

A Framework for Integrating Web Accessibility Requirements in Agile Methodologies

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Abstract

In the Software Engineering area, Web Accessibility is gaining more space, establishing itself as an important quality attribute. However, considering the agile context, accessibility requirements continue to be neglected. Existing methods and models tend to be overly complex for non-technical stakeholders to properly express their goals and communicate them to the agile team. We propose the development and assessment of a framework to support the elicitation and analysis of web accessibility requirements, in an agile context. The framework consists, primarily, of an accessibility requirements model defined by extending (systematically) a goal-oriented model (the iStar framework).

Keywords

Accessibility, Agile, Goal-oriented Modeling

1. Introduction

The concerns about web accessibility and the discussion about its importance for a wide variety of users, including those with disabilities, starts in 1994 when Tim Berners-Lee founded the World Wide Web Consortium (W3C). A couple of years later, a group of members launched the Web Accessibility Initiative (WAI), an initiative to guide how to handle accessibility in the face of the web's growing complexity [1]. Nowadays, websites and web applications (combining with assistive technologies) have a higher impact on improving persons with disabilities' access to socio-cultural, educational, and economic activities [2].

Among the W3C guidelines, the Web Content Accessibility Guidelines (WCAG) 2.1 covers a wide range of recommendations for making web content more accessible [3]. WCAG is primarily intended for web content developers (page authors, site designers, etc.), web authoring tool developers and to others who want or need a standard for web accessibility. There are other relevant standards similar to WCAG 2.1, such as the Section 508 of the Rehabilitation Act of 1973 [4]; the Guidance on Software Accessibility (ISO 9241-171:2008) [5]; the Information Technology-User Interface Accessibility (ISO/IEC 29138-1:2018) [6]; the International Telecommunication Union (ITU-T) [7]; the European Mandate 376 (EN 301 549) [8].

However, the issues involving web accessibility specifications, implementation, and evaluation are still a concern among IT professionals [9]. Although these guidelines are internationally recognized, they are often difficult to interpret and understand by developers or software

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engineers who end up neglecting their content [9]. In the context of agile methodologies, approaching this type of requirement by development teams is also a challenging task, as there is often a lack of knowledge about the subject and, sometimes, it is only considered in the final phase of the projects [10].

Based on this scenario, we propose the development and assessment of a framework to support the elicitation and analysis of web accessibility requirements in an agile context, since the vast majority of development teams and projects now embrace those methodologies [10]. The framework aims to automate the reuse of these requirements, to support the generation of artifacts such as user stories and personas, and consequently, improve the visualization and communication between stakeholders, and support the analysis of the possible impact of these accessibility requirements on the other system's features.

The remainder of this paper is organized as follows. Section 2 presents the state-of-the-art web accessibility approaches in the literature. Section 3 presents the research objectives and methodological approach used in this PhD thesis. Section 4 presents an overview of the past work and preliminary results. Section 5 presents the future work and expected results, following by the conclusion in Section 6.

2. State of the Art

After conducting a systematic mapping study (see section 3.1), it was feasible to identify some relevant works that addressed the problem of accessibility in web-based systems.

Snider et al. [11], presents a study conducted by IBM researchers, which carried out an analysis of the main sources of data on accessibility used in the company to build an ontology (EACO), which was used to improve the performance of a question-answering accessibility conformance chatbot and others systems used in the company to help IT professionals to get more information about accessibility requirements.

Oliveira et al. [12] proposed a method to elicit web accessibility requirements, followed by a correlation catalogue that summarizes the identified conflicts among its Non-functional requirements (NFRs), and a checklist to help engineers during the design and programming. To accomplish this goal, the authors provided the OmnesWeb tool to support the elicitation activity. A case study revealed that teams using OmnesWeb gathered more requirements, produced all the required artefacts, and spent a quarter of the time less than the time spent by teams that did not use the tool.

Moreno et al. [13] proposed a domain-specific metamodel for web accessibility to support engineers in modeling aspects of accessibility, using the Model Driven Architecture standards, such as meta-object facility and Model-Driven Development. The authors developed the Accessibility for Web Applications (AWA), a methodological framework for the development process of accessible web applications.

The Reichling et al. [14] approach used the User-Centered Design (UCD), which relies on an interactive process of three main phases: analysis, design, and evaluation. The authors proposed to integrate an agile approach to UCD by intertwining the two and applying the UCD principles during the pre-sprint phases to enhance a user-centered approach.

Martín and Yelmo [15] presented a systematic approach to the development of an accessibility

evaluation tool, which was oriented by the Unified Software Development Process (USDP). The authors proposed artifact templates to deal with the different disciplines managed by USDP: a business model and a domain model to kick off the requirements elicitation, a use-case model to represent functional requirements, an analysis model to reflect an intermediate view of the architecture, and a deployment model to describe the physical bindings.

