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What stakeholders will or won't say: A theoretical and empirical study of topic importance in Requirements Engineering elicitation interviews ☆

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ABSTRACT

Interviewing stakeholders is a way to elicit information about requirements for a system-to-be. A difficulty when preparing such elicitation interviews is to select the topics to discuss, so as to avoid missing important information. Stakeholders may spontaneously share information on some topics, but remain silent on others, unless asked explicitly. We propose the Elicitation Topic Map (ETM) to help engineers in preparing interviews. ETM is a diagram showing topics that may be discussed during interviews, and shows how likely stakeholders discuss each of these topics spontaneously. If a topic is less likely to be discussed spontaneously, then this suggests that engineers may want to prepare questions on it, before the interview. ETM was produced through theoretical and empirical research. The theoretical part consisted of identifying topic sets based on a conceptual model of communication context, grounded in philosophy, artificial intelligence, and computer science. The empirical part involved interviews with Requirements Engineering professionals to identify the topic sets and topics in each set, surveys of business people in order to evaluate how likely they would spontaneously share information about topics, and evaluations of how likely students would share information about each topic, when asked about requirements for social network websites.

1. Introduction

1.1. Context: Requirements elicitation via interviews

Requirements Engineering (RE) focuses on the elicitation, modeling, and analysis of requirements and environment of a system-to-be, in order to help produce its specification. Requirements elicitation (only elicitation hereafter) refers to activities done in RE in order to acquire information about requirements and the environment of the system-to-be [2–6].

Elicitation often involves communication with stakeholders, through, for example, structured, semi-structured, or unstructured interviews, workshops, and so on [3,5]. Hereafter, we write interviews to refer to any form of direct communication with stakeholders, and which is done in order to elicit information. Interviews provide invaluable information through verbal and nonverbal communication.

Elicitation via interviews is important. Misunderstanding stakeholders, or in some other way missing important information, can result in the specification of the wrong

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system, one that fails to satisfy requirements, and/or is inconsistent with the conditions in its operating environment. For example, misunderstanding what the system should do may result in missing to identify the legislation that applies to the system, and in it not being compliant.

1.2. General issue: how to reveal important implicit information about requirements in interviews?

A difficulty when doing interviews is that the requirements engineers and stakeholders have different backgrounds, experiences of existing systems, and expectations from the system-to-be. They will come into interviews with different assumptions about the environment, requirements, and system-to-be. In itself, it is not a problem that different stakeholders hold different assumptions.

However, it becomes a problem if some of their key assumptions remain implicit in elicitation interviews. If, instead of remaining hidden, these assumptions were known, then this could have helped with, for example, requirements inconsistencies, stakeholder negotiations, or the identification of other requirements, which were not mentioned.

A more technical way to see this is to look at it through the notion of non-monotonic reasoning in artificial intelligence [7–11]: when the requirements engineer is doing elicitation interviews, she is asking questions to the stakeholder; the stakeholder's thinking before answering could be – roughly speaking – seen as an inference that the stakeholder makes on the basis of her defaults (statements that can be rejected when there is new information) and her certain knowledge (statements which remain relevant despite any new information) [9]; the stakeholder's answers are the conclusion of her reasoning process. If we see things this way, then it can be useful for the Requirements Engineering to try to reveal at least some of the stakeholder's defaults, in order to understand the requirements better, discuss other requirements, or otherwise.

This is, for RE research, the issue of how to make sure that elicitation interviews reveal as much as feasible the defaults that may be important for RE? This is not a new research issue. Any contribution on how to prepare elicitation interviews is also inevitably interested in how to use these interviews to elicit as much as feasible relevant information for RE [6,12–15].

However, an approach to this issue that has not received attention consists of trying to understand what domain-independent categories of information the stakeholders tend to talk spontaneously about during elicitation interviews, and which others tend to remain implicit. The latter are the defaults mentioned above. This line of research, we believe, can give interesting insight into categories of information to ask questions about, especially if information in these categories is not spontaneously shared. Conclusions from such a research would suggest domain-independent checklists of topics to discuss during elicitation interviews, which should be helpful in preparing the interviews.

In a summary, the point above is this: if we can get some idea, on the basis of empirical research, about what topics the stakeholders tend to talk about spontaneously in elicitation interviews, and what they tend to leave out, we can suggest a checklist of topics to discuss during interviews, in order to identify defaults that could otherwise have been missed.

1.3. Contributions: checklist of elicitation interview topics, and their relative importance

The contribution of this paper is twofold: (i) the definition, through an exploratory study, of the so-called Elicitation Topic Map (ETM), and (ii) the validation, through a larger scale study, of the ETM for a specific class of system, namely social networks, leading to the ETM-SN, the ETM for social networks.

An ETM is a list of topics to discuss in elicitation interviews, combined with an indication of the relative importance of these topics. ETM-SN is an ETM specialized for requirements elicitation for social networks.

Topic importance reflects our measure of the stakeholders' tendency to share spontaneously information on topics: a topic is more important if we observed, in our sample of stakeholders, that they were more willing to share information about it spontaneously.

This does not mean that less important topics are less important for the engineer: it simply means that fewer stakeholders would spontaneously share information on them; if the engineer needs information on lower importance topics, she will have to be proactive in finding that information (for example, the engineer would need to stimulate stakeholders to discuss those topics).

1.4. Overview of research methodology

The general ETM was produced through three phases of research. It is easier to understand the rationale for them, by starting from the second phase, and then see how social networks fit the picture.

The ETM includes 30 topics. The second phase of research focused on exploring the relative importance of these topics. Their relative importance was estimated with a set of stakeholders, who had somehow been involved in a RE project, of any type. In other words, we were not looking for stakeholders with experience in a particular system class. Subjects were asked to evaluate a set of 30 generic topics. We asked each individual to evaluate, for each topic, if she would share information on it spontaneously, or only if asked.

In order to have the 30 generic topics to evaluate, the first phase of research focused on identifying these topics. We did this through interviews with requirements engineers and business analysts, drawn from five RE and systems engineering projects done in Belgian small and medium size businesses. Projects differed in terms of the number of participants (from 15 to 150) and in terms of the system domain (pharmacology, finance, etc.). To prepare our interviews in this first phase, we surveyed various definitions of the notion of communication context, and identified some important dimensions of context that could be relevant to account for during elicitation interviews.

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To check how ETM would be different when we go from a small sample of stakeholders to a larger set of stakeholders, who all have knowledge of the same system class, we did the third phase of the empirical research for this paper. We selected a sample of social network users, and placed them in the role of users of a future social network system, which is yet to be made. We took the ETM made in phase two, specialized it to social networks, and asked each individual in this new sample to evaluate, for each topic, if she would share information on it spontaneously, or only if asked.

As a summary, we identified in phase one a list of topics by discussing with requirements engineers and business analysts. From there, we evaluated in phase two the importance of these topics, by collecting our data on importance from stakeholders of various RE projects. This gave us the ETM, independent of any type of system. From there on, we tested based on a larger sample whether the ETM is applicable, if we focused on one specific class of system, namely social networks.

1.5. Organization

This paper is organized as follows. In Section 2, we give the background to this paper and identify some key concepts. We then describe in Section 3, how we identified our initial list of topics for the ETM. In Section 4, we explain how we found the relative importance of these topics, and how we obtained the first, generic ETM. We present in Section 5 how we validated the ETM by specializing it to social networks, and how this led us to ETM-SN. We discuss the validity of our results in Section 6, and related research in Section 7. We summarize our conclusions in Section 8.

2. Baseline and terminology

We start from the observation that there is explicit and implicit information when doing an interview. *Explicit information* is that which the stakeholder shared with the requirements engineer who did the interview. *Implicit information* is that which the stakeholder did not share by the end of the interview. The fact that some information is explicit or implicit does not matter for its relevance for understanding the requirements and the environment of the system-to-be.

The next observation is that the stakeholder decides what information to share, and thereby which information will be explicit or implicit. Stakeholders' decision to share undoubtedly depends on many factors, such as the requirements engineer's questions, the stakeholder's assumptions about the system-to-be and the environment of the system-to-be, her understanding of her role in the systems engineering process, and so on.

The goal of the ETM is to influence primarily the set of questions that the requirements engineer asks, rather than other factors. We see the *elicitation interview* as an exchange of information and questions between the stakeholders and the requirements engineers. Although the number of stakeholders and engineers in an interview will have an influence on the content and the procedure of the interview in practice, they do not influence the contributions in this paper – the ETM is not designed with a specific interview duration and the number of participants in mind. This exchange can be more or less controlled; more, for example, if the engineer wishes to proceed exactly in the same way with every stakeholder and in every interview, perhaps through the same list of questions.

In this paper, the term *Topic* designates an entity that different pieces of information refer to. A topic can be, for example, a time period (talking about the events in March 2013), a physical object (the company's product packaging), an event (merger with another company), a position (CEO), etc. We see any interview as a conversation about a set of Topics, regardless of how controlled that conversation is, or the engineer may want it to be.

Another key term is *Topic Set*, which refers to a set of Topics that are somehow related. For example, if there is a Topic for past events, another for current events, and a third for future events, then there can be a Topic Set about time, which includes all the three Topics. It is important to keep in mind that Topic is not a subclass of Topic Set, and that a same Topic can be in more than one Topic Set. We have also found no universal set of Topic Sets, or of Topics per Topic Set; we are reporting in this paper those Topics and Topic Sets that may prove to be useful with regard to the issue we are interested in, namely, providing an ETM and an evaluation of Topic importance in it.

It is important to understand how the notion of Topic in this paper is related to common concepts in requirements modeling languages, such as RML [16], ERAE [17,18], Telos [19], KAOS [20] or i* [21]. A requirements modeling language suggests concepts and relations to use, to represent information about requirements, environment, and the system-to-be.

If an elicitation interview results in explicit information about key actors in the environment, and how they depend on the system-to-be to achieve some specific goals, then, for example, an i* model can be used to capture these as instances of its agent, role, and goal concepts, and its dependency relation. In a way, the concepts and the relations of the language can be seen as suggesting Topics to discuss. If the language is i*, then Topics would be the agents and roles in the environment, the goals of the agents, and the dependencies between them for achieving these goals.

