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DEPENDENCIES BETWEEN REQUIREMENTS ELICITATION TECHNIQUES: A SURVEY STUDY IN UKRAINIAN COMPANIES

The **subject** of research in the article is requirements elicitation practices in IT projects. The **goal** of the work is to define how project context influences requirement elicitation technique selection and identify dependencies between requirement elicitation techniques. The following **tasks** are solved in the article: examine the industrial standards and experience of business analysts and requirements engineers in requirements acquisition activities, create and conduct a survey on practices in requirement elicitation activities in IT projects, define practitioners' preferences regarding elicitation techniques, and define how project context influences requirement elicitation technique selection, identify dependencies between requirement elicitation techniques. The following **methods** are used: a survey $(N = 324)$ was performed among business analysts and requirement engineers in Ukraine regarding their use of requirement elicitation techniques and the context of using them. The Chi-Square test of independence and Cramer's V effect size measure were applied to define statistically significant dependencies between project context and elicitation techniques, as well as dependencies between techniques. The following **results** were obtained: Top elicitation techniques were identified and compared with other comprehensive studies. Twenty statistically significant associations for pairs "project context – elicitation technique" and "elicitation technique – elicitation technique" were found (based on the p-value and Cramer's V effect size measure). **Conclusion**: It is concluded that project context influences particular elicitation technique selection in IT projects. There are also dependencies between requirements elicitation techniques. These dependencies can guide the selection of an initial set of techniques or adjust a set of used elicitation techniques during business analysis planning and monitoring activities.

Keywords: requirements elicitation techniques; IT project; requirements engineering; Chi-Square test; Cramer's V.

Introduction

Business analysis is the practice of providing opportunities for change in the context of an enterprise's work by identifying needs and recommending solutions that bring value to stakeholders [1]. This discipline broadens the requirements engineering scope and application areas [2]. Depending on the project methodology and solution type, there are varying opinions on the set of business analysis tasks. Overall, all business analysis tasks can be grouped into six knowledge areas: Business Analysis Planning, Elicitation, Requirements Life Cycle Management, Strategy Analysis, Requirements Analysis and Design Definition, and Solution Evaluation [3]. Whereas the business analysis laid the groundwork for all future development and testing activities, the elicitation provides the baseline for subsequent requirements analysis, specification and modeling, verification and validation, prioritization, maintenance, monitoring [4], etc. Therefore, failure in the requirements acquisition leads to significant issues with project outcomes. According to [5], 39% of respondents identified errors in the requirements gathering phase as one of the most influential factors that caused software projects' failure. Elicitation is not an isolated act. Information is collected while performing any task involving interaction with stakeholders and while the business analyst analyzes existing data. Elicitation may trigger additional elicitation for details to fill in gaps or increase understanding. Elicitation activities can be divided into three tasks: prepare for elicitation, conduct elicitation, and confirm elicitation results [6]. During the preparation, the scope of the elicitation should be understood, and an appropriate set of elicitation techniques selected. Choosing the proper techniques and ensuring that each technique is carried out correctly is extremely important for the elicitation activity's success. Best practices and recommendations in the field of elicitation techniques are defined by international standards [5], industrial bodies of knowledge [1], [7], [8], and international empirical studies [9], [10].

Many elicitation techniques have proven themselves in practice and are recommended in the abovementioned sources. Each has advantages and limitations and requires stakeholders' involvement or availability of study materials. As a part of the business analysis approach and business analysis activities plan, a business analyst must decide which techniques best suit a particular project. Usually, multiple methods are used for elicitation. A decision about the set of techniques depends on time and cost constraints, the types of business analysis information sources, their accessibility, the company's culture, and the desired outcomes [1]. If elicitation is built based on the collaborative approach to the stakeholders' needs, their availability and location must be considered.

This study was conducted to analyze the current preferences of business analysts and requirement engineers regarding selecting elicitation techniques for software development projects. We also wanted to define the attributes of project contexts that influence the probability of choosing a specific elicitation technique. We studied the experience of practicing specialists from Ukrainian and international companies using a questionnaire, experts' judgment, and simple statistical analysis in conjunction with the Chi-Square test.

The paper is the extension and continuation of a paper [11] originally published in the Proceedings of the Federated Conference on Computer Science and Information Systems 2020. Research findings have been expanded by the result of the "technique-technique" pairs analysis and more detailed statistical analysis. The association nature's interpretation was performed for statistically significant dependencies based on the Standardized Pearson Residual values. The Chi-Square based measure of the effect size – Cramer's V – was used to define the strength of the found associations.

This article is organized as follows. Section II includes a review of related works describing elicitation activities and technique selection. Section III is devoted to the survey results, and section VI includes the result of statistical analysis. Section V concludes the paper with a discussion of the findings of our study and future work.

