A Strategy for Information Source Identification

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Abstract

Eliciting requirements is well known to be a difficult task. Several strategies exist that makes it possible to elicit information from different information sources. These strategies vary and should be selected in accordance with the situation at hand. For instance, selecting a strategy to a situation where there are available COTS solutions is different from a tailored and specialized software application. This article reports on a strategy to be used before the selection of an elicitation strategy. We are concerned in how to select the information sources that should be taken in consideration for the requirements elicitation. We consider this activity of fundamental importance to the elicitation process. Selecting the appropriate sources is fundamental as to deliver quality requirements. The article describes the proposed strategy and exemplifies it with a well known and published case, The London Ambulance Service.

1. Introduction

Requirements engineering has been focusing on different ways to model and to contextualize the models it generates. Different approaches such as scenarios, viewpoints, use cases, goal oriented requirements, natural language sentences and early aspects have been proposed and widely discussed by the literature [1] [2] [3] [4] [5] [6] [7]. However, literature concerned with the tasks of elicitation [8] is less discussed in the literature itself. Elicitation is a fundamental part of the engineering effort that must be taken before writing models that properly fits the desire of the demanding clients. Some of these efforts are mostly centered on models [9] [10] that are to be used as to drive a feedback process where new information is elicited.

The focus of this paper is on the selection of information sources. It assumes that a Universe of Discourse has been outlined. Universe of Discourse is defined as "The overall context in which software will be developed and operated. The UofD includes all the sources of information and all the people related to the software. It is the reality trimmed by the set of objectives established by those demanding a software solution." [11][1] The identification of information sources helps to better define the UofD, which is an evolving conceptualization.

Information sources are not restricted to people; also referred as: stakeholders, users or clients. Information sources may include different sorts of reading material, documents, such as: books, internal memos, specifications of different sort, scientific literature, news, product descriptions, manuals, or any document relevant to better understanding our focus of interest (UofD). Places where situations occur may also be an information source, such as the factory plan, the office, the meeting room, the counter of a store, the news room of a newspaper, or any place where actions are performed.

Identification of information sources is of fundamental importance, since they will be the target of elicitation strategies. As the requirements engineers identify the information sources, it is possible to establish a ranking of these information sources. Ranking information sources is a multi-criteria selection, since several non-functional

[1] Reference [11] provides a definition of our understanding of the term, as an improvement over the definition provided in [1] and with the knowledge acquired in [2]. Several disciplines define Universe of Discourse to fit their purposes, but overall these definitions are congruent with that of the Merrian-Webster´s Online Dictionary that states: "an inclusive class of entities that is tacitly implied or explicitly delineated as the subject of a statement, discourse, or theory".

attributes will influence the choice. Sometimes cost and easy of access may be the critical factor, whereas in other cases presumed importance may be the best choice.

Our strategy, as of now, opted for using simple ranking strategies instead of strategies like, for instance, the Condocert election method, which demands pairwise comparisons (http://en.wikipedia.org/wiki/Condorcet_method). Using more refined strategies is only justifiable, if future experimentation with the strategies points in that direction. The major goal is helping the requirements engineering to deal explicitly with information source identification.

We will describe the overall strategy being proposed, Section 2, shows the application of the strategy for an example, Section 3, correlate our strategy with the literature, Section 4, and will conclude, Section 5, stressing the importance of information source selection and what lies ahead in terms of research.

