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An Industrial Survey on Business Analysis Problems and Solutions

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Abstract. The paper focuses on the problems reported by business analysts which have a negative impact on their work and on the applicability of available business analysis (BA) techniques as solutions to such problems. A unified set of BA techniques was developed on the basis of 3 industrial standards associated with IIBA, REQB and IREB certification schemes. A group of 8 business analysts was surveyed to list problems they encounter in their work activities and assess their frequency. A subset of most frequent problems was further analyzed and solutions were proposed by selecting the most suitable BA techniques. Solution proposals were validated through follow-up discussions with business analysts. The results indicate that the unified set of techniques addresses the problems reported by practitioners and solution proposals are generally accepted as valid, although several techniques can be used interchangeably.

Keywords: requirements engineering, business analysis, certification schemes, industrial standards, survey

1 Introduction

Since the software crisis in 1960s, requirements engineering (RE) is recognized as one of the crucial aspects of software projects. Also currently, requirements engineering and business analysis (BA - understood as a broader term, which encompasses more activities) strongly influence project's results. The post-mortem reviews of software project failures and the reasons behind them reveal that RE/BA issues are among top factors contributing to project success or failure [1-2].

The importance of this subject is widely recognized, which can be confirmed by issued standards, published books, presence among topics of software engineering conferences and a growing number of certification schemes (and certificates issued) for RE/BA practitioners.

As the research reported in this paper concern Polish software industry, we would like to focus more on the local context. The recognition of RE/BA is also visible in Poland and a trend of growing interest can be noticed. Dedicated job positions of "business analyst", "system analyst" or similar are becoming more common. The

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available certification paths associated with International Institute of Business Analysis, International Requirements Engineering Board and Requirements Engineering Qualifications Board are becoming more popular (partially thanks to Polish versions of training materials). A significant number of training courses is offered - some dedicated to particular certification exams, while others more general, based on several sources. Another sign of interest are the recently published books entirely dedicated to requirements, either being (promptly) translated from international publications [3] or written by Polish authors [4].

As a result, many sources of knowledge about RE/BA became available and numerous BA techniques dedicated to requirements elicitation, analysis, specification and validation are described in the literature. On the other hand, RE/BA is still perceived as a difficult and error-prone part of the software project and the problems related to e.g. cooperation with stakeholders, obtaining the necessary information or scope creep are quite common. Therefore, the question we would like to ask is how well do available BA techniques address the problems encountered by the business analysts in their everyday work. For this purpose we planned and conducted a research study involving practitioners from Polish IT industry.

2 Related Work

Our research included: identifying frequent problems encountered in BA activities, analyzing state of the art BA techniques and selecting the techniques which provide solutions to particular problems. Two main areas of related work are: surveying the industry about RE/BA related issues and comparing RE/BA techniques.

A number of surveys (based on questionnaires or interviews) about requirements engineering in the industry are available, but most of them focus more on learning about processes and practices actually used [5-6] than on problems encountered. Davey [7] provides a summary of surveys related on requirements elicitation problems, but it does not cover other RE/BA areas like requirements analysis or validation. A list of most common requirements problems is included in [8], however it is only based on the author's industrial experience, instead of a wider survey. The most similar approach is reported in [9], which describes a survey on problems and practices of the software industry in Malaysia. It is also worth mentioning that we are not aware of any recent survey research on RE/BA in Polish industry, except [10], which focuses on a particular issue (hidden requirements anti-pattern).

Several works comparing RE/BA techniques gathered from different sources are available [11-12], however the referenced sources are original papers describing new techniques and/or RE textbooks, no comparison between present industrial standards has been found. A comparison of BABOK, IREB and SWEBOK is provided in [13], but with respect to the general approaches, terms used etc., not techniques included. Selected techniques dedicated to requirements elicitation [14-15] or prioritization [16] were assessed, but with respect to the predefined criteria or measurements in controlled experiments, not applicability to particular problem situations.

3 Research Study

Our research aimed at addressing the following questions:

- Which BA techniques are recommended by the state-of-the-art sources?
- What problems affecting BA are perceived as most frequent by business analysts?
- Are the available techniques effective in coping with such problems according to business analysts' opinions?

