any attributes that did not have associated empirical studies or for which the evidence in favour did not outweigh evidence against.

Finally, remember that the shortage of empirical studies dealing with the same attribute and the same technique led us to abandon the idea of making a more fine-grained comparison of the influence at technique level.

8. Conclusion

This paper reports a systematic mapping study on the contextual attributes influencing the effectiveness of requirements elicitation techniques. In particular, this mapping reviewed the theoretical and empirical publications to determine how aligned theoretical papers proposing contextual attributes are with empirical studies using these attributes.

The results suggest that there is some general alignment between theory and experience, which is in the slipstream of the theory. There are empirical studies dealing with more than half of the attributes proposed in theoretical papers as having an influence on elicitation techniques. Generally, the empirical papers tend to study attributes proposed by theoreticians, and only one attribute was studied in several empirical papers without being mentioned in theoretical proposals.

Further analysis of the empirical studies reveals that the confirmation of contextual attributes is poorly aligned, as the influence of contextual attributes was strongly confirmed only in one-third of the cases. This does not mean that the others do not influence elicitation but suggests that there may not have been enough or adequate empirical validations of their influence. Note that, due to the shortage of empirical studies, we were unable to study alignment at the technique-attribute level, even though it was an objective of interest, as this would have led to non-significant results.

Finally, we can say that even more empirical research is necessary for many of the attributes and, in this respect, an important contribution of this research is to provide researchers with guidance as to the future empirical studies in elicitation that should be conducted primarily in order to build an evidence-based body of knowledge on the elicitation process.

Acknowledgement

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Appendix. Sanitized extraction form

Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
Elicitor	Information Gathering Experience	Theoretical	Dhaliwal and Benbazat, 1990	Knowledge Acquisition Experience	No values	This attribute can be hypothesized to have a potential impact on the process of knowledge acquisition	Framework
		Empirical	Lloyd, Rosson, and Arthur, 2002	Requirements Elicitation Experience	Rating	We discovered a rather weak but positive relationship between a group's average requirements engineering experience and the quality of their' SRS documents (FI)	Experiment
			Agarwal and Tanniru, 1990	Knowledge Acquisition Experience	Novice (academic knowledge of problem but no practitioner experience), Experienced (MIS practitioners with at least one KA project or at least 3 andears in systems analysis)	Two interview techniques allowed novice knowledge engineers to perform at a level that was comparable to experiences knowledge engineers (AI)	Experiment
	Elicitation Technique Training	Theoretical	Dhaliwal and Benbazat, 1990	Technical Knowledge/Experience with Specific Elicitation Methods	No values	This attribute can be hypothesized to have a potential impact on the process of knowledge acquisition	Framework
			Davis and Hickey, 2003	Knowledge/ Experience with Specific Elicitation Techniques	No values	The match between the characteristics of the bridge-builders and the elicitation techniques used is essential	Ontology
			Batista and Carvalho, 2003	Techniques Training/knowledge Level	Low, Medium, High, Stranglehold	The developer must know the techniques to be used in the elicitation process and must undergo training	Taxonomy
	Domain Familiarity	Theoretical	Dhaliwal and Benbazat, 1990	Domain Knowledge	No values	This attribute can be hypothesized to have a potential impact on the process of knowledge acquisition	Framework
			Fowlkes et al, 2000	Domain Knowledge	No values	Interviews may require extensive domain knowledge	Comparison of techniques
			Davis et al, 2006	Business Knowledge	Known, Unknown	Some technique allows analysts to elicit requirements in scenarios where they do not have "business knowledge"	Typology of challenges
			Davis and Hickey, 2003	Experience in the Problem Domain and Application Type	No values	The match between the characteristics of the bridge-builders and the elicitation techniques used is essential	Ontology
		Empirical	Hadar, Soffer and Kenzi, 2012	Domain Knowledge	With and Without	Analysts who had domain knowledge presenting more specific questions (FI)	Experiment
			Hadar, Soffer and Kenzi, 2012	Perceived	Positive, Negative	Domain knowledge supports the communication between the analyst and the stakeholders.	Experiment
				Effects of Domain Knowledge		Domain knowledge can positively as well as negatively affect the formation of the analyst's deep understanding of the customer's needs (FI)	