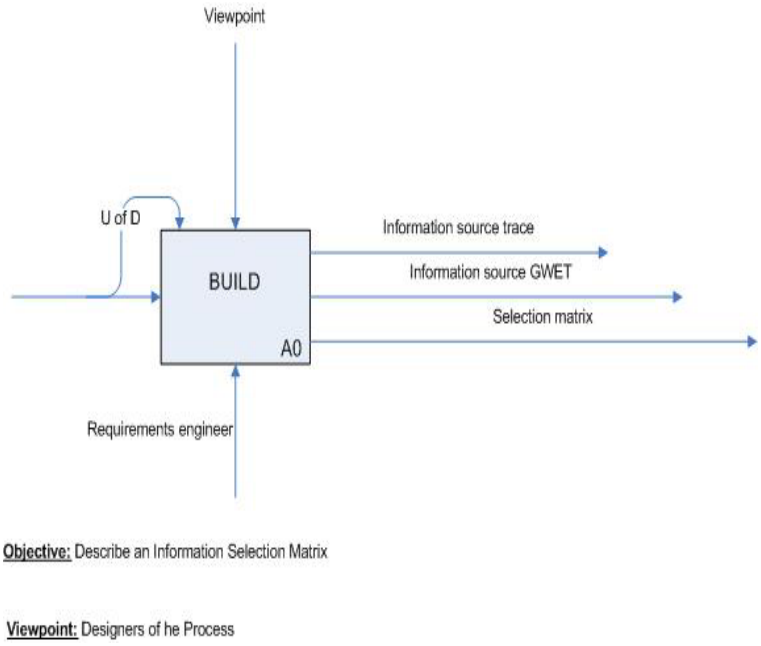
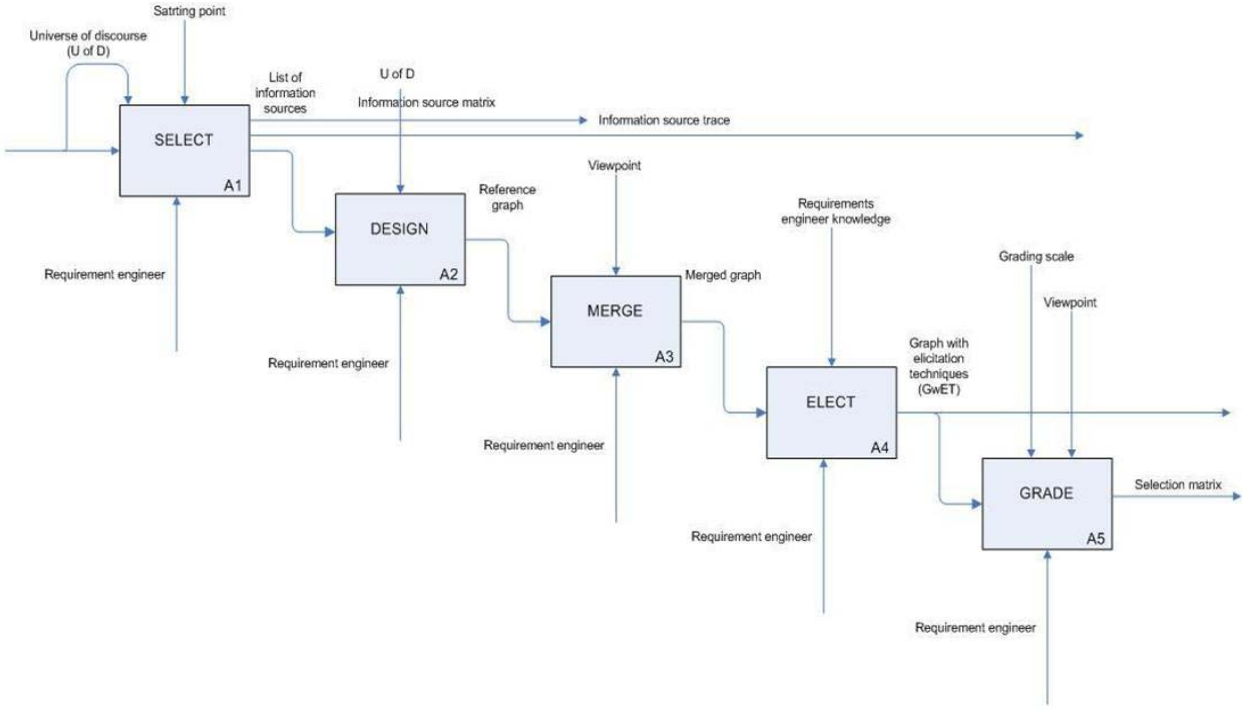


Figure 1 - A0: The Process for Information Source Selection

2. The Strategy

The SADT model [12], Figures 1, 2 and 3, describes the overall strategy. Given a Universe of Discourse (UofD) one information source is selected as the central one (Starting point). Different requirements engineers (Viewpoints) using our strategy (Grading scale) will build (BUILD): an influence graph (Information source GwET), a list of traces (Information source trace) and a table with grades (Selection matrix). The Selection matrix will be the key document for the requirements team to choose the information sources to be used in the elicitation process. The objective and viewpoint of the model contextualize our proposal.

