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Ksenija Lace, Marite Kirikova

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# The Models for Knowledge Acquisition in PMI Specific Requirements Engineering

Ksenija Lace and Marite Kirikova

Riga Technical University, Latvia  
[ksenija.lace@gmail.com](mailto:ksenija.lace@gmail.com), [marite.kirikova@rtu.lv](mailto:marite.kirikova@rtu.lv)

**Abstract.** Knowledge acquisition is an important part of any requirements engineering activity, as it builds the foundation for all decisions and actions performed. In PMI activities knowledge acquisition is equally important and more complicated as in requirements engineering in general. This leads us to the conclusion that PMI initiative should have an additional focus on the knowledge acquisition. This paper explores requirements elicitation for PMI as a knowledge acquisition process and proposes models for its accomplishment. It covers the following research steps - required characteristics of an effective PMI requirements elicitation are identified, corresponding existing research is analyzed, possible adjustments to the previously presented requirements elicitation model are identified, enhanced knowledge acquisition model is proposed, and the proposed model is illustrated with a real application example. As a result of this research the adjusted and detailed PMI specific knowledge acquisition model for PMI specific requirements engineering has been created that consists of two parts – the knowledge acquisition process model and the knowledge acquisition data model.

**Keywords:** Mergers & Acquisitions, Knowledge Management, Requirements Engineering, Elicitation

## 1 Introduction

Nowadays one of the main approaches for business growth is merge of several companies to create one bigger and stronger company, with more resources and higher potential. Merge initiative is a complex and long process with the extensive planning phase. Planning includes merge goal definition, search for potential merge partners, discussions, and agreements. But once planning is finished and the deal is signed, a merge should be executed. Practical execution of a merge initiative is called post-merger integration (PMI) and during this process companies are combined to form one union [24]. PMI covers all different aspects of the organizational architecture, including technical perspective, social perspective, and cyber perspective. This makes PMI a process for integration of several socio-cyber -physical systems (SCPSs) [25].

Knowledge acquisition is an important part of any requirements engineering (RE) activity, as it builds the foundation for all decisions and actions performed. If some

knowledge is missing, under-evaluated or misinterpreted, there is a high risk that requirements will not represent the real need [4]. This becomes even more important in the scope of PMI activity, as it has additional difficulties to the knowledge acquisition, such as cultural barriers, strict time limitations, high complexity, and limited ability to learn from previous projects [5]. In the recent research [23], the authors of this paper, by studying existing RE models from the perspective of their applicability for the requirements identification of PMI initiatives, detected required improvements, and proposed a generic RE Model for PMI contexts [23]. The proposed model was verified through its application for the PMI initiative example. This model covers both static and dynamic perspectives of the PMI RE and includes three stages of PMI project, namely, Initial Assessment, Decisions and Plan, and Plan Execution. In the model, the initial assessment phase of PMI corresponds to the RE elicitation phase. The model was feasible in general, but further improvements were required including more detailed description of each RE activities. In this paper, the Initial Assessment phase of PMI Specific RE Model, i.e., RE elicitation phase is explored in detail from the point of view of knowledge acquisition.

Thus, the goal of this paper is defining a detailed knowledge acquisition process and main concepts relevant in requirements elicitation in PMI context. To achieve this goal, the following research method was used: PMI requirements elicitation related literature was reviewed regarding PMI specific requirement elicitation quality criteria, PMI elicitation related quality criteria, and exiting approaches how these criteria are achieved; after that the most promising approaches were selected and adopted into the previously proposed PMI specific RE model [23]; then, the adjusted model was applied to the PMI project example to verify its applicability and identify possible improvements.

The rest of the paper is structured as follows: Section 2 is focused on the definition of a quality criteria for PMI specific requirement elicitation and review of most suitable existing requirements elicitation approaches; Section 3 proposes PMI RE elicitation specific model; Section 4 presents the demonstration of the proposed model applicability; brief summary is provided in Section 5.

## **2 PMI Requirements Elicitation Quality Criteria and Literature Review**

In this section the most suitable requirements elicitation approaches are reviewed from the perspective of an applicability for PMI RE.