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
			Niknafs and Berry, 2012	Mix of Domain Familiarities	Teams consisting of: 3 DIs and 0 DAs, 2 DIs and 1 DAs, 1 DIs and 2 DAs, 0 DIs and 3 DAs.	The mix of domain familiarities in a team affects the quality of the ideas generated by the team (FI)	Experiment
	Cognitive Aspects	Theoretical	Batista and Carvalho, 2003	Analist Abilities	Too much values	Each technique requires a developer's personal capacity	Taxonomy
			Tiwari, Rathore and Gupta, 2012	Analyst Ability/Skill	New, Less experience, Experienced, Expert	Analysts (elector) skill is one of the key factors for selecting requirement elicitation techniques because the requirement elicitation process is highly affected by the skills of analysts	Framework
			Davis and Hickey, 2003	Communication/ Facilitation Skills	No values	The match between the characteristics of the bridge-builders and the elicitation techniques used is essential	Ontology
			Tsumaki and Tamai, 2005	Requirements Engineer Type	Logical, Imaginative	The Requirement Engineer type is a characteristic considered in the authors' proposal	Framework
		Empirical	Vale, Albuquerque and Beserra, 2011	Relevant skills	Written communication skills, Communication skills, Ability to relate, Ability to hear	Skills and factors that may be relevant for requirements analysts can act effectively in the role played (FI)	Survey
Informant	Number of Informants	Theoretical	Maiden and Rugg, 1996	Number of Stakeholders	1, 2, 6	A framework is presented with techniques that capture requirements from different number of stakeholders	Framework
			Kausar et al., 2010	Number of Stakeholders	Single, Multiple	We need to identify the total number of system stakeholders for selecting the right elicitation technique	Guidelines
			Davis and Hickey, 2003	Stakeholder Count	None, One, Few, Many	Inherent characteristics of all the people involved in a software development project, especially they are major drivers of the selection of appropriate elicitation techniques	Ontology
		Empirical	Massey and Wallace, 1991	Experts Number	Individuals, Group	focus groups performed better in generating "original" responses than the individual interview, and focus groups were at least as good as individual interviews in terms of the "quality" and "acceptance" of responses (FI)	Experiment
	Stakeholder Participation	Theoretical	Tsumaki and Tamai, 2005	User Involvement	Little, Much	The user involvement is a characteristic considered in the authors' proposal	Framework
			Kausar et al., 2010	Stakeholder Involvement	Maximum, Average, Minimum	we must know about stakeholder position in the organization and his/her interest in the project for selecting the right elicitation technique	Guidelines
			Batista and Carvalho, 2003	User' Participation Level	Low, Medium, Hugh	Some techniques require more stakeholder participation	Taxonomy
		Empirical	Lloyd, Rosson, and Arthur, 2002	Customer Participation	Rating	A weak positive trend was seen between ratings (perception) of customer participation and overall SRS quality (FI)	Experiment

(*continued on next page*)

Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
	Geographical Aspects	Theoretical	Davis and Hickey, 2003	Temporal Co-Location	Same time, Different time	It captures whether or not the technique demands that participating parties be located at the same physical location, e.g., in the same room	Ontology
			Davis and Hickey, 2003	Physical Co-Location	Same place, Different place	It captures whether or not the technique demands that participating parties be located at the same physical location, e.g., in the same room	Ontology
			Zhang, 2007	Culture Diversity	National, Organizational	Analysts shall using an appropriate method to interact wit h stakeholders from different nationalities and organizations	Framework
		Empirical	Damian and Zowghi, 2002	Cultural Diversity	Cultural, Language, Organizational, Functional	Differences in stakeholders' language and national culture affect global collaboration. Equally important in this case study was the impact of differences in organizational and functional culture (FI)	Case study
			Damian and Zowghi, 2002	Time Difference	Synchronous, Asynchronous	Hence asynchronous channels were predominant in the communication, complemented by teleconferencing calls. Synchronous meetings across continents are always awkward for at least one site – either too early or too late in the day, and involve someone having to compromise on their work schedule (FI)	Case study
			Lloyd, Rosson, and Arthur, 2002	Synchronization	Synchronous, Asynchronous	There is some suggestion that synchronous collaboration in the requirements process in this study was possibly more effective than asynchronous collaboration (FI)	Experiment
	Information Source	Theoretical	Dhaliwal and Benbazat, 1990	Stage of Expertise	No values	The stage of development of an expert has a direct impact on his or her ability to articulate expertise and thereby influences both the choice of the KA technique selected	Framework
			Serna, 2012	Source of Requirements	Human being, Other envirements	The font may be embedded in people skills or physical environments, requiring different approaches to capture them.	Framework
			Tiwari, Rathore and Gupta, 2012	Type of End Users	New user, Some knowledge of domain, Domain expert	If the user has knowledge about the domain then always ask from users about their expectation of the system or about functionality otherwise try to understand users need by some other mean	Framework
			Tiwari, Rathore and Gupta, 2012	Type of Stakeholders	Homogeneous, Heterogeneous, Domain expert, Not domain expert but decision maker	To include all the stakeholders in elicitation process is required, so that any conflict between them is resolved and the requirements, which will elicited are consistent and reflect the actual needs of the customer	Framework

