Characterizing Usability Inspection Methods through the Analysis of a Systematic Mapping Study Extension

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Abstract. Usability is one of the most relevant quality aspects in web applications. A web application is usable if it provides a friendly, direct and easy to understand interface. Many Usability Inspection Methods (UIMs) have been proposed as a cost effective way to enhance usability. However, many companies are not aware of these UIMs and consequently, are not using them. A secondary study can identify, evaluate and interpret all data that is relevant to the current knowledge available regarding UIMs that have been used to evaluate web applications in the past few decades. Therefore, we have extended a systematic mapping study about Usability Evaluation Methods by analyzing 26 of its research papers from which we extracted and categorized UIMs. The results analysis provides practitioners and researches with the rationale to understand both the strengths and weaknesses of the emerging UIMs.

Keywords: Usability Inspection Methods, Web Applications, Systematic Mapping Extension

1 Introduction

In recent years, web applications development demand has grown considerably. Consequently, controlling and improving the quality of such applications has increased. Olsina et al. [11] state that when evaluating software quality one of the most relevant aspects is usability. In the last decade, the software development industry has invested in the development of a variety of Usability Inspection Methods (UIMs) to address web usability issues [6]. However, Offut [10] affirms that many of the existing web applications still do not meet most customers' usability expectations. According to Insfran and Fernandez [4], despite the increasing number of emerging UIMs, companies are not using them. The lack of employment of these UIMs can be one of the reasons for the low quality of web applications.

Alva et al. [1] and Cunliffe [2] present studies and comparisons of existing UIMs. However, these studies, like many others, show that the selection of a UIM is normally driven by the researcher's expectations. There is a need for a more organized identification of those UIMs that have been successfully applied to web development. A literature review with an objective procedure for identifying the state of art of UIMs

can provide practitioners with a knowledge background for choosing a determined UIM. Moreover, this type of review can identify gaps in current research in order to suggest areas for further investigation.

Fernandez et al. [3] carried out a systematic mapping study to assess which Usability Evaluation Methods have been used for web usability evaluation and their relation to the web development process. We based our work in this study and reduced its scope from the point of view of the following research question: "*What new Usability Inspection Methods have been employed by researches to evaluate web artifacts and how have these methods been used?*" In this systematic literature review analysis we have extended the study in Fernandez et al [3]. We selected papers from the systematic mapping that address new Usability Inspection Methods. We have created new research sub-questions to thoroughly analyze each of the selected papers. This new analysis has allowed us to provide further details on the actual state of Usability Inspection Methods for the web. Furthermore, we present practitioners and researchers with useful information of the new UIMs that have emerged.

The extended analysis of the systematic mapping has allowed us to outline important issues, which are, among others: (a) at what extent the inspection process is automated; (b) which is the most commonly evaluated artifact; (c) what type of applications are being evaluated by UIMs; and (d) which basic Usability Evaluation Methods or Technologies are used by UIMs as background knowledge to carry out the inspection process.

This paper is organized as follows. Section 2 presents the background of Usability Inspection Methods and introduces readers to the scope of this work. Section 3 describes how we extended the systematic mapping in Fernandez et al. [3]. Section 4 presents the results from the literature review that answers the research question. In Section 5 we discuss our findings and their implications for both research and practice. Finally, Section 6 presents our conclusions.

2 Background

In this section we provide a background of usability inspection methods, presenting some core ideas and the main methods for usability inspection. Finally, we justify the need for this systematic literature review analysis.

2.1 Usability Evaluation

The term usability is defined in the ISO 9241-11 [5] as "*the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use*". According to Mendes et al. [7], a web application with poor usability will be quickly replaced by a more usable one as soon as its existence becomes known to the target audience. Insfran and Fernandez [4] discuss that many usability evaluation methods (UEMs) have been proposed in the technical literature in order to improve the usability of different kinds of software systems.

