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Comparing Requirements Analysis Techniques in Business Intelligence and Transactional Contexts:
A Qualitative Exploratory Study

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ABSTRACT

Requirements elicitation is a key concern in information technology (IT) projects. Business intelligence systems (BI) have emerged and are now used widely in organizations. These systems are designed to support manager's decision-making in their business performance monitoring activities and their requirements are very different from those of transactional systems. But past research did not consider these differences. Therefore, this paper relies on a comparative approach to assess differences in the level of use and perceived effectiveness of requirements analysis techniques in both business intelligence and transactional contexts. An exploratory qualitative study was conducted with two phases of semi-structured interviews with experienced practitioners. The results show that 28% of the techniques differ in their level of use or perceived effectiveness, thus demonstrating the specificity of decision makers' needs. The results reveal the importance of using techniques appropriate to the context to adequately define requirements and improve project success.

KEYWORDS

Business Intelligence, Dashboards, Development Process, Elicitation, Perceived Effectiveness, Qualitative Study, Requirement Analysis Process, Requirement Analysis Techniques, Requirements, Use

INTRODUCTION

Since 1994, the Standish Group has periodically produced the CHAOS report, which presents the state of performance of information technology (IT) projects. From 2011 to 2015, between 27% and 29% of the projects were successfully completed on time, on budget and with satisfactory results, but on average 71% were either challenged or considered a failure (Hastie & Wojewoda, 2015). The annual CHAOS reports have been the target of criticism for their methodology. However, since their first edition, these reports revealed that a substantial proportion of IT projects have presented significant problems.

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Since the first edition of the CHAOS report, requirements have continued to be a key concern in IT projects (e.g. Bormane, Grzibovska, Berzisa, & Grabis, 2016; Meth, Mueller, & Maedche, 2015; Rosenkranz, Vranesic, & Holten, 2014). While clear requirements are a major success factor, incomplete and changing requirements are identified as a major cause of the problems leading to project failure (e.g. Alflen, Prado, & Grotta, 2020; Babar, Bunker, & Gill, 2018; Batra & Bhatnagar, 2019; Davey & Parker, 2015; Jukic & Velasco, 2010; Pacheco & Garcia, 2012a; Rosenkranz et al., 2014; Sandhu & Weistroffer, 2018; Taghavi & Woo, 2017). Despite this, little effort has been made within organizations to tackle this issue (PMI, 2014).

Most studies on IT requirements from a business perspective were conducted in the context of transactional projects, which are undertaken to automate business processes such as payroll or accounting systems, ERP, CRM or e-commerce web sites. However, new types of systems associated with business intelligence (also called descriptive analytics) have emerged (Foley & Guillemette, 2010; Jukic & Velasco, 2010). Since these systems are designed to support decision-making and managers in their business performance monitoring activities, their requirements are very different from those of transactional systems. Business intelligence requirements are based on decision-making processes rather than on the conventional day-to-day operational processes of the organization (Jukic & Velasco, 2010). They are loosely structured, poorly shared and unsynchronized with the evolving organizational context (Jukic & Velasco, 2010).

Although context is important, when it comes to determining technique effectiveness, a technique that is effective for one project is not necessarily effective for another. (Lane, O'Raghallaigh, & Sammon, 2016). Most of the published studies on requirements do not consider these differences related to the type of systems, i.e. whether it is transactional or business intelligence. However, professional literature is paying more attention to these differences and tends to indicate that business intelligence requirements are often more difficult to satisfy than the requirements of transactional systems (Briggs, 2015; Sherman, 2015; Wells, 2008*;* Whitehorn, 2012). This suggests that different approaches should be adopted by analysts depending on their project's development context (Prakash & Gosain, 2008; Taghavi & Woo, 2017; Wells, 2008*a*). Nevertheless, the literature does not provide any guidance on which techniques to use specifically in the context of business intelligence.

Consequently, the main objective of this paper is to explore whether there are differences in the use and effectiveness of requirements analysis techniques depending on the context of the system, according to the practitioner's perspective. To this end, requirement analysis techniques were evaluated in the business intelligence context and in the transactional context, and then compared to highlight the differences and similarities between them in terms of perceived use and perceived effectiveness. The results of this research will highlight the importance of considering the context (type of system being developed) in selecting the requirements analysis techniques that are best suited to each. Ultimately, it should help increase the success rate of business intelligence projects.

This article is structured as follows. The next section presents the relevant literature, problem statement and research questions. Then, we introduce the conceptual framework and explain how we identified the requirement analysis techniques in the literature. The next section presents the methodology consisting of two phases of qualitative interviews. We then present our results. We conclude with a discussion relating our findings with existing literature, limits, and scientific and managerial contributions of our research.

LITERATURE REVIEW AND CONCEPTUAL BACKGROUND

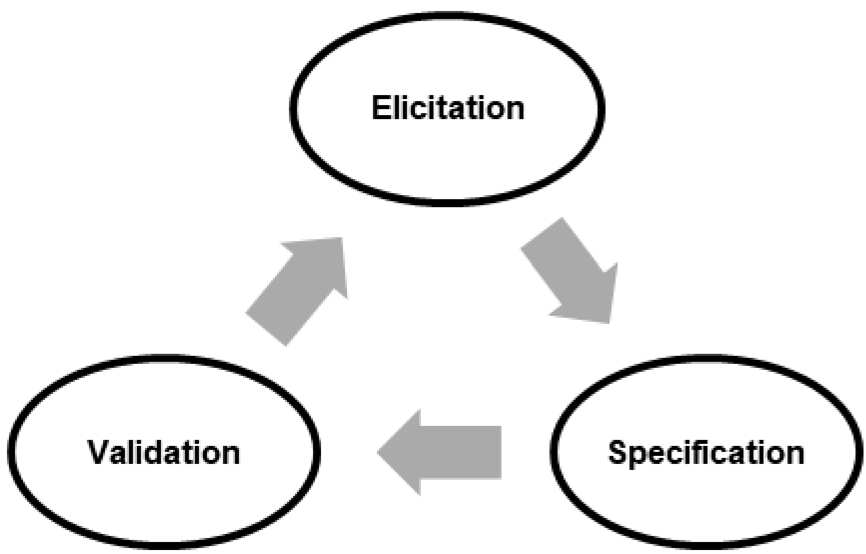
Requirements analysis is the first step in the information systems development cycle (Carrizo, Ortiz, & Aguirre, 2014). It is also an essential step in the information system development process (Alflen et al., 2020; Bourque & Fairley, 2014) a system cannot be developed if we do not know what it should do. *Needs* are perceptions of the system from the client's point of view, whereas *requirements* represent perceptions of the system from the analyst's point of view (Konaté, Sahraoui, & Kolfschoten, 2014).