From the elicitation process organizational perspective, PMI Specific RE Model includes the following high-level requirement elicitation activities [23]:

- Identify related information resources
- Gather knowledge on goals
- Gather knowledge on the context
- Gather knowledge on architectures

Existing requirements engineering approaches covering one or several of the elicitation activities were reviewed in [23]. Additionally, SCPS specific and PMI specific elicitation approaches were investigated.

From elicitation process related risks and issues perspective, if we look on the PMI as the SCPS initiative with a major part being social elements, there are the following open questions that need to be addressed in the scope of PMI specific requirement elicitation [6, 21]:

- How to elicit both tacit and explicit knowledge
- How to elicit SCPS specific requirements
- How to elicit merge & acquisition specific requirements

In total 53 research papers were reviewed for the publication period from 2000 or later. The following research libraries were used – Science Direct, Springer, IEEE Xplore. The following key words were searched – elicitation & SCPS, elicitation & mergers and acquisitions, knowledge & mergers and acquisitions, tacit knowledge & mergers and acquisitions. Research did not follow any specific methodology. First, all papers were explored to filter out papers discussing M&A knowledge related challenges. Selected papers were investigated in more details to define main issues that need to be solved for the effective M&A knowledge elicitation. To get more deep understanding, authors additionally explored research papers identified as a research foundation for papers focusing on knowledge elicitation issues. After that, additional search was executed to find papers focusing on the solutions for more efficient knowledge elicitation in general, as well as on the solutions for previously identified M&A knowledge elicitation issues. All found papers were evaluated from the point of solution applicability to M&A context. Below are summarized the findings from the existing research, which is related to required requirements elicitation adjustments for SCPS and PMI specifics, by focusing on the above-mentioned questions. Additionally, research works exploring other risks and issues for PMI related requirements elicitation were reviewed.

Goal information elicitation is one of the first steps in RE. In [16] the goal, question, and answer approach is proposed. This approach focuses on the acquiring detailed information about goals, as well as creating tree-like goals decomposition structure. The approach uses required and anticipated functions perspective to define and formulate project goals. In PMI it is important to state clear and detailed goals, as this defines overall PMI initiative direction. In [9] authors describe the method how to organize goal related knowledge acquisition using the perspectives challenge – goal-function. This helps to focus on real problems and not create non required goals. In [14], overconfidence of involved leaders is stated as one of the reasons for PMI failure, meaning that often PMI related risks are underestimated. Research describes the way how PMI related risks can be identified early in a project, and corresponding action plan created. It is advised to start risk identification as soon as goals are defined.

After goals are defined, next step is to identify corresponding information sources. As finding tacit knowledge is one of the biggest challenges for requirements elicitation, stakeholders should be identified very carefully, as well as each of them should be assessed from the perspective how tacit knowledge can be gathered. In [18] the approach for stakeholder identification is described. In addition to common practices, the research points out the necessity to gather additional information about stakeholders, as well as to use information about relationships between stakeholders to find out additional stakeholders for the PMI initiative.

After all information sources are defined, it is time to plan for the elicitation. In [8] the importance of the assessment of data availability and quality prior any elicitation activities are highlighted, so that required adjustments in the elicitation can be planned. In [2] authors propose the approach for identification of unknown by using adjusted elicitation techniques. Challenges for tacit knowledge identification, as well as appropriate elicitation techniques are described in [19]. In PMI it is important to define all known knowns and known unknowns prior the elicitation, as well as elaborate on the list after each elicitation activity to find new known unknowns and plan the elicitation for them. Knowing goals, risks, related information sources and issues with data accessibility and quality helps to find the most effective elicitation techniques. Possible elicitation techniques are described also in [17]. But [13] gives the method how to apply efficiency criteria for elicitation technique selection procedures. As PMI initiatives usually have time and resource availability constraints, it is important to choose the most effective techniques to acquire the knowledge with minimum required effort.