Related works

Most related works focus on analyzing elicitation activities and elicitation techniques in particular. Dieste and Juristo [12] performed a systematic review on requirements elicitation techniques based on 26 empirical studies published until 2005. They aggregated the results in terms of five guidelines for RE practitioners. Wong et al. [13] performed a systematic review on software requirement elicitation activities based on 35 articles. They defined that most contributions were focused on the "Identify Requirements" activity (91%). Still, other activities are poorly covered: "Acquire knowledge" (17%), "Identify sources" (4%), "Defining technique" (9%), "Document" (9%) and "Refine requirements" (4%). Pacheco and Garcia [14] performed a systematic review of stakeholder identification during requirements elicitation based on 47 primary studies dated 1984 to 2011. They found that identified approaches cannot cover all aspects of stakeholder identification during requirements elicitation. In [15], authors noticed a need to replicate studies in different contexts wherein existing requirement engineers' interventions were evaluated and implemented in practice. It confirms that most case studies involve practitioners as participants; there is a need to work more closely with practitioners. Several studies assess the effectiveness of elicitation techniques in the context of a particular project. Hafsa et al. [16] performed a systematic study on elicitation techniques in a mobile application development project. Based on the analysis of 36 selected articles, 22 requirement gathering methods and eight categories of requirement gathering challenges for mobile applications were identified. In [17] authors defined several factors that can influence elicitation technique selection. This study selected five practitioners as informants from Yemen's companies and government agencies. Dieste and Juristo [18] proposed a framework to help requirements engineers select adequate elicitation techniques. The set of attributes is relevant to the elicitation process's context and influences the selection of one or other techniques that were discovered. Two groups of students were involved in the experiment. Practitioners did not take part in the experiment. The author noticed that their results were not generalizable and should be checked with larger samples. Wong and Mauricio [19] defined a set of factors that influenced each activity of the requirements elicitation process and, consequently, the quality: learning capacity, negotiation capacity, permanent staff, perceived utility, confidence, stress, and semi-autonomous. An empirical study was carried out on 182 respondents from software development companies in Peru. The empirical studies' main restrictions are the limited number of participants and low practitioners' involvement. Last year's dispersed team and outsourcing/outstaffing services model has become a rule rather than an exception. There is a series of studies devoted to the use of machine learning methods to select the optimal set of detection techniques [20], [21], [22]. The main limitation of these studies is a training sample, which may lose its relevance.

The following sources were used for the elicitation technique long list creation: "A Guide to the Business Analysis Body of Knowledge" (BABOK) from the International Institute of Business Analysis (IIBA), "The PMI Guide to Business Analysis" from the Project Management Institute (PMI), a study guide from the

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International Requirement Engineering Board (IREB) "Requirements engineering fundamentals" and book "Business Analysis" from British Computer Society (BCS). The analysis of the contents of these sources gives us a set of 13 requirements elicitation: Benchmarking, Brainstorming, Business rules analysis, Collaborative games, Data mining, Document analysis, Interface analysis, Interview, Observation, Process analysis, Prototyping, Questionnaires or Survey, Workshop.

Based on feedback received from business analyst experts during survey review sessions and survey structure from [10], the following techniques were added:

- Design thinking / Lean startup [23].
- Reuse database and guidelines (as a subset of document analysis).
- Stakeholders list, map, or personas.

Survey study

A. *Research questions*

The primary research objective was to identify factors that influence elicitation techniques in IT projects. The first research question (RQ) makes the research objective explicit.

RQ1: Which elicitation techniques do practitioners use in their IT projects?

The answer of this RQ provides information about what specific elicitation techniques are used by practitioners. It allows to compare technique popularity in comparison with other researches result.

RQ2: Does the context of the IT project influence the choice of requirements elicitation techniques?

This RQ is aimed at defining factors that have to be taken into account during forming the start set of elicitation techniques in IT projects.

RQ3: Are there dependencies between elicitation techniques in IT projects?

The answer of this RQ allows us to form recommendation regarding tailoring a set of elicitation techniques for projects where start set of techniques has been already formed.

Questionnaire Design

The literature review has shown that many kinds of research have been conducted to identify common patterns and problems in IT business analysis and requirements elicitation. However, after studying the existing questionnaires developed for international surveys, we realized the necessity of adjusting them to Ukrainian IT companies' specifics. It was decided to take the questions' basis from the NaPIRE initiative [9], [10] and rework it concerning mentioned above sources such as [1], [6], [7], [8]. Survey items were carefully written using the business analysis vocabulary, mostly from BABOK. The questionnaire's types of questions are open-ended, closed-ended (multiple and single choices), and Likert scale. Details regarding survey structure and target group are provided in [11]. The overall number of survey participants is 328. Four participants were filtered out because they were not involved in elicitation activities and were not in this research's target group. English and Ukrainian languages were used for questionnaires. The questionnaire was created using Google forms and links to it. It was shared in the local Business Analysis communities, professional and social networks, and via personal contacts in TOP 10 Ukrainian IT companies. The answers were collected in one month. After that, data were merged and coded for further analysis. The dataset of the survey results is published in the Mendeley Data repository [24].