Younas et al. [16] proposed an elicitation guideline for NFR, for agile software development. Since in agile methodologies, story cards are used for the elicitation of functional requirements, the authors proposed another user story card for eliciting NFRs, including accessibility requirements. The process involves the requirements elicitation through interviews, identification of the software type, the identification of requirement type through a glossary, the selection of experts in the area related to NFR type, list of candidate NFR, validation with specialists and validation with the end-user.

Scott et al. [17] presented the VERITAS, a framework that simulates and systematically analyses how users with different impairments interact with the use of ICT products and services. The framework is supported by three core tools: (i) VerGen, to specify the nature of the impairments to be simulated in terms of a virtual user; (ii) VerSEd-GUI, to define and configure a series of actions to test on the user interface of the product or service; and (iii) VerSim-GUI, where the various impairments are simulated to reproduce the experience of an impaired user.

Although these studies present solutions to improve the elicitation, development, and evaluation of accessibility requirements, they do not consider the development context adopted by companies, the artifacts used by them, and the type of users involved in the software project. Our framework aims to fill this gap and also including the use of goal-oriented models, making this process simple and effective.

3. Research Objectives

One of the main objectives of this thesis is to develop a framework to support professionals (with or without expertise in the web accessibility domain) in the process of elicitation, analysis, development, and validation of accessibility requirements following the agile routine. Another objective is related to the engagement of stakeholders in the requirements engineering process, improving communication and involvement between them. The framework aims to improve the specification and use of accessibility requirements through a goal-oriented model in accordance with the accessibility guidelines proposed by W3C [3]. Also, the framework aims to facilitate the visualization of requirements according to each project and with each users' special needs, as well as allowing the analysis of the impact of these requirements on the other features of the system. To achieve these objectives, the following phases need to be addressed.

3.1. Systematic Mapping Study

This phase is concerned with the delimitation of the scope of this thesis. For this purpose, a systematic mapping study was conducted to identify the existing approaches (including methods, processes, techniques, frameworks, and tools) in the literature that could be used by IT professionals to elicit, develop and evaluate accessibility requirements in agile projects to

offer a comprehensive overview of these methods, their characteristics, applicability, possible limitations and a research roadmap with the open issues requiring future research.

3.2. Planning and design

This phase is concerned with the diagnosis of current accessibility requirements approaches adopted by agile teams, with the definition of the features to support the design and development of the framework, and with the design of the experiment to be conducted with stakeholders. First, it is necessary to analyze selected companies that adopt the agile methodologies to identify, through questionnaires and interviews, how web accessibility requirements are approached and what is the impact of using these approaches on the final product – we will follow the principles of a Straussian Grounded Theory (GT) [18]. To analyze this impact, accessibility tests will be carried out on the products developed through the AChecker evaluation tool [19]. This first step is necessary to (i) identify the main problems in the approaches used by companies to elicit accessibility requirements and find solutions to fix them through our proposed method; (ii) identify and translate these problems to a set of features to be used in the design and implementation of the framework. After the identification of the features, a catalog of web accessibility requirements will be defined and represented by extending the iStar framework, which supports goal-oriented modeling of socio-technical systems and organizations. The extension will be carried out systematically adapting a process for extending iStar, called PRISE [20]. Some studies show that goal-oriented models have been used as an effective means to capture interactions and trade-offs between requirements, helping stakeholders to have a graphical view of the team's goals and how to achieve them [21, 22, 23, 24, 25]. The next step is providing a set of artifacts to be used by the agile team and other stakeholders in the process of elicitation of accessibility requirements. Also, it will be carried the analysis of the impact of accessibility requirements on other system's features and perform the necessary trade-offs. To accomplish this, we will use multi-criteria decision methods (MCDM) that can be used to identify possible conflicts (semi-)automatically and help solve them [26].

Regarding the experiment with stakeholders, we need to plan it systematically, starting with the definition of a hypothesis (e.g., it is possible to use the framework to support IT professionals and stakeholders in the elicitation of accessibility requirements). The expected deliverables for this phase are: a) a report with the results of the GT; b) a report with the framework features, the impact analysis and design planning for the experiment with stakeholders.

3.3. Implementation and evaluation

The implementation of the framework allows not only the elicitation process of the accessibility requirements, but also the (semi)automated generation of artifacts that can be used in an agile context, such as user stories and personas, according to the WCAG guidelines proposed by W3C. The framework will be developed as a web platform that will provide a catalog, an accessibility requirement model based on the iStar framework (in conformance with the notation of the goal-oriented model and the artifacts produced by agile teams), a checklist with the correlations between these requirements with other system's feature and the impact of the requirements in the final product. The expected deliverable is the framework including editor, catalog, and the

generator of user stories, personas and other features, which can be consulted by the entire agile team, at any stage of development.

