Towards a Catalogue of Mobile Elicitation Techniques
Research Preview

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Abstract. [Context and Motivation] Mobile apps are crucial for many businesses. Their reach and impact on the end users and on the business in return demands that requirements are elicited carefully and properly. Traditional requirements elicitation techniques may not be adequate in the mobile apps domain. **[Question/problem]** Researchers have proposed numerous requirements elicitation techniques for the mobile app domain, but unfortunately, the community still lacks a comprehensive overview of available techniques. **[Principle ideas/results]** This paper presents a literature survey of about 60 relevant publications, in which we identify 24 techniques that target mobile apps. We found that only every second strategy was evaluated empirically, and even worse, non-functional requirements were rarely considered. We provide an evaluation scheme that is intended to support readers in efficiently finding opportune elicitation techniques for mobile apps. **[Contribution]** The found literature characteristics may guide future research and help the community to create more efficient, yet better, apps.

Keywords: Requirements elicitation, Mobile applications, Literature survey

1 Introduction

Mobile applications have substantially gained traction since the two major distribution platforms and their operating systems came into existence a decade ago, *i.e.,* Google's Play Store (Android OS), and Apple's App Store (iOS OS). For example, the iOS platform encountered an increase in numbers of published apps from 2008 to 2018 of about 2 500 times, leading to 2M apps that are currently available in the store.[1] Similar numbers have been reported for the Android platform.[2] As a result, there exists a large base of users who demand seamless app experiences.

The requirements elicitation phase of requirements engineering, which plays a critical role in the success of software applications, must take innovative forms to meet the individual needs of mobile app users. Typical difficulties are caused by the global variety of user affections, inconsistent device capabilities such as different screen size or battery life, and contextual factors such as user mobility. The research community has recognized this need, and since then has either proposed new elicitation techniques or modified existing ones to overcome these difficulties.

This paper aims to survey relevant literature, and to provide an initial step towards a comprehensive overview of requirements elicitation geared specifically towards mobile apps. Furthermore, we classify elicitation methods and propose an evaluation scheme for practitioners, based on our own criteria, which should provide invaluable immediate feedback to its users. Towards this aim, we pose the following three research questions:

[1] https://www.statista.com/statistics/263795
[2] https://www.statista.com/statistics/266210

- **RQ**$_1$: *What are the characteristics of current research in the field of mobile requirements elicitation i.e. requirements elicitation for mobile apps and use of mobile devices in requirements elicitation?* We elaborate on seven major properties found during the literature survey.
- **RQ**$_2$: *What are the existing techniques to elicit requirements for mobile applications?* We reviewed 60 publications shortlisted by well-defined inclusion and exclusion criteria, and we could identify 32 distinct elicitation methods.
- **RQ**$_3$: *How can developers be supported in the efficient selection of appropriate elicitation techniques?* We established an evaluation scheme that supports 19 parameters in six categories on which our elicitation methods can be evaluated successfully with little overhead for the practitioner.

The remainder of the paper is structured as follows: section 2 outlines the research methodology we followed for conducting our literature survey. Section 3 presents an overview of the current research characteristics we found. In section 4 we present several elicitation methods and propose a classification of these methods, leading ultimately to an actionable scheme for development leads. Finally, in section 5 we report our conclusions.

2 Literature Survey

To carry out the literature survey we closely followed a well-known procedure from Kitchenham *et al.* [2]: conducting an initial search, screening the primary studies based on inclusion and exclusion criteria, before finally, the data are extracted and aggregated.

We performed three search iterations on five major digital libraries, *i.e.,* the ACM Digital Library, Springer Link, IEEE Explore, ScienceDirect, and Google Scholar. In the first iteration we used the search term "mobile requirements elicitation", and in the second the two terms "mobile requirement elicitation" and "mobile requirements engineering", as these terms lead to different results in some search engines. After carefully reviewing the results, we evaluated the cited publications of all relevant papers in the third iteration. We considered publications until October 2018, and did not apply any other filter to avoid incomplete results due to papers not closely following the publication guidelines, *e.g.,* using proper release dates. Ultimately, we collected 182 publications.