B. *Survey Results.*

The most used elicitation techniques are shown in fig. 1. Participants were allowed to select multiple techniques.

Regardless of the context in which the Ukrainian business analyst is working, we may see the following most popular elicitation techniques:

- Interview (87.35%)
- Document analysis (85.49%)
- Interface analysis (71.3%)
- Brainstorming (69.44%)
- Prototyping (66.36%)
- Process analysis/Process modeling (66.36%)

The rare techniques are Collaborative games (1.25%) and Design thinking (13.89%).

In the table 1 we compared our results with the NaPiRE study, namely, their top 5 elicitation techniques versus ours. In general, the list of techniques in [8] was adopted from SWEBoK [25]. The results of NaPiRE surveys indicate that the most frequently used techniques are interviews (167 respondents or 73% of the respondents) and facilitated meetings (153 / 67 %), closely followed by prototyping (132 / 58 %) and scenarios (93 / 41 %). Observations were only quoted 62 times (29%). Additional answers for "others" included "Created

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personas and presented them to our stakeholders", "Questionnaires" / "Surveys", "Analysis of existing system" and "It depends on the client" [12].

Our survey results demonstrate a slight difference from the NaPiRE study regarding the popularity of elicitation techniques. The sample size and uniformity could explain it, i.e., the number of respondents in our study is more significant. It is worth mentioning that the list of proposed elicitation techniques in our study is not limited to SWEBoK only but refers to international standards [6] and industrial bodies of knowledge [1], [7], [8].

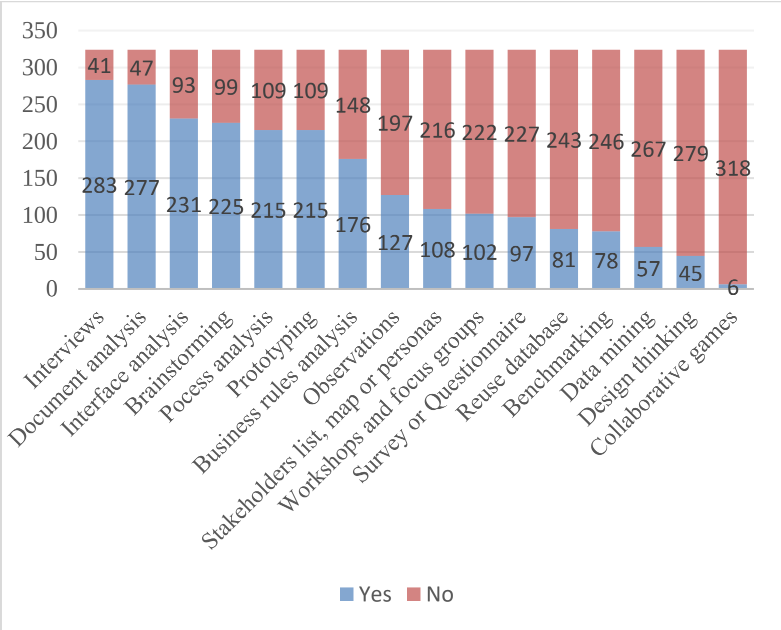

Fig. 1. Elicitation techniques popularity

Table 1. *Survey-based comparison of top elicitation techniques*

Elicitation technique	Gobov, Huchenko (2020)	Popularity	Wagner et al. (2019)
Interview	283 respondents or 87.35%	1	167 respondents or 73%
Document analysis	277 respondents or 85.49%	2	–
Interface analysis	231 respondents or 71.3%	3	–
Brainstorming	225 respondents or 69.44%	4	–
Prototyping	215 respondents or 66.36%	5	132 respondents or 58%
Workshop and focus group	102 respondents or 31.48%	10	153 respondents or 67%
Scenarios	–	–	93 respondents or 41%
Observation	127 respondents or 39.19%	8	62 respondents or 29%

Survey Results. Elicitation Techniques Usage Analysis with Chi-Square and Cramer's V

The questionnaire results analysis checked each "background factor-elicitation technique" and "technique-technique" pair for the association. The Chi-Square test of independence, commonly used for testing relationships between categorical variables, was applied to examine the differences within a single dependent sample (population). A set of hypotheses about the association between techniques was developed. An example of the null and alternative hypothesis is:

H0: There is no association between technique A and elicitation technique B usage.

H1: There is an association between technique A and elicitation technique B usage.

After calculating P-Value, which should be less than 0.05 considering a 0.95 confidence level, the conclusion about statistical significance was made for the technique – technique pairs.