The difference between Topics, and concepts and relations in requirements modeling languages, is that a Topic may correspond one to one to a concept or relation, or to more concepts and relations among those in the language. Our aim in defining the Topics was not to suggest an ontology for requirements modeling languages. Some languages may be able to capture the information associated with some Topics more easily than others, but that discussion is one of the language designs, being thereby beyond the scope of this paper, and influences in no way the contributions here.

3. Phase 1 – defining the variables of the study

The purpose of the first phase of our research was to define Topic Sets and related Topics. In phase 2, we used these Topic Sets and Topics as a starting point to identify

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Topics' importance, on the basis of experiments with stakeholders of various information systems.

3.1. Finding Topic Sets

To define the list of Topic Sets, we started from the idea that all elicitation interviews can be said to involve context-specific communication [22]. This means that an elicitation interview is specific to a time, place, RE project, requirements engineer doing the interview, stakeholder(s) being interviewed, and so on. In other words, to say that elicitation is context-specific is simply to say that no two elicitation interviews are alike.

The useful implication of this observation is that context influences the answers that stakeholders give: if we keep the same engineer who interviews, the same stakeholder who is being interviewed, and the same questions, and change something else in the context (such as interview location, and time), then we may get different information from the interview. Notice that we are careful in the above to say that we actually do not know if a change to context will, or would in fact change the information that the stakeholder chooses to share.

Consequently, the identification of Topic Sets involved two important tasks: (i) the identification of various the so-called Context Dimensions, that is, groups of variables which characterize the context, so that if they change, then we say that context changed from an old context to a new context and (ii) the identification of some Topic Sets, which are Context Dimensions that are likely to be of particular relevance in the specific case of requirements elicitation.

3.1.1. Identifying context dimensions

To identify Context Dimensions, we first drew on conceptualizations of context in philosophy [23,24], artificial intelligence [25] and computer science. In computer science, for instance, fields like ubiquitous computing, context-awareness and adaptative systems are particularly interested in the notion of context, and, so to speak, what context is made of (see [26–28] for surveys).

These conceptualizations of context were used as a support for deciding about the scope of context in this paper, i.e., to decide what is part of the RE context, and what is not. In our case, the RE context is seen as being any information which may prove to be relevant for the specification of a system, or more generally, for solving the requirements problem at hand [29].

The interest for context has also lead to operational definitions of context [30,31], which decompose context into dimensions which group related information. Such dimensions are relevant in this paper, as they are candidates for our Topic Sets. A partial list of context definitions using or suggesting context dimensions is given in Table 1. The symbol (X) is used when a dimension is explicitly expressed in the definition, while the symbol (?) is used whenever that dimension seemed to us to be suggested, but not explicitly mentioned in the definition.

From Table 1, we see that many authors concur in their observation that Time and Space are important dimensions of context. We conclude the same for the Individual dimension, which concerns people who are part of the context. Resource may refer to animals and non-living things such as materials, objects, or any other artifacts that are salient to individuals in the context, and with which they may interact. It seems to be agreed that a context involves at least a set of individuals and resources, at a given time, and at a given place.

There is no agreement on other dimensions in Table 1. Physical conditions – such as temperature, noise, and humidity – are sometimes considered as relevant for the definition of context. The Knowledge dimension, which deals with the content of knowledge, its justification and how it is evaluated by individuals, is also considered as a candidate dimension of context.

The notion of Relationship between individuals is another recurrent element in the literature on context, and deals with the relationships between individuals and/or resources. Activity is a dimension dealing with the goals/intentions of individuals. Computer's state and Spirits (topics that individuals can interact with, and that are considered as other instances of individuals; for example, a hobby) are other plausible, yet more specific, dimensions of context.

Previous survey is not intended to be exhaustive: we do not claim that our survey is representative of all context conceptualization in AI, ubiquitous computing, etc. However, we believe that it is a good groundwork for the identification of Topic Sets in RE, as it is built on a review of various definitions, from various fields.

3.1.2. Selecting Topic Sets from context dimensions

Using the dimensions studied in Table 1, we define six dimensions of context that appear to be particularly relevant during elicitation: (i) Items, (ii) Rules; (iii) Localization, (iv)

Table 1
A survey of some context dimensions in computer science literature.

	Schillit and Theimer [32]	Schillit et al. [33]	Brown [34]	Abowd et al. [35]	Lenat [30]	Dey et al. [36]	Dey [37]	Zimmermann et al. [31]
Place/Time	X	X	X	X	X	X	X	X
Individual	X	X	X	X	X	X	X	X
Resource	X	X	?	?	X	X	X	X
Physical conditions		X	X			X		
Knowledge				?	X			
Relations		?	?				X	X
Activity							?	X
Computer state/ Spirits			X					

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Activity, (v) Connections and (vi) Granularity. The latter dimensions are what we call Topic Sets in the rest of this paper, and will be used during interviews to identify the Topics of the ETM. This section provides additional details about those dimensions, as well as some examples.

To ease their interpretation, we split the six Topic Sets in two distinct families. A first family of Topic Sets is dealing with the Scope of the context, or in other words, its content. The Depth of context deals with the details to which Scope Topic Sets are described. Unlike Scope sets, Depth Topic Sets cannot exist by themselves, and are always dependent on another Topic Sets.

We see three Scope Dimensions:

- *Items* is a set dealing with the salient entities existing inside the context. Those entities can be human or not, living or not, physical or not. Examples of Items are employees of a company, furniture, servers, printers, but also abstract entities such as ideas or knowledge.
- *Rules* is a set dealing with the constraints that are applicable in the context, and which somehow influence the behavior of Items. Examples of Rules are laws, norms, cultures or habits.
- *Localization* is a set dealing with the physical position of the context. Localization is divided into two subcategories: one relating to the time when the context occurs, the other dealing with place where the context occurs.

Items, Rules and Localization (Scope Topic Sets) can be defined independent of any other dimension. For instance, an engineer could simply elicit information about what server will be used by the system-to-be (item), or about when the system-to-be ought to be implemented (localization). Those Topic Sets are consistent as is, and do not require information on other sets.

We see three Depth Topic Sets:

- *Activities* is a set dealing with the goals and actions of Items from the context. Examples of Activities are business strategies, people personal motivations, intentions, and goals.
- *Connections* is a set dealing with the relationships between Items and/or Rules. Examples of Connections are collaboration, friendship, competition, and applicability of a rule to.
- *Granularity* is a set dealing with the nature, the quantity and the level of any additional piece of information that is provided about the Context. Examples of Granularities are the age of a Person, the temperature in a room or the sanction that is applicable when a Rule is violated.

Activities, Connections and Granularity (Depth) cannot be defined without a reference to another set. For instance, an engineer cannot document an information like "It must have 500Go of available disk space" (Granularity), without documenting the "It". That information would only make sense if related to, for example, an Item such as the server mentioned in the Scope illustration.

3.2. Finding topics for each Topic Set

While Topic Sets are interesting on their own, they are not particularly useful for elicitation, as they are too general. Asking questions about Items, Rules, Localization, and so on, is not a concrete recommendation to give, to individuals who need to prepare elicitation interviews.

In order to identify specific Topics for Topic Sets, we decided to collect data directly from experts in the field of RE and business analysis. We selected requirements engineers and business analysts, and did interviews with them. The aim in the interviews was to discuss the Topic Sets and the perception by experts of the relevance of these Topic Sets, and to identify Topics that these experts would have, or actually had discussed with stakeholders.

Topics obtained from these interviews are summarized in Table 3. The rest of this section describes in more detail how we arrived at this list of Topics.

3.2.1. Participants

We obtained access to five systems engineering or reengineering projects, which involved professional requirements engineers and/or business analysts. The projects took place at small and medium sized companies (of up to 250 employees) located in Belgium and Luxembourg. When we did our study, all projects had ended in 12 months that preceded our study.

We interviewed the requirements engineers and business analysts involved in these projects. The interviews took place at the respective companies that employed these individuals. In addition to the interviews, we had access to requirements documentation produced for the projects.

We applied Stratified sampling [38] to form the sample of RE projects, choosing projects so as to cover different domains and project sizes. Systems engineering buyers and providers remain anonymous in this paper. This was a condition which we had to satisfy, in order to gain access to project documentation and the people involved. Table 3 gives an overview of project characteristics.

3.2.2. Procedure

The interviews were semi-structured in which the goal in each interview was to discuss all Topic Sets identified through our survey of context definitions. At any time during an interview, subjects were free to mention any aspect outside the scope of the Topic Sets, or challenge the Topic Sets which we were discussing.

An interview typically had three parts, each with a different focus. These parts were the following:

- An overall discussion of Topic Sets, with direct references to the latter such as, e.g., "Do you think it is relevant to collect information about Rules during an interview with a stakeholder? or "What is your feeling about the likelihood that stakeholders discuss Localizations spontaneously?".
- A more specific discussion about what Topics might be in each Topic Set, with questions such as, for example, "What aspects related to Rules would you want to

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elicit?" or "Do you consider culture of the company is a relevant aspect to be discussed with stakeholders when you want to collect information about Rules".
- A concluding discussion with broader questions such as, for example, "Do you see other aspects/comments that are relevant during interviews with stakeholders, and that we did not mention during this interview?".

Our approach during interviews was mainly exploratory. We were not testing some predefined variables, but instead trying to find relevant variables. The interpretative approach [39] was valuable in this regard. It helped us to make observations about how experts react to Topic Sets and about the type of social constructions they perceive when doing business analysis, that is, how they think that things work in their customers' companies. The systematic analysis of those constructions, together with the study of resulting documentation, led us to a list of 30 Topics.

The Topics were collected from RE practitioners in several steps. We conducted an initial interview, then analyzed the documentation we had access to, for the relevant RE project. Afterwards, we asked more questions when we observed that the information we got in the interview diverged from documentation. Such iterations happened up to three times (three interviews, three documentation analyses, for each engineer).

3.2.3. Results

The result of phase 1 is a list of 30 Topics, organized by Topic Set and is given in Table 2. The limit of 30 Topics was decided taking into account the largest possible set of Topics on which we could work and for which methodological concerns (in terms of validity, data collection and treatment) remained manageable. As a convention, we refer to these Topics by mentioning their identifiers in Table 2. For example, if we write I2, then we are referring to the Topic "Objects that could be related to the system", as given in Table 2.

Table 2
A list of Topics, by Topic Sets.