We then applied several inclusion and exclusion criteria to abstracts and introductions of the found literature. The inclusion criteria were: (i) the abstract or introduction should indicate a proposed elicitation method for mobile applications, or the use of a mobile device for eliciting requirements, (ii) the abstract is written in English, and finally, (iii) the study is accessible. In contrast, the exclusion criteria were: (i) languages other than English are used in the body of the paper, (ii) the paper is a short version of an extended paper, or (iii) the content is not relevant, *e.g.,* it presents a literature review rather than proposing a method.

In the end, 60 publications satisfied all criteria and were considered for the subsequent in-depth study. The complete list of the papers can be accessed online.[3]

3 Empirical Discoveries

We now present the seven major subjects that we identified while carrying out the literature survey in our investigation of RQ$_1$. We collected the properties by carefully reading each publication, while taking notes about specific peculiarities, *i.e.,* related to the *evaluation*, *meta* information, and *people*. Complementary

[3] `http://scg.unibe.ch/download/supplements/REFSQ19_Supplementary_Materials.pdf`

information is only available online due to page limit restrictions.[3]

Evaluation. 31 publications included an evaluation, while 29 did not report any evaluation. Of the 31 publications, 13 presented a case or field study, 16 described a controlled or industrial experiment, and two publications reported on evaluations with students. We clearly see that constrained (controlled or industrial) experiments prevail. Objective data-driven evaluation techniques were highly popular, *i.e.,* about 63%.

Effectiveness. Several different factors have a major impact on effectiveness; the ethnicity or cultural background of analysts being one of them. For example, the risk of misunderstood cultural differences is omnipresent when Indian citizens are working on requirements elicitation for a Swiss project. The literature proposes for such scenarios the *observation* technique that forces the subject to reason about localities. Another factor concerns data privacy obligations, which could substantially impede the effectiveness of traditional elicitation methods, *e.g., interview*, if the client or stakeholder is not allowed to reveal the desired information. Unfortunately, the corresponding resolution strategy remains unclear from literature. In our study we found several factors that reduce effectiveness of requirements elicitation techniques, however, a resolution strategy has been proposed only for a few.

Focus. Most of the methods are either human- or data-centric; only six publications propose an aggregation instead. Data-centric methods are useful to gather non-functional requirements (NFRs) or feature improvement requirements. They could cause severe privacy breaches, due to the availability of sensitive data. Furthermore, data-centric methods do not require stakeholders to be involved, but instead they rely heavily on natural language processing experts, and they require additional physical assets, such as computing hardware and workspaces, to analyze an enormous number of apps. In contrast, human-centric methods encourage creativity throughout the elicitation phase, and depend on the intensive use of human resources. We further discovered that benefits, drawbacks, and the evaluation of the proposed methods are frequently not the main concern of the authors, but rather they tend to focus on technical aspects of their solution.

Non-functional requirements. While no method pays exclusive attention to NFRs, some methods do support the elicitation of certain NFRs, for instance, run time performance and user interface issues highlighted in app store reviews [1]. NFRs are crucial since they increase the app's usability for users, and answer special user needs, *e.g.,* the need for privacy and compatibility. Unfortunately, we did not find any guideline or evaluation scheme that would assist developers in choosing opportune methods for NFR elicitation.

Traditional requirements elicitation techniques. Numerous traditional elicitation techniques such as *interview*, *brainstorming*, and *focus groups* have been adapted for mobile apps [4]. In addition, techniques based on data mining have also become very popular in mobile app requirements elicitation due to the extraordinarily large corpora used in app stores that provide a plethora of different features ready to use for requirements engineering, *e.g.,* end user review data and ratings. How to adapt a particular traditional requirements elicitation technique for mobile apps domain remains unanswered, as we did not find any guidelines or efforts put into this direction.

Collaboration strategies. We found that about 68.3% of the reviewed publications, encourage active collaboration between analysts and stakeholders, 26.6% put the elicitation responsibility completely on the analysts' shoulders, and 31.6% suggest working only with data, avoiding any collaboration. Surprisingly, starting in the year 2004, 19% suggest that stakeholders should perform elicitation themselves. Furthermore, collaborative methods are frequently used in combination with methods targeting analysts, *e.g., interviews*. Unfortunately, clear patterns and guidelines are missing to help analysts choose a satisfactory combination.