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
		Empirical	Burton et al., 1990	Level of Expertise	Novices (null experience), Experts (experienced)	Unlike experts, novices do not show a characteristic pattern of efficiency across techniques (FI)	Experiment
			Todoran, Seyff and Glinz, 2013	Target Audience	Heterogeneous, No Heterogeneous	It was generally admitted that the target audience for cloud services is much more heterogeneous than the audience for traditional software or hardware products (FI)	Survey
	Articulacy	Theoretical	Davis et al., 2006	Articulability Difficulties	No values	Some technique allows analysts to elicit requirements that usually are not articulated by users	Typology of challenges
		Empirical	Crandall, 1989	Verbalizations of Knowledge	Quality cues	Results from the present study offer evidence that CDM techniques can gain access to aspects of expert knowledge that are resistant to articulation (FI)	Experiment
	Personal Aspects	Theoretical	Dhaliwal and Benbazat, 1990	Cognitive Styles	No values	Attribute of experts that impact quality and efficiency of knowledge acquisition techniques	Framework
			Dhaliwal and Benbazat, 1990	Personality Variables	No values	Attribute of experts that impact quality and efficiency of knowledge acquisition techniques	Framework
			Thew and Sutcliffe, 2008	Motivations	Power, Possession, Achievement, Self-esteem, Peer-esteem, Self-efficacy, Curiosity, Learning, Sociability, Altruism	Motivations are important for understanding stakeholder groups and for individual-level requirements when systems can be customized or configured	Taxonomy
			Thew and Sutcliffe, 2008	Values	Trust, Sociability, Morals/Ethics, Creativity, Innovation, Aesthetics, Security, Personal, Characteristics, Motivation, Beliefs & attitudes	Value analysis may both alert the analyst to potential stakeholder conflicts, and help the analyst better understand the causes of those conflicts	Taxonomy
			Thew and Sutcliffe, 2008	Emotions	Fear, Pleasure, Anxiety, Frustration, Disgust, Depression	Understanding values and emotions helps requirements engineers interpret the concerns held by individuals and to predict their actions and responses	Taxonomy
			Proynova et al., 2010	Personal Values	Attitudes	But knowing the users' attitude towards the tasks allows deeper insight into the requirements. Requirements engineering (RE) process is heavily influenced by soft issues such as politics or personal values of stakeholders	Approach
			Zhang, 2007	Cognitive Limitations	Ability of comprehension, Capacity of memory and recall, The information processing activities, The decision-making processes	The cognitive limitations vary from people to people, so different methods may be suitable for different people to elicit requirements within the same context	Framework
			Byrd, Cossick and Zmud, 1992	Communication Obstacles	Within, Between, Among	Examinations of techniques and how they are used to overcome communications obstacles and enrich understanding	Comparison of techniques
			Aranda et al., 2005	Stakeholders Categories	Visual, Verbal, Active, Reflective	It suggests an appropriate set of groupware tools and elicitation techniques according to stakeholders' preferences	Model