In [1] authors discuss the importance of predefined standardized questionnaires during elicitation activities, as well as the process of lessons learned. As software integration plays important role in the overall PMI success, in [12] specific questions for software related knowledge identification are defined. As for tacit knowledge acquisition, as well as for respecting cultural aspect, it is required to identify stakeholders' perspectives on the elicited knowledge. This topic is elaborated in [10] by incorporating opinions and rationales as part of acquired knowledge on the previously identified information. As for cultural perspective importance, [7] stresses out the value of cultural aspects in scope of PMI, as well as defines the approach how to identify cultural aspects which can become blockers for PMI success. Crucial element during the elicitation is also constant evaluation of gathered information quality and planning adjustments in the elicitation. Method for the elicitation results evaluation is explored in [15].

Elicited information should be structured so that it can be analyzed in the next requirement engineering phases. Structuring approaches are defined in the following articles:

- [11] – incorporation domain ontology
- [3] – statement of all three perspectives: economic, social and technical
- [20] – depiction of embedded systems specifics
- [22] – representation of enterprise architecture

None of the above reviewed research works covers all elicitation activities and takes into account all PMI and SCPS specifics. However, each of them can contribute to the PMI specific RE knowledge acquisition models for requirements elicitation.

### **3 PMI Specific Knowledge Acquisition Model**

This section describes how previously defined PMI specific high abstractions level elicitation [23] can be detailed and enhanced, based on the findings in the existing research.

As stated before, there is no one holistic approach for PMI requirements elicitation, however, generic knowledge acquisition process can be enhanced by incorporating activities focused on solving the identified PMI issues and risks (as illustrated in Fig.1):

- During PMI goal identification – create more detailed goal-trees [9, 16], as well as identify all known knowns and known unknowns [2]
- During identification of related information sources – focus more on the identification of stakeholders and related information [18]
- During planning elicitation – incorporate data accessibility and quality evaluation [8], state elicitation challenges and come up with corresponding elicitation techniques [13, 17, 19]
- During conducting elicitation – use standardized elicitation questionnaires [1, 12], pay attention to stakeholder perspectives and rationales [10]
- During analysis of elicitation results – structure knowledge per economic, technical, social, and cultural perspectives [7, 10], use gathered knowledge to identify new known unknowns [2], evaluate gathered data quality and plan additional elicitation if necessary [15], as well as define goals related risks [14]

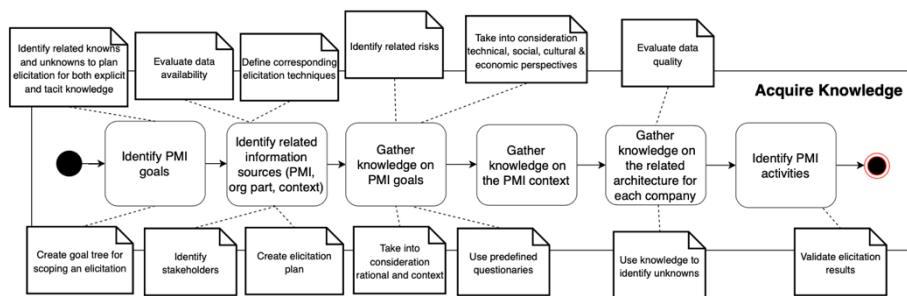


Fig. 1. Possible enhancements in the knowledge acquisition process (6 steps, UML activity diagram)

Based on the defined possible enhancements, Initial 6-step knowledge acquisition process model was reworked and transformed into 5-step model (as illustrated in Fig. 2) where:

- Initially, goals tree for PMI initiative should be created
- For each goal, related information sources (stakeholders, documents, and systems in operations) are defined