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While the Chi-Square test is advantageous for testing a relationship, it has several weak points. One of the difficulties with the test is that it does not indicate the nature of the relationship. It is impossible to determine how one variable changes as the values of the other variable change. The only way to do this is to carefully assess the table to ascertain the relationship between the two variables. Standardized Pearson Residual (further SPR) was used to identify those specific cells that contributed most significantly to the Chi-square test results. According to [26], a cell-by-cell comparison of observed and estimated expected frequencies is used to assess the evidence's nature. SPR having an absolute value that exceeds +/– 2 when there are few cells or +/– 3 when there are many cells indicates a lack of fit of H0 in that cell:

● If the residual is less than –2 or –3, respectively, the observed frequency is less than the expected frequency.

● If the residual is greater than 2 or 3, respectively, the observed frequency is greater than the expected frequency.

Considering mentioned above, SPRs were used to interpret the identified dependencies for project factor – elicitation technique pairs defined in [11] and elicitation technique – elicitation technique pairs.

The second issue with the Chi-Square independence test is that the chi-square statistics' value may vary based on the number of cells in the table. It may be misleading to compare the chi-square statistics for two tables of entirely different dimensions (i.e., different numbers of rows and columns in the table). Cramer's V – Chi-square based association measure – was used to adjust the Chi-Square test results and consider differences in table size. Different sources give a different interpretations of Cramer's V value [27], [28].

As we used the IBM SPSS tool [28] for analysis, we refer to their stricter definition of effect size, namely:

$V \leq 0.2$ – week association.

$0.2 < V \leq 0.6$ – moderate association.

$V > 0.6$ – strong association.

SPR and Cramer's V were also used to adjust the Chi-Square test results for associations between project factors and techniques usage defined in [11].

The associations' analysis is presented below but only for some techniques where the effect size is at least more than 0.25.

C. Benchmarking

Twelve statistically significant associations have been found for benchmarking. Three of them are "project factor-technique", and nine are "technique-technique".

● "Project Category – Benchmarking": p-value=0.011, Cramer's V = 0.186. Benchmarking is used more frequently in greenfield engineering projects (SPR=2.9) and less frequently in product/platform customization projects (SPR= –2.4). SPRs for user interface engineering and reengineering projects are 0.6 and –1.4, respectively.

● "Experiment – Benchmarking": p-value=0, Cramer's V = 0.209. Benchmarking is more frequently used if experiment elicitation sources are used (SPR=3.8) and less frequently used in the contrary case (SPR = –3.8).

● "Research – Benchmarking": p-value=0, Cramer's V = 0.274. Benchmarking is more frequently used if research elicitation sources are used (SPR=4.9) and less frequently used in the contrary case (SPR= –4.9).

● Benchmarking is more frequently used if the following techniques are used as well: Brainstorming (SPR=2.2), Business rule analysis (SPR=2.3), Interface analysis (SPR=2.4), Observations (SPR=4.1), Process analysis (SPR=3.1), Prototyping (SPR=3.9), Stakeholders list, map, or Personas (SPR=4.7), Survey (SPR=4.7), Workshop (SPR=2.9).

D. Business rules analysis

Thirteen statistically significant associations have been found for Business rule analysis. Four of them are "project factor-technique", and nine are "technique-technique".

● "Company size – Business rule analysis": p-value=0.014, Cramer's V = 0.162. Brainstorming is more frequently used in companies with over 1500 specialists (SPR=2.4) and less frequently used in companies with up to 200 specialists (SPR= –2.8). SPR for a company with 201–1500 specialists is 0.2.

● "Project Category – Business rule analysis": p-value=0.024, Cramer's V = 0.171. Business rule analysis is more frequently used in greenfield engineering projects (SPR=1.7) and less frequently used in product/platform customization projects (SPR= –3). SPRs for user interface engineering and reengineering projects are 0.7 and 0.4, respectively.

● "Experiment – Business rule analysis": p-value=0.001, Cramer's V = 0.177. Business rule analysis is more frequently used if experiment elicitation sources are used (SPR=3.2) and less frequently used in the contrary case (SPR = –3.2).

● "Research – Business rule analysis": p-value=0, Cramer's V = 0.246. Business rule analysis is more frequently used if research elicitation sources are used (SPR=4.4) and less frequently used in the contrary case (SPR= –4.4).

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● Business rule analysis is more frequently used if the following techniques are used as well: Benchmarking and Market analysis (SPR=2.3), Data mining (SPR=2.1), Document analysis (SPR=2.1), Interface analysis (SPR=2.8), Observations (SPR=2.3), Process analysis (SPR=4.5), Prototyping (SPR=2.4), Stakeholders list, map, and Personas (SPR=3.6), Workshop (SPR=5.4).

E. Collaboration games

Two statistically significant associations have been found:

● "Industrial Sector – Collaboration games": p-value=0.001, Cramer's V = 0.404.

● "Design Thinking – Collaboration games": p-value=0.01, Cramer's V = 0.143.