It should be stressed that we sought for the problems from the perspective of business analyst (not e.g. company or customer) and from the practical viewpoint (real life experiences). As for the BA techniques, we decided to focus on areas of requirements development (elicitation, analysis, specification and validation) and to exclude requirements management.

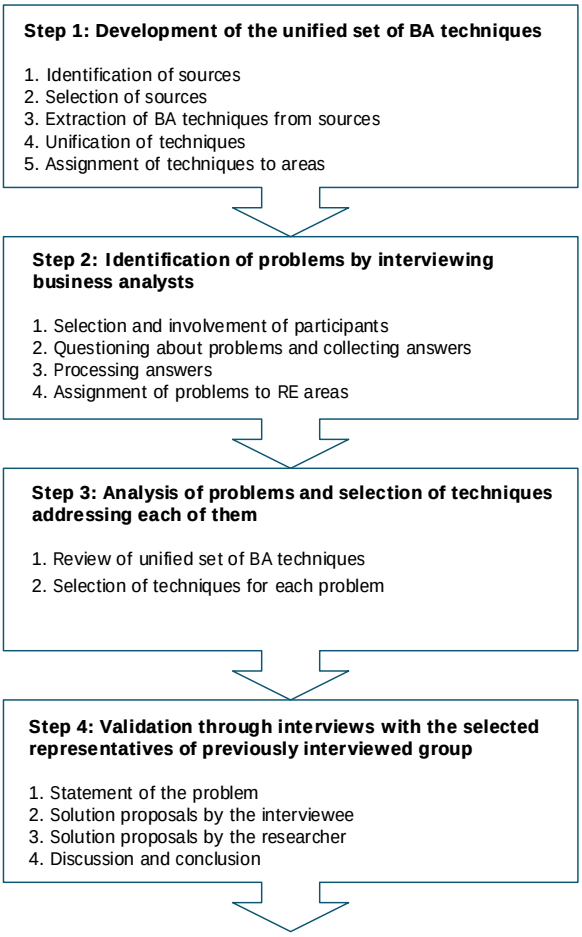

Fig. 1. The overview of the research process

The research was conducted in a number of steps. Each of the steps included several subsequent activities. This process is illustrated in Fig. 1.

3.1 Step 1 – Development of a Unified Set of BA Techniques

The prerequisite to fulfill the aim of step 1 was to identify the candidate sources of knowledge and to choose the basis for further work. At first, we tried the international standards. However, the current main requirements engineering standard (ISO/IEEE 29148:2011 [17]) is not very elaborate in regard to this matter. It lists and briefly summarizes several techniques for e.g. elicitation (page 22) or validation (page 31), but mainly focuses on other issues like requirements engineering process or SRS contents. The previous standards (ISO/IEEE 830:1998 [18] and ISO/IEEE 1033:1998 [19]), superseded by 29148, contain even less information about particular techniques.

We turned to certification schemes and associated "industrial standards" instead. We consider them as representative to the present industrial practice - the growing numbers of certificates issued indicate the interest of practitioners and the syllabi/examination criteria are updated to reflect the current trends. Also, an important factor from the point of view of our research was that many particular BA techniques are described in these sources. We decided not to rely on one certification scheme only, but to analyze several ones, compare them with respect to the recommended BA techniques and to develop a unified list of such techniques based on all analyzed sources. We selected certification approaches established by International Requirements Engineering Board (IREB), Requirements Engineering Qualifications Board (REQB) and International Institute of Business Analysis (IIBA). The following documents describing these 3 approaches were used:

- IIBA BABOK Guide ver. 2 [20],
- IREB CPRE Foundation level syllabus ver. 2.2 [21],
- IREB CPRE Elicitation & Consolidation, Advanced Level syllabus ver. 1.0 [22],
- REQB CPRE Foundation Level syllabus ver. 2.1 [23],
- REQB CPRE Advanced Level Requirements Manager ver. 1.0 [24].

We used the documents which were available at the time and e.g. IREB CPRE Advanced Level Requirements Modeling syllabus was published later. As for BABOK, its current version (3) was published when our work was already in progress (and the standard was not immediately available to us), so we decided to proceed with BABOK 2. Of course, our comparison of 3 approaches can be updated to reflect changes in BABOK contents, but in the interview-based study (sections 3.2 - 3.4) we used techniques from BABOK 2, so we do not introduce such change to this paper for consistency sake.