UEMs are procedures composed by a set of well-defined activities that are used to evaluate the system's usability. There are two categories of UEMs: user testing and inspections. A user testing is a user centered evaluation, in which empirical methods, observational methods and question techniques can be used to measure usability. User testing captures usage data from real end users while they are using the product (or a prototype) to complete a predefined set of tasks. The analysis of the results can provide testers with information to detect usability problems and to improve the system's interaction model. Inspections, on the other hand, are evaluations that make use of experienced inspectors to review the usability aspects of the software artifacts. The inspectors base their evaluation in guidelines that check the system's level of achievement of usability attributes. Based on this evaluation, inspectors can predict whether there will be a usability problem or not.

When carrying out a usability evaluation, both approaches have advantages and disadvantages. User testing can be used to address many usability problems affecting real end users. However, according to Matera et al. [6], it may not be cost-effective as it requires more resources to cover the different end user profiles. Furthermore, as it needs full or partial system implementation, it is mostly used in the last stages of the web development process. Inspections, on the other hand, can be used in early stages of the web development process. Moreover, inspections methods require fewer resources and therefore can lower the cost of finding usability problems [13].

2.2 Usability Inspection Methods

According to Matera et al. [6], the main Usability Inspection Methods (UIMs) are the Heuristic Evaluation [8] and The Cognitive Walkthrough [12]. The Heuristic Evaluation, proposed by Nielsen [8], assists the inspector in usability evaluations using guidelines. The evaluation process consists of a group of evaluators who examine the interface using heuristics, which are a collection of rules that seek to describe common properties of usable interfaces. Initially, inspectors examine the GUIs looking for problems and if one is found it is reported and associated with the heuristics it violated. Afterwards, inspectors can rank problems by their degree of severity.

The Cognitive Walkthrough, proposed by Polson et al. [12], is a method in which a set of reviewers analyze if a user can make sense of interaction steps as they proceed in a pre-defined task. It assumes that users perform goal driven explorations in a user interface. During the problem identification phase, the design team answers the following questions at each simulated step: Q1) *Will the correct action be made sufficiently evident to the user?* Q2) *Will the user connect the correct action's description with what he or she is trying to do?* Q3) *Will the user interpret the system's response to the chosen action correctly?* Each negative answer for any of the questions must be documented and treated as a usability problem.

According to Rocha and Baranauska [13] there are other usability inspection methods which are based in guidelines and consistencies. Guidelines Inspections, which are similar to the Heuristic Evaluation, have their own usability set of rules and need experienced inspectors to check them. A consistency inspection verifies if an interface is consistent with a family of interfaces. Another technique, proposed by Zhang et al.

[14], is the Perspective-based Usability Inspection in which every section of the inspection focuses in a sub-set of questions according to the usability perspective. These techniques can be used to increase the system's usability and therefore its quality.

2.3 Motivation for a Literature review about UIMs

There have been several studies concerning Usability Evaluation Methods. However, there are few studies regarding the state of art of Usability Evaluation Methods. Insfran and Fernandez [4] investigated which usability evaluation methods have been used in the web domain through a systematic mapping study. Later, Fernandez et al. [3] published an expanded version of the systematic mapping by adding new studies and further analysis. The goal of both researches was to provide a preliminary discussion about how UEMs have been applied in the web domain.

Regarding Usability Inspection Methods, which are a subset of Usability Evaluation Methods, we found out that there have been many studies assessing UIMs. Nonetheless, we are not aware of any study regarding the state of art of such methods. There is a need for a more specific investigation on Usability Inspection Methods. Consequently, we have extended part of the study available in Fernandez et al. [3]. We have selected papers describing new UIMs and thoroughly analyzed them using new data extraction criteria in order to present useful information about new UIMs.

3 Procedure

This systematic mapping extension was based in the systematic mapping executed by Fernandez et al. [3]. With this extension, we aim to answer more questions regarding the state of art of UIMs for the web.

Figure 1 shows the four stages for performing this systematic mapping extension: selection of primary studies, data extraction strategy, conducting stage and reporting. In the next sub-sections we describe activities previous to the reporting stage. We will thoroughly describe the reporting stage in section 4.