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
		Empirical	Corbridge et al., 1994	Personality Characteristics	Extroversion/introversion, Field dependency/independency	There was no evidence of effect of personality characteristics in this domain (AF)	Experiment
			Chao and Salvendy, 1995	Cognitive Abilities	Fluency, Induction, Integrative processes, Reasoning, Flexibility of use	Cognitive abilities of experts affect significantly the effectiveness of the elicited data and the percentage of total knowledge acquired (FI)	Experiment
			Tan et al., 2010	Consensus	Rating (%)	The focus group technique was more effective than modified Delphi method in achieving consensus on ventilation Management (FI)	Case study
			Chiravuri, Nazareth, and Ramamurthy, 2011	Consensus Among Experts	Rating	RepGrid appears to be a superior technique to reduce disagreement and create consensus in the long run (FI)	Experiment
Problem Domain	Information Types	Theoretical	Maiden and Rugg, 1996	Observable Phenomena	Domain objects and processes	A framework is presented with techniques that capture or not observables phenomena	Framework
			Maiden and Rugg, 1996	Knowledge Types	Behavior, Process, Data	A framework is presented with techniques that capture different knowledge types	Framework
			Maiden and Rugg, 1996	Internal Filtering of Knowledge	Future system, Non-tacit, Semi-tacit, Tacit	A framework is presented with techniques that acquire knowledge about the existing domain, requirements for the new system, or both	Framework
			Lauesen, 2002	Information Types	Current work, Current problems, Goals and key issues, Future system, Realistic possibilities, Consequences and risks, Commitment, Conflict Resolution, Requirements, Priorities, Completeness	It presents an assessment of the adequacy of the techniques for different types of information requirements	Approach
			Eva, 2001	Knowledge Types	Non-tacit, Semi-tacit, Tacit	The knowledge that RAD has to address is more susceptible to heuristic, iterative approaches than to traditional systems analysis techniques. The JRP/JAD workshop helps to pull out tacit and semi-tacit knowledge factors behind certain of the requirements as a necessary pre-requisite for prototyping. Traditional systems analysis, which focused on automating data processing, looked mostly at non-tacit or semi-tacit knowledge	Comparison of techniques
			Byrd, Cossick and Zmud, 1992	Problem Domain Categories	Information requirements, Process understanding, Behavior understanding, Problem frame understanding	Proposal of matching between certain elicitation techniques and problems domain categories	Comparison of techniques
			Skidmore, 1994	Knowledge Types	Non-tacit, Semi-tacit, Tacit, Taken-for-granted	For the automation of data processing tasks, these generally proved satisfactory; for providing IS support for organizations that are already computerized, and where tacit and semi-tacit knowledge is involved, they are less helpful. Where a Greenfield system is in development, they are less appropriate	Framework

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
			Hua, 2008	Types of Knowledge	Concept, Process, Tacit, Explicit	It presents the various techniques and shows the types of knowledge (tacit/Explicit, concepts/processes) they are mainly aimed at eliciting	Comparison of techniques
			Moody, Blanton and Will, 1999	Human Knowledge Categories	Declarative, Procedural, Episodic, Semantic	Matching knowledge elicitation techniques with the human knowledge categories	Framework
			Zhang, 2007	Requirements Abstraction Level	Problem Analysis (It refers to the business requirements such as the product vision, project scope, and the constraints), Product description (It refers to the product features including functional and nonfunctional requirements)	Taking into account the nature of requirements on different abstraction levels, a proper set of elicitation methods have to be chosen	Framework
			Kim and Courtney, 1988	Types of Knowledge	Concepts, Heuristics, Reasoning	Different Knowledge Acquisition techniques elicit these three types of knowledge	Comparison of techniques
		Empirical	Browne and Rogich, 2001	Generic Requirements Categories	Goal level, Process level, Task level, Information level	There were no significant qualitative differences in the types of requirements elicited by each technique (AF)	Experiment
			Scapolo and Miles, 2006	Types of Knowledge and Information	No values	Different techniques, then, even if based on soliciting experts opinions through mean of inquiries and applied on the same topic, are likely to achieve different levels and types of knowledge and information (FI)	Case study
			Grabowski, 1988	Heuristics Types	Conceptual, Operational, Logistics	Techniques capture different types of heuristic (FI)	Experiment
			McCloskey, Geiwitz and Kornell, 1991	Knowledge Types	Evaluation dimension, Goal dimension	It revealed important differences in the knowledge elicited by the techniques (FI)	Experiment
			Moore and Shipman, 2000	Types of Requirements	High level functional, Fine-grained procedural	The most striking difference between gathering textual argumentation using a questionnaire or GRC was the type of information elicited. The questionnaire process produced mainly functional information with little information regarding procedural details (FI)	Experiment
			Boulila, Hoffmann and Herrmann, 2011	Type of Knowledge	Tacit knloledge, Non tacit	Storytelling is a more effective tool than brainstorming for eliciting requirements and including the tacit knowledge as part of the elicitation process (FI)	Experiment
	Domains Types	Theoretical	Coulin, Zowghi and Sahraoui, 2006	Type of Application Domain	Examples of application domains include Business Information, Group Support, and Embedded Control	The general application domain of the envisaged system is a characteristic considered in the authors' proposal	Approach
			Tsumaki and Tamai, 2005	Domain Stability	Stable, Unstable	The application domain type is a characteristic considered in the authors' proposal	Framework
		Empirical	Burton et al., 1990	Domains Types	Flint, Pottery	There is no significant difference across domains (AF)	Experiment