All the documents were reviewed to identify particular BA techniques. This task was not as straightforward as it may appear. In BABOK most of BA techniques are explicitly listed and described in separate sections, but some techniques e.g. RACI Matrix are not included in the list, only mentioned in the text. The other two sources do not as explicitly focus on techniques. REQB enumerates most of them in tables or as bullet items, but some are only mentioned in accompanying description (e.g. sever-

al analysis techniques based on various models are listed in Table 4 on p. 76 [23], but prototyping is only mentioned on p. 79). For IREB, [21] only enumerates the techniques, while descriptions are provided in [22], but these two sets of techniques have some differences. Such differences can also be spotted in REQB sources e.g. [23] lists and describes 11 elicitation techniques, while [24] omits one of them: use cases.

Table 1. Requirements elicitation techniques from IREB, REQB and IIBA sources.

Technique	IREB	REQB	IIBA
Apprenticing	X	X	
Benchmarking			X
Brainstorming	X	X	X
Context modeling	X	X	X
Contextual inquiry	X		
Customer representative on site		X	
Decision analysis			X
Document analysis	X	X	X
Elevator pitch	X		
Focus groups			X
Functional decomposition	X	X	X
Interface analysis			X
Interviews	X	X	X
Observation	X	X	X
Organization modeling			X
Persona	X	X	
Perspective-based reading	X		
Problem tracking			X
Process analysis / modeling	X	X	X
Prototyping	X	X	X
Questionnaires / surveys	X	X	X
RACI matrix			X
Reuse of requirements	X	X	X
Scenarios	X		X
Self-recording		X	
Stakeholder map / classification	X	X	X
Storyboards	X		
Use cases	X	X	X
User stories	X	X	X
User-Centered Design	X		
Walkthrough	X	X	X
Workshop	X	X	X

The review of the sources was not just about extracting the name of each technique mentioned in the text - we aimed at developing a unified list of techniques based on 3 sources. It required several actions and decisions to be made. The first and easiest issue were language differences - quite often similar techniques are given different names e.g. Observation (BABOK) and Field Observation (REQB and IREB); Functional Perspective (IREB), Functional Decomposition (BABOK) and Logical Analy-

sis including Functional Decomposition (REQB). Sometimes however, the difference was not just about names e.g. Document Analysis (BABOK) and System Archaeology (IREB) look similar, but the latter includes analysis of existing system code, while the former does not explicitly mention it and is more document-oriented.

Another issue was to decide if some variants of a more general technique should be recognized as separate techniques. For example, Brainstorming is listed as one of elicitation techniques both in BABOK and REQB, while IREB provides several variants of brainstorming and creativity techniques e.g. Method 6-3-5 or 6 Thinking Hats. A similar situation is about reviews because different sources explicitly mention various kinds of this technique (peer review, technical review, informal review etc.). There is no space available here to describe each decision we had to make, in general we tended to merge very detailed variants into one (e.g. Reviews), but we were careful not to step too far (e.g. we distinguish Reviews and Walkthroughs).

The techniques were also assigned to requirements development areas [3][25]: elicitation, analysis, specification, validation. Specification area differs from the others - neither of sources provides details on SRS contents. BABOK enumerates several kinds of specification documents, IREB refers to IEEE 29148:2011 [17], while REQB to the older standard (IEEE 830:1998 [18]). We compared two latter ones, but it is de facto a comparison between two ISO standards with respect to SRS contents and requirements categories. As example, the resulting set of techniques (only the ones assigned to elicitation area) and their traceability to sources are shown in Table 1.

For each item of the resulting unified set of techniques, an analysis of their applicability according to sources (advantages, limitations) was made. Information from all sources which included a given technique was compiled into a more comprehensive description of its applicability.

3.2 Step 2 – Identification of Problems

Step 2 aimed at identification of problems encountered in business analysts' professional experience. It started with gathering a group of analysts and making arrangements for interviews.

The participating analysts represented two companies (4 analysts from each one). For confidentiality sake we will use names Company A and Company B. Company A employs about 140 staff and specializes in outsourcing of IT services and development of web-based solutions for business. Projects are mostly run using agile methodology, by relatively small teams (4-10 persons per project). Company B employs over 350 persons and is mainly active in the financial industry, but includes its own IT department (30 persons) responsible for IT infrastructure, data storage and software development. Software projects are managed using various approaches and methodologies e.g. waterfall model, V model, agile - depending on project's size and other constraints. Project teams vary greatly (from 3 to 20 persons) and some projects, especially maintenance-oriented ones, are rather short-staffed.