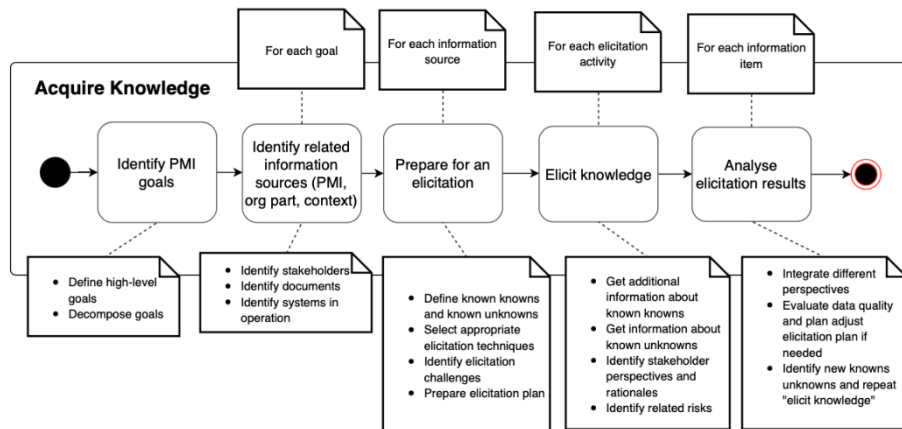


Fig. 2. Enhanced knowledge acquisition process (5 steps, UML activity diagram)

- For each information source the elicitation is planned – known knowns and known unknowns are defined, elicitation techniques are selected, potential elicitation challenges are defined, and corresponding solutions selected. All previously mentioned issues are summarized in an elicitation plan
- For each planned elicitation activity elicitation is conducted – additional information about known knowns and known unknowns is gathered, stakeholders' perspectives together with their rationales are identified, respecting related risks, which can block goal achievements
- For each acquired information item – gathered information is structured into economic, technical, social and cultural perspectives. Information quality is evaluated and required action items are planned. Finally, new known unknowns are defined, and additional elicitation activities are planned

Together with process changes, adjustments in initial class (sub)model of PMI RE model [23] also were required (see Fig. 3).



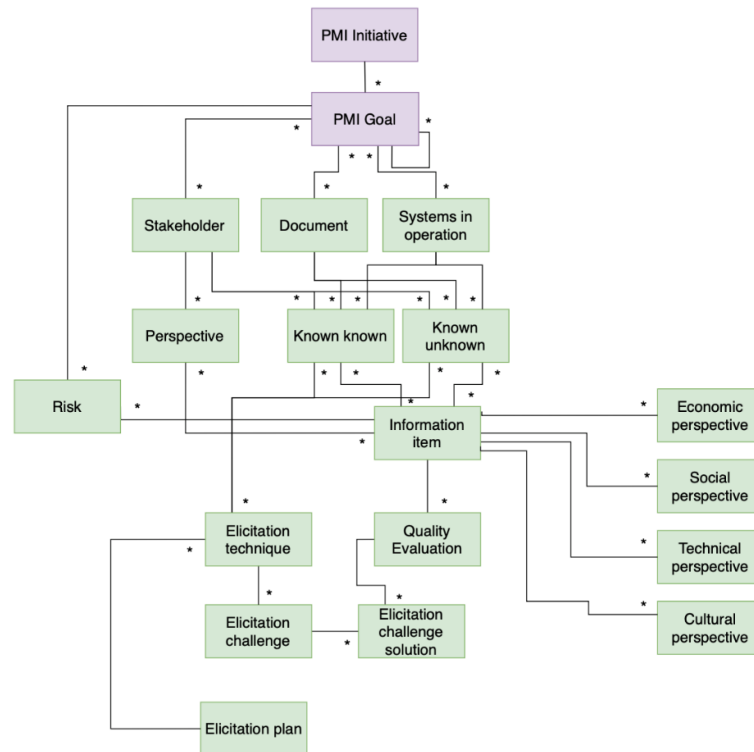


Fig. 3. Knowledge acquisition related class model (UML class diagram)

The initial model contained the information and knowledge artefacts related to PMI initiative, current organizational structure perspectives, context perspectives, as well as future merge decisions and related changes. PMI goal and PMI initiative are the only elements reused from the previous model. The following additional elements were added:

- To cover elicitation information source elements - Stakeholder, Document and System in operation elements were added, as well as related Known known and Known unknown elements
- To include elicitation planning - Elicitation technique, Elicitation challenge, Elicitation challenge solution and Elicitation plan elements were added
- To keep data about knowledge evaluation - Quality evaluation and Elicitation challenge solution elements were added
- To accumulate knowledge gathered during the elicitation - Information item element was added
- To structure gathered knowledge - Economic perspective, Technical perspective, Social perspective, and Cultural perspective elements were added
- To highlight identified risks for goal achievement - Risk element was added

#### 4 Demonstration of the Applicability of the Proposed Model

In this section the proposed model was used for the real-life example to verify model's applicability, as well as find possible model improvements. The process of model application, as well as the resulting artefacts in a form of object models are described below.