The challenge lies in translating needs into requirements. A requirement is, therefore, a representation of a need that constrains the observable behavior of a system and that answers a real-world problem (Bourque & Fairley, 2014; IIBA, 2015; Van Lamsweerde, 2009).

The concept of business intelligence has emerged from the evolution of decision support (Negash, 2004). Business intelligence systems, including dashboards, scorecards, reports and OLAP analysis, allow managers to track (ideally in real time) the company's performance and the implementation of its business strategy. In contrast, transactional systems, such as enterprise resource planning (ERP) software, manage the organization's day-to-day operations by automating certain portions of its business processes. Thus, business intelligence systems and transactional systems respond to different business needs. Given these differences, the analyst must take into account the specificities of each environment when analyzing requirements (Jukic & Velasco, 2010; Rahman, Rutz, & Akhter, 2011; Watson & Frolick, 1993).

The process of requirements analysis entails different steps akin to elicitation, specification, and validation (Figure 1) (Pachero, Garcia, & Reyes, 2018; Wells, 2008). In the case of transactional systems, the steps are generally carried out sequentially, although some iterative methods have emerged in recent years (Bormane et al., 2016). While transactional systems occasionally follow this route for requirements analysis, this is almost always the path taken in business intelligence development projects (Jukic & Velasco, 2010; Moss & Atre, 2003; Rahman et al., 2011).

Figure 1. *Steps in the requirements analysis cycle*



Because of the intuitive nature of business decisions, business intelligence requirements are often difficult to analyse (Rahman et al., 2011; Yu, Chen, Klein, & Jiang, 2015). Iterative approaches facilitate the analysis process by allowing future users to become more aware of the various possibilities and system's limitations within each successive iteration (Rahman et al., 2011). It is not uncommon for business managers and analysts, who are the main users of business intelligence systems, to fail at articulating their needs. An iterative approach allows them to define their needs and expectations more clearly with each successive iteration (Rahman et al., 2011). This cycle of steps, especially when supported by prototyping, makes it possible to propose solutions to the users, who can then ask for changes until the proposed system is deemed adequate. This "final" solution incorporates all the requirements of the system to be developed. In other words, the person who does not know how to describe a requirement can recognize it when she sees it (Boehm, 2000). Iterations are essential to this recognition process.

To accomplish these steps in a business intelligence or transactional information system development project, analysts apply several techniques (Browne & Rogich, 2001; Coulin, 2007; Gobov & Huchenko, 2020; Hickey & Davis, 2003; IIBA, 2015; Zowghi & Coulin, 2005). The analyst's objective when selecting requirements analysis techniques is to determine the best possible combinations of techniques, context, and needs properties.

There is extensive literature in computer science on requirements (Jarke, Loucopoulos, Lyytinen, Mylopoulos, & Robinson, 2011). This field has been particularly dynamic since the 2000s, and some reviews describe the current state of knowledge. In this exploratory study, we were interested mainly in the *requirements elicitation techniques* in information systems/information technology. By narrowing our literature search this way, we were able to find two main streams of research relevant to our research questions, as synthesized in Table 1.

The first research group focused on understanding the best techniques for eliciting requirements in information systems. It emerged that structured interviews are more effective than card sorting, ranking, and thinking aloud (Davis, Dieste, Hickey, Juristo, & Moreno, 2006). Literature reviews have shown that interviews produce more and better information (Dieste, López, & Ramos, 2009), and that the laddering technique is more efficient than the card sorting technique (Dieste et al., 2009). However, for each of these conclusions, the authors point out that some studies conclude otherwise (Carrizo, Dieste, & Juristo, 2017). It follows from this research that, depending on the dependent variable (completeness of information, efficiency, effectiveness, duration, etc.), some techniques may prove superior to others (Aguirre-Arredondo & Carrizo-Moreno, 2017; Dalpiaz, Gieske, & Sturm, 2021).

The second research group focused on understanding the determining performance factors of the main requirements elicitation techniques (Carrizo et al., 2017). In the case of the interview technique, the analyst's experience is not a determining factor of performance (Browne & Rogich, 2001; Fuller, Tremblay, & Berndt, 2006) a well-prepared novice analyst performs just as well as an experienced analyst. Identification of the "correct" participants is even more important than the choice of the technique itself (Pacheco & Garcia, 2012a). The development approach, whether cascaded or agile, has no impact on the choice of the requirements elicitation techniques used, with the interview being by far the most popular technique (Bormane et al., 2016). Collaboration and knowledge sharing were also found to be significant factors (Alflen et al., 2020; Chakraborty, Sarker, & Sarker, 2010; Coulin, Zowghi, & Sahraoui, 2006; Hadar, Soffer, & Kenzi, 2014; Hsu, Lin, & Cheng, 2012; Konaté et al., 2014; Rosenkranz et al., 2014). All of these studies have led researchers to propose decision frameworks for choosing a requirements elicitation technique, taking into account the sector, objectives, the size of the project, and various organizational characteristics (Batra & Bhatnagar, 2019; Carrizo, Ortiz, et al., 2014). Others have proposed research programs based on fundamental principles (Jarke et al., 2011) or on more complex types of systems (e.g. artificial intelligence systems) (Cheng & Atlee, 2007; Nalchigar & Yu, 2020).

Problem Statement and Research Questions

Some considerations are relevant to the problem addressed by our exploratory study. First, we noted that most studies used an experimental method or illustrative scenarios (Dermeval et al., 2016; Dieste & Juristo, 2011) to assess technique performance. On one hand, the experimental contexts were often heterogeneous to the system development context (choosing between restaurants, types of cars, or olive oils; deciding what to do in a fire incident; identifying native rocks, etc.).[1] However, we believe that this context greatly influences the conclusions that can be drawn from the literature, and such an approach does not take into account the complexity of requirements analysis in the real IS/IT world.

Table 1. *Synthesis of the literature on requirements gathering techniques*

Aims	Examples of papers	Findings	Gap
Group 1: Which elicitation techniques are most effective?	(Carrizo, Dieste, & Juristo, 2014; Davis et al., 2006; Dieste & Juristo, 2011; Dieste, Juristo, & Shull, 2008; Dieste et al., 2009; Gobov & Huchenko, 2020; Hoffman, Shadbolt, Burton, & Klein, 1995; Kumar & Panneerselvam, 2019; Meth et al., 2015; Rosenkranz et al., 2014; Tsumaki & Tamai, 2006; Zowghi & Coulin, 2005)	Structured interview is used the most often. Structured interview is a successful technique for gathering requirements.	Findings are inconsistent between studies. Various dependent variables are used to assess superiority of techniques.
Group 2: What are the main factors of influence of the performance of the elicitation process?	(Batra & Bhatnagar, 2019; Bormane et al., 2016; Browne & Rogich, 2001; Carrizo, Ortiz, et al., 2014; Hickey & Davis, 2004; Pacheco & Garcia, 2012b; Serna & Serna, 2018; Tsumaki & Tamai, 2006)	The choice of the technique to use should follow a decision framework based on various factors.	Findings are inconsistent between studies. Several influencing factors of the choice of techniques to be used by the analyst have been identified. Findings mainly take the form of theoretical decision-making models. We still do not know which techniques are really used by analysts in practice. Mostly theoretical or opinion studies.