These two companies were selected because of their different profiles. A number of business analysts from both companies were initially identified as potential interviewees through the network of professional contacts of one of us. Only persons with

designated job position as business analyst and experience in this field were approached. The participants of the study were recruited by contacting them in person or via email, explaining the rationale and scope of the study and asking them to participate. Initially more people were asked, but some either refused to participate or proved uncooperative. The participation was entirely voluntary, the study was not e.g. endorsed by the management.

The final group consisted of 8 people with a substantial experience in the field of business analysis:

- 5 persons with more than 5 years of experience;
- 3 persons with the experience between 2 and 5 years.

Each of 8 participants was individually asked about the problems encountered in his/her job experience using an open question: "As an analyst, what problems do you encounter most often in your work?". The participant was supposed to list as many problems as he/she could think of. Also, he/she was asked to evaluate each of the mentioned problems with respect to the frequency of its occurrence. The frequency was measured using an ordinal scale (1 - least frequent, 10 - most frequent). Answers were collected within two weeks by e-mail.

After collecting all answers, a "data processing" activity was conducted. Answers for an open question usually require some clarification and this case was no exception. In particular, it was essential to merge the answers which reported the same problem, but using different natural language expressions.

For example, one interviewee listed as problems: "Functional changes after user acceptance tests" and "Additional requirements issued during customer-analyst meetings, compared to already agreed and prioritized requirements", while another one reported "Changes of functionality during the whole project". These 3 sentences were merged into a more encompassing one: "Changing requirements".

In all such cases the problem was only listed once (preferably under the most meaningful name), but with a sum of all frequency scores. Sometimes a clarification and/or refinement was required when we had doubts about the meaning of a particular problem or the problem was too generic (e.g. "communication problems"). In such cases, a participant was contacted to clarify doubts and/or provide additional details. Also, the problems that turned out not directly related to RE/BA (but to e.g. company politics or interpersonal issues instead) were rejected or refined.

Next, a classification of problems into the particular areas (elicitation, analysis, specification, validation) was done. A given problem could be assigned to one or more areas (e.g. "Lack of stakeholders' commitment" problem was assigned to elicitation and validation areas, while "Changing requirements" problem was considered to affect all four areas). Four problems were revealed to belong to requirements management area (excluded from study scope) and were omitted from further analysis.

Some reported problems were quite surprising to us, because their source turned out to be the analyst, not the customer, market situation or other independent factor. For example: "An analyst prematurely assumes that he/she understands stakeholder's requirements" (resulting in lack of commitment to pursue the issue further), or "An analyst skips recording some requirements during elicitation phase". At first, we in-

tended to exclude such problems from the further analysis, as it appeared that they stem from analyst's negligence. If so, then no advanced BA technique, but rather a more responsible approach of the analyst to his/her duties is required. However, follow-up contacts and requests for explanation revealed that the interviewees encountered such problems working together with their fellow analysts (often less experienced ones) and believed that application of a technique capable of preventing such errors would be beneficial. Finally, we decided to treat those problems like all others and try to find appropriate solutions to them.

Table 2. Results of interviews – problems with the highest summary scores.

#	**Problem**	**Score**	**E**	**A**	**S**	**V**
1	Changing requirements	30	X	X	X	X
2	Too short deadlines to complete BA	30	X	X	X	X
3	Lack of the authorized stakeholders (capable of making decisions)	30	X			
4	The stakeholders are unable to express their needs/requirements	29	X			
5	Analyzing undocumented existing system	28	X	X		
6	Lack of stakeholders' commitment	19	X			X
7	The stakeholders completely do not know what they want	15	X			
8	The stakeholders express requirements which are outside system's scope	14	X			
9	Failure to identify an essential stakeholder	13	X			
10	The stakeholders are unavailable, difficult/delayed contact	13	X			
11	The software developers ignore specified requirements	13			X	
12	Low quality of specified requirements (e.g. incomplete, too generic)	12			X	
13	The stakeholders avoid participating in Verification and Validation activities	12				X
14	Conflicting requirements	12	X	X		
15	Ambiguous requirements' descriptions	12			X	