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
	Uncertainty	Theoretical	Dhaliwal and Benbazat, 1990	Uncertainty Degree	No values	Attributes of the application domain that impact quality and efficiency of knowledge acquisition techniques	Framework
			Davis and Hickey, 2003	Fuzziness of Definition	No values	Inherent characteristics of the problem, including the fuzziness of its definition have a major impact on the techniques that should be used.	Ontology
			Davis et al, 2006	Unknown Domain Degree	No values	Some technique provides analysts and designers with a clearer picture of the context in which tasks are performed by users The RepGrid prompted a discussion that revealed a 'requirement' that was previously 'unknown' to either party	Typology of challenges
			Serna, 2012	Certainty Level	Existing domain, New Domain	An important factor in selecting a technique is the level at which the organization is familiar with the application domain.	Framework
			Zhang, 2007	Level of Certainty	New Domain, Existing domain	An important factor influences on method selection is whether the organization is acquainted or unfamiliar with the application domain. An acquainted domain implies a higher level of certainty with the problem than the new domain	Framework
			Kim and Courtney, 1988	Structuredness	Well-structured, Semi-structured, Ill-structured	The model is based on the arguments that the choice of KA techniques is dependent upon problem structuredness	Comparison of techniques
			Fazlollahi and Tanniru, 1991	Uncertainty/ Equivocality Degree	No values	It calls for assessment of the degree of uncertainty and equivocality present in the application and, based on this, an appropriate information acquisition strategy is identified.	Approach
	Tasks Types	Theoretical	Dhaliwal and Benbazat, 1990	Tasks Types	Interpretation, Monitoring, Prediction, Debugging, Diagnosis, Repair, Design, Instruction, Planning, Control	Within a specified domain, the nature of the task selected will affect the choice of KA technique	Framework
		Empirical	Wagner, Chung and Najdawi, 2003	Problem Types	Analysis problems (Classification, Debugging, Diagnosis, Interpretation) Synthesis problems (Configuration, Design, Planning, Scheduling) Combination problems (Command and control, Instruction, Monitoring, Prediction, Repair)	It offers more tangible evidence regarding the possible linkages between problem domains and KA techniques (FI)	Case study
			Massey and Wallace, 1991	Scenarios	Company president seeking an additional credit line, Company treasurer with cash management priorities, Dentist seeking a loan to set up her own practice.	These mixed results imply that there may be a relation between the scenario (task), and the performance of the focus group and individual interviews (FI)	Experiment

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
	Problem Size	Theoretical	Kim and Courtney, 1988	Number of Elements	Small, Medium, Large	The model is based on the arguments that the choice of KA techniques is dependent upon problem size	Comparison of techniques
			Jiang and Eberlein, 2007	Project Size	Very small (X< 100 requirements), Small (100 <=X< 500), Medium (500 <=X< 1000), Big (1000 <=X< 4000), Very big (X>=4000)	Large projects require systematic techniques to elicit, analyze, document, verify and validate requirements.	Model
			Tsumaki and Tamai, 2005	Information Resource Amount	Scarce, Abundant	The available information is a characteristic considered in the authors' proposal	Framework
	Complexity	Theoretical	Kim and Courtney, 1988	Number of Interrelationships	Simple, Moderate, Complex	The model is based on the arguments that the choice of KA techniques is dependent upon problem complexity	Comparison of techniques
			Jiang and Eberlein, 2007	Project Complexity	Very low, Low, Medium, High, Very high	A project with high complexity requires systematic techniques to be used in the RE process.	Model
			Davis and Hickey, 2003	Complexity	No values	Inherent characteristics of the problem, including the fuzziness of its definition have a major impact on the techniques that should be used.	Ontology
		Empirical	Holsapple, Raj and Wagner, 2008	Domain Complexity	Simple, Complex	Regardless of the choice of KA method, we do not have conclusive evidence that domain complexity strongly affects KA efficiency. However, as pointed out earlier, the experiment does suggest the direction of the trend (FI)	Experiment
			Holsapple and Raj, 1994	Domain Complexity	Simple, Complex	Domain complexity does have a bearing on the performance of a knowledge acquisition method (FI)	Experiment
Solution Domain	Product Types	Theoretical	Jiang and Eberlein, 2007	Project Category	Communication, Embedded, Semi-detached, Organic	Projects in different categories require different techniques to be used in the RE process. For example, the techniques used in a safety-critical system will not be the same as the ones used in a non-safety critical system.	Model
			Davis and Hickey, 2003	Type of Solution	Application, System, Embedded software, Custom development, Customizing, Commercial-off-the-shelf software, Planning to purchase, Build in-house	The type of solution anticipated may also impact the selection of elicitation techniques	Ontology
			Tiwari, Rathore and Gupta, 2012	Domain of the System being Developed	New system domain, Existing system domain	Selection of elicitation technique is influenced by the nature (domain) of the system, which will develop, i.e. it means that whether we developed system for a new domain or for an existing one domain.	Framework
			Tiwari, Rathore and Gupta, 2012	Scope of System	Customize, System use within an organization, Generic product use, Publicly	The scope of the system mean whether it is customized (use of an organization inside) or generic (use by common users generally) is affecting the selection of elicitation techniques	Framework