Unfortunately, too many cells (70% and 25%, respectively) have an expected count of less than 5.

F. Design thinking

Ten statistically significant associations have been found for Design thinking. Two of them are "project factor-technique", and eight are "technique-technique".

● "Way of working – Design thinking": p-value=0.001, Cramer's V = 0.201. Design thinking is more frequently used in agile (SPR=3.5) and less frequently used in hybrid projects (SPR= -3.2). SPR for a plan-driven project is 0.2.

● "Experiment – Design thinking": p-value=0.007, Cramer's V = 0.149. Design thinking is more frequently used if experiment elicitation sources are used (SPR=2.7) and less frequently used in the contrary case (SPR = –2.7).

● Design thinking is more frequently used if the following techniques are used as well: Brainstorming (SPR=3.1), Collaboration games (SPR=2.4), Interface analysis (SPR=2.1), Prototyping (SPR=2.8), Reuse database (SPR=2.5), Stakeholders list, map, and Personas (SPR=4.8), Survey (SPR=2.6), Workshop (SPR=3.4).

G. Document analysis

Nine statistically significant associations have been found for Document analysis. Two of them are "project factor-technique", and seven are "technique-technique".

● "Industrial sector – Document analysis": p-value=0.006, Cramer's V = 0.372. Unfortunately, 64% of cells have an expected count of less than 5.

● "Research – Document analysis": p-value=0, Cramer's V = 0.241. Document analysis is more frequently used if experiment elicitation sources are used (SPR=4.3) and less frequently used in the contrary case (SPR = –4.3).

● Document analysis is more frequently used if the following techniques are used as well: Business rules analysis (SPR = 2.1), Interface analysis (SPR = 4.4), Interviews (SPR = 3.3), Process analysis (SPR = 4.1), Prototyping (SPR = 2.1), Reuse database (SPR = 3.2), Workshop (SPR = 2.6).

H. Interview

Eleven statistically significant associations have been found for the Interview. Two of them are "project factor-technique", and nine are "technique-technique".

● "System service class – Interview": p-value=0.015, Cramer's V = 0.18. Unfortunately, 50% of cells have an expected count of less than 5.

● "Experiment – Interview": p-value=0, Cramer's V = 0.182.

● The interview is more frequently used by specialists with experience between 5 and 10 years (SPR=2.1) and less frequently used by specialists with experience up to 3 years (SPR = –2.2).

● Interview is more frequently used if the following techniques are used as well: Brainstorming (SPR=2.7), Document analysis (SPR=3.3), Observations (SPR=2.8), Process analysis (SPR=3.3), Prototyping (SPR=4.7), Reuse database (SPR=2), Stakeholders list, map, and Personas (SPR=2.7), Survey (SPR=2.7), Workshop (SPR=2.1).

I. Process analysis

Sixteen statistically significant associations have been found for Process analysis. Six of them are "project factor-technique", and ten are "technique-technique".

● "Company type – Process analysis": p-value=0.005, Cramer's V = 0.198. Process analysis is more frequently used in Non-IT, In-house development (SPR=3.1) and less frequently in outstaff companies (SPR = –2.3). SPRs for IT Outsource and IT product companies are –0.6 and 0, respectively.

● "Experience – Process analysis": p-value=0.014, Cramer's V = 0.181. Process analysis is less frequently used by specialists with experience up to 3 years (SPR= –3.1). SPRs for 3–5 years, 5–10 years, and over ten years are 1.8, 1.6, and 0.1, respectively.

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● "Project Category – Process analysis": p-value=0.001, Cramer's V = 0.227. Process analysis is more frequently used in greenfield engineering projects (SPR=3.7) and less frequently used in product/platform customization projects (SPR= –2.4) and user interface engineering projects (SPR= –2.3). SPR for reengineering projects is –0.6.

● "Experiment – Process analysis": p-value=0, Cramer's V = 0.202. Process analysis is more frequently used if experiment elicitation sources are used (SPR=3.6) and less frequently used in the contrary case (SPR = –3.6).

● "Research – Process analysis": p-value=0, Cramer's V = 0.256. Process analysis is more frequently used if research elicitation sources are used (SPR=4.6) and less frequently used in the contrary case (SPR= –4.6).

● "Elicitation responsibility – Process analysis": p-value=0.013, Cramer's V = 0.164. Process analysis is more frequently used if the business analyst/requirement engineer has the primary responsibility for the solution requirements (FRs/NFRs) elicitation (SPR=2.6) and less frequently used if nor business analyst/requirement engineer nor Product Owner/Business analyst have the primary responsibility (SPR= –2.3). SPR for the case "Product owner/Business analyst has primary responsibility for the solution requirements (FRs/NFRs) elicitation" = –0.9.