Items	I1. Actors who are going to use the system
	I2. Objects that could be wired to the IS
	I3. Other systems that are in use in the firm
	I4. Expected Input/Output from the system
	I5. Units/structures that compose the firm
Rule	R1. Laws/regulations applying to the firm
	R2. Norms/guidelines applied in the firm
	R3. Habits/traditions in the firm
	R4. Recommendations from management
	R5. Best practices that apply to the firm
Localization	L1. Place where the system will be used
	L2. Repetitive trends in the firm
	L3. Frequency of recurring events in the firm
	L4. Recurring events in the firm
	L5. History and evolution of the firm
Activity	A1. Core business of the firm
	A2. Reason why the company needs the IS
	A3. The main purpose of the IS
	A4. Goals assigned to you/your colleagues
	A5. Vision and strategy of the firm
Connection	C1. Type of relations between colleagues
	C2. Power of agents who use the IS
	C3. IS criticality for people of the firm
	C4. Strength of relationships between colleagues
	C5. Connection between Requester and Provider
Granularity	G1. Atmosphere in the company
	G2. Legal or financial status of the firm
	G3. Relevant monitoring metrics of the firm
	G4. Synergies inside the firm
	G5. Special facts about the firm

Table 3
Summary of project characteristics.

Name (#P)	Industry	Description
PP (60)	Pharmacology	Reporting for customers' feedback
FD (15)	Finance	Implementation of a CRM system
ML (20)	Accounting	Automation of accounting dashboards
AP (90)	Communication	Design of a BI system
BD (100)	ICT	Scheduling tool for human resources

There are Topics which we identified in phase 1, but excluded from Table 2. This is because they are either too project-specific or too repetitive. For instance, "Important financial ratios" has been identified as a potential Topic in the ML project (see Table 3), but has been rejected because dealing with aspects that are only relevant in the scope of an accounting reporting system. Similarly, "Assignments from management team about ergonomics" has been rejected because it is too precise, and partially redundant with R4.

4. Phase 2 – exploring the variables: the elicitation Topic Map

The goal of phase 2 was to evaluate the assumption that the stakeholders of a system would spontaneously share information about some of the Topics identified in phase 1, while they would remain silent about some other of these Topics. The approach here was also exploratory: our intention was to discover if there is actually a difference of importance (from the perspective of the stakeholders) between various Topics, and various Topic Sets.

Our premise is that if our data suggests that stakeholders tend to spontaneously share information about a Topic, then that topic is likely to produce explicit information in elicitation interviews. If data suggests that stakeholders do not tend to spontaneously share information about a Topic, then this information will remain implicit in elicitation interviews, unless the requirements engineer asks stakeholders about it.

Based on the results from phase 2, we performed a more thorough validation in the specific case of social networking systems. Results of that validation are presented in the third and the last phase of our study, in Section 5. The rest of this section describes how we collected the data, presents the ETM and discusses the conclusions that can be drawn from phase 2.

4.1. Participants

The subjects in this second stage were employees and managers in Belgian companies. The sampling method was a random sampling. From a list of 5000 alumni from the business and economic school of the University of Namur,

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Table 4
Description of the sample for the exploratory study.

Experience		Industry		Position	
1–3	11	Public sector	4	Employee	14
4–10	17	ICT	13	Consultant	12
More than 10	12	Banking and finance	8	Manager	8
		Consultancy and services	8	Top manager	6
		Manufacturing	7		

we picked 100 candidates at random, and asked them to take part of our survey.

We obtained answers from 51 people, but we rejected answers from 11 of them, who had no experience as stakeholders of IT project. The other 40 subjects, for which we kept the data, have been stakeholders in systems engineering or reengineering projects. Table 4 summarizes the resulting sample.

4.2. Procedure

Data collection took the form of an online survey. Subjects were asked to recall the last project in which they were involved as stakeholders, and were interviewed by requirements engineers. More precisely, subjects were asked to recall the beginning of the project, when they first got interviewed by a business analyst, requirements engineer or equivalent (hereafter used as synonyms). We then submitted two sets of questions to subjects.

The first series of questions focused on the Topics themselves. Questions took the following form: "During an interview with the business analyst, would you mention X" where X is to be replaced by a Topic. For instance, the first question of the series takes X="actors that are going to use the system-to-be (e.g. employees, customers, suppliers, other companies, …)". Subjects were asked, for each possible X in Topics listed in Table 2, whether they would discuss it with the business analyst. For each question, the subject had the choice between

- "A: I would discuss this aspect even if not asked by the business analyst"; and
- "B: I would discuss this aspect only if asked by the business analyst".

We interpret A as suggesting that the subject would spontaneously share information on the Topic. We interpret B as suggesting that the information on the Topic would remain implicit, unless the business analyst asks questions about it. We refer to the resulting set of answers as Topic evaluation.

We acknowledge that there could have been more alternatives, e.g., "C: I would be reluctant to discuss this aspect even if asked by the business analyst". However, our main concern is if the information would be shared. Although interesting, knowing the reason why a stakeholder did not share the information (for example, because she did not judge it was relevant, or because she was too shy to mention it) is not the purpose of this paper. For this reason, we remained with our initial explicit/implicit distinction.

In the second part of the questionnaire, the subjects were asked to evaluate how frequently, in their own experience, the Topic Sets are discussed with business analysts during interviews. In this second section, no Topics are mentioned, and subjects are asked to answer, considering the Topic Groups from a general point of view.

Given our objective to measure frequency, a six-level Likert scale of frequency was proposed to subjects: "Never", "Very Rarely", "Rarely", "Occasionally", "Very Frequently" or "Always". We chose a scale with more than two levels (unlike Topic evaluations) because Topic Sets are more generic and thereby less concrete to the stakeholders. As a consequence, a binary answer was probably too strict to capture relevant information, and a more detailed scale has been adopted. We refer to the resulting set of answers as Topic Sets evaluation.

4.3. Results

The collected data are summarized in Table 5 for Topics evaluation, and Table 6 for Topic Sets evaluation. The results are presented under the form of contingency tables, given that all the variables that we used in our survey are categorical.[1] Numbers reported in the tables are occurrences. For example, in Table 5, we learn that the Topic I1 has been evaluated as being explicit by 36 of our stakeholders (Answer A), while only four of them evaluated that same Topic as being implicit (answer B). Heads of the columns are the Topic identifiers from Table 2.

In the rest of this paper, a contingency table is typically formed by the crossing of two data dimensions. For instance, data presented in Table 5 is a contingency table of Topic evaluations by Topics, while the one in Table 6 is the contingency table of Topic Set evaluations by Sets.

4.4. Data analysis

We applied correspondence analysis to the data collected in phase 2. Correspondence analysis is conceptually similar to Principal Component Analysis in which it aims to summarize within two or three dimensions most of the variance of a data set. Correspondence analysis is however more adapted for categorical variables such as those we used in our survey. Correspondence analysis is particularly useful in the scope of our study because it provides a

[1] The full raw data set is available at http://perso.unamur.be/~cburnay/ETM/.

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Table 5
Topics evaluations for the exploratory study.

	I1	I2	I3	I4	I5	R1	R2	R3	R4	R5
A	36	23	24	32	19	12	21	15	21	23
B	4	17	16	8	21	28	19	25	19	17
	L1	**L2**	**L3**	**L4**	**L5**	**A1**	**A2**	**A3**	**A4**	**A5**
A	26	9	18	19	5	36	38	35	19	13
B	14	31	22	21	35	4	2	5	21	27
	C1	**C2**	**C3**	**C4**	**C5**	**G1**	**G2**	**G3**	**G4**	**G5**
A	7	25	25	8	6	6	5	16	17	4
B	33	15	15	32	34	34	35	24	23	36

Table 6
Topic Sets evaluations for the exploratory study.

	I	R	L	A	C	G
Never	0	1	2	1	1	9
Very rarely	2	3	3	0	3	7
Rarely	1	8	5	5	7	8
Occasionally	9	20	16	13	20	12
Very frequently	26	7	13	18	8	3
Always	2	1	1	3	1	1

graphical representation for the contingency tables we built from answers of our stakeholders. Such graphical displays are convenient for identifying patterns in data. Correspondence analysis was performed with the R package FactoMineR [40].

This section describes the correspondence analyses we performed to analyze our data. Next section presents some hypotheses we draw from these analyses in combination with previous qualitative study.

4.4.1. *Elicitation Topic Map*

The most significant output from this second stage of the study is the ETM. ETM is obtained from a correspondence analysis performed on the data presented in Table 5, i.e. on the contingency table of Topic evaluations by Topics.

The result of the correspondence analysis is presented in Fig. 1. The graph shows the distances between Topics, and distances between Topics and some *Points of Interest* (bold text). Points of interest can be seen as the representation, on the diagram, of stakeholders' behavior regarding the sharing of information: one point represents spontaneous sharing (the label Explicit in Fig. 1), the other one (Implicit in Fig. 1) the tendency not to spontaneously share the information on the topic. The graph is to be read as follows: the closer a Topic is to a *points of interest*, the more it is associated by our stakeholders with the related sharing behavior. For instance, L1 can be considered to be an explicit Topic, because it is relatively close to the Explicit *points of interest*. Yet, it is less explicit than A1 or A2, because the latter are at a larger distance from the Implicit *points of interest*.

The ETM is helpful during elicitation in which it provides indications about the risk of omissions of certain Topics. For example, observe that A5 and A4 to a lesser extent are closer to the Implicit *points of interest*, that is, they are associated with implicit sharing behavior. This does not mean that they are not relevant to RE. Understanding the strategy and the vision of the company might be critical to make appropriate specification design decisions.

However, it means that stakeholders are likely not to mention these Topics spontaneously during interviews. Consequently, the engineer might decide to prepare her interview with questions that focus specifically on understanding the vision, strategy, and targets of the business. It also suggests that it may be useful to the engineer to prepare for these interviews by researching the vision, strategy, and targets that the business had already been publicly announced in press releases, annual reports, and so on.