A key issue is the election of the Starting point. This information source can be a stakeholder, or a document. Depending on the type of the information source either interviews or reading will be the elicitation strategy to be used with the Starting point. Another important definition is the number of requirements engineers that will perform the strategy. Since the strategy is a viewpoint oriented strategy [1], at least two viewpoints must be present.



Figue 2 - A1 to A5: The Build Process

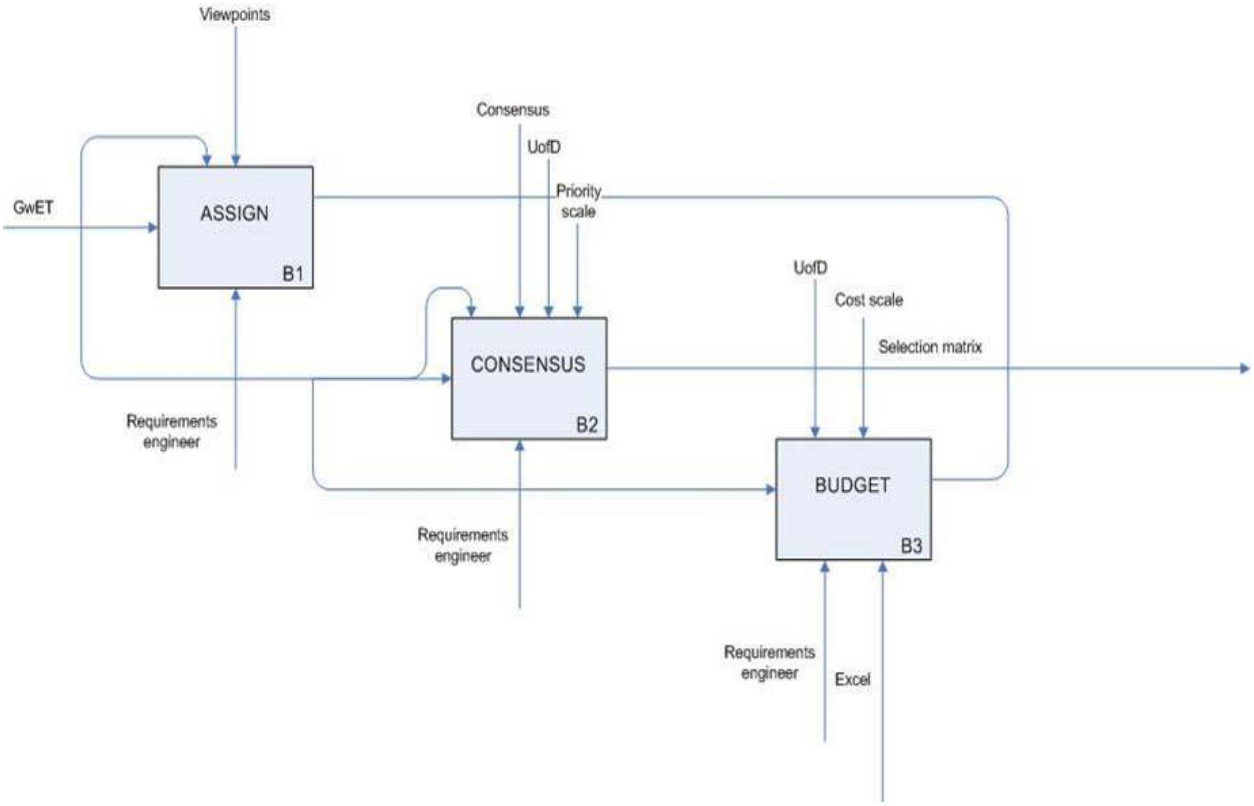


Figure 3 - A5: The Grade Process for Information Source Selection

Once a starting point is defined, each requirement engineer (Viewpoint) will select (SELECT) from the source (Starting point) a list of information sources (List of information sources). The overall heuristic for this task is "*pay attention to "what/whom/where" can provide information about the UofD*". The performance of this task is dependent on the skill and experience of the requirements engineer; information sources can be of different sorts: people, documents, places. Each requirements engineer will produce its own list. It is mister that the trace information should be kept to each selected source (Information source trace).