For the evaluation of the proposed framework, we will carry out case studies in companies that adhere to the agile methodologies, that already considered the accessibility requirements in their projects and that work with web-based systems. Based on this evaluation, we will be able to analyze how satisfactory or not our method was in the process of eliciting requirements and improving communication between stakeholders. The framework will be evaluated by IT professionals and accessibility specialists in terms of accessibility, usability, and applicability to support the elicitation process. Also, it will be carried out an evaluation with a group of people with special needs, to identify whether the framework complies with WCAG parameters.

Also, one needs to evaluate the usability of the notation of the models approaches from the perspective of ordinary users, by using biometric equipment like EEG scanners, eye-trackers, and cognitive processes. These techniques will also be useful to assess the effort spent by users in order to create, change, and understand different models. We will follow the process described by Jedlitschka et al. [27].

4. Past work and preliminary results

As mentioned in Section 3.1, a systematic mapping study was conducted to find in the literature approaches that focused on solving web accessibility issues. The mapping study has shown that many of these approaches are not widely disseminated in industry, and other identified techniques have not been empirically validated, which may increase the chances of discontinuity. Another point to be highlighted is that some of these studies only focused on one type of disability, which continues to be an accessibility concern. Given that the complexity and qualities of the web content are constantly changing, frequent validations of the techniques and methods adopted are crucial to guarantee the minimum of accessibility. Finally, we also found that many papers focus on accessibility evaluation processes, i.e., to verify that websites meet the accessibility requirements defined by guidelines such as WCAG. Validation methods were also identified during the development phase, which is critical to ensuring that the system is patched and improved before it is made available to the end-user.

After analyzing the results, we also identified that the agile approach, adopted by most companies in the world, was not considered in most of the studies. Those methodologies are broadly used by improving project quality and reducing development costs. Although the adoption of those methodologies intending to deliver high-quality products, we identified that many organizations still adopt a waterfall approach to accessibility testing, leaving it to the end of the project lifecycle. This information was crucial to delimit the scope of our proposed framework.

5. Future work and expected results

The thesis is currently on the initial steps mentioned in the section 3.2, regarding the planning and design phase (see Appendix A). The results of this thesis will contribute to software development in general, and requirements engineering in particular, with a support framework

for improving the accessibility requirements' process with early detection of accessibility problems in agile requirements models. The expected contributions are: (i) a framework to facilitate the process of identifying, analyzing and implementing accessibility requirements and to support the generation of artifacts as user stories and personas; (ii) a goal-oriented accessibility requirements model suitable for agile routine; (iii) an accessibility catalog; (iv) an identification of issues on the current methods adopted by companies to incorporate accessibility requirements in agile projects; (v) an evaluation of the framework from the perspective of common users and requirements engineers, by using biometric equipment like EEG sensors and eye-trackers [28], combined with process metrics such as effort, in the production, understanding, and modification of the accessibility requirements model (measured in terms of time to complete tasks and of achieved correctness), in order to classify engineers' and user's experience and progress during modelling tasks.

6. Conclusions

This paper presents a broad overview of the doctoral thesis work plan that is being carried out in the context of accessible web systems. After conducting a systematic mapping study, it was possible to identify a gap to be filled: the need to develop a framework that can improve the process of eliciting accessibility requirements considering the agile development. The paper also presented the past and future work, including the conduction of a Grounded Theory to identify and understand the current elicitation, development, and evaluation process of this type of requirement in agile teams, followed by the development and validation of the framework using well-established techniques adopted in the literature.

From the several reports created in each one of the phases, the most relevant contributions will be submitted to major scientific conferences, seminars, and journals. The produced framework will be published in an open software repository so that requirements engineers can access it and use it in their projects.