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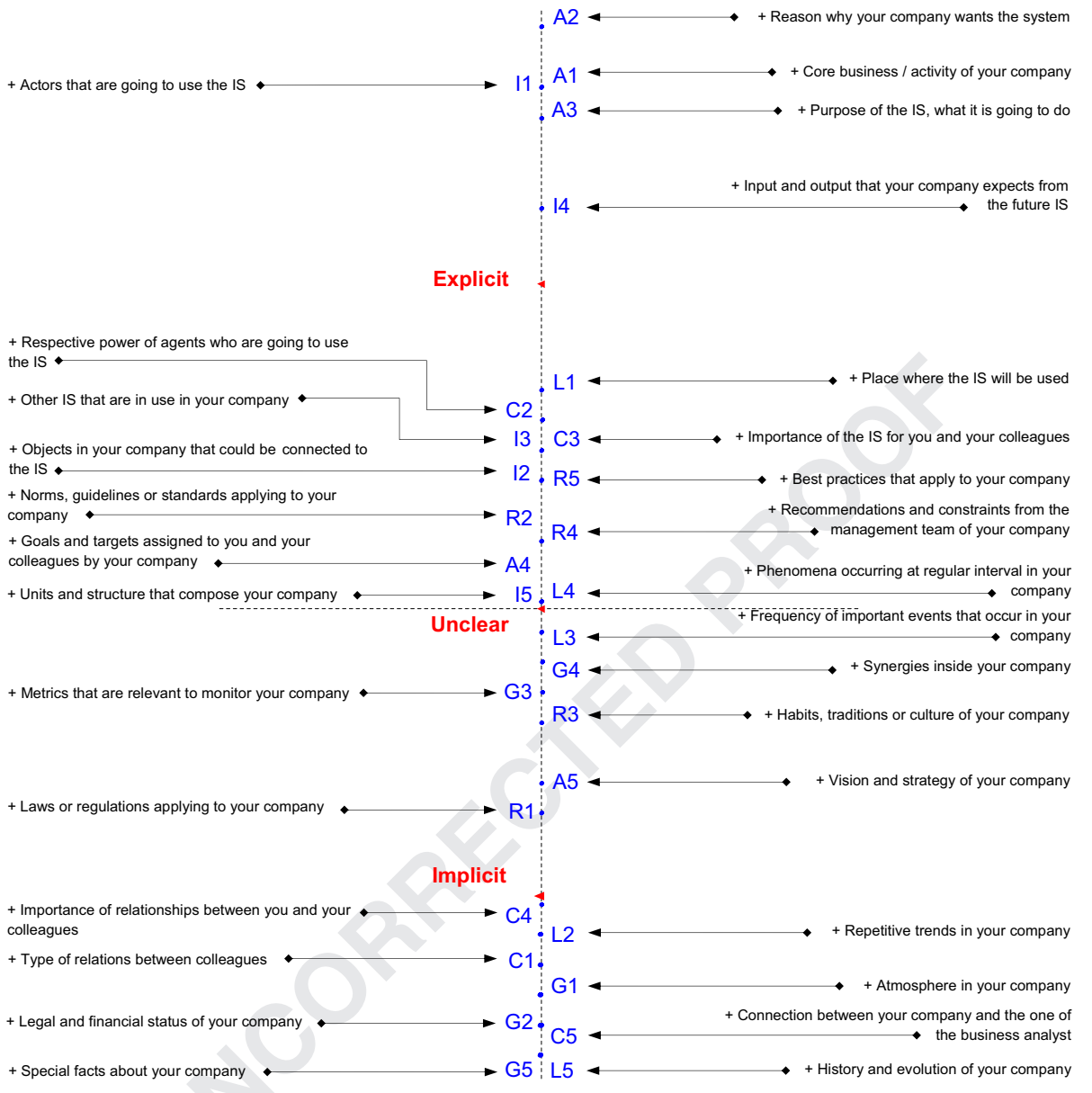

Fig. 1. The Elicitation Topic Map (ETM).

4.4.2. *Analysis of topic sets*

The collected data lets us make observations about Topic Sets as well. We now look at data in Table 6. The mechanisms for presenting and reading the correspondence analyses stay the same as the preceding section.

Fig. 2 presents the correspondence analysis in Table 6, with contingency table of Topic Set evaluations by Sets. We observe that Activities and Items topics are very close to the Always and Very frequently *points of interests*. This is interpreted as the fact that our stakeholders tend to spontaneously share information on Topics in these Topic Sets. In sharp contrast, Granularity is close to Very rarely and Never answers, thereby suggesting implicit behavior. Connections, Localization, and to a lesser extent Rules are associated with Occasionally and Rarely answers. Fig. 2 can be used in the same way as the ETM. It gives hints about the expected sharing behavior of stakeholders toward Topic Sets. For instance, Fig. 2 suggests that it may require more effort to elicit Localizations than Items.

4.4.3. *Analysis of experience and profile*

We now focus on the analysis of Experience (the number of projects in which the stakeholder has been involved) and Profile (the position that the stakeholder was holding in most of these projects). These two characteristics are studied because they are easily identifiable by business analysts at the beginning of an interview. Again, the mechanisms for presenting and reading the correspondence analyses stay the same as for the ETM section. Our aim here is not to provide a detailed

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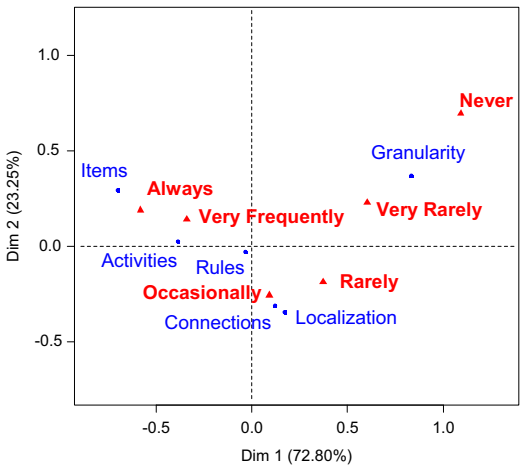

Fig. 2. Correspondence analysis on Topic Sets.

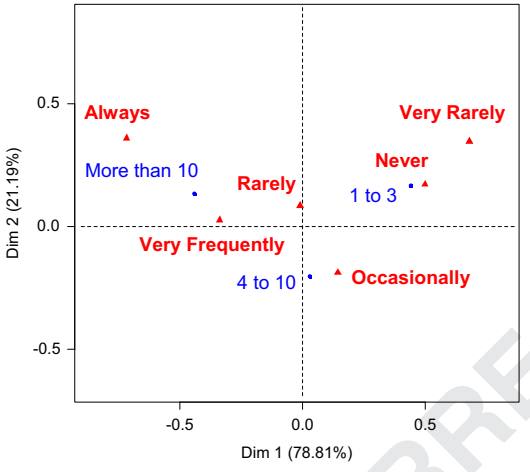

Fig. 3. Correspondence analysis on Experience.

discussion of such characteristics, but rather to illustrate their potential impact. Further research could however go on the investigation of other stakeholders' individual characteristics that influence sharing of Topics and Topic Sets.

Experience: A correspondence analysis for the experience of the stakeholder is presented in Fig. 3, and is computed from the contingency table of Experience by Topic Sets' evaluations. In our survey, we distinguish between four different levels: people with no experience (we omitted them from the study), people who participated from 1 to 3 projects, those who took part from 4 to 10 projects, and finally those with more than 10 projects. The analysis suggests that more experienced stakeholders are associated with Very Frequently to Always answers. This in turn suggests an explicit sharing behavior about Topics. Stakeholders with smaller experience selected more Very Rarely and Never answers, while stakeholders who took part in 4–10 projects favor the Occasionally answer.

Profile: A correspondence analysis for the profile of the stakeholder is presented in Fig. 4, and is computed from

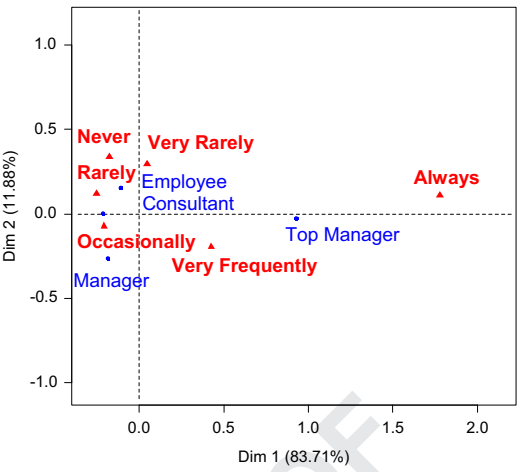

Fig. 4. Correspondence analysis on Experience.

the contingency table of Profile by Topic Sets' evaluations. We distinguish among four groups of profiles: employees (i.e. people working for the buyer who have negligible responsibilities for that project), consultants (i.e. people from outside the company helping on the project), managers (i.e. people with some responsibilities in the project) and top managers (i.e. CEO/direction of the buying company). The impact of profile on sharing behavior is less evident, as the distances between our data points (i.e. our profiles) are smaller than in previous figures. It is still possible to observe that stakeholders with wider responsibilities – managers and top managers – are more often associated with Always, Very Frequently and Occasionally *points of interests*. On the contrary, stakeholders with narrower responsibilities – employees and consultants – are more often associated with Rarely, Very Rarely and Never *points of interests*.

4.5. Hypotheses about topic importance

The ETM and the data from our samples suggest a number of hypotheses about information sharing behavior of stakeholders during elicitation interviews. We believe that it is worth doing further empirical research into these hypotheses. As a reminder, the approach in phase 2 is exploratory: we observe patterns of answers, and then suggest hypotheses that could explain these patterns. We validate some of these hypotheses in stage 3. The hypotheses are always about sharing behavior of stakeholders during an interview with a business analyst, in the scope of an IT project. They should not be considered outside these particular settings. They are to be read as potential explanations why stakeholders behave differently toward different Topics.

4.5.1. Some overall hypotheses about topic importance

We are interested here in hypotheses that can be formulated regardless of the Set to which a Topic belongs. Such hypotheses are called overall hypotheses, and are usually dealing with some general characteristics of Topics. In other words, we expect these hypotheses to hold for any

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new Topic that is added to the ETM, whatever the Topic Sets to which it may belong.

Some overall hypotheses are the following:

- $H1$: Information on Topics dealing with information systems (e.g. A3, L1, I3) is usually spontaneously discussed.
- $H2$: Information on Topics that pertain to information that stakeholders encounter on a daily basis (e.g. A1, G3, R5) is usually spontaneously discussed.
- $H3$: Information on Topics dealing with concrete instances of concepts (e.g. I4, R2, L4) (as opposed to those referring to concepts themselves, e.g. C1, G1, A5) is usually made spontaneously discussed.