Using the list of sources, each requirements engineer will design (DESIGN) a reference graph (Reference Graph). A reference graph is a simple node and link graph, where the nodes are the information sources and links are "*associations/relationships*" among the nodes. Each link of the graph should reflect a connection that exists among the two nodes (information sources)[2]. There are no constraints on the graph, a node may be unlinked and the link names are of the requirements engineer responsibility. A useful, but not mandatory, heuristic is that verbs or verbal phrases be used. Naming the nodes, the items of the list of information sources (List of information sources), **must** preserve the same names as found in the original source (Starting point).

Once the reference graphs are available, the requirements engineer should meet to consolidate the graph, discuss elicitation strategies and grade the sources in order to produce a table with grades (Selection matrix). As such, the activities of MERGE, ELECT and GRADE need the presence of the requirements engineers who produced the graphs, and a meeting is a proper way of doing. Note that, there is no restriction on the number of meetings, neither to an in-place meeting [13].

MERGE uses the available graphs which are collapsed in just one graph. The construction of a sole graph is performed cooperatively (meeting) by the authors of each "Reference Graph". A good way of doing this is using a blackboard, where one of the requirements engineer draws one graph using the observations of each other participant. Like in many collaborative tasks, there should be a consensus policy, shared by the participants. Conflicts may occur, and usually the mediator, the one drawing the merged graph, is key in conducting the consensus. This activity produces the Merged graph.

ELECT uses the requirements engineering knowledge of the group to point to which requirements elicitation strategy could be used for eliciting information for each node (information source). This activity is also driven by consensus, and less conflict is expected here. The output of this activity is the graph annotated with the elicitation strategies (Information source GwET).

GRADE is the activity that produces a table with grades (Selection matrix) and its decomposition is presented in the A5 SADT diagram. ASSIGN, CONSENSUS, and BUGET are the sub-activities for grading the information sources.

Using the graph, each requirements engineer gives a grade from a scale of 1 (worst) to 3 (better) (Relevance scale) for the relevance (ASSIGN) of the information source. Relevance is understood as how each requirements engineer perceives the information source as related to the matter at hand. Relevance shows how strong or less strong is an information source in relation to the UofD. Of course, that relation to the UofD, means that source is more able to provide the information being sought for. Each grade is appended to the appropriate node. So, by the end of this activity we will have each information source of the relevance graph annotated with grades (Relevance grades).

After grading the information sources, requirements engineer have to once more engage on a consensus (CONSENSUS) activity as to discuss and select a priority number to each information source. The priority scale ranges from 1 (high) to 3 (low) (Priority scale). Priority is different from relevance, it is the status established in order of importance. Priority reflects precedence, that is, which of the information sources should be inquired first. As we noted above, consensus decision may bring conflicts, and as such the role of a mediator is of great importance. Experience of the requirements engineers will be an important factor in grading priority. Since the elicitation strategies have been already mapped, the engineers will also consider this information when choosing priority (Priority).

After establishing the priorities, the engineers ought to consider how costly it would be (BUDGET) to use each information source. The grading policy here is the same as the one used for relevance. Each engineer gives a 1, 2 or 3 (Cost scale) considering how much resources would be spent in using each

[2] Is node "a" connected to node "b"? The answer to this question is made without prior knowledge of the details of each information source. The connection is, as such, bounded by the shallow knowledge that exists at this point.

information source. Higher the grade, higher will be the cost. After all the grading, the average for each source is calculated (Average cost).

The process produces three documents: the relevance graph with elicitation strategies, the information source trace, and the selection matrix. See Figures 4, 5 and 6 for an abstract representation of each of these documents.