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A. Work Plan

PhD Project

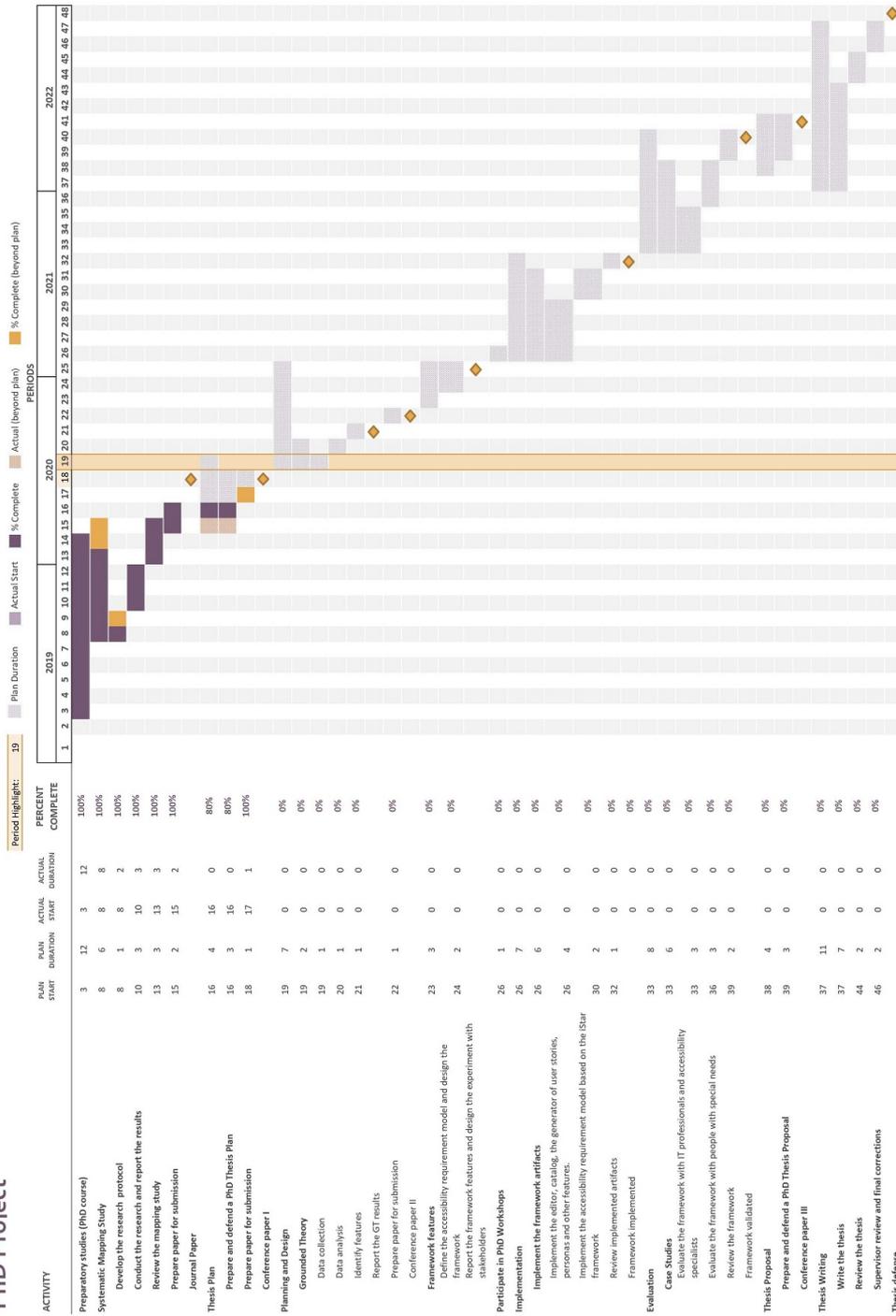


Figure 1: Timeline of the research.

B. Poster

A Framework for Integrating Web Accessibility Requirements in Agile Methodology

Context

Over a billion people, about 15% of the world's population, have some form of disability [1].

About 3.2 billion people, or almost half of the world's population, use the internet. Of them, about 2 billion are from developing countries [2].

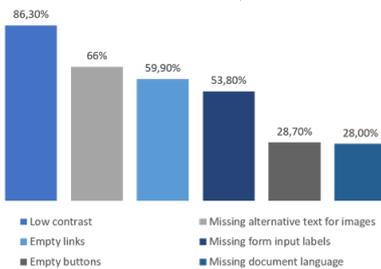


Problem

International standards and guidelines are often difficult to interpret and understand by developers or software engineers who end up neglecting their content.

The majority of development teams and projects now embrace the agile methodology [3]. However many organizations still adopt a waterfall approach to accessibility testing.

Causes of Most Common Accessibility Failures (% of Home Pages)
Source: The WebAIM Million Report, 2020



Proposal



The development and assessment of a framework to support the elicitation and analysis of web accessibility requirements in an agile context.

Methodological Approach



Planning and Design

- Systematic Mapping Study
- Straussian Grounded Theory
- Define a catalog of web accessibility requirements
- Adapt the PRISE - a process for extending iStar framework.



Implementation

- The framework will be developed as a web platform
- Develop an accessibility requirement model based on the iStar framework
- Develop a checklist with the correlations between accessibility requirements with other system's feature



Evaluation

- Case Studies
- Evaluate the framework with IT professional, accessibility specialist and people with special needs
- Use biometric equipment like EEG scanners, eye-trackers, and cognitive processes



The framework aims to improve the specification and use of accessibility requirements through a goal-oriented model and agile artifacts in accordance with the accessibility guidelines proposed by W3C.

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Figure 2: The poster with an overview of this research.