These considerations are of particular importance in the context of business intelligence, where requirements are vague, incomplete or very difficult to discover (Briggs, 2015; Sherman, 2015; Wells, 2008*a;* Whitehorn, 2012). On the other hand, the participants in these studies were, in most cases, students in computer science. This profile generally represents subjects with limited experience in a simplified artificial context and does not adequately depict the reality of business.

Second, among the few studies conducted in the context of system development, very few deal with transactional systems (e.g. a web-based purchasing system, reservation system, or student enrolment management system) or advanced systems (e.g. an expert system in archaeology) (Dieste & Juristo, 2011). We found no studies devoted to requirements analysis in the context of business intelligence.

Four considerations led us to want to identify the similarities and differences between the definitions of requirements in transactional information systems and business intelligence contexts: (1) the scale of the above-mentioned developments over the past decade (e.g. Rowsell-Jones, Lowendahl, Howard, & Nielsen, 2016) (2) the majority of systems developed within firms are either in a business intelligence or a transactional context (Duerst & Smith, 2018; Florentine, 2018; Foley & Guillemette, 2010) (3) requirements analysis is often performed by the same analyst, independent of the context (Lane et al., 2016) and (4) the choice of technique is often a matter of the analyst's preference (Lane et al., 2016; Serna & Serna, 2018).[2]

Therefore, this exploratory study aims to answer the following three specific questions:

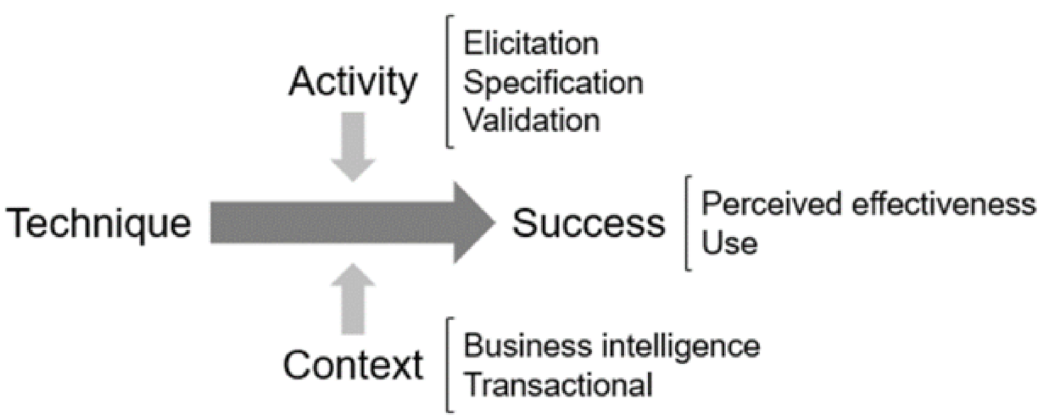
(1) Are there differences between requirements analysis techniques in business intelligence and transactional contexts from the analysts' perspective?
(2) Which techniques are used most often to analyze requirements in business intelligence and in transactional contexts?

(3) Which techniques are perceived as the most effectives for requirements analysis in business intelligence and in transactional contexts?

Conceptual Framework

Four constructs form the basis of our conceptual framework (Figure 2). We are interested in assessing the success of the techniques in two main contexts (transactional systems and business intelligence systems) and across the three steps of the requirements analysis cycle (Figure 1). Success is conceptualized with two constructs: use and perceived effectiveness. Use, defined as perceived frequency of use, is interesting because we wanted to assess which techniques are really used in the requirements gathering process, in both contexts. Indeed, the literature describes numerous techniques that can be used for requirements analysis, but it is not clear which are used more often by analysts in each information systems context. In this sense, use is a measure of the success of each technique. Perceived effectiveness was included in our framework because it's a construct largely studied in group 1 (Carrizo, Dieste, et al., 2014) (see Table 1) of the literature. Using it should help build knowledge on similar constructs. Perceived effectiveness is defined as the perception that the technique helps to produce complete, clear, and usable requirements (Tuunanen, Rossi, Saarinen, & Mathiassen, 2007) in a business intelligence system context and a transactional system context. Finally, techniques themselves were at the heart of our exploratory study, as we will explain below.

Figure 2. *Conceptual framework*



Creating a List of Techniques

We analyzed the professional and scientific literature in order to create a list of requirements analysis techniques, regardless of the systems, i.e. transactional or business intelligence context.

The professional literature includes the Guide to the Business Analysis Body of Knowledge (BABOK) (International Institute of Business Analysis, 2009, v2). This guide is considered the standard of practice for business analysts.

Our study was conducted with BABOK 2 (2009) rather than BABOK 3 (2015). This choice seems appropriate for at least three main reasons. 1) The BABOK 3 does not make any distinctions between the different types of analytics (descriptive, predictive and prescriptive analytics) in their recommendations. However, this research focuses on requirements analysis for descriptive analytics (business intelligence) only. There is no way to easily distinguish the recommendations included in BABOK 3 according to these different types of analytics. 2) Business intelligence requirements analysis is often done by business analysts who work in both transactional and business intelligence contexts. Predictive and prescriptive analytic requirements analysis is often done by specialists in statistical analytic (ex: statisticians, miners or data scientists). Our participants (see later in this paper) are analysts who operate in both contexts, but they do not evolve into the predictive or prescriptive analytic domain. 3) Predictive and prescriptive analytic are fundamentally different from traditional business intelligence and their requirement analysis process follows a very specific and different approach (ex: CRISP_DM). Therefore, they fall out of the scope of this paper.

The 26 BABOK 2 techniques associated with the elicitation, specification, and validation steps of requirement analysis were selected (sections 3.2, 5.1, 6.3 and 6.6 of the BABOK 2 were associated with one of the three activities of the analysis process). The guide does not describe a specific context of application for the techniques; they can be used in various contexts, for both business intelligence and transactional systems. To obtain techniques specific to the context of business intelligence, we turned to The Data Warehousing Institute—the professional organization usually recognized as the reference in this field. Ten techniques were identified from Wells (2008).