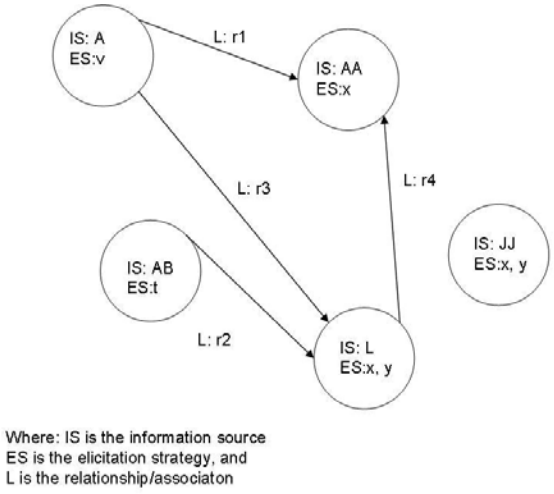


Figure 4 - The Relevance Graph

Idenfication Number	Source Name	*Reference for Source Graph*
1	*Name 1*	*Ref. 1*
2	*Name 2*	*Ref 2*
...	...	...

Figure 5 - Information source trace

Source Name	R. Grd.1	R. Grd.2	R. Grd.n	Priority	Cost 1	Cost 2	Cost n	Avg. Cost
Name 1	0	0	0	0	0	0	0	0
…	…	…	…	…	…	…	…	…

Figure 6 - Selection Matrix

3 - The Example

Our instantiation of the strategy was performed in a restricted laboratory environment. The use of the strategy provided feedback as to the final writing of the strategy itself. We have used what Parnas calls the "rational desing process" [14]. The laboratory use of the strategy made it possible to prune it and to achieve the process as described in the last Section.

The UofD selected was a familiar case to the first author, the London Ambulance Service. As such we pretended to be involved in this UofD and selected one document to be our Starting point. For the sake of simplicity we started not with the auditing report of the LAS, but we based our activities on a journal paper that analyzed the inquiry report [15].

The authors of this paper acted as the requirements engineers. Each of us produced a reference graph (DESIGN), which was amalgamated at one meeting where we did use the blackboard as the workspace (MERGE). We met at two other meetings to perform the ELECT and GRADE activities, see Figure 2. The consensus (CONSENSUS), Figure 3, was achieved smoothly, with some discussions. The fact that one of us is also at a senior position certainly influenced such outcome. The costing (BUDGET) was an activity performed at the time of writing the final report. We have discussed that on our second meeting, but it was not explicitly performed.

Figure 7 shows the final table we have produced. Note that this table is different from Figure 6, since it collapsed both the trace and the elicitation strategy information. Figure 8 shows the graph we have produced for the LAS. It also contains more information than the one in Figure 4. We decided to present them as they were produced, since its format does not alter the results.

As can be seen from the selection matrix, we have identified 20 candidates' information sources for the LAS case, which 7 were stakeholders, 10 were documents and 3 were places or working environments. As such, this example shows that stakeholders are not the only source of information, despite their relevance. As noted by Breitman et al [15] several of the failures of the LAS case could be traced to inappropriate selection of information sources.

N.	Source	Reference	Relevance	Priority	Strategy	Cost	Avg. Cost
1	Contract Analyst	E 2.1	1,3,2	3	E, R	1,3,1	1,67
2	Systems Manager	E 2.1	1,3,2	3	E, R	3,3,1	2,33
3	Ambulance Crews	E 2.1	3,3,2	2	E, R	2,3,1	2
4	Paper Forms	E 2.6	2,2,2	1	LD	1,1,2	1,33
5	Control Assistant	E 3.9	3,3,3	1	E, R	2,2,1	1,67
6	Central Ambulance Control	E 3.9	2,2,3	3	OBS	3,2,3	2,67
7	Map book / Map Ref. Coord.	E 3.9	2,1,2	3	LD	1,1,1	1
8	Control Room Services Man.	E 3.6	2,3,3	2	E, R	2,2,1	1,67
9	Director of Suport Services	E 3.6	2,2,2	2	E, R	3,3,1	2,33
10	Home Station	E 2.2	2,2,2	2	OBS	3,2,3	2,67
11	DATATRACK	E 2.10	1,2,3	1	LD	3,1,2	2
12	Visual Basic	E 5.9	1,2,3	1	LD	3,1,2	2
13	Windows 3.0	E 5.9	1,2,3	1	LD	3,1,2	2
14	MDT – Mobile Data Terminal	E 3.5	1,1,2	1	LD	3,1,2	2
15	AVLS	E 2.10	1,1,1	1	LD	3,1,2	2
16	Financial Instructions	E 5.10	1,2,3	2	LD	2,1,2	1,67
17	Management	E 2.3	2,3,3	1	E	2,3,1	2
18	ORCON Standards	E 4.6	3,3,3	1	LD	3,3,2	2,67
19	Operational Procedures	E 2.9	3,3,3	1	OBS	3,2,3	2,67
20	Organizational Structure	E 2.8	1,3,3	2	LD	1,1,2	1,33