These three hypotheses (and their opposites), if validated, could be used by interviewers as guidelines for understanding where to seek information that is not represented in the ETM. For instance, an engineer may be interested in a Topic such as "The strengths/weaknesses of the firm (SWOT)", which is not represented in the ETM. Using $-H1$ and $-H3$, she could estimate that the Topic is likely to remain implicit during an interview with a business analyst, because it does not refer to any information system, and deals with abstract concepts. Hence, the engineer could decide to include question in her interview that focuses on collecting sufficient information about that supposedly implicit Topic.

4.5.2. Some specific hypotheses about topic importance

Some hypotheses can also be suggested that only apply within a particular Topic Set. The interest of such specific hypotheses for engineers is basically the same as for overall hypotheses. The main difference is that their usage is restricted to Topics existing within the related Topic Set. Some examples of specific hypotheses are the following:

- $H4$: Rules that are dictated by the business (e.g. R2, R4, R5) are usually made explicit.
- $H5$: Activities related to how the business runs (e.g. A4, A5) are usually kept implicit.
- $H6$: Localizations that suggest a distance (in terms of space or time) (e.g. L2, L5) are usually kept implicit.
- $H7$: Items that are capable of accomplishing some tasks (e.g. I1, I4) are usually made explicit.
- $H8$: Connections involving human relationships (e.g. C1, C4, C5) are usually kept implicit.
- $H9$: Granularities with coarse grain (e.g. G5, G1, G2) are usually kept implicit.

5. Phase 3: ETM for social networks

The results which we presented in phase 2 of our study came out of a small sample. The goal of phase 3 was to replicate the study from stage 2, for a specific system class, the social networks. Our objective is double: try to see the extent to which the ETM holds true for a system class and, if not, try to understand the impact of changing the type of elicited context on the ETM.

Note that we do not replicate all the aspects of phase 2: we are particularly interested in validating the ETM itself, so we seek new Topics evaluations. Topic Sets evaluations are not collected in this last study. The characteristics of subjects that we use are also slightly different, as previous characteristics – for example, "Position" – are not all relevant in phase 3.

The rest of this section describes how we performed such validation for the case of social networks. Note that, as our objective is to replicate part of results obtained in phase 2 for a specific system class, most of the details about the experimental design remain unchanged in this third and last phase.

5.1. Participants

Participants in phase 3 were undergraduate students from various schools and various fields, in the french speaking part of Belgium. We invite the reader to refer to Section 6 for a discussion about the use of students in our study.

The sampling method was a Stratified sampling, as in phase 1. We chose subjects so as to represent different characteristics, such as gender, study background and experience. Our objective was to obtain parity in these different characteristics, while reaching a minimum of 20 subjects for each of the characteristics. We collected data from a total of 204 subjects. Table 7 summarizes our sample.

5.2. Procedure

Data collection took the form of an online survey, in which subjects were first asked to read the following text. Subjects were given this text in French.

> "Imagine a company interviews you in order to get information on a social network that it plans to launch in a few years. The latter should combine all the advantages of existing networks (such as Facebook, Linkedin, Twitter, Google+, etc.). To ensure its success, the company meets various potential users (and among others, you) to collect their requirements for this new network. You are taking part in an interview with a consultant from the firm. The interviewer explains that she is collecting information about your needs and your

Table 7
Description of the sample for the validation study.

Gender		Study	
Women	107	Computer sciences	65
Men	97	Business administration and economics	74
		Law	65
Experience		**Frequency**	
2 years or less	21	1 time a day or less	25
3– 4 years	24	2–5 times a day	63
4–5 years	46	6–15 times a day	66
5–6 years	56	Constantly connected	50
6–7 years	26		
7 years or more	31		

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Table 8
A list of social networks Topics, by Topic Sets.

Items	I1. Type of person you want to meet on the new network? I2. Device(s) you want to use to access the new network? I3. Other networks or online services that you already use? I4. Type of content you want to share on the new network? I5. Way you categorize friends you have in different groups?
Rule	R1. Laws and regulations that you can think of, that influence the way you use social networks? R2. Personal rules when you share content on a social network? R3. Your habits, which are not directly related to the social network? R4. Suggestions that your parents, friends, or others, give you, about using a social network? R5. Best practices when sharing content on a network?
Localization	L1. Place where you want to access the new network? L2. Routines you have when you come back from school/work? L3. How often you post status updates, pictures, etc.? L4. What recurring events would you like to be notified of? L5. What past events you want to share?
Activity	A1. Main occupations you have during the day? A2. Reason why you need the new network? A3. Things you want to do with the new network? A4. Number of contacts you want to have, so that your network is large enough and hence useful? A5. Values or ethical ideas that you feel are important?
Connection	C1. Type of relationships you expect to find on the new network? C2. Different privileges you want to provide to your contacts? C3. Extent to which the new network would replace existing ones? C4. Strength of relationships you expect to establish on the new network? C5. Extent to which you trust the analyst that interviews you?
Granularity	G1. Atmosphere between you and your friends G2. Information about marital status, children, or your revenue G3. Way you want to evaluate your new social network? G4. Collaborations you expect to find between some groups of friends? G5. Some peculiarities about your friends or your family?

environment. She tells you that you can share any information you think would be useful in order to design the perfect social network. In the remainder of this form, we offer a list of 30 topics that you could discuss with the interviewer. We ask you to decide whether you think this information could help the company in designing its network. Do you think the topic is relevant, and so would you share it with the consultant during the interview?"

As in phase 2, subjects were then asked to answer a series of questions about their behavior toward our list of Topics: "During the interview with the business analyst, do you decide to speak spontaneously about X?" where X is to be replaced by one of the social network Topics listed in Table 8. Topics in Table 8 are the Topics we identified for the generic ETM in Table 2, but adapted to fit the particular context of use of social networks. By "adapted", we mean that the Topics in this study use the jargon of social networks, for example, "I1. Actors who are going to use the system" became "I1: the type of person you want to meet on the future social network".

For each question, the subject had the same binary choice as in phase 2. Interpretation is also similar to phase 2: answering A reflects explicit sharing behavior, while B reflects implicit sharing behavior:

- "A: I would discuss this aspect even if not asked by the business analyst".
- "B: I would discuss this aspect only if asked by the business analyst".

As a summary, phase 2 and phase 3 differ in the following ways:

- In phase 3, subjects are asked to make the decision to share or not during the study, unlike in phase 2, where the subjects had to remember some of their experience in sharing or not information about Topics.
- There is also a greater control of the application domain in stage 3: social networking is clearly in the assignment, and subjects are asked to focus on it only. This differs from stage 2, where subjects were deciding themselves about the type of system (as a reminder, subjects were asked to remember their last experience as a stakeholder, and were therefore free to choose their own application domain).
- Topics used in phase 3 are those initially identified for phase 2, but which have been adapted to social networks.

5.3. Results

The data we collected in phase 3 are summarized in Table 9, under the form of a contingency table.[2]

[2] The full raw data set is available at http://perso.unamur.be/~cburnay/ETM/.

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Table 9
Topics evaluations for the validation study.

	I1	I2	I3	I4	I5	R1	R2	R3	R4	R5
A	190	174	147	186	87	125	152	62	67	67
B	14	30	57	18	117	79	52	142	137	137
	L1	**L2**	**L3**	**L4**	**L5**	**A1**	**A2**	**A3**	**A4**	**A5**
A	127	40	92	188	106	114	172	143	131	96
B	77	164	112	16	98	90	32	61	73	108
	C1	**C2**	**C3**	**C4**	**C5**	**G1**	**G2**	**G3**	**G4**	**G5**
A	70	125	172	86	93	21	15	102	123	32
B	134	79	32	118	111	183	189	102	81	172

As previously explained, we did not collect Topic Set evaluations in this phase of the study, as we are mainly interested in the validation of the ETM.

5.4. Data analysis

The replication of the ETM in the case of social networks was obtained by performing a correspondence analysis as given in Table 9. The same statistical tool has been used to perform the analysis, namely the R package FactoMineR.

In addition to the correspondence analysis, phase 3 also tested some of the overall hypotheses from Section 4.5.1. To perform those tests, we used a new measure, called the *Hit Rate*.

The Hit Rate is the score obtained by subjects during the elicitation, and is obtained with the simple following ratio:

$$\frac{\#AnswerA}{(\#AnswerA + \#AnswerB)}$$

The Hit Rate reflects the performance of a subject in sharing information during an interview. The maximum Hit Rate is 100%, suggesting that the subject has picked answer A for all the 30 submitted Topics. Hit Rate is an additive measure, so that it can be aggregated according to various groups of subjects (for instance, Hit Rate of experienced subjects versus Hit Rate of inexperienced subjects), or various groups of Topics (for instance, Hit Rate for Items versus Hit Rate for Rules). Hit Rate is used hereafter to perform means comparison between several such groups. These comparison tests were also performed with R, using standard statistical tools (see below for more details).

This section describes in more detail the result of the validation.

5.4.1. Elicitation Topic Map Replication

The ETM for social networks. ETM-SN is obtained from a correspondence analysis performed on the data presented in Table 5, i.e. on the contingency table of SN Topic Evaluations by SN Topics. The result of the analysis is presented in Fig. 5. Like the initial ETM, the graph shows the distances between social network Topics, and distances between social network Topics and some *points of interests* (bold text).

In Fig. 5, both ETMs are represented, and Topics are related to social network Topics, so that it is somehow possible to visualize how much the importance of a Topic changes between the two phases. It is possible to observe that some social network Topics are located in the same region as their corresponding Topics. For example, most of the granularity social network Topics are located near the Implicit *points of interest*, which suggests that they are Topics of low importance to social network stakeholders. From Fig. 5, it is also possible to see that other Topics seem to have moved radically along the sharing axis. For example, the Connection Topics have switched from a rather implicit position to a clearly explicit one.

Although interesting, previous observations are too informal to provide actual conclusions on the similarities between the original ETM and ETM-SN. Next subsection hence provides a quantitative comparison of both ETMs.