During "Identify PMI goals" step, initial goal "Align practices and optimize resources" was initially divided into two separate goals "Use same common processes" and "Optimize resources". After that "Optimize resources" was parted into two sides of optimization "Merge resources" and "Improve resources efficiency". Then "Merge resources" was decomposed into more tangible goals "Merge human resources", "Merge IS resources" and "Merge other resources". The results are illustrated in Fig. 4.

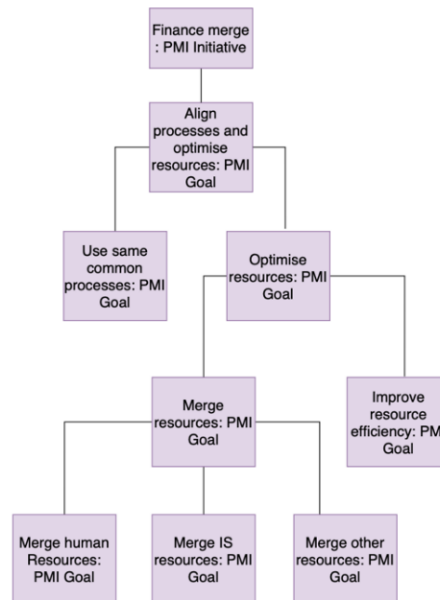


Fig. 4. Goal identification artefacts - goal tree (UML object diagram)

For the next step - "Identify information sources", goal "Use same common processes" was selected for illustrative purpose in scope of this article. For the simplicity, this paper covers elicitation in scope of one company only – acquiring company. But in real life the same activities should be performed also for the acquired company. For this goal the following information sources were identified (illustrated in Fig. 5):

- Stakeholders – customer, finance clerk and finance manager
- Systems in operation – invoicing system, that is currently being used
- Documents - process description, invoice example, process audit results

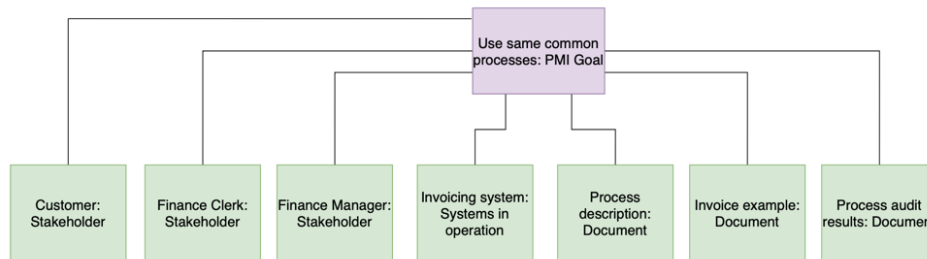


Fig. 5. Information sources artefacts – stakeholder, document, and systems in operation (UML object diagram)

For the next step - “Prepare for an elicitation”, in this paper, one specific information source “Invoicing system” was selected. For current invoicing system known and unknown data is identified:

- Known known – system user manual and data available in the information system
- Known unknown – real usage of information system and possible improvements for this system

Then for each of identified known and unknown data corresponding elicitation technique was selected:

- System user manual – manual document inspection
- Data in the IS – existing data analysis
- Real usage of the IS – observation sessions of real users
- Possible improvements for IS – survey and interviews of stakeholders

For each elicitation technique, respecting also information that should be elicited, challenges and solutions for solving these challenges were identified:

- Outdated version of user manual – verify version relevance
- Non structured data in the IS – create data model to structure IS data
- Too many approaches how data is entered in the IS – prioritize approaches to focus on the most important
- No trust from user to share real usage of IS – build trust relationships
- Ambiguous survey results – walk through results with respondents to get additional comments
- Too many and too different opinions about IS improvements – analyze and prioritize stakeholders to prioritize their input
- Conflicting opinions about IS improvements – apply conflict resolution techniques to find agreement

All artefacts are illustrated in Fig. 6.