Observations:

1 – Relevance ranking: 1 < 2 < 3;

2 – Priority ranking: 1 > 2 > 3

3 - Techniques: E - interview, R – meeting, LD – document reading, OBS – observation.

4 – Cost: E < R < LD < OBS – 1 < 2 < 3, however considering the volume of the source or the number of stakeholders the cost grading may be different.

Figure 7 - The Selection Matrix

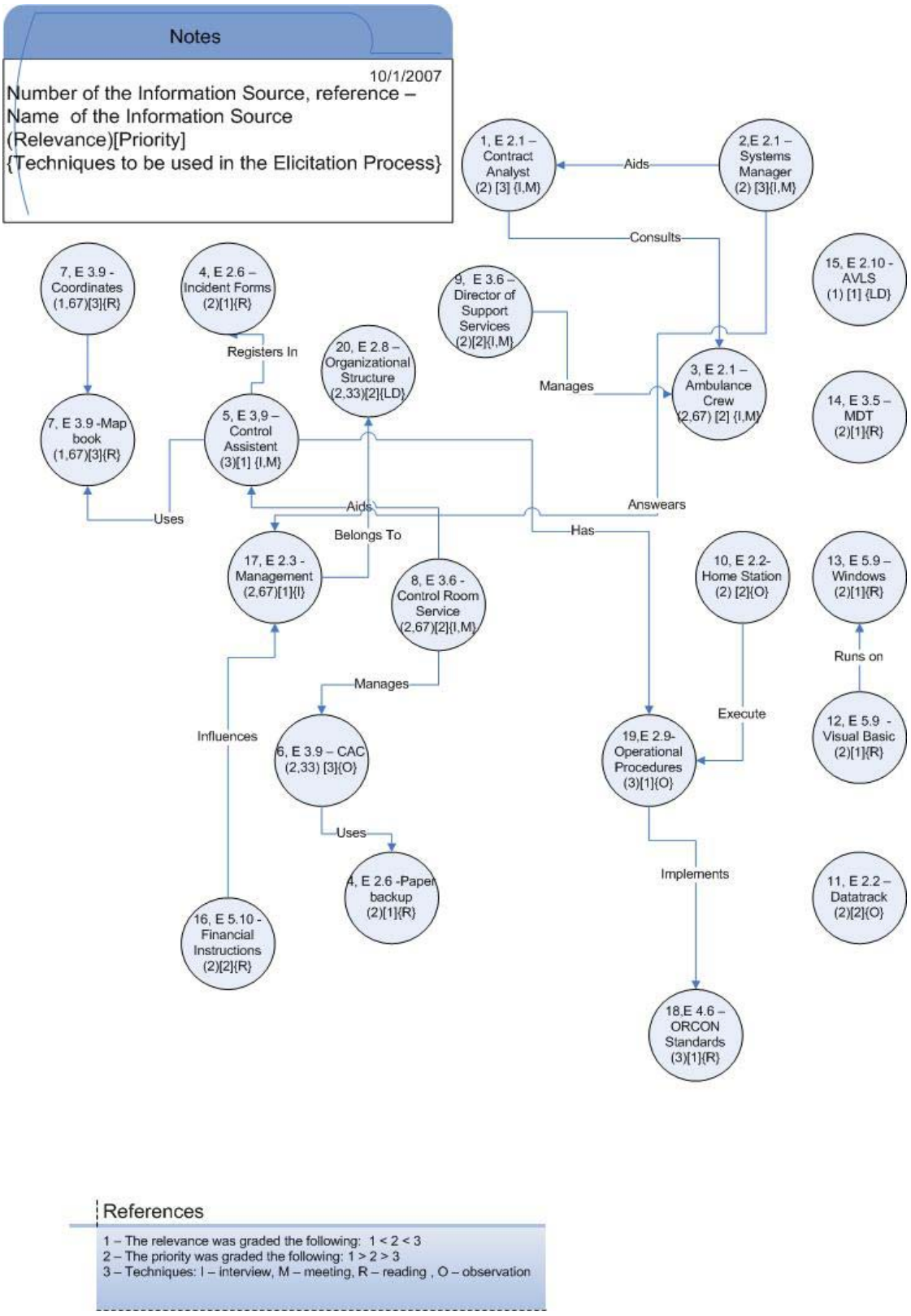


Figure 8 - The Information Source Reference Graph with Elicitation Strategies

5 - Related Work

Although it is common knowledge that requirements should be elicited from different information sources, few stress the problem of relying on just people as an information source. Rayson et al. [16] states: "It is seldom sufficient to elicit requirements by face-to-face meetings or interviews with the system stakeholders. These techniques are important but problematic if not supplemented with other sources of requirements information.". They go on and list examples of other sources: "In order to fill in the missing information and to understand the information provided that the stakeholders have provided, the requirements engineer needs to supplement it with information about, for example: the stakeholders' work domain; the structure of their organization; the constraints and rules to which users of a system work; the operational environment in which the system will execute." [16].

Although there is requirements literature on the identification of stakeholders [17], our literature survey failed to find a process to help the identification of information sources. Sommerville and Sawyer [18] mention the activity of source identification, but do not provide a process to perform such activity. They say: "In a well-understood application, the identification of viewpoint sources normally follows identification of the viewpoint's focus. A source is concrete (a named individual or identifiable document) while a viewpoint's focus may be a role within an organization, a sub-system or some physical, cognitive or social phenomenon of the domain. However, in an unfamiliar application domain or organizational structure, the processes of viewpoint identification, focus definition and source selection are inter-leaved." [18], but no process description is given. Roseti et