A comparison of ETMs. Based on the Hit Rate scores of each Topic and social network Topic, it is possible to have a

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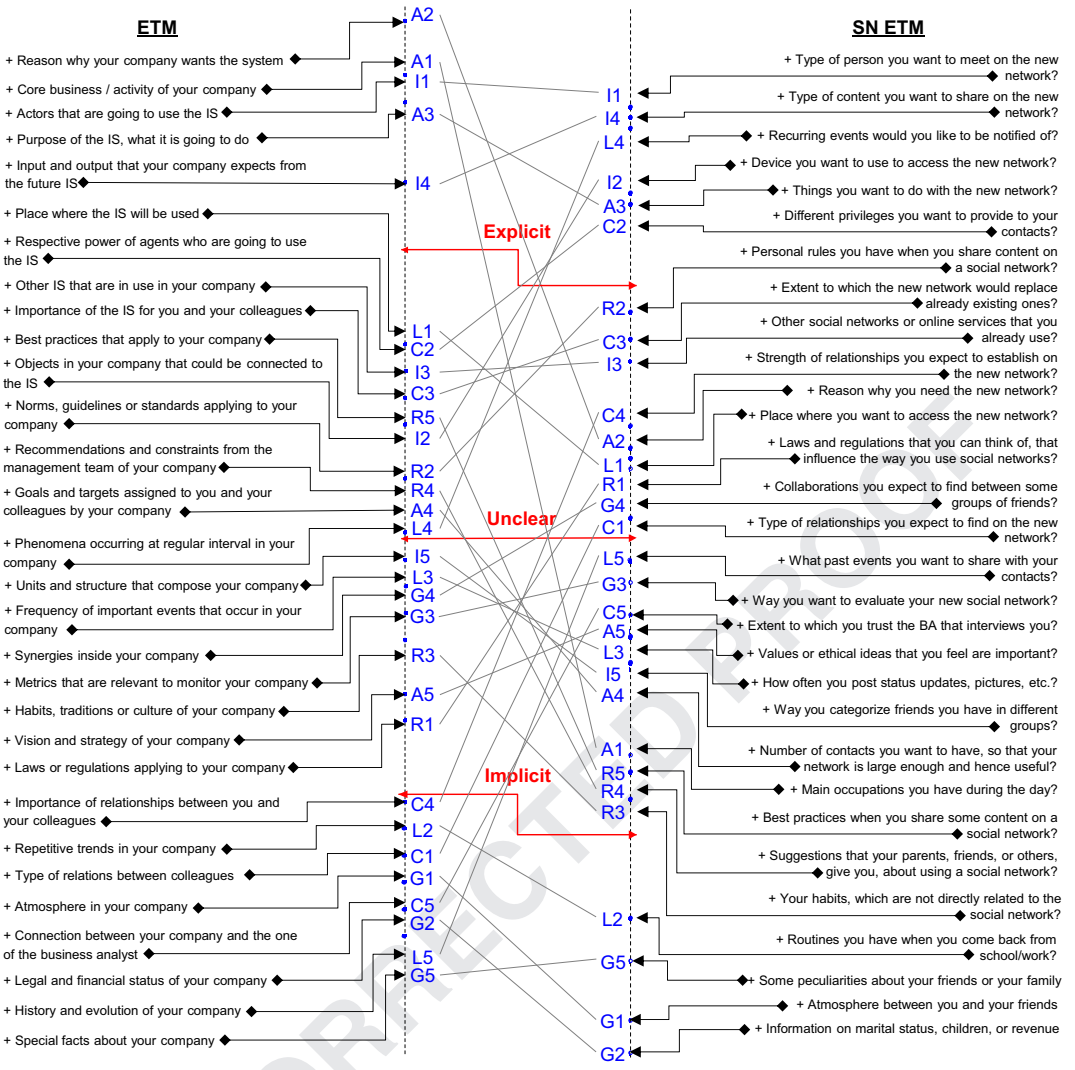

Fig. 5. The Elicitation Topic Map for Social Networks (ETM-SN).

clearer comparison of ETMs. This comparison is performed in Table 9. The Column ETM reports the observed Hit Rate score for each Topic in the original ETM. The column SN reports the same scores observed in the case of social networks. The last column reports the difference between the two. Five regions are defined, to make it easier to read. Topics are attached to these regions based on the value in the Difference column. Using Table 10, it is possible to make several observations about the replication of ETM for social networks. Another visualization is given in Fig. 6:

- Nearly half (13/30) of the Topics have the same importance in general and in social networks (Similar region): this suggests that the importance of some Topics is independent of the system class.
- Some Topics (4/30) become less explicit for social networks. For example, we observe that Topics dealing with privacy are less explicit in ETM-SN, such as occupation during the day or recommendation from the family.
- Nearly half (13/30) of the Topics have become more explicit in the case of social networks. For example, we observe that Topics dealing with Connections between subjects are more explicit in ETM-SN.

Previous observations bring us to a first central conclusion: the importance of a Topic to a stakeholder somehow depends on the type of system being studied, i.e. an ETM is domain-dependent. In other words, a Topic that is highly important to a stakeholder in the context of social networks, such as connections, may prove to be of very little interest to that same stakeholder in the context of an e-commerce application. This brings us to the more general conclusion that there may not be a universal ETM, and that an ETM has to be designed for each possible type of system, in order to adequately support elicitation. While such work is clearly out of the scope of this paper, it could easily be accomplished for other types of systems by using the methodology we used in phase 3, and replicating the experiment for other information systems.

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Table 10
A comparison of the ETM and the ETM-SN.

	Topic	ETM	-SN	δ
More implicit				
$-20 < \delta$	A1	90	34	−56
	A2	95	61	−34
Slightly more implicit				
$-20 \leq \delta < -10$	R4	52	32	−20
	R5	57	38	−19
Similar				
$-10 \leq \delta < 10$	A3	87	84	−3
	A4	47	42	−5
	C3	62	70	8
	G1	15	10	−5
	G2	12	7	−5
	G3	40	40	0
	G5	10	15	5
	I1	90	93	3
	I5	47	42	−5
	L1	65	62	−3
	L2	22	19	−3
	L3	45	45	0
	R3	37	30	−7
Slightly more explicit				
$10 \leq \delta < 20$	A5	32	45	13
	G4	42	60	18
	I3	60	72	12
	I4	80	91	11
More explicit				
$\delta > 20$	C1	17	55	38
	C2	62	84	22
	C4	20	64	44
	C5	15	47	32
	I2	57	85	28
	L4	47	92	45
	L5	12	51	39
	R1	30	60	30
	R2	52	74	22

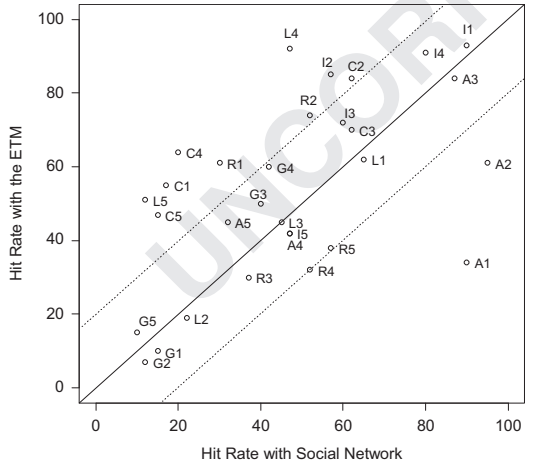

Fig. 6. A graphical comparison of the ETM and the ETM-SN.

5.4.2. *Validating the overall hypotheses*

In this section, we are interested in the validation of the overall hypotheses H1 and H3 suggested in Section 4.5.1. As a consequence, there is no more comparison with the original ETM, and all the data used in this section are obtained from the phase 3 of our paper.

Table 11
Groupings of Topics for the validation of overall hypotheses.

	I1	**I2**	**I3**	**I4**	**I5**	**R1**	**R2**	**R3**	**R4**	**R5**
A	R	R	K	R	K	K	K	K	K	K
B	S	S	S	S	S	S	S	S	S	S
	L1	**L2**	**L3**	**L4**	**L5**	**A1**	**A2**	**A3**	**A4**	**A5**
A	R	K	K	R	R	R	R	R	R	K
B	S	S	S	S	S	D	D	D	D	D
	C1	**C2**	**C3**	**C4**	**C5**	**G1**	**G2**	**G3**	**G4**	**G5**
A	K	K	R	K	K	K	K	R	R	K
B	D	D	D	D	D	D	D	D	D	D

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As a reminder, H1 has been formulated as follows: "Information on Topics dealing with information systems (e.g. A3, L1, I3) is usually spontaneously discussed". To ease its validation and make it more RE-oriented, H1 can be rephrased as follows: "Information dealing with Requirements (R) is shared more spontaneously than information about Domain Assumptions (K)", i.e., $HitRate_R > HitRate_K$.

Similarly, H3 was initially formulated as follows: "Information on Topics dealing with concrete instances of concepts (e.g. I4, R2, L4) (as opposed to those referring to concepts themselves, e.g. C1, G1, A5) is usually made spontaneously discussed", and can be rephrased it as follows: "Information dealing with the Scope of context (S) is shared more spontaneously than information about Depth of the context (D)", i.e., $HitRate_S > HitRate_D$.

H1 and H3 can be easily tested, because they deal with intrinsic properties of the Topics; these properties do not depend on the subject who is answering our questionnaire. For example, I1 (actors who will use the system) is a requirement, regardless of who consider that Topic. I1 can also be attached to the Scope group, as it is part of the Item dimension. Table 11 describes the groups to which Topics have been attached in order to be compared.

We did not investigate H2 because it would have required more data to be collected, which was hardly feasible given the significant list of Topics we had to test. Since the authors cannot decide whether I1 is a frequent Topic to stakeholders, and data could not be collected, it was impossible to validate H2.

Requirements versus Domain Assumptions: Here, we are interested in the study of the overall hypothesis H1: $HitRate_R > HitRate_K$. To do so, we work on a list of 204 paired observations: for each participant to the study, two Hit Rate measures are computed. A first one is the average Hit Rate on Topics belonging to the Requirements group. A second one is computed for Topics belonging to the Domain Assumptions group. What we want to show is that, on average, subjects have better Hit Rate for the Requirements Topics than for the Domain Assumption Topics.