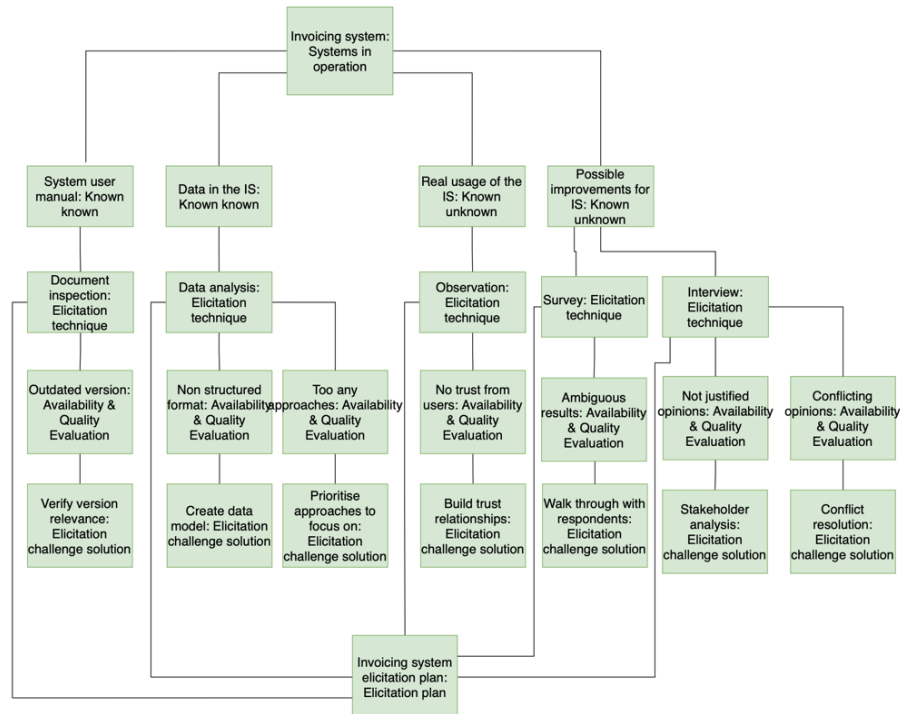


Fig. 6. Preparation for elicitation artefacts - known knowns, known unknowns, related elicitation techniques, information evaluation and elicitation challenge solutions, as well as overall elicitation plan (UML object diagram)

One specific known unknown “Real usage of the IS” was selected for the next step “Elicit knowledge” illustration. After selected elicitation techniques were executed, the following information items were created – “Observation video” and “Observation protocols”.

Each of this information items were analyzed in order to identify risks related to the ability to achieve stated goal “Use same common processes”. The following risks were identified:

- System requires comprehensive learning for new users
- System contains only part of required data
- Additional licenses are required to use the system for both companies

For each information item stakeholder perspectives were additionally elicited:

- Finance clerk - comments from user perspective about the observation video
- Finance manager – additional comments from user perspective about the observation video and the opinion on required IS changes for observation protocol
- Customer – opinion on observation protocol about IS issues from a customer perspective

Results are illustrated in Fig. 7.