We then examined the techniques studied in the scientific literature. The works of Coulin (2007) and Tuunanen et al. (2007) attracted our attention due to their exhaustiveness. Coulin (2007) classifies 40 techniques into 9 categories: traditional, cognitive, group, contextual, modeling, combined, collaborative, social, and methodological. Tuunanen et al. (2007) identifies 85 techniques, some of which involved methods or approaches comprising more than one technique. In line with our research objective, we kept only techniques involved in the elicitation, specification, and validation steps. This process resulted in a set of 12 techniques from scientific literature.

We eliminated redundancies and constructed a final list of 31 recommended techniques for requirements analysis in the context of business intelligence systems and in the context of transactional systems. This list is presented in Table 2. Because these authors/sources were not explicit about the type of system (transactional or business intelligence) each of their techniques was related to (except for TDWI), we restrained ourselves from makig this association and decided to let our results speak by themselves.

METHODOLOGY

An exploratory qualitative study was conducted with two phases of semi-structured interviews (Figure 3). We chose this approach for various reasons related to validity. First, we wanted to make sure that our participants had the same understanding of what a transactional project is about and what a business intelligence project is about, because business intelligence is still a rather recent type of information system and there is still confusion surrounding it (Foley & Guillemette, 2010). For our results to be valid, we had to control this aspect. Second, we wanted to make sure that participants were able to explain their use of each technique, in context, to make sure to associate each "use" with the appropriate type of system. Third, we wanted to make sure that participants were able to clearly articulate their thoughts about the effectiveness of each technique. For example, we wanted to make sure that their judgment was based on their own use of the technique and not on general beliefs surrounding techniques.

Data collection involved 14 participants, all of whom had been involved in requirements analysis for transactional and business intelligence systems projects. Their experience in both types of projects was essential to identify the techniques used in each of these two contexts. The group of participants was composed of five consultants, five IT professionals (IT side), and four IT professionals (business side). The participants were part of the business network of the researchers, but we never worked directly with them on projects. We knew they were well articulated, which helped us to obtain rich data. All participants either work for, or are involved in, large organizations (domestic and international) and medium to large size projects. Their profiles are presented in Table 3.

Table 2. *Techniques used in the conceptual framework*

	BABOK®				Tuunanen et al. (2007)				
Techniques	Define Business Need	Conduct Elicitation	Specify and Model	Validate	Discovery	Specification	Experimentation	Coulin (2007)	TDWI
1. Acceptance and Evaluation Criteria Definition			x	x					
2. Benchmarking	x								
3. Brainstorming	x	x			x			x	x
4. Business Rules Analysis	x		x						
5. Data Dictionary and Glossary			x						
6. Data flow diagram			x			x			
7. Data Models			x			x			
8. Document Analysis		x							
9. Focus groups	x	x			x			x	
10. Functional Decomposition	x		x						
11. Goal modeling					x	x		x	
12. Interface Analysis		x	x						x
13. Interviews		x						x	x
14. Joint Application Design (JAD)					x		x	x	
15. Laddering					x			x	
16. Metrics and Key Performance Indicators			x	x					
17. Non-functional Requirements Analysis			x						
18. Observation		x						x	x
19. Organization Modeling			x						
20. Process mapping			x						
21. Protocol analysis					x			x	
22. Prototyping		x	x	x			x	x	x
23. Repertory Grids					x			x	
24. Requirements workshops		x	x		x			x	x
25. Root Cause Analysis	x								
26. Scenarios and used cases			x		x	x		x	x
27. Sequence Diagrams			x						
28. State charts			x			x			
29. Structured walkthroughs				x	x				
30. Surveys / Questionnaire		x			x			x	x
31. SWOT analysis			X						

Figure 3. *Two-phase research process*

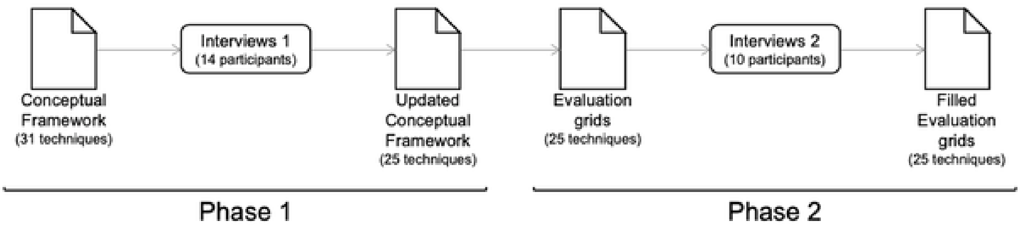


Table 3. *Participants demographics*

	#	Work experience (years)	IT experience (years)	BI experience (years)	Nb of projects	Current occupation	Occupational experience (years)
Consultants	1	39	36	20	60	Manager	3
	2	30	30	15	20	Architect	1
	3	28	28	16	20	Manager	1
	4	23	18	3	35	Analyst	11
	5	18	18	15	25	Manager	2
IT professionals (IT unit)	6	35	11	16	80	Manager	3
	7	30	27	9	12	Manager	1
	8	26	26	10	0	Architect	10
	9	25	25	15	20	Architect	4
	10	12	12	12	15	Manager	1
IT professionals (business unit)	11	23	12	0	5	Analyst	12
	12	18	8	6	10	Analyst	1
	13	17	2	0	3	Manager	2
	14	12	12	5	5-10	Manager	2

Phase 1

The first phase consisted of conducting interviews with the 14 participants, using an interview guide (see Appendix 1) to learn about which techniques the participant used and how he/she perceived their effectiveness, both in the transactional and business intelligence systems contexts. The first part of the interviews was based on open questions. Participants were encouraged to speak freely about their experience in requirements analysis in general and in the context of business intelligence systems in particular. The objective was to capture techniques not referenced in the surveyed literature. In the second part of the 31 interviews techniques (Table 2) were presented one by one to the participants and their relevance and use in business intelligence and transactional context were discussed. This second part of the interview aimed to ensure that none of the techniques was forgotten. To facilitate analysis, the interviews were recorded and transcribed (producing 168 pages of verbatim transcripts).

The researcher's notes were also analyzed. The techniques most used by the participants were identified and associated with the appropriate technique (pattern-matching, see Appendix 2) using a simple coding scheme composed of the name and description of each technique (230 citations in total).