● Process analysis is more frequently used if the following techniques are used as well: Benchmarking and Market analysis (SPR=3.1), Business rules analysis (SPR=4.5), Document analysis (SPR=4.1), Interface analysis (SPR=2.8), Interviews (SPR=3.3), Observations (SPR=3.3), Prototyping (SPR=2.1), Reuse database (SPR=3.1), Stakeholders list, map, and Personas (SPR=2.8), Survey (SPR=3).

J. Prototyping

Sixteen statistically significant associations have been found for Prototyping. Four of them are "project factor-technique", and twelve are "technique-technique".

● "Experience – Prototyping": p-value=0.005, Cramer's V = 0.2. Prototyping is less frequently used by specialists with experience up to 3 years (SPR= –3.6). SPRs for 3–5 years, 5–10 years, and over 10 years are 1.6, 1.3, and 1.3, respectively.

● "Experiment – Prototyping": p-value=0, Cramer's V = 0.294. Prototyping is more frequently used if experiment elicitation sources are used (SPR=2.2) and less frequently used in the contrary case (SPR = –2.2).

● "Research – Prototyping": p-value=0.03, Cramer's V = 0.121. Prototyping is more frequently if research elicitation sources are used (SPR=2.2) and less frequently used in the contrary case (SPR= –2.2).

● "Elicitation responsibility – Prototyping": p-value=0.008, Cramer's V = 0.171. Prototyping is more frequently used if the business analyst/requirement engineer has the primary responsibility for the solution requirements (FRs/NFRs) elicitation (SPR=2.6) and less frequently used if neither the business analyst/requirement engineer nor Product Owner/Business analyst have the primary responsibility (SPR= –2.6). SPR for the case "Product owner/Business analyst has primary responsibility for the solution requirements (FRs/NFRs) elicitation" = –0.6.

● Prototyping is more frequently used if the following techniques are used as well: Benchmarking and Market analysis (SPR=3.9), Brainstorming (SPR=3.5), Business rules analysis (SPR=2.4), Design thinking (SPR=2.8), Document analysis (SPR=2.8), Interface analysis (SPR=3.6), Interviews (SPR=4.7), Observations (SPR=3.1), Process analysis (SPR=2.1), Stakeholders list, map, and Personas (SPR=4.1), Survey (SPR=2), Workshop (SPR=4.1).

K. Stakeholders list, map, and Personas

Sixteen statistically significant associations have been found for the Stakeholders list, map, and personas. Four of them are "project factor-technique", and twelve are "technique-technique".

● "Company size – Stakeholders list, map, and personas": p-value=0.017, Cramer's V = 0.158. Techniques are more frequently used in companies with over 1500 specialists (SPR=2.8) and less frequently in companies with up to 200 specialists (SPR= –2.1). SPR for a company with 201–1500 specialists is –1.2.

● "Team distribution – Stakeholders list, map, and personas": p-value=0.019, Cramer's V = 0.131. Techniques are more frequently used in distributed teams (SPR=2.4) and less frequently used in co-located teams (SPR= –2.4).

● "Experiment – Stakeholders list, map, and personas": p-value=0.005, Cramer's V = 0.157. Techniques are more frequently used if experiment elicitation sources are used (SPR=2.8) and less frequently in the contrary case (SPR = –2.8).

● "Research – Stakeholders list, map, and personas": p-value=0, Cramer's V = 0.212. Stakeholders list, map, and personas are more frequently used

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if research elicitation sources are used (SPR=2.2) and less frequently used in the contrary case (SPR= –2.2).

● Stakeholders list, map, and Personas are more frequently used if the following techniques are used as well: Benchmarking and Market analysis (SPR=4.7), Brainstorming (SPR=2.3), Business rule analysis (SPR=3.6), Data Mining (SPR=3.1), Design Thinking (SPR=3.6), Interviews (SPR=2.7), Observations (SPR=3.1), Process Analysis (SPR=2.8), Prototyping (SPR=4.1), Reuse Database (SPR=3).

L. Survey

Thirteen statistically significant associations have been found for Survey. Four of them are «project factor-technique», and nine are «technique-technique».

● "Project Category – Survey": p-value=0.015, Cramer's V = 0.179. A survey is more frequently used in greenfield engineering projects (SPR=2.6). SPRs for user interface engineering projects, reengineering projects, and product/platform customization projects are –1.5, –0.6, and –1.6, respectively.

● "Experiment – Survey": p-value=0.024, Cramer's V = 0.125. The survey is more frequently used if experiment elicitation sources are used (SPR=2.3) and less frequently in the contrary case (SPR = –2.3).

● "Research – Survey": p-value=0.001, Cramer's V = 0.188. The survey is more frequently used if research elicitation sources are used (SPR=3.4) and less frequently used in the contrary case (SPR= –3.4).

● Survey is more frequently used if the following techniques are used as well: Benchmarking and Market analysis (SPR=4.7), Brainstorming (SPR=2), Design thinking (SPR=2.6), Interviews (SPR=2.7), Observations (SPR=3.2), Process analysis (SPR=3), Prototyping (SPR=2), Stakeholders list, map, and Personas (SPR=3), Workshop (SPR=2.7), Reuse Database (SPR=3).