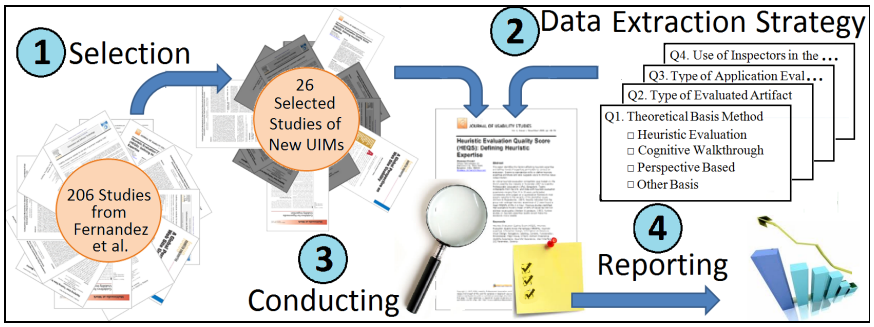

Fig. 1. Stages for performing the Systematic Mapping Extension.

3.1 Selection of Primary Studies

In Fernandez et al. [3] we found a total of 206 papers which referred to UEM's. In order to better address their research question, the authors created a set of seven research sub-questions each paired with a set of possible answers. Table 1 shows the questions Fernandez et al [3] used in order to divide the extracted papers into categories for analysis purposes.

Table 1. Research sub-questions and possible answers from Fernandez et al. [3].

Research Sub-Question	Possible Answers	
Q1. Origin of the UEMs employed	**a) New**	b) Existing
Q2. Underlying usability definition of the UEMs employed	a) Standard	b) Ad-Hoc
Q3. Types of UEMs employed	a) User Testing c) Simulation e) Inquiry	**b) Inspection** d) Analytical Modeling
Q.4 Empirical Validation of the UEMs	a) Survey c) Experiment	b) Case Study d) No
Q5. Type of evaluation performed by the UEMs employed	a) Manual	b) Automated
Q6. Phase(s) and Web artifacts in which the UEMs are applied	a) Requirements c) Implementation	b) Design
Q7. Feedback provided by the UEMs	a) Yes	b) No

Our goal with this systematic mapping extension is to analyze the current use of new UIMs in the web domain by answering the following research question: "*What new usability inspection methods have been employed by researchers to evaluate web artifacts, and how have these methods been used?*" If we look at the terms in bold in Table 1, we can see that papers having answers "new" and "inspection" to questions Q1 and Q3 respectively are related to our research question. Therefore, from the total of 206 papers, cited in Fernandez et al. [3], we selected those describing the application of new inspection methods.

Since our research question is too broad to thoroughly describe how UIMs are being applied, we also decomposed it into sub-questions for it to be better addressed. Table 2 shows these research sub-questions and their motivation. Furthermore, we only selected studies thoroughly describing UIMs at a mature stage. Consequently, we discarded papers that met at least one of the following exclusion criteria:

(a) Papers presenting usability problems and no methodology to identify them.
(b) Papers describing only ideas for new research fields.
(c) Papers presenting techniques with no description of their execution process.

Table 2. Research sub-questions and motivations for this systematic mapping extension.

Research Sub-Question	Motivation
Q1. Theoretical Basis Method	To discover whether the Usability Inspection Methods for the Web have been developed considering well known Generic Usability Inspection Methods or whether they have been using new bases.
Q2. Type of Evaluated Artifact.	To discover what artifact is the most commonly evaluated in Usability Inspection Methods for the Web.
Q3. Type of Web Application Evaluated by the Inspection Method	To discover whether the Usability Inspection Methods for the Web have been crafted to discover generic usability problems or usability problems of a specific type of Web application.
Q4. Use of Inspectors in the Inspection Process	To discover whether the Usability Inspection Methods for the Web have been automated to a point where inspectors are no longer necessary.

3.2 Data Extraction Strategy

In order to extract data for further analysis, we used the answers provided in each of the research sub-questions we defined. This strategy guarantees that all selected papers will be objectively classified. The possible answers to each research sub-question are explained in more detail as follow.