Phase 2

Based on the results obtained in Phase 1, an evaluation grid of requirements analysis techniques was prepared, including 4 columns: 1) name of the technique; 2) description of the technique; 3) use of the technique by the participant; 4) perceived effectiveness of the technique. We asked 10 of the 14 participants to read the grid before the second meeting[3]. The purpose of this meeting was to ensure that participants, in each system context, understood the intricacies of and differences between the techniques, knew how to measure use and perceived effectiveness, and could explain the reasoning behind the evaluation of each technique. All 10 evaluation grids (see Appendix 3) were consolidated and averages calculated to produce results on the use and perceived effectiveness of each technique. Use was measured on a scale of 1 to 5, from "never used" to "almost always used." Perceived efficiency — defined as "the ability of the technique to produce complete, clear and usable requirements" (Tuunanen et al., 2007) — was measured on a scale of 1 to 10, from "ineffective" to "very effective." For each technique, measurements were made in each of the studied contexts (transactional and business intelligence).

RESULTS

The first phase of interviews was aimed at selecting, among the 31 techniques of the conceptual framework, those used by practitioners. Over 230 citations were matched to the definitions of each technique in the conceptual framework. Subsequently, the number of times that a technique was clearly cited as having been used was calculated. Only 23 of the 31 techniques from the conceptual

Table 4. *Techniques resulting from the first phase of interviews, by category*

Group	Modeling
1. Brainstorming	15. Business rules analysis
2. Creativity sessions	16. Data dictionary and glossary
3. Focus groups	17. Data flow diagram
4. Joint application design	18. Data models
5. Requirements workshops	19. Multidimensional modeling
6. Structured walkthroughs	20. Functional decomposition
Traditional	21. Goal modeling
7. Documents analysis	22. Metrics and key performance indicators
8. Interviews	23. Organizational modeling
9. Surveys and questionnaires	24. Process mapping
10. Benchmarking	25. Scenarios and use cases
Contextual	
11. Ethnography/observation	
12. Protocol analysis	
13. Prototyping	
14. Repertory grids	

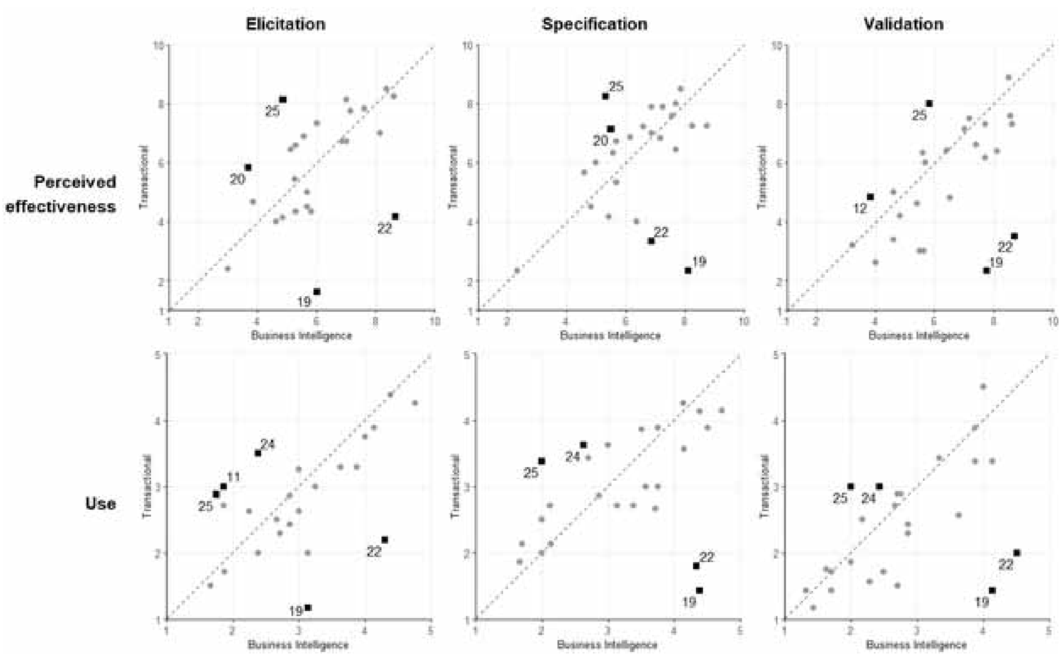
framework were mentioned by participants. Two other techniques (ethnography and multidimensional modeling) were added as a result of the interviews, for a total of 25 techniques.

The 25 selected techniques were grouped into four categories: group, contextual, modeling, and traditional to facilitate the presentation and interpretation of the results (Batra & Bhatnagar, 2019; Coulin, 2007). *Group techniques* aimed at fostering agreement between stakeholders through team dynamics. *Traditional techniques* include generic techniques of information gathering, such as interviews and questionnaires. *Contextual techniques* focus on gathering requirements directly from the context in which the target system will exist. Finally, *modeling techniques* provide a specific model of the type of information to be gathered. The techniques are presented in Table 4.

In the second phase of interviews, 25 techniques were presented to participants in the form of an evaluation grid. We asked them to measure the use and perceived effectiveness of each technique for each requirements analysis step (elicitation, specification, and validation) in the two contexts under study. Figure 4 presents the results of this interview phase in six graphs.

The graphs compare the average scores obtained by each of the 25 techniques in the business intelligence context (x axis) and in the transactional context (y axis). The first line of three graphs shows the perceived effectiveness of the techniques, and the second line illustrates their level of use. Each column represents one of the three requirement specification stages (elicitation, specification, and validation). For example, the graph at the bottom right shows the average score for the use variable (out of 5) for the validation phase of each of the 25 techniques in the context of business intelligence systems (x axis) and in the context of transactional systems (y axis).

Figure 4. *Perceived effectiveness and use of the techniques by requirements analysis steps and system's contexts*



Each graph shows how the techniques are specific to a system context or are shared between them. Two symbols are used to represent each technique: a black square and a grey circle. The black squares, with the technique's code, represent the two techniques that are the most specific to a system context in each graph. In order to identify them, we calculated the differences between the average scores between both contexts (business intelligence and transactional) for each technique. For instance, technique “25. Scenarios and use cases” for perceived effectiveness in the elicitation step has an average score of 8.14 for the business intelligence context and an average score of 4.86 for the transactional context. The difference is -3.29. The individual average scores and differences between both contexts can be found in Appendix 4. They are all rounded to the nearest hundredth, but differences were computed taking into account all decimal values.

Once all differences were calculated for perceived effectiveness and use for all three requirement analysis steps, the differences were placed in descending order. Techniques with a difference of 0 are represented by a grey circle along each graph’s dotted diagonal. Techniques below the dotted diagonal (positive difference values) are specific to the business intelligence systems context, whereas techniques above the dotted diagonal (negative difference values) are specific to the transactional systems context. For each of the six graphs, the black squares represent techniques with the two highest and two lowest difference scores, with one exception: the graph for use of the elicitation step has three black squares for the transactional systems context because two of them represent techniques (“24. Process mapping” and “25. Scenarios and use cases”) with the same difference values (-1.13).