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
			Kausar et al., 2010	Target Stakeholder	Market Need, Specific Organizational Need	The selection of elicitation technique is dependent on target stakeholder: if needs have no well-defined stakeholder (market) or if we have defined set of stakeholders (organizations)	Guidelines
			Kausar et al., 2010	Project Status	New System, Existing System	Depending on whether the system is new or existing we select the appropriate elicitation techniques	Guidelines
			Kausar et al., 2010	Type of Project	Safety Critical Systems, Security Critical Systems, Real Time Systems, Distributed Systems, Interactive Systems, Information Systems, Small and medium sized projects.	We need to know about the project type and nature, and then on this basis we select the suitable elicitation technique and other dependent properties	Guidelines
		Empirical	Keil and Carmel, 1995	Development Environments	Package (in which software is developed as a product for external sale), Custom (in which software is either developed in-house or under contract and is intended for internal use)	Given these differences, one would expect to find differences in the links that are used across the two environments (FI)	Case study
			Todoran, Seyff and Glinz, 2013	Mass Market Systems	Cloud, Conventional	Traditional approaches (interviews, questionnaires, analysis of existing documentation, surveys) and prototyping are the most popular and highly applied existing requirements elicitation methods among cloud providers (FI)	Survey
	Criticality	Theoretical	Jiang and Eberlein, 2007	Degree of Safety Criticality	(It measured by the potential loss of human life or property) Very low, Low, Medium, High, Very high	Degree of safety criticality is considered as an important attribute for the selection of RE techniques. Projects with a high degree of safety criticality require more rigorous and disciplined techniques.	Model
	Problem-Solving Methods	Theoretical	Moody, Blanton and Will, 1999	Representation of Knowledge	Rule-based, Frame-based, Semantic Networks, Case-based	It provides a framework for matching knowledge elicitation techniques with the representation of knowledge in expert systems	Framework
			Dhaliwal and Benbazat, 1990	Methods of Resolution	Heuristic classification, Heuristic configuration	Attribute that impact quality and efficiency of knowledge acquisition techniques	Framework
Elicitation Process	Purpose of Requirements	Theoretical	Maiden and Rugg, 1996	Purpose of Requirements	Package selection, Bespoke system, Requirements procurement	A framework is presented with techniques that lead to different purpose	Framework
			Serna, 2012	Level of Abstraction	Problem analysis, Product description	Given the nature of the requirements, at different levels of abstraction must select a suitable set of elicitation techniques	Framework
	Deliverable	Theoretical	Coulin, Zowghi and Sahraoui, 2006	Deliverable Type	Examples of project deliverables include Requirements Specification, Concept of Operations, and Vision & Scope documents.	The required deliverable document from the elicitation project is a characteristic considered in the authors' proposal	Approach