With regards to Q1 (Theoretical Basis Method), a paper can be classified in one of the following answers: (a) Heuristic Evaluation: if the presented method is a UIM based on Nielsen's [9] Heuristic Evaluation; (b) Cognitive Walkthrough: if the presented method is a UIM based on Polson's [12] Cognitive Walkthrough; (c) Perspective Based: if the presented method is a UIM based on different Perspectives (such as Zhang et al [14] Perspective-based Usability Inspection); and (d) New Basis: if the presented method is based on a new approach.

With regards to Q2 (Type of Evaluated Artifact), a paper can be classified in one of the following answers: (a) HTML: if the presented method analyzes code in order to find usability problems; (b) Model: if the presented method analyzes models in order to find usability problems; and (c) Application/Prototype: if the presented method analyzes applications or prototypes in order to find usability problems.

With regards to Q3 (Type of Web Application Evaluated by the Inspection Method), a paper can be classified in one of the following answers: (a) Generic: if the presented method can be applied to any type of web applications; and (b) Specific: if the presented method evaluates specific types of web applications.

With regards to Q4 (Use of Inspectors in the Inspection Process), a paper can be classified in one of the following answers: (a) Yes: if the presented method needs the intervention of experienced inspectors in order to find usability problems; and (b) No: if the presented method is fully automated and can carry an usability evaluation without the supervision of experienced inspectors.

3.3 Conducting Stage

From the initial set of 206 papers in Fernandez et al. [3], we selected 37 papers by using their answers to questions Q1 and Q3. However, 5 papers were unavailable for download forcing us to reduce the initial set to 32.

After reading each study, we discarded 6 studies for meeting the exclusion criteria we defined above. The Selected Primary Studies List in this paper shows the 26 selected papers that we analyzed in this literature review. We used the data extraction strategy defined in the previous sub-section to address the current stage of UIMs for the web. We discuss our results in Section 4.

4 Results

The results of the classification of primary studies and its summary are shown in Table 3. We based these results on counting the number of answers to each research sub-question. Readers must take note that questions Q1 and Q2 are not exclusive. A study can be classified in one or more of the answers of these questions and, therefore, the summation of the percentages is over 100%.

Table 3. Results of the classification analysis.

		Paper																										
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total Studies	%
Q01	A	x									x	x	x					x			x				x			7	26.92
	B						x	x	x						x		x											5	19.23
	C									x			x											x		x		4	15.38
	D		x	x	x	x				x				x		x			x	x	x	x	x	x		x	x	15	57.69
Q02	A		x																			x		x			x	4	15.38
	B				x														x			x		x				4	15.38
	C	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x		x	x		20	76.92
Q03	A		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	23	88.46
	B	x				x																			x			3	11.54
Q04	A	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		24	92.31
	B		x																								x	2	7.69

Categorization of Primary Studies
Q01.- Theoretical Basis Method: (a) Heuristic Evaluation (b) Cognitive Walkthrough (c) Perspective Based (d) Other Basis
Q02.- Type of Evaluated Artifact: (a) HTML (b) Model (c) Application/Prototype
Q03.- Type of Web Application Evaluated by the Inspection Method: (a) Generic (b) Specific
Q04.- Use of Inspectors in the Inspection Process: (a) Yes (b) No

In the following sub-sections we present the analysis of the results for each research sub-question, describing how the analyzed methods have been used. Readers must take note that we will reference the papers listed in the Selected Primary Studies List by using an S followed by the paper's sequence number.

4.1 Theoretical Basis Method

The results for sub-question Q1 (Theoretical Basis Method) revealed that, with respect to already known usability inspection methods, around 27% of the reviewed papers were based on Nielsen's [9] Heuristic Evaluation, around 19% were based on Polson's [12] Cognitive Walkthrough, and around 15% were based on Perspectives.

Papers based on Nielsen's [9] Heuristic Evaluation, mainly focused on better describing or self explaining how or in which situation each heuristic could be applied. Papers S11 and S24 provide inspectors with a set of examples in order to better address usability problems while using heuristics. Papers S12 and S20 make improvements in Nielsen's original set of heuristics by combining them with other methods.