Table 5 presents the techniques represented by black squares in the graphs of Figure 4. For each technique, the number in parentheses corresponds to the frequency count of graphs in which this technique is represented by a black square and the technique category is specified between brackets. Of the seven techniques, five are associated with the modeling category (techniques 19, 20, 22, 24 and 25) and two with the contextual category (techniques 11 and 12). In sum, the modeling techniques are highly differentiated between the two contexts. Both for perceived effectiveness and use and for all three requirements analysis steps (all six graphs), techniques “19. Multidimensional Modeling” and “22. Metrics and Key Performance Indicators” are specific to the business intelligence systems context, whereas technique “25. Scenarios and use cases” is specific to the transactional systems context. Technique “24. Process mapping” is specific to the transactional systems context for all three requirements analysis steps, but only regarding use.

Table 5. *Techniques specific to each information systems context*

Business intelligence context
19. Multidimensional modeling (6) [Modeling]
22. Metrics and key performance indicators (6) [Modeling]
Transactional systems context
25. Scenarios and use cases (6) [Modeling]
24. Process mapping (3) [Modeling]
20. Functional decomposition (2) [Modeling]
11. Ethnography/observation (1) [Contextual]
12. Protocol analysis (1) [Contextual]

DISCUSSION

The purpose of this exploratory study was to assess the level of use of various requirements analysis techniques, and to examine the perceived effectiveness of each technique in producing complete, clear, and usable requirements in a business intelligence systems context and a transactional systems context.

The first series of interviews was used to identify 25 requirements analysis techniques employed by IT or business intelligence professionals. The second round of interviews measured the level of use and perceived effectiveness in producing complete, clear, and usable requirements. The results show that 28% of the techniques (7 out of 25) differ in terms of level of use or degree of perceived effectiveness in one context compared to the other (Figure 4 and Table 5). This result answers our first research question and indicate that the systems context matters in requirement analysis. Each requirements analysis technique presents specific features that can make it more relevant to certain tasks (IIBA, 2015; Kumar & Panneerselvam, 2019). Indeed, business intelligence systems are designed to support decision-making and monitoring of business performance, whereas transactional systems are intended to manage large volumes of detailed transactions (sales, purchasing, payroll, etc.), integrate work processes, and automate repetitive tasks. Business intelligence must evolve with the organization. The needs for this type of transactional systems are usually much less specific, as decision makers often find it difficult to clarify the nature of the information they will need over the next few years in order to make decisions whose nature is still unknown (Jukic & Velasco, 2010). The expressed needs are therefore, by nature, changing, diffuse, and difficult to explain. Emphasis is placed on performance monitoring, the selection of indicators, and comparisons over time (Eckerson, 2011). These characteristics lend themselves well to the use of techniques such as multidimensional modeling and metrics and key performance indicators. These are among the techniques most used and they are perceived by the participants to be the most effective in a business intelligence systems context.

Conversely, transactional needs are limited in time, structured, and not very complex. Once completed and implemented, a transactional system generally does not undergo any significant changes because the requirements are well known and relatively stable. These characteristics necessitate the use of special techniques such as scenarios and use cases, process mapping, functional decomposition, ethnography/observation and protocol analysis. Our results show that, in a transactional systems context, these techniques are perceived to be the most efficient in producing complete, clear and usable requirements.

Our results also show considerable homogeneity in the other techniques adopted by practitioners in their requirements analysis activities. In keeping with research conducted by other authors in this field, the traditional techniques of interviews, structured walkthroughs, and laddering are equally used, and perceived as equally effective (e.g. Davis et al., 2006; Dieste & Juristo, 2011) in both contexts.

Contributions

The results of this exploratory study will improve knowledge about the business intelligence requirements analysis process and the most appropriate techniques to be used. To date, no studies have evaluated the use and perceived effectiveness of techniques in the context of business intelligence systems. Our approach of comparing the techniques used in the context of business intelligence systems with that of transactional systems has made it possible to gain some perspective on these two spheres of the world of information systems and demonstrate that they differ in their approaches to requirements analysis.

In addition, by classifying techniques according to the nature of the business intelligence systems context and the transactional systems context, we have highlighted the techniques that can be most useful and perceived as effective in each context. Without this comparison and without the experience of practitioners in the two contexts under study, it would have been difficult to justify eliminating those techniques that are not appropriate to the context of business intelligence systems. This approach has also demonstrated that a given technique has different levels of perceived effectiveness, depending on the context.

In short, our work provides a contextual and in-depth view of the requirements analysis process, emphasizing the importance of considering the type of system that is being analyzed when choosing the techniques to be used. In this regard, our research did not propose new techniques, but rather "focus on validation of existing guidelines and techniques in different contexts, and attempt to build and improve on top of existing work" (Ambreen, Ikram, Usman, & Niazi, 2016, p. 20).

Managerial Contributions

From a practical point of view, this exploratory study allows managers to adjust their requirements analysis approach to a business intelligence context. By better understanding the requirements analysis process, activities and techniques to be used in defining business intelligence requirements, analysts and other IT practitioners can focus on learning these techniques and improving their performance and the success of business intelligence projects at the same time.

This exploratory study also allows professionals tasked with requirements specification to select appropriate techniques according to the step to be achieved throughout the required iterations, from interviews with executives to the specification of detailed requirements. Our results suggest that, in line with previous arguments found in the literature (e.g. Hickey & Davis, 2004), this approach might increase the success rate of IT projects in which they are involved.

Finally, our work contextualized important distinctions between business intelligence systems and transactional systems contexts from a highly operational point of view for managers and analysts tasked with requirements analysis. On the one hand, this will enable them to understand in concrete terms how the requirements analysis approach and, potentially, their management approach to this activity should be adapted to each context. On the other hand, it will underscore the fact that they are using a set of techniques, often with little knowledge of them, that nevertheless have the potential to improve their project success rate.

CONCLUSIONS

This study has some limitations. First, we decided to use BABOK 2 to make the initial selection of requirements analysis techniques for the 3 main reasons listed earlier in this paper. While we did not doubt the wisdom of this choice, we wanted to go further and ensure that this choice did not impede the validity of our results. To ensure the sustainability of our work, we analyzed the list of business intelligence techniques from Babok 3 in light of our findings to assess whether new techniques should have been included in our research. In doing so, we retained only those techniques that could be associated with the descriptive analysis, since that was the focus of our study. Based on these criteria, we did not find any additional techniques in BABOK 3 that were not already included in our study (note that some techniques were renamed in BABOK 3, but by analyzing their descriptions we were able to associate them with a corresponding technique included in Table 4).