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
	Project Environment	Theoretical	Tiwari, Rathore and Gupta, 2012	Social Environment	Low, Medium, High	Most of the computer-based system are developed without any systematic help of social science, the result of this is that the needs of users are not addressed completely and there are often serious misconceptions are occurring.	Framework
	Elicitation Project Type	Theoretical	Coulin, Zowghi and Sahraoui, 2006	Type of Elicitation Project	Examples of project definitions include Custom Development, COTS Selection, and Feasibility Study.	The definition of the type of elicitation project being conducted is a characteristic considered in the authors' proposal	Approach
		Empirical	Zapata et al., 2012	Software Development Scenarios	Distributed, Collocated	The effectiveness of the techniques in a co-located setting is 10% higher than in a distributed environment (FI)	Experiment
	Communication Types	Empirical	Corbridge et al., 1994	Versions	Textual, Graphical, Tool	The differences in the gain elicited by the three versions of laddering employed in this study were statistically significant (FI)	Experiment
			Rugg et al., 1992	Versions	Item, Cars, Label	No significant differences were found between the types of knowledge elicited by different types of sort (AF)	Experiment
			Ahmad, Tahir and Kasirun, 2012	Communication Mode	Face-to-Face, Rich Media, Text-Based Communication	F2F has the highest level of satisfaction, comfort, and perceived engagement, during the negotiation and elicitation stages, in comparison to the other two modes (FI)	Experiment
			Sauer, Schramme and Rüttinger, 2000	Conference Types	Face-to-face, Computer, Multimedia	The computer conference group was generally more productive than the two other groups during the conference (FI)	Experiment
			Todoran, Seyff and Glinz, 2013	Meeeting Type	Remote, Physical	The cloud calls for methods which can be applied remotely time (FI)	Survey
	Process Constraints	Theoretical	Maiden and Rugg, 1996	Time/Cost Constraints	Meeting is needed, Time to prepare session, Time for acquisition session, Time to obtain requirements	A framework is presented with constraints that influence techniques	Framework
			Kausar et al., 2010	Budget Constraints	Critical, High, Medium, Low	Elicitation techniques should be selected based on the available budget	Guidelines
			Kausar et al., 2010	Schedule Constraints	Critical, High, Medium, Low	Schedule has their own impact and significance in the project; few are strict deadline specific while others are less. The elicitation techniques chosen for strict deadline specific projects should be short, quick and effective.	Guidelines
			Kausar et al., 2010	Resource Constraints	Critical, High, Medium, Low	The system resources factor also has major impact on elicitation technique selection	Guidelines
			Serna, 2012	Barriers in Communication	National culture, Organizational Culture, Cognitive limitation, Geographically distributed environment	Because software development projects are products of global collaboration, engineers face challenges multinational organizations to elicit requirements.	Framework

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Factor	Attributes (name given in our mapping study)	Study Type	Authors	Original Name (name given in the primary study)	Attributes Values (discussed in the primary study)	Excerpt/Results	Primary Study Category
			Jiang and Eberlein, 2007	Time Constraints	(Degree of the time-to-market pressure for the software project) Very low, Low, Medium, High, Very high	Projects with high time constraints require lightweight techniques to be used because heavy-weight techniques will significantly delay the overall project.	Model
			Jiang and Eberlein, 2007	Cost Constraints	(Ratio of the overall budget of the project with respect to its actual cost) Very low, Low, Medium, High, Very high	Projects with high cost constraints require lightweight techniques to be used in the RE process because heavy-weight techniques will increase the cost, especially when training for the use of the technique is required.	Model
		Empirical	Todoran, Seyff and Glinz, 2013	Available Time	Less time, More time	The cloud calls for methods which take less time (FI)	Survey
	Process Moment	Theoretical	Zowghi and Coulin, 2005	Activities	Understanding domain, Identifying requirements sources, Analyzing stakeholders, Selecting techniques and approaches, Eliciting Requirements	Its presents a guide to the use of some techniques related to the type of activity to support	Guidelines
			Fowlkes et al, 2000	Analysis Job	No values	Unstructured Interview is most applicable early in job analysis. Verbal protocols are most applicable late in job analysis. Structured interview may be useful at any time during a job analysis.	Comparison KA techniques
			Christel and Kang, 1992	Early Tasks	Fact-finding, Requirements gathering, Evaluation and rationalization, Prioritization, Integration.	It incorporates the advantages of existing elicitation techniques while comprehensively addressing the activities performed during requirements elicitation.	Methodology
	Methodologies	Theoretical	Tiwari, Rathore and Gupta, 2012	Approach to be	Agile, IBIS, FODA etc.	These methodologies force the analyst to select a particular elicitation technique for elicitation process	Framework
			Dhaliwal and Benbazat, 1990	Followed out System Development Methodology	No values	Attribute that impact quality and efficiency of knowledge acquisition techniques	Framework

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