The final list of problems reported by interviewees included 49 items, together with 86 frequency scores. The top 15 items of the list ordered by summarized frequency scores are presented in Table 2. For each problem the areas it concerns (elicitation, analysis, specification, validation) are also marked. It is visible from the summary scores (and the ratio: 49 items - 86 scores) that the sets of problems stated by particular interviewees differ from each other. This is obviously the result of an "ad hoc" manner of identifying problems, however it was intentional - we wanted not to restrict the potential outcome by e.g. providing a checklist of problems. We assumed,

that if a particular issue is really a frequent problem in the analyst's working activities, then he/she will remember about it and include it in the list.

3.3 Step 3 – Solution Proposals

In step 3, the analysis of gathered problems and available BA techniques was planned to propose solution to each problem. However, because of such a significant number of reported problems, we decided to exclude some of them and focus on the ones with higher frequency scores (28 out of 49).

The search for appropriate solutions to problems was based on the guidelines for applying each particular technique (description, pros and cons) compiled from 3 sources described in section 3.1. The process was iterative, first several candidate techniques were considered, then a selection of the most promising solutions (up to 3 techniques) was made. The process was based on the analysis of issues expressed in natural language, therefore it is hardly possible to describe it in an algorithmic form, with precise decision criteria.

Only some of the techniques were selected as solutions to considered problems. Table 3 shows how many techniques from particular areas were finally used.

Table 3. Techniques used as solutions to problems.

	Elicitation	Analysis	Specification	Validation
Total no. of techniques in the unified set	32	16	35	6
No. of techniques used	11	8	8	2

3.4 Step 4 - Validation

Step 4 focused on validation - finding out whether the solutions developed using guidelines from recognized sources are useful in practice from the business analyst's point of view. Interviews were chosen as the method of validation. Two analysts from the previous group of 8 were contacted. They were among the most active participants who contributed the highest numbers of problems. Also, they worked for different companies (A and B) and held different positions (A - senior analyst, B - junior analyst). Validation interviews were arranged separately with each analyst. During the interview each of 28 considered problems was discussed using the following scheme:

1. The researcher asked the interviewed analyst to come up with proposal of solutions to a given problem.
2. The researcher revealed his own proposal developed in step 3.
3. A comparison of the proposals by both participants took place, followed by a discussion to reach a consensus.

In some cases the proposals of the researcher and the interviewee were exactly the same, so no discussion was necessary, but mostly there were at least partial differ-

ences. Incidentally, the interviewee admitted he had no idea which technique to apply for a given problem (literally 2 cases). The outcome of the discussion could be either:

1. The interviewee admitted that the proposals of the researcher are a better solution (or at least not worse - quite often the conclusion was that different techniques can be used as equivalent solutions).
2. The interviewee convinced the researcher that his proposal should be changed or at least extended by applying additional technique.

The researcher took detailed notes documenting the discussions and afterwards summarized the outcomes for each of the problems. An example is presented below.

Name of the problem: *Lack of stakeholders' commitment.*

Author: *Two different solutions can be applied. A more "friendly" approach is to facilitate* ***workshops*** *or* ***brainstorming*** *and therefore to stimulate the stakeholders to be more active and creative in requirements elicitation. These techniques were selected, because they are generally known to stimulate creativity and involve participants. An alternative approach results in a more confrontational way and includes usage of the* ***stakeholders map*** *technique. The map enables the analyst to understand the organizational hierarchy of a company or project and to contact a superior of an uncooperative stakeholders who can deal with them or find a replacement.*

Analyst A: *The first analyst was inclined to apply* ***workshops*** *or* ***brainstorming*** *with an emphasis on choosing the ones with a more attractive form. He said that an approach which includes a creative way of eliciting requirements and is considered fun would be more profitable than a standard "boring" meeting. During the discussion, the researcher presented his solutions including the "unpleasant way" with using a* ***stakeholders map****, but the analyst disagreed with that approach.*

Analyst B: *The second analyst also proposed* ***workshops*** *and* ***brainstorming****, but he also suggested using* ***prototypes*** *as a way to capture stakeholders' attention and as result effectively elicit requirements. After hearing researchers' proposals, the analyst agreed that they are suitable.*