End user demographics. Eleven publications specifically focused on methods for children, the elderly, disabled people, and the illiterate. Of concern were elements that make apps delightful to use for them, or that match surprise factor to the audience, *e.g.,* gaining attention by audible notification is inaccessible to people suffering from deafness. All of the reviewed publications rely either on direct or indirect measures

to gather contextual information and tacit knowledge. Direct measures, for example in app user feedback functionality, show a preference for eliciting requirements in the stakeholders' domain, which is especially helpful to capture functional requirements that are hard to formulate verbally. Indirect measures provide valuable insights without any end user interaction, for instance, data is collected autonomously while an app executes in the background (*e.g.,* location), or is gathered by observing user activities within the app.

4 Discussion

Here we present the found elicitation methods, classify them, and build a first version of an actionable scheme. RQ_2 and RQ_3 are briefly covered in subsections 4.1 and 4.2, respectively.

Analyst-centric category	**Collaboration-centric category**	**Data-centric category**	**Stakeholder-centric category**
Gamification	Activity theory	App description mining	Mobile feedback app
Interview/survey/questionnaire	Brainstorming	App log/ App usage data mining	User feedback on MVP
Modelling	CRC sessions	App store mining for similar apps	
Persona or User profiles	Crowdsourcing	Observation/Contextual data/Reflection	
Wizard of Oz	Focus groups	Opinion mining	
	Mobile requirements engineering app		
	Photo essay		
	Prototyping		
	Scenario		
	Story telling		
	Social networking sites/ Wiki		
	Viewpoints/ Six thinking hats		

Table 1: Classification of methods

4.1 Elicitation

A total of 24 elicitation methods were found in the 60 publications we studied. Due to space restrictions we only present an overview of the found methods in Table 1.

The classification of such methods is a non-trivial task as several parties with diverse interests are involved, *e.g.,* stakeholders, developers, and end users. Numerous solutions to this classification problem have been proposed, *e.g.,* based on the means of communication [4], or as suggested in our previous work, based on the commonalities between identifying problems and finding solutions [3].

As elicitation methods for mobile applications differ from traditional requirements elicitation methods, most evaluation schemes provide barely any help to mobile application developers. Hence we propose a novel evaluation scheme, where methods are classified according to data- and people-centric criteria, since one of the main purposes of current mobile apps is to provide access to a service-oriented infrastructure (*e.g.,* social media), that relies on a plethora of user data (*e.g.,* user feeds) to connect people (*e.g.,* friends).

We consequently grouped the elicitation methods into four categories as shown in Table 1: (i) *Data-centric.* Physical involvement of stakeholders is not required; these methods are intended to be used by analysts or requirement engineers. (ii) *Collaboration-centric.* Stakeholders and analysts have to physically work together in dedicated sessions. (iii) *Stakeholder-centric.* Stakeholders do not require the presence of analysts or requirement engineers to elicit requirements. (iv) *Analyst-centric.* These methods are intended to be used exclusively by analysts or requirement engineers; physical presence of stakeholders is not mandatory.

4.2 Evaluation Scheme

As it is important for practitioners to quickly select elicitation methods that best suit their organizational needs, we propose an evaluation scheme that provides immediate feedback regarding the selection of major

Category	Methods	Data					Stakeholders and users					
		P01: Store reviews available?	P02: Social media feedback available?	P03: Similar apps available?	P04: Contextual data available?	P05: Complex app analysis possible?	P06: Are users known?	P07: Are users not known?	P08: Are users geographically distributed?	P09: Have beneficiaries special needs?	P10: Do beneficiaries lack literacy?	P11: Stakeholders ethnographic diverse?
Analyst-centric	Gamification						✓		✓	✓		
	Interview						✓			✓	✓	✓
	Modeling			✓					✓			
	Persona or user profiles							✓	✓			✓
	Wizard of Oz method						✓			✓		
Collaboration-centric	Brainstorming						✓					
	CRC sessions						✓					
	Crowdsourcing							✓	✓			✓
	Focus groups						✓			✓	✓	
	Mobile RE app						✓		✓			
	Photo essays						✓			✓	✓	
	Prototyping						✓					
	Scenarios						✓					
	Story telling						✓			✓	✓	
	Using social network sites or wikis						✓		✓			
	Viewpoint or six thinking hats						✓					
Data-centric	App description mining			✓		✓		✓				
	App log or app usage data mining				✓			✓	✓	✓		✓
	App store mining for similar apps			✓		✓						
	Observation/contextual data/reflection				✓		✓	✓	✓	✓	✓	✓
	Opinion mining	✓	✓	✓		✓		✓				
Stakeholder-centric	Activity theory						✓					
	Mobile feedback app						✓	✓	✓			
	User feedback on MVP						✓					