M. Workshop and Focus group

Fifteen statistically significant associations have been found for the Workshop and Focus group. Five of them are "project factor-technique", and ten are "technique-technique".

● "Company size – Workshop and focus group": p-value=0.005, Cramer's V = 0.181. Workshop and focus group is more frequently used in companies with over 1500 specialists (SPR=3.1) and less frequently used in companies with up to 200 specialists (SPR= –2.7). SPR for a company with 201–1500 specialists is –0.9.

● "Team distribution – Workshop and focus group": p-value=0.019, Cramer's V = 0.156. Workshop and focus group are more frequently used in distributed teams (SPR=2.8) and less frequently in co-located teams (SPR= –2.8).

● "Experience – Workshop and focus group": p-value=0, Cramer's V = 0.265. Workshop and focus group are more frequently used by specialists with experience over 10 years (SPR=2.9) and less frequently used by specialists with experience up to 3 years (SPR= –4.4). SPRs for 3–5 years and 5–10 years are 0.6 and 1.9, respectively.

● "Experiment – Workshop and focus group": p-value=0.004, Cramer's V = 0.158. Workshop and focus group are more frequently used if experiment elicitation sources are used (SPR=2.8) and less frequently used in the contrary case (SPR = –2.8).

● "Research – Workshop and focus group": p-value=0.038, Cramer's V = 0.115. Workshop and Focus groups are more frequently used if research elicitation sources are used (SPR=2.1) and less frequently used in the contrary case (SPR= –2.1).

● Workshop and focus group are more frequently used if the following techniques are used as well: Benchmarking and Market analysis (SPR=2.9), Brainstorming (SPR=3.9), Business rules analysis (SPR=5.4), Design thinking (SPR=3.4), Document analysis (SPR=2.6), Interface analysis (SPR=2.2), Interviews (SPR=2.1), Prototyping (SPR=4.1), Stakeholders list, map, and Personas (SPR=5.6), Survey (SPR=2.7).

Conclusion

A survey study has been undertaken to analyze the current state and requirements elicitation techniques in different software project contexts. The survey structure was built based on the worldwide known industrial standards. Attributes of project context were established to analyze their influence on the requirement elicitation techniques selection. The survey was conducted among practitioners from Ukrainian IT and non-IT companies, 328 specialists (mainly business analysts and product owners) took part in it. The most used elicitation techniques were identified and compared with top techniques from the NaPiRE study [10]. Further analysis was conducted based on the Chi-Square test of independence to examine the "project context-elicitation technique" dependencies and possible "technique-technique" associations. One hundred seventy-nine statistically significant associations were found (based

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on the p-value). This result was adjusted using the SPR value for the dependency interpretation and Cramer's V effect size measure to define the strength of association.

The pairs for which moderate association has been found are shown in fig. 2 in yellow $(0.25 \le V < 0.3)$ and green $(0.3 \le V < 0.6)$ colors. No strong associations have been found.

These dependencies can guide the selection of supportive techniques or adjust a set of core elicitation techniques.

Our study had several limitations. The list of techniques included in the survey is not exhaustive, and elicitation techniques may be applied alternatively or in conjunction with other techniques. Due to specific project context, business analysts are encouraged to modify techniques or create new ones. The survey result gathering was done via a google survey engine and was intended to be anonymous (requiring personal data is problematic on legal and ethical grounds). Therefore, we cannot prove that respondents provided accurate information about the project context and used elicitation techniques. Considering that the survey was limited to one country only, its results cannot be extrapolated to the worldwide software industry (even though the IT industry in Ukraine is integrated into international environments, especially outsourcing and outstaffing companies, whose employees were the majority of respondents (65%). Several directions for future research can be considered. Other business analysis' tasks can be analyzed to define dependencies and recommendations regarding selection techniques for requirement specification and modeling, validation, and verification.

	Industrial Sector	Experience	Experiment	Research	Benchmarking	Business rule analysis	Design Thinking	Interviews	Process Analysis	Prototyping	Stakeholders List, Map, and Personas	Survey	Workshop
Benchmarking			0,209	0,274		0,125			0,172	0,218	0,26	0,262	0,162
Business rule analysis			0,177	0,246	0,125				0,252	0,134	0,202		0,301
Collaborative games	0,404						0,143						
Design Thinking			0,149							0,154	0,265	0,147	0,189
Document Analysis	0,372			0,241		0,115		0,186	0,226	0,115			0,147
Interviews		0,182							0,181	0,259	0,151	0,147	0,118
Process Analysis		0,181	0,202	0,256	0,172	0,252		0,181		0,115	0,157	0,166	
Prototyping		0,2	0,294	0,121	0,218	0,134	0,154	0,259	0,115		0,226	0,109	0,229
Stakeholders List, Map, and Personas			0,157	0,212	0,26	0,202	0,265	0,151	0,157	0,226		0,167	0,31
Survey			0,125	0,188	0,262		0,147	0,147	0,166	0,109	0,167		0,152
Workshop		0,265	0,158	0,115	0,162	0,301	0,189	0,118		0,229	0,31	0,152	