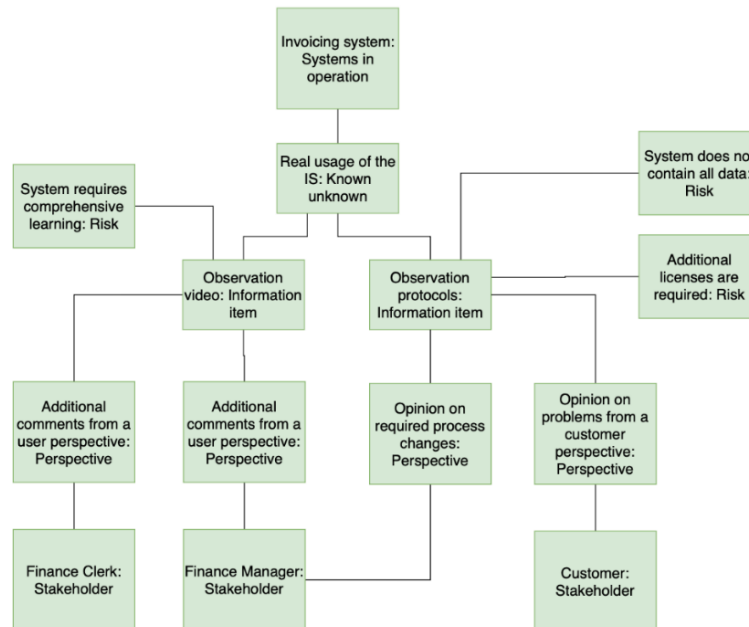


Fig. 7. Knowledge acquisition artefacts - information items, related risks and stakeholder perspectives (UML object diagram)

“Observation protocols” information item was selected for the illustration of the next step “Analyze elicitation results”. Firstly, information item data was divided into different perspectives:

- Economic perspective - cost of required system changes and financial losses due to system issues
- Technical perspective – system functionality
- Social perspective – user characteristics
- Cultural perspective – attitudes towards the system usage

Information item data quality was evaluated and “No statistical data” represented in the protocols issue was identified. To solve this issue, solution “Observe mode users” was selected. This solution requires additional elicitation sessions to be executed using the process described previously.

Additionally, related new known unknowns were identified – “Priority of found issues” and “User competence level”. For each of them elicitation activity should be planned and executed as it was described earlier.

The results are illustrated in Fig. 8.

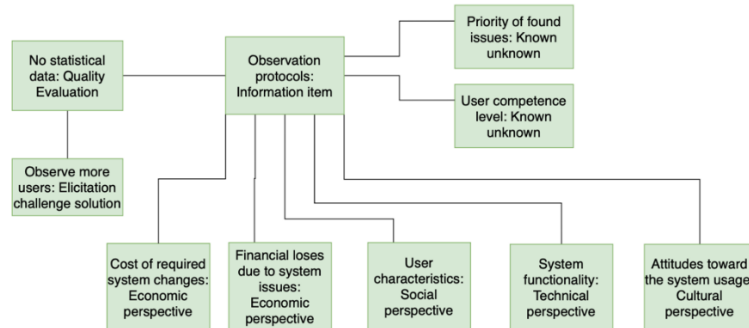


Fig. 8. Elicitation results analysis artefacts - information item evaluation and elicitation challenge solutions, as well as economic, technical, social, and cultural perspectives (UML object diagram)

## 5 Summary

This article explores the elicitation part of PMI specific requirements engineering model. Authors defined the required elicitation quality criteria, reviewed existing research works and identified possible solutions for the adjustments and elaborations of the previously defined high-level PMI specific elicitation process.

PMI specific elicitation requires enhanced goal analysis, proper planning with potential issue resolution plan. All these aspects are included in the proposed PMI RE elicitation model with a dedicated goal model, and elicitation plan model as crucial elements of PMI RE. Additionally, PMI RE as SCPS RE requires structured information covering all economic, technical, social, and cultural perspectives. All SCPS perspectives are incorporated into proposed model. With a high risk to miss PMI related tacit knowledge, which simultaneously is one of core components for PMI success, model's cultural perspective, includes also eliciting stakeholder opinions on the gathered information. The proposed models also support iterative elicitation approach, through uncovering new known unknowns during the elicitation process and repeating elicitation activities for them.

For the future research the following improvements and additions to the model could be made:

- Describe in more details process of information sources identification and sources related information structure
- Detailed description of elicitation technique selection (including technique selection criteria)
- List of standardized elicitation questions
- Checklist for possible PMI goals related risks
- Templates for artefacts contents
- Incorporate into data model relationships to enterprise architecture and context

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