Second, we chose to focus on effectiveness as perceived by professionals in the field rather than using objective measures of performance. This choice seemed to be the most relevant given that, during requirements analysis activities, it is up to the analyst to choose the technique that he/she wishes to use to carry out the task. Knowing that decisions are most often based on the individual's perceptions of a given situation, it would appear that the analyst's perception of the effectiveness of a technique can play a key role in this selection (Gobov & Huchenko, 2020). The strong relationship that we observed between use and perceived effectiveness seems to support this idea.

Third, we recognized that our sample was quite small compared to other more controlled studies. However, our exploratory study is based on comprehensive qualitative data (interviews) from experienced practitioners, which allowed us to gain more confidence in our conclusions because we were able to validate that each participant really understood each technique that was presented to him or her and justified each of their assessments of the technique's perceived effectiveness and use. This chain of evidence and validation all over data collection and analysis made us confident about our results. Nonetheless, further studies might want to pursue the investigation of these questions using alternate methodologies and a greater number of participants from various industries and countries.

Fourth, in this exploratory study we chose to interview experienced analysts rather than novices, because we wanted to discuss the techniques with analysts who had mastered both contexts and had used a wide variety of techniques during their careers. This allowed them to make more informed judgments about the effectiveness of these techniques in each context. Even though this choice seems the most appropriate for our exploratory study, we recognize that it may have influenced the results, particularly regarding the use of techniques. Indeed, analysts predominantly choose techniques that are familiar to them, regardless of the context in which they find themselves (Babar et al., 2018; Batra & Bhatnagar, 2019; Dhaliwal & Benbasat, 1990; Laiq & Dieste, 2020). In an unfamiliar context, faced with a technique that may be more effective but which they do not master, analysts tend to use the techniques they know best, regardless of their comparative effectiveness (Carrizo, Dieste, et al., 2014; Carrizo, Ortiz, et al., 2014; Hickey & Davis, 2003*a;* Hickey & Davis, 2003).

Fifth, our exploratory study has focused on the perceived effectiveness and use of techniques as part of the requirements analysis process. The high level of use of many techniques in each of the steps (elicitation, specification, and validation) in requirements analysis (Figure 4) suggests that analysts use several different techniques in a project to produce a complete set of requirements. This observation is consistent with past research (e.g. Maiden & Rugg, 1996). Further studies should pursue research into the analysis process itself to understand how, when and why these techniques are used.

Our research has shed new light on a subject of interest by questioning the current perception among some practitioners that business intelligence systems and transactional systems requirements can be defined using the same approach and techniques. The results of this exploratory study show otherwise: that different requirements analysis techniques must be adopted in each of these two contexts. By applying a comparative approach to the respective needs of the business intelligence system context and the transactional system context, and evaluating the use and perceived effectiveness of several techniques in each of these contexts, this exploratory study demonstrates the specificity of decision makers' needs and the importance of using techniques appropriate to the business intelligence systems context in order to adequately define their requirements.

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APPENDIX 1

Interview Guide

Introduction

· Short presentation of the research project, and the objectives
· Signature of the consent form

Phase 1: Exploratory discussion

· Questions to assess their understanding of the differences between transactional systems and business intelligence systems. We corrected their perceptions when needed.
· Questions to explore the participant's experiences in requirements analysis activities for transactional and business intelligence systems development projects. We focused on how the activity was conducted, the techniques used and the related perceptions of usefulness, efficacy and other success measures.
· Presentation of the 31 techniques. Discussion of each technique.
  - Did you use the technique? Explain how and in which context.
  - How do you evaluate the relevance, usefulness (or other success measure) of each technique?

Phase 2: Requirements analysis techniques – Evaluation grid

· Presentation of research's objectives
· Clarification of the differences between transactional and business intelligence systems to ensure everyone is on the same page
· Explanation of the requirement analysis process (Elicitation, Analysis, Validation)
· Presentation of the evaluation grid for requirements analysis techniques and evaluation

APPENDIX 2

Table 6. *Coding scheme – Phase 1 interviews*

Technique	Definition	Citation
Benchmarking	Benchmark studies are conducted to compare organizational practices against the best-in-class practices that exist within competitor enterprises in government or industry. The objective of benchmark studies is to determine how companies achieve their superior performance levels and use that information to design projects to improve operations of the enterprise. Benchmarking is usually focused on strategies, operations and processes. **(Babok 2)**	I looked in the market, but there was nothing that matched because it had to fit the business processes in place." [Participant #9] "These people do benchmarking. They observe other companies [...] we go to several places to see their facilities [...]. And we look at how they manage their operations, how they perform their maintenance inspections, and how they do their maintenance tracking using dashboards. We see that they have BW (SAP) and other tools that help them. We're taking the best possible solutions." [Participant #8]
Brainstorming	Brainstorming (Osborn 1979) is a process where participants from different stakeholder groups engage in informal discussion to rapidly generate as many ideas as possible without focusing on any one in particular, where quantity is paramount and not quality. This is typically followed by a consolidation stage where the number of ideas is narrowed down by removing those ideas that the group immediately identifies or recognises as inappropriate or unsuitable, and then the remaining ideas are examined and evaluated, refining and combining them until the group is satisfied with the results. (Coulin 2007)	"We throw out ideas, sometimes a little crazy, sometimes not so much. The person pays attention to a particular point, even if they haven't expressed it in their need. Part of this activity is used to re-trigger the participants and narrow down their needs." [Participant #6] "We did a brainstorm at the beginning, with yellow cards. [...]. It went very well, and from what came out of that, we have all the tools [needs] on hand." [Participant #8]

APPENDIX 3: CONCISE VERSION OF THE EVALUATION GRID

Table 7. *Excerpt of the evaluation grid*

			Transactional context			Business Intelligence context		
	Techniques	Mesures	ELICITATION	ANALYSIS	VALIDATION	ELICITATION	ANALYSIS	VALIDATION
1.	**Technique 1** Description of the technique 1	Use						
		Efficiency						
2.	….	Use						
		Efficiency						
N.	**Technique N** Description of the technique N	Use						
		Efficiency						

Use frequency: scale of 1 to 5, from "never used" to "almost always used."
Perceived efficiency: scale of 1 to 10, from "ineffective" to "very effective."