To test that hypothesis, we must resort to a Student's *t*-test, with the null hypothesis that $H_0: HitRate_R = HitRate_K$, and alternative hypothesis being $H_A: HitRate_R \neq HitRate_K$. Since we were not able to confirm that the paired differences came from a normal distribution (Shapiro–Wilk normality test – $W = 0.9849$, p-value $= 0.028$), we proceeded with a non-parametric test which is equivalent to student test for paired values, namely the Wilcoxon signed rank test. The Wilcoxon test returned the following results: $V = 20832$, $p\text{-value} < 2.2e-16$. Since the p-value is smaller than an alpha level $= 0.05$, we can reject H_0 and conclude that the means are significantly different between Requirements and Domain Assumption Topics. In other words, our subjects were better (they had higher Hit Rates) for one of the two groups of Topics.

To see the direction of the difference, a boxplot is provided in Fig. 7. We can observe that, in our study, subjects were much better sharing information about their Requirements than they were for Domain Assumptions. This suggests that H1 is verified in our sample, and brings us to a second important conclusion: engineers should be more proactive during an interview intended to elicit Domain Assumptions than during an interview intended to elicit Requirements.

Scope versus Depth: Here, we are interested in the study of the overall hypothesis H3: $HitRate_S > HitRate_D$. We proceed in the same way as for H1: we work on a list of 204 paired observations. For each participant of the study, two Hit Rate measures are computed. The first one is the average Hit Rate on Topics belonging to the Scope group. The second one is computed for Topics belonging to the Depth group. What we want to show is that, on average, subjects have better Hit Rate for the Scope Topics than for the Depth Topics.

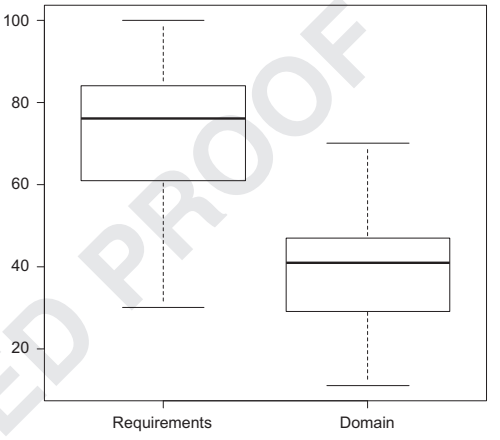

Fig. 7. Boxplot – Hit Rate for Requirements versus Domain Assumptions.

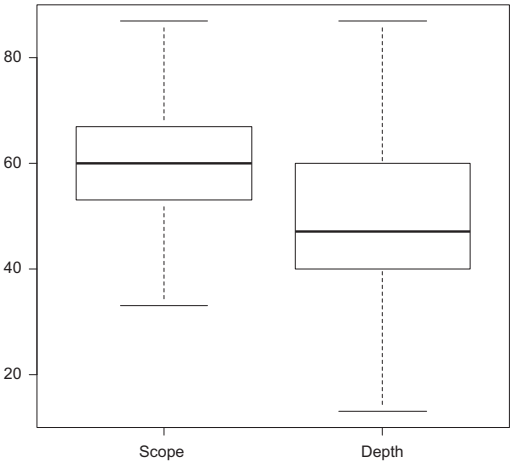

Fig. 8. Boxplot – Hit Rate for Requirements versus Domain Assumptions.

Table 12
Anova on the Hit Rate, for several stakeholders' characteristics.

	Kruskal–Wallis chi-squared	Freedom degree	*P*-Value
Gender	0.1138	1	0.7359
Frequency	1.5906	3	0.6615
Experience	7.0793	5	0.2148
Study	11.6586	2	0.00294***

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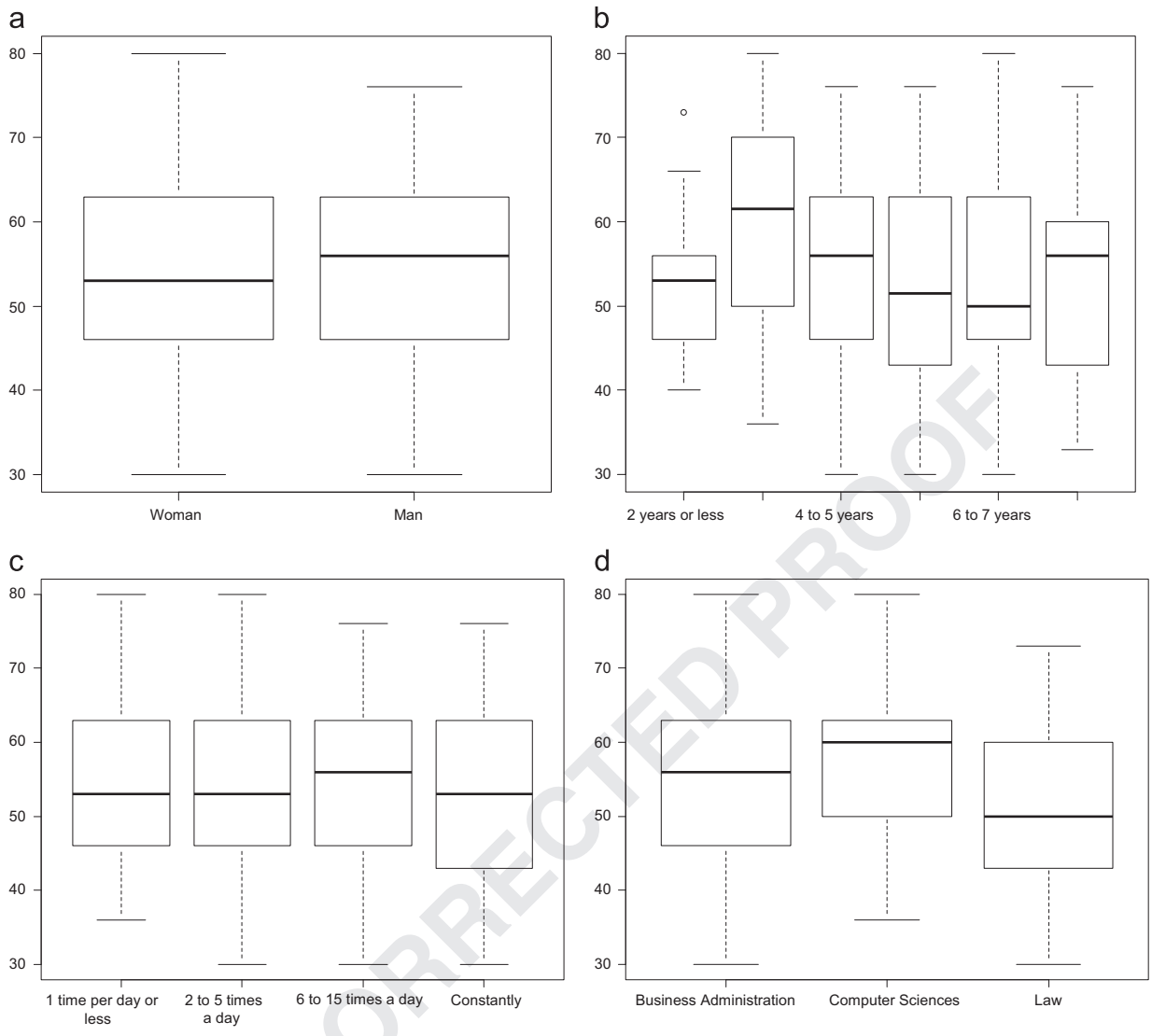

Fig. 9. Boxplots for stakeholder's characteristics. (a) Gender; (b) experience; (c) frequency; and (d) study.

We were not able to confirm that the paired differences came from a normal distribution (Shapiro–Wilk normality test – $W=0.9833$, p-value$=0.01587$), so that we also proceeded with the Wilcoxon signed rank test. The Wilcoxon test returned the following results: $V=12\,074.5$, p-value$=6.451e-14$. Since the p-value is smaller than an alpha level$=0.05$, we can reject H_0 and conclude that the means are significantly different between Scope and Depth Topics. In other words, our subjects had higher Hit Rates for one of the two Topic groups.

To see the direction of the difference, a boxplot is shown in Fig. 8. We can observe that, in our study, subjects were much better discussing the Scope of the context rather than the Depth of that context. This suggests that H3 is verified in our sample, and brings us to the third conclusion: engineers should be more proactive during an interview intended to elicit Details about concepts than during an interview intended to elicit the concepts themselves.

5.4.3. Some additional results

Although they are not central to this paper, we also present some other results we obtained from our data. Our objective here is to show some additional conclusions about the impact of stakeholders' properties on their sharing behavior. Our approach is similar to the one in Section 5.4.2: we attach subjects to some groups, depending on their own characteristics (see Table 7), and then compare the average Hit Rate between these groups.

We use one-way Anova. As we were not able to assume a Gaussian distribution of Hit Rates (Shapiro $W=0.9801$, p-value$=0.005517$), we however opted for its non-parametric equivalent, the Kruskal–Wallis Anova. Results are presented in Table 12. From Table 12, it appears that nothing can be concluded about the performance of women versus men during interviews. This suggests that engineers should not worry about the gender of stakeholders in interviews. Visualization of this is shown in Fig. 9a.

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Similarly, we were unable to conclude that Frequency of use and Experience influence the performance of Stakeholders when sharing information. It is interesting to observe that people with lot of experience do as well as people with small experience, i.e., during elicitation, there is no gain in questioning more experienced stakeholders. Note that we are careful enough to not say that there is no gain at all in having experience, as we performed no comparison between the Hit Rate of experienced and totally inexperienced stakeholders, i.e., in our study, all subjects had at least some experience in using social networks. This suggests that engineers should not worry about how information sharing is influenced by how experienced stakeholders are (in terms of how often they use the system over a certain period, or how long they have been using that system). Additional visualization is proposed in Fig. 9b and c.

Finally, we learn from Table 12 that the background (Study) of stakeholders has a significant influence on sharing during elicitation interviews. Additional visualization is given in Fig. 9d. Despite the positive results we obtained with the Kruskal–Wallis test, the variations we observe in Fig. 9d are probably too small to justify a background selection during elicitation interviews. What we mean is that, although the test shows that there is a statistically significant difference, that difference likely remains too small to influence RE practice.

For instance, in Fig. 9d, we observe that, on average, the difference in Hit Rate between Business Administration students and Computer Science student is of 5%. In practice, such a difference will likely appear to be virtually null, so that it brings us to our sixth and last conclusion that engineers should not worry about the study background of Stakeholders when they perform interviews.