al [19] point out that despite being mentioned by the literature on domain analysis, there is no detailed description of how to identify information sources: "We were able to observe that most approaches include an information source identification activity, which can be either specialists or existing systems, and some also indicate technical references about the subject. However, the necessary procedures to elicit the information are not precisely described, nor how to conduct them in an adequate way.".

Regarding identification of stakeholders, the management literature is rich in essays on the importance of this process, whereas, usually, the focus is geared towards representativeness. Management also refers to this activity as stakeholder analyses [20]. There are several categorizations of stakeholders, being the most usual the ones that differentiate between users, clients and developers. Sharp et al. [17] note that some have voiced their concern with a general view that stakeholders are *obvious* and with some literature on stakeholders categorization as being too generic to be of practical use. They [17] propose a categorization named "baseline stakeholders", which is comprised of four types: users, developers, legislators, and decision makers.

Bryson [20] says: "There are differences in the specific categories used to label different stakeholders, but the ubiquity and importance of the concept are clear". He clarifies this by pointing out different categories according to fields; for instance: in Political science, there are constituencies, citizens, formal office holders; in Economics, there are stockholders, management, employees; in Public planning, there are policy makers, organizational leaders, planners, communities, developers. We understand this as central issue. Stakeholder identification is domain oriented.

Sharp et al. list five steps to identify the web of stakeholders. The steps are: "1) identify all specific roles within the baseline stakeholder group; 2) identify "supplier" stakeholders for each baseline role; 3) identify "client" stakeholders for each baseline role; 4) identify "satellite" stakeholders for each baseline role; 5) repeat steps 1 to 4 for each of the stakeholder groups identified in steps 2 to 4." [17].