APPENDIX 4: DETAILED CALCULATIONS

The following table presents the calculations used to create Figure 4 and Table 5. The average results of the evaluation of each technique obtained during the interviews (phase 2) and the difference in values between the two contexts. The gray cells in the last six columns identify the highest and lowest difference values and correspond to the techniques represented by a black square in figure 4.
PE = Perceived effectiveness; U = Use; Elic. = Elicitation; Spec. = Specification; Val. = Validation; Tr = Transactional systems; BI = Business intelligence systems; Δ = Difference

Table 8. *Calculations*

			Perceived effectiveness 3 phases and 2 contexts (average)						Use 3 phases and 2 contexts (average)						Δ perceived effectiveness 3 phases			Δ for use 3 phases		
Code	Technique	Category	PE_Elic._Tr	PE_ Elic._BI	PE_Spec. Tr	PE_ Spec. BI	PE_Val._Tr	PE_Val._BI	U_ Elic._Tr	U_ Elic._BI	U_ Spec._Tr	U_ Spec._BI	U_Val._Tr	U_Val._BI	Δ_ PE_Eli.	Δ_PE_Spec.	Δ_PE_Val.	Δ_U_ Elic.	Δ_U_ Spec.	Δ_U_Val.
1	Brainstorming	Group	7.83	7.63	5.33	5.67	3.20	3.20	3.75	4.00	2.14	2.14	1.86	2.00	-0.21	0.33	0.00	0.25	0.00	0.14
2	Creativity sessions		5.43	5.25	4.50	4.83	2.60	4.00	2.00	2.13	2.00	2.00	1.43	1.71	-0.18	0.33	1.40	0.38	0.00	0.29
3	Focus groups		6.43	5.13	5.67	4.60	3.00	5.50	2.00	2.13	2.14	1.71	1.71	1.71	-1.30	-1.07	2.50	0.38	-0.43	0.00
4	Joint application design		6.71	7.00	6.33	5.57	4.80	6.50	2.63	3.00	2.71	3.14	1.57	2.29	0.29	-0.76	1.70	0.38	0.43	0.71
5	Requirements workshops		8.50	8.38	6.71	5.67	6.60	7.40	4.38	4.38	3.86	3.50	2.71	2.67	-0.13	-1.05	0.80	0.00	-0.36	-0.05
6	Structured walkthroughs		2.40	3.00	7.20	6.60	8.88	8.50	1.50	1.67	3.43	2.71	4.50	4.00	0.60	-0.60	-0.38	0.17	-0.71	-0.50
7	Documents analysis	Traditional	8.14	7.00	8.50	7.86	5.00	4.60	3.88	4.13	3.88	4.50	2.50	2.17	-1.14	-0.64	-0.40	0.25	0.63	-0.33
8	Interviews		8.25	8.63	7.57	7.57	6.40	6.40	4.25	4.75	3.57	4.14	2.29	2.86	0.38	0.00	0.00	0.50	0.57	0.57
9	Surveys and questionnaires		4.00	4.63	2.33	2.33	3.40	4.60	2.00	3.13	1.86	1.67	1.43	1.33	0.63	0.00	1.20	1.13	-0.19	-0.10
10	Benchmarking		6.71	6.88	6.83	7.17	4.60	5.40	3.29	3.63	2.67	3.71	1.50	2.71	0.16	0.33	0.80	0.34	1.05	1.21
11	Ethnography/ observation	Contextual	7.33	6.00	6.86	6.14	4.20	4.83	3.00	1.86	2.71	2.13	1.17	1.43	-1.33	-0.71	0.63	-1.14	-0.59	0.26
12	Protocol analysis		6.88	5.57	6.00	5.00	4.83	3.83	2.38	2.25	2.25	2.00	1.75	1.63	-1.30	-1.00	-1.00	-0.38	-0.50	-0.13
13	Prototyping		4.33	5.29	4.17	5.43	7.29	8.63	2.29	2.71	2.86	2.86	3.88	3.88	0.95	1.26	1.34	0.43	0.00	0.00
14	Repertory grids		4.67	3.86	7.00	6.86	7.50	7.17	1.71	1.88	2.57	3.14	2.43	2.86	-0.81	-0.14	-0.33	0.16	0.57	0.43

continued on following page

Table 8. Continued

			Perceived effectiveness 3 phases and 2 contexts (average)						Use 3 phases and 2 contexts (average)						Δ perceived effectiveness 3 phases			Δ for use 3 phases		
15	Business rules analysis	Modeling	6.57	5.29	7.88	7.25	6.33	5.60	3.25	3.00	4.25	4.13	3.43	3.33	-1.29	-0.63	-0.73	-0.25	-0.13	-0.10
16	Data dictionary and glossary		4.33	5.83	7.25	8.75	6.38	8.13	2.86	2.86	4.13	4.38	3.38	4.13	1.50	1.50	1.75	0.00	0.25	0.75
17	Data flow diagram		5.00	5.67	8.00	7.71	7.29	7.71	2.43	2.86	3.88	3.75	2.88	2.75	0.67	-0.29	0.43	0.43	-0.13	-0.13
18	Data models		4.14	4.86	7.25	8.25	7.57	8.57	2.50	2.67	4.14	4.71	3.38	3.88	0.71	1.00	1.00	0.17	0.57	0.50
19	Multidimensional modeling		1.60	6.00	2.33	8.13	2.33	7.75	1.17	3.14	1.43	4.75	1.43	4.13	4.40	5.79	5.42	1.98	2.95	2.70
20	Functional decomposition		5.83	3.67	7.13	5.50	6.00	5.67	2.71	1.86	3.38	2.75	2.88	2.71	-2.17	-1.63	-0.33	-0.86	-0.63	-0.16
21	Goal modeling		7.00	8.14	6.43	7.71	6.17	7.71	3.29	3.88	3.00	3.75	2.57	3.63	1.14	1.29	1.55	0.59	0.75	1.05
22	Metrics and KPI		4.17	8.67	3.33	6.86	3.50	8.71	2.20	4.29	1.80	4.33	2.00	4.50	4.50	3.52	5.21	2.09	2.53	2.50
23	Organizational modeling		4.50	5.67	4.00	6.38	3.00	5.63	3.00	3.25	2.71	3.38	1.71	2.50	1.17	2.38	2.63	0.25	0.66	0.79
24	Process mapping		7.75	7.14	7.88	6.88	7.14	7.00	3.50	2.38	3.63	2.63	3.00	2.43	-0.61	-1.00	-0.14	-1.13	-1.00	-0.57
25	Scenarios and use cases		8.14	4.86	8.25	5.33	8.00	5.83	2.88	1.75	3.38	2.00	3.00	2.00	-3.29	-2.92	-2.17	-1.13	-1.38	-1.00

ENDNOTES

1 See Dieste and Juristo (2011) for a detailed synthesis.

2 We acknowledge that some methods advocate the use of conventional techniques, such as interviewing and brainstorming, but often these recommendations do not take into account the type of system to be developed. However, we want to better understand whether context plays a role in the use and perceived effectiveness of the techniques.

3 10 participants were involved in the second phase because two were not available to participate in the second interview and two did not have an adequate understanding of the differences between transactional systems and business intelligence systems.

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