6. Discussion

Many results have been presented over the past sections. They were obtained through various studies, which have been performed with various empirical designs. This section tries to provide a critical discussion about those results, their validity, and the kind of recommendations they may suggest to RE.

6.1. Validity of the study

Usually, a distinction is made between the internal and the external validity [41]. Internal validity is concerned with the extent to which the study measures what it was intended to measure. In other words, it ensures that there is no bias in the observations that are made, and that no influencing factors have been omitted. On the other hand, external validity is concerned with the extent to which conclusions drawn in the study can be generalized beyond the samples used in the study.

Internal validity is important for all three phases in this research. We paid particular attention to the following threats to internal validity:

- *Measurement bias*: The same observation procedures have been used across the different subjects taking part in the same study, to control the risk of measurement bias.
- *Selection bias*: There are no proper experimental groups in our study, since most of the results are based on a repeated measure design, and we did not use a classical experimental versus control group distinction.
- *Maturation bias*: In order to avoid subjects' changes during the course of the experiment influence the results, two different questionnaires (with the same questions, but in different sequences) have also been used within a same study, so that the maturation effect is reduced.

Regarding external validity, our first two phases of research are clearly exploratory. As a consequence, the focus during data collection was not on generalization, but rather on the creation of the ETM. In other words, we do not claim that ETM is general, but instead only a useful tool for preparing elicitation interviews. The threats to external validity that we judged relevant, and on which we paid particular attention in phase three are the following:

- *Subjects bias*: We used students as the reference population. Our decision to resort to students as subjects for our third study is based on several arguments. Students are among typical social network users. As our intention in phase 3 was to validate the ETM with actual stakeholders of social networks, students appeared to be a particularly relevant group. This adds to the fact that most students are frequent and long-term users of the Internet and have likely been using various types of information systems, which make them "expert stakeholders" of social networks. Note finally that some studies have conducted the comparison between students and professionals for empirical studies in software engineering, and have found no significant difference between the two groups [42];
- *Sample size*: Data was collected from 204 subjects, with various genders, backgrounds, and experiences in using social networks, and from multiple schools in Belgium.

6.2. Recommendations and future works

This section summarizes the conclusions from the three phases of research.

6.2.1. There is no universal ETM

The first conclusion is probably the most central one in this paper: an ETM designed for one type of system may not be useful as is for the elicitation of another type of system. For example, the ETM-SN cannot be used as a support to elicit information from an e-commerce system, or any other system which has not the characteristics of a social network. Further research should be devoted to the identification of ETM for other types of systems. Understanding how those ETMs differ from each other may provide additional support for understanding how stakeholders decide about the importance of a Topic. The replication of existing ETM (such as the ETM-SN) could also be conducted with other subjects. In fact, it may be that age also impacts the Hit Rate of subjects

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during elicitation interviews. Such research would contribute to improving the insight we have into the problem of implicit information, and could ultimately help improve the quality of requirements elicitation. ETMs come with no guarantees. The ETM can be used to recall Topics that, a priori, may appear to be less important to stakeholders and which therefore present a higher risk of not being discussed.

6.2.2. Stakeholders speak more easily about expectations than environment

The second conclusion may appear as common-sense: stakeholders tend to share information about what they want, and less about the environment in which those expectations need to be realized. Our study confirmed the intuition that the engineer cannot expect stakeholders to know what information on requirements and the environment is the most relevant for designing the system-to-be. If they are not asked specific questions, the stakeholders will assume that most of the relevant information is related to their expectations from the system. One way to reduce that perverse effect during interviews would be to clearly emphasize, at the beginning of an interview, which type of information is relevant, and which is not; for example, an engineer could use any classical elicitation technique, yet taking a few minutes at the beginning to provide examples about what different types of information needs to be collected. This may help in increasing the Hit Rate for Domain Assumption Topics.

6.2.3. Stakeholders speak more easily about independent concepts than about details on these concepts

The third conclusion, that Scope is more easily discussed by stakeholders than Depth, is also interesting. It does not deal with a classification of information that is usually used in RE (unlike the classical requirements and domain knowledge distinction). The distinction comes from the definition of Context which we gave in this paper, and offers a new interesting perspective on the type of information that can be collected during elicitation interviews.

In addition to recommendations provided for conclusion 2, we could add some methodological observations. During an interview, it may not be relevant to start eliciting Depth as long as Scope is not well understood. For stakeholders, this would amount to share detailed information about things that have not been discussed yet with the engineers. The risk is then that stakeholders do not share information at all, considering that it is not relevant for the engineer. As a solution, it could be useful to start focusing an interview on the important concepts (either requirements or domain assumptions) belonging to predefined Scope, and then systematically reviewing those concepts to add new Depth concepts. ETM should come as a support to guide such process.

6.2.4. The gender of a stakeholder has no bearing on the overall Hit Rate

Although this conclusion is not central in this paper, it is interesting to observe that, in our study, there was no statistically significant difference in Hit Rate between women and men. This conclusion is however based on a student sample, and may not be applicable for stakeholders of systems in organizations.

6.2.5. The experience of a stakeholder has no bearing on the overall Hit Rate

The fifth conclusion in this study is that the years of experience of a stakeholder with a system class has no impact on the Hit Rate, as long as that stakeholder has at least some experience. This was a surprising result, as we were expecting before the study to find a significant impact of that factor.

Research could go on the study of that particular question. For instance, it might be interesting to investigate the impact of experience on Hit Rate with a few more levels: in fact, we only used 4 or 5 different levels in our study, which might be the reason why we find no significant impact. Another interesting issue is the study of the impact of the first experience increment. In other words, comparing the elicitation of requirements from stakeholders with no experience at all with stakeholders who have some (even small) experience of the system. Our idea is that stakeholders may have "heavy tailed" learning curve, with important difference in Hit Rate for small levels of experience, and less important variations as the experience increases.

6.2.6. The background of a stakeholder has no bearing on the overall Hit Rate

The sixth conclusion is probably the most controversial one in this paper. It is that there is a significant effect of Study on Hit Rate, although that variation is too small to justify specific recommendations for requirements elicitation.

There are several possible reasons why Study can influence Hit Rate. For example, some studies may focus on analytical skills (engineering), while others may put the stress on creative thinking (arts, literature). Similarly, the knowledge background people acquire during studies may vary strongly, which may also influence how stakeholders acquire experience of a system.

For example, two stakeholders with different study backgrounds, who use a system in the same way, may acquire different knowledge on that system, because they have different perspectives on it. As a result, the kind of information they keep implicit is also likely to vary.

7. Related work

Importance of context (or environment, or domain) is hardly new to RE. The contextualist approach – in which it is claimed that peculiarities of a context must be understood before the requirements can be derived – is often presented as an alternative design philosophy to information systems design [43]. Other examples of context importance are provided in [44], where the machine is to be considered within its environment and cannot be dissociated from it, or in [45] where ethnographic analysis is claimed to be valuable to RE.

Domain modeling languages also emphasize the importance of context in RE, but from a more practical point of

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view. Languages such as SARL [46], RML [16], ERAE [18], TELOS [19], KAOS [20] or i* [21] provide support to engineers for capturing and documenting information about the context.

The importance of context to RE has been highlighted in the NATURE research project; [47] stresses the importance of a representation dimension in RE, which copes with the tools (formal or not) that can be used to express knowledge about the system, while [48,49] propose a conceptual model to support the documentation of domain theories.

More recently, authors have emphasized the importance of relating requirements to context. Some emphasize the importance of context and empirical validation of RE models as a direction for future research to accelerate the transfer of research results into RE practice [50]. Others even identify context study as an important research area on which RE should re-focus [51].

Modeling information about the domain obviously requires that information to be collected, and hence elicited. That aspect has also been the center of great attention from RE. Research efforts have been devoted to the definition of elicitation methods that provide ways for acquiring contextual information. From Contextual Inquiry [52] to Inquiry Cycle [53], context is put at the center of the acquisition effort.

Other approaches indirectly account for the context of use of a system-to-be during elicitation. CREWS [54] for instance suggests that elicitation can be guided by the use of scenarios and use-cases. SCRAM [55] also positions scenarios as an important tool for RE. Alternatively, several viewpoints can be adopted to cover different concerns related to a system-to-be and therefore support completeness of elicitation (e.g. [56–58]).

The specific question of how stakeholders behave during elicitation when being asked about the context has been the center of less attention from RE community. Some research has been devoted to the risks related to stakeholders' behavior during interviews, e.g. personal, social or cognitive factors, and suggests ways to handle those risks [59]. A framework for the communication issues during elicitation has even been proposed [60], which is composed of four important dimensions: (i) stakeholders' participation and selection, (ii) stakeholders' interaction, (iii) elicitation techniques and (iv) communication activities involved by the elicitation activity. None of these studies tackle however the issue of implicit and explicit information.

Yet, the existence and importance of implicit information/knowledge is recognized in RE. Tacit knowledge is probably the most recurring example of implicit information in RE. It is defined as the phenomenon that people are able to do things, without being able to say how they do them [61]. It is often acknowledged that ethno-methodologies, some of which have been presented above, can be used to make tacit knowledge explicit [61]. Some research has focused on the elicitation of such tacit knowledge [62–64]. To the best of our knowledge however, the problem of implicit information due to defaults in elicitation has not been addressed. Implicit information has also been discussed in RE under the more specific perspective of implicit requirements [65,66].

8. Conclusions

In this paper, we discussed the importance of distinguishing between the information stakeholders have that is made explicit during interviews and the information that they keep implicit. Such distinction brought us to the question of how to discover the implicit information that stakeholders may have.

As an answer, we introduced the ETM, a list of RE relevant Topics that are mapped by the order of importance. In this paper, importance is understood from the point of view of stakeholders, and expresses the likelihood of a topic to be discussed explicitly. To build the ETM, we used a combination of a qualitative study (to identify Topics) and a quantitative study (to determine the importance of Topics). The ETM enabled us to formulate a set of nine hypotheses about the sharing behavior of stakeholders during interviews. Starting from the generic ETM, we performed an additional study to obtain a ETM-SN, presenting topics importance for the particular class of social networking systems. This showed that topic importance varies depending on the system class.

There are many directions for future work. New Topics can be added to the list, and larger-scale validations of already proposed Topics are needed, to produce more relevant ETMs for specific system classes and application domains, and thereby help the preparation of elicitation interviews.

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