Bryson [20] believes there are 8 stakeholder analysis techniques. They are: "1) The basic stakeholder analysis techniques, 2) Power versus interest grids, 3) Stakeholder influence diagrams, 4) Bases of power and directions of interest diagrams, 5) Finding the common good and the structure e of a winning argument, 6) Tapping individual stakeholder interests to pursue the common good, 7) Problem-frame stakeholder maps, and 8) Ethical analysis grids". Of those, we believe that the second one deserves special attention. It uses a 2 by 2 matrix, to define four quadrants where power is low or high and interest is low or right. The resulting quadrants give the types of stakeholders, from clockwise, starting from the left lower corner, which are: crowd, subjects, players and contest setters.

We list, *ipsis literis*, 5 propositions by Ramirez [21] in his conceptual framework for stakeholder analysis: "*1) Stakeholder analysis must address THREE INTERRELATED DIMENSIONS: the nature of a problem, its*

boundaries, and those actors who "own the problem"; 2) A STAKEHOLDER's likelihood of being noticed and involved is a function of several ATTRIBUTES including power, urgency and legitimacy ; 3) Any group or organization SEEKING TO CONVENE other stakeholders should first analyze its own role and objectives, and its relationship with those stakeholders it seeks to invite; 4) Stakeholders' attributes are a function of the SOCIAL NETWORKS they belong to and the multiple roles they play. START HERE when in a proactive, no-conflict situation; 5) Stakeholders may be identifiable, but it is those empowered with KNOWLEDGE and CAPACIT Ywho participate as 'social actors'."

From the citation above, we would like to stress: the idea of who owns the problem, which Leite [22] calls the system owner, the idea of social networks, which can be nicely mapped by Yu´s Strategic Dependency model [26] and the attributes of a stakeholder to be engaged. The last one, proposition 2, is a concern that can be mapped by the power versus interest grid, mentioned above. These propositions help to understand the broad issue of stakeholder identification, but we have to remember that our main interest is not only stakeholder identification, but information sources in general.

A study of how non-developers stakeholders are selected to participate in requirements activities brings out an interesting observation. The authors say: "We can also see from the above results that 'work nature' is the most decisive factor in the selection of end users for participating in the requirements specification process. This may sound like the right thing to do, after all domain knowledge depends on the work nature. However the interviews showed that managers, when selecting members of their staff, try to strike a balance between allowing the software practitioners to talk to the right people and maintaining the smooth running of the rest of the business." [23]. This is an interesting instantiation of Ramirez´s proposition 2. Sometimes the diluted interest or the lack of commitment from some stakeholders may influence in a negative way how a requirements elicitation is conducted.

As it was found in the LAS review, the lack of involvement of important stakeholders, like the ambulance crew, led to misunderstandings as noted in [15]: "It is clear that the management and the ambulance staff had opposite opinions in regard of the unit allocation procedure and the system was used to settle the matter".

Work on analyzing expert requirements engineers [24] provide insights on the use of elicitation technique. Most of the experts focused on techniques were stakeholder involvement was necessary. There is no mention of identification source selection.

An earlier proposal by the first author devised a general strategy [22] comprised of three stages: a) a better understanding of the Universe of Discourse the system is embedded in, including recognizing and identifying social groups b) the creation of a committee to promote system discussion among different social groups, and c) a study of the system possible impacts. However, no process was proposed on how to conduct the identification of social groups.

6 – Conclusion

As we have noted, we could not find literature on the process of information source selection. Even the literature from management fails to give a detailed process of how to conduct the discovery of information sources. Our proposal is a mixture of several previous successful general heuristics. We use the concept of centrality in a graph to focus on more important information sources, which helped with grading relevance [25]. We use the concept of viewpoint [2], the idea of voting [26] and of consensus building. Priority schemas are used by the literature on ranking requirements [27], which inspired our use of priority. The table produced by the strategy is, itself, a source of information, from where the requirements team or the requirements decision maker will finally select the information sources to be used in the elicitation process.

The contribution of this paper is the strategy itself. The work relevance comes from the fact that it is of fundamental importance to select and trace the sources of information for producing quality requirements. The drawback is that the process has not been fully used in a real setting. Its use in the laboratory environment gave excellent results, as we have demonstrated in Section 4, but we still need to use it in more real world situations as to tune the process or evolve it as necessary.

Future work will try to model the process in other description languages [28], [29] as well as evolve the current proposal by using it in practice.

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