Conclusion: *In all 3 cases, the preferable solution was to stimulate stakeholders' initiative by using creativity-based techniques like* ***workshops****,* ***brainstorming*** *and* ***prototyping****. The researcher decided to add* ***prototyping*** *to the short list of suitable solutions to this problem. On the other hand, the idea of using* ***stakeholders map*** *was discarded as a result of validation. The researcher was convinced by the argument of Analyst A, that it could result in a negative attitude and harm relationships between the project team and the stakeholders.*

Depending on the outcomes of the interviews, the following course of action could be taken to incorporate validation results into the proposed set of solutions:

1. No change - validation confirmed that the proposal is sound, no counter-proposals were issued by the interviewees (12 problems).
2. Extension - another technique was added as part of the solution, especially if it reinforced the techniques already included in the solution (14 problems).

3. Alteration - the initial solution proposal was modified by substituting one or more techniques with others, as suggested by one or both interviewees (2 problems).

All the techniques proposed by the interviewees and included as extensions or alterations could be found in the unified set based on 3 certification sources, there was no case that would require modification of the outcome of step 1. The example results of validated solutions to problems are included in Table 4. The table also shows changes resulting from validation – the techniques added to the initial proposal and removed from it are distinguished by underline and strikethrough respectively.

Table 4. Techniques assigned as solutions (examples).

Problem	**Techniques assigned (after validation)**
Analyzing undocumented existing system	Document analysis, Observation, "Stakeholders" section of SRS
Changing requirements	Requirement diagram, Cost-value prioritization, Prototyping
Failure to identify an essential stakeholder	Stakeholder map, RACI matrix, Process modeling
Lack of authorized stakeholders (capable of making decisions)	Stakeholder map, RACI matrix
Lack of stakeholders' commitment	~~Stakeholder map,~~ Brainstorming, Workshop, Prototyping
Low quality of specified requirements (e.g. incomplete, too generic)	Non-functional requirements analysis, User stories, Scenarios, Process modeling
The stakeholders completely do not know what they want	Brainstorming, Interviews, Workshop
The stakeholders express requirements which are outside system's scope	Scope modeling, Process modeling
The stakeholders are unable to express their needs/requirements	Observation
Too short deadlines to complete BA	Timeboxing, MoSCoW prioritization

4 Conclusions and Further Work

The review of the state of the art RE/BA knowledge sources resulted in a large set of recommended BA techniques. A side effect of this work is the observation that apart from the "core" established and well known techniques (like prototyping, questionnaires or observations), the reviewed industrial standards recommend different techniques as tools for business analysts.

The study uncovered a number of problems expressed by a group of business analysts and related to their work activities. For each of frequent problems a solution in the form of one or more BA techniques was proposed. Validation shows that the set of BA techniques developed by unifying contents of 3 selected sources was sufficient to address each of the problems considered. Moreover, the guidelines on applicability of particular techniques compiled from 3 sources allowed to select the right techniques (only 2 out of 28 proposals were rejected by business analysts participating in validation). The substantial number of proposals which were extended with additional techniques as result of validation suggest that the set of available techniques includes many items which can be used interchangeably, as replacements for each other.

The main threat to the validity of the results is a relatively small group of study participants and the fact that they all come from Polish software industry. The reported small-scale study (conducted as part of the MSc thesis [26]) was designed from the beginning to target Polish IT sector. We do not make any assumptions whether conditions of business analyst's work in Poland are significantly different than elsewhere or not - we simply report our results. Within the scope of our study, we made some effort to include representative participants (different companies and profiles of BA practitioners). Another potential threat is the subjectivity of assessments made by interviewees about problems' frequencies and applicability of solutions, however subjectivity is an integral part of the selected survey approach.

As for future work, we consider reviewing additional sources e.g. SWEBOK or PMI Guide – even if the current set of techniques seems to be "sufficient", more guidelines and hints about which one to apply would be helpful (especially in case of similar techniques). Also, a study involving a larger number of participants and companies (preferably from different countries) is a possible direction of research. As our approach of asking open questions about problems proved to have its drawbacks (low similarity of problems reported), it is worth to consider using a combined approach - a list of problems (based on literature analysis) available to the participant, together with the opportunity to add problems not present on the list.

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