Fig. 2. Strength of association (Cramer's V)

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ЗАЛЕЖНОСТІ МІЖ ТЕХНІКАМИ ВИЯВЛЕННЯ ВИМОГ: ОГЛЯДОВЕ ДОСЛІДЖЕННЯ В УКРАЇНСЬКИХ КОМПАНІЯХ

Предметом дослідження в статті є практики виявлення вимог у ІТ-проєктах. **Мета роботи** – визначити, як контекст проєкту впливає на вибір технік виявлення вимог, а також визначити залежності між техніками виявлення вимог. У роботі вирішуються такі **завдання**: вивчення галузевих стандартів і досвіду бізнес-аналітиків та інженерів з вимог у діяльності щодо визначення вимог у ІТ-проєктах; створення та проведення опитування з практик виявлення вимог у ІТ-проєктах; визначення вподобання фахівців-практиків щодо технік виявлення та з’ясування, як контекст проєкту впливає на вибір технік виявлення вимог; визначення залежності між техніками виявлення вимог. Використовувались такі **методи**: опитування $(N = 324)$ бізнес-аналітиків та інженерів з вимог, що працюють в України, щодо використання ними технік виявлення вимог та контексту їхнього застосування. Для визначення статистично значущих залежностей між контекстом проєкту та техніками виявлення, а також залежностей між техніками виявлення застосовувалися критерій незалежності хі-квадрат та критерій розміру V-ефекту Крамера. Були отримані такі **результати**: визначено найпопулярніші техніки виявлення вимог, проведено порівняння цих результатів з іншими всебічними дослідженнями; виявлено 20 статистично значущих асоціацій для пар "контекст проєкту – техніка виявлення" та "техніка виявлення – техніка виявлення" (на основі p-значення та міри розміру V-ефекту Крамера). **Висновок**: для низки технік виявлення вимог контекст проєкту істотно впливає на їхнє використання для отримання інформації в процесі ІТ-проєктів. Також існують статистично значущі залежності між техніками виявлення вимог. Ці залежності можуть бути застосовані для формування початкового набору техніки виявлення або зміни набору використовуваних технік виявлення під час планування й моніторингу ефективності робіт з бізнес-аналізу.

Ключові слова: техніки виявлення вимог; ІТ-проєкти; інженерія вимог; критерій хі-квадрат; V Крамера.

ЗАВИСИМОСТИ МЕЖДУ ТЕХНИКАМИ ВЫЯВЛЕНИЯ ТРЕБОВАНИЙ: ОБЗОРНОЕ ИССЛЕДОВАНИЕ В УКРАИНСКИХ КОМПАНИЯХ

Предметом исследования в статье являются практики выявления требований в ІТ-проектах. **Цель работы** – определить, как контекст проекта влияет на выбор техник выявления требований, и обнаружить зависимости между техниками выявления требований. В работе решаются следующие **задачи**: изучить отраслевые стандарты и опыт бизнес-аналитиков и инженеров по требованиям в деятельности по сбору требований в ІТ-проектах; создать и провести опрос по практикам выявления требований в ІТ-проектах; определить предпочтения практикующих специалистов в отношении техник выявления и определить, как контекст проекта влияет на выбор техники выявления требований; определить зависимости между техниками выявления требований. Используются следующие **методы**: опрос $(N = 324)$ бизнес-аналитиков и инженеров по требованиям в Украине относительно использования ими техник выявления требований и контекста их использования. Для определения статистически значимых зависимостей между контекстом проекта и техниками выявления, а также зависимостей между техниками применялись критерий независимости хі-квадрат и критерий размера V-эффекта Крамера. Были получены следующие **результаты**: определены наиболее популярные техники выявления требований, проведено сравнение с другими всесторонними исследованиями; обнаружено 20 статистически значимых ассоциаций для пар "контекст проекта – техника выявления" и "техника выявления – техника выявления" (на основе p-значения и меры размера V-эффекта Крамера). **Вывод**: для ряда техник выявления требований контекст проекта существенно влияет на их использование для извлечения информации в ходе ІТ-проектов. Также существуют статистически значимые зависимости между техниками выявления требований. Эти зависимости могут быть использованы для формирования начального набора техник выявления или изменения набора используемых техник выявления в ходе планирования и мониторинга эффективности работ по бизнес-анализу.

Ключевые слова: техники выявления требований; ІТ-проекты; инженерия требований; критерий хі-квадрат; V Крамера.

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