(a) data/stakeholder/user-based elicitation methods

Category	Methods	Communication channel		Developers			Domain specificity	App specificity	
		P12: Is physical communication possible?	P13: Is digital communication possible?	P14: Are NLP experts available?	P15: Are MVPs/ prototypes feasible?	P16: Are developers geographically distributed?	P17: Is tacit knowledge involved?	P18: Does existing app, process, or web app exist?	P19: Is initial app idea present?
Analyst-centric	Gamification							✓	✓
	Interview	✓						✓	✓
	Modeling						✓		
	Persona or user profiles								✓
	Wizard of Oz method	✓							✓
Collaboration-centric	Brainstorming	✓					✓	✓	✓
	CRC sessions	✓					✓		✓
	Crowdsourcing		✓				✓	✓	
	Focus groups	✓					✓	✓	
	Mobile RE app		✓				✓		✓
	Photo essays	✓							✓
	Prototyping	✓			✓				✓
	Scenarios	✓					✓		✓
	Story telling	✓					✓		✓
	Using social network sites or wikis					✓			
	Viewpoint or six thinking hats	✓						✓	✓
Data-centric	App description mining			✓					✓
	App log or app usage data mining		✓					✓	
	App store mining for similar apps			✓				✓	✓
	Observation/contextual data/reflection						✓	✓	✓
	Opinion mining			✓					
Stakeholder-centric	Activity theory								
	Mobile feedback app		✓					✓	
	User feedback on MVP	✓			✓				✓

(b) communication/developer/domain/app-based elicitation methods

Fig. 1: Mobile requirements elicitation evaluation scheme

requirements elicitation techniques in the mobile application domain. For each of the elicitation techniques we propose 19 evaluation parameters (*P01, ...,P19*) classified into six high level categories. Each category addresses a specific organizational resource.

The scheme is illustrated in Figure 1 and supports various use cases: in the primary use case, the reader first determines the relevance of parameters or parameter categories in the topmost rows. Once the reader chooses the convenient parameters, the available methods are ready to explore in the respective columns. For example, if the reader is willing to convert an existing web application or a business process into a mobile app (*P18*), methods such as *Focus groups* or *Collaborative problem definition* will be efficient to apply as shown in Figure 1a. Furthermore, the reader can exclude techniques by avoiding parameter combinations that are guaranteed to be unfeasible in the corresponding environment. For instance, if the reader can not afford to have personal collaborative interactions (collaborative-centric row category) with users or stakeholders (Stakeholders/Users column), all techniques that lie on the intersection of the row and the column are out of reach for the reader, however, the other techniques still remain available, *e.g.,* the elicitation method *App log/app usage data mining* would be a legitimate choice. We provide another motivating example for requirements engineers that already hold data assets, *e.g.,* data collected from app store reviews or social media platforms: These users can directly obtain all data-related methods by considering all methods available in the *Data-centric* row. Identical procedures, but with other parameters, can be performed with Figure 1b.

In future work we plan to evaluate the utility of the evaluation scheme in practice, and to iterate its design to better support the selection of requirements elicitation methods for mobile apps.

5 Conclusion

We have reviewed major relevant literature in the domain of requirements elicitation for mobile apps or using mobile devices, we extracted numerous elicitation methods, and derived categories suitable for easy selection. In addition, we discovered several different characteristics that have not yet been comprehensively covered in existing literature. Ultimately, we built an evaluation scheme which remains to be validated in practice, though we believe it is well-suited for all complex requirements elicitation scenario, as it is easy to apply and delivers immediate results. We are currently in the process of preparing an extended version of this literature survey.

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