Regarding the use of the Cognitive Walkthrough, two new inspection methods were developed: Blackmon's CWW described in papers S06, S07 and S08; and Filgueiras' RW described in S14. Moreover, paper S16 validates how eye tracking and cognitive Walkthrough can be applied together in a study carried out by Habuchi et al.

Studies S09, S12, S23 and S25 make use of perspectives to help focus on each usability attribute when carrying out the inspection. This basis was applied along with other methodologies to guarantee better performance.

The remaining 58% of the studies reported that other techniques are being proposed to focus on the web domain. Most studies describe techniques based on heuristics specifically proposed for the web domain. Another approach is the transformation of usability principles found in standards like ISO 9241-11 [5].

These results may indicate that new approaches are being designed. Nevertheless, many of the proposed UIMs still make use of general approaches and were adapted to the web domain. In fact, some of the selected papers (S12, S20, S23 and S25), that make use of adapted methods, combine two or more approaches to improve inspectors' performance during the usability evaluation.

4.2 Type of Evaluated Artifact

The results for sub-question Q2 (Type of Evaluated Artifact) revealed that most UIMs analyze Applications or Prototypes. Around 77% of the reviewed papers reported a UIM that made use of a functional prototype/system or a paper based prototype. Inspectors carry out the evaluation process by analyzing the interaction provided by the prototype or product while executing a task on it. These results may indicate that unless the prototype was paper based, most of the usability inspection techniques are being used in stages where at least part of the system is functional.

The remaining papers are divided into HTML analysis (15%) and Model analysis (15%). Papers S02, S21, S23 and S26 describe automated techniques in which HTML code can be analyzed in order to, based on usability guidelines and patterns, discover usability problems. The selected papers show that HTML analysis is generally used in the final stages of web development where the actual system's code is available for inspection. Automating HTML analysis can reduce the cost of this type of inspection. However, that does not imply that correcting the usability problems will be inexpen-

sive, since they will be found in the last stages of the development process. Studies S04, S18, S21 and S23, show UIMs that make use of models to identify usability problems. Models aid to represent human computer interaction while the inspector verifies if the model meets rules for interaction in the web domain. This type of UIMs can help find usability problems on early stages of the development process, thus reducing the cost of correcting them. Nonetheless, according to the selected studies, these UIMs still make use of usability experts to analyze web artifacts.

4.3 Type of Web Application Evaluated by the Inspection Method

The results for sub-question Q3 (Type of Web Application Evaluated by the Inspection Method) revealed that around 88% of the selected studies could be applied to any web application. For instance, papers S06, S12 and S14 described UIMs that adapted generic usability inspections to the web domain. Studies S18, S19 and S25 are examples of techniques that created their own web usability features but still remained broad to analyze any type of web application.

The remaining papers (S01, S05 and S24), around 12% of the selected studies, focused the proposed UIMs to a specific type of web application in order to be more effective in identifying usability problems. Allen et al. (S01) describe a paper based technique to evaluate medical web applications. Basu (S05) proposes a new framework to evaluate e-commerce applications in order to find usability problems based on the applications' context of use. In paper S24, Thompson and Kemp evaluate web applications developed within the Web 2.0 context.

4.4 Use of Inspectors in the Inspection Process

The results for sub-question Q4 (Use of Inspectors in the Inspection Process) revealed that around 92% of the selected studies made use of inspectors to carry out the UIMs evaluation process. The remaining 8% did not use any inspectors at all. A further analysis shows that there is a relationship between the UIM's evaluated artifact and the degree of automated process. We noticed that HTML analysis could be fully automated but other type of UIMs still depend on inspectors. Despite using HTML analysis, papers S21 and S23 describe partially automated UIMs. These studies propose hybrid types of UIMs and consequently make use of inspectors to verify the overall inspection process.

5 Discussion

This section summarizes the principal findings of this literature review. We also present the implications for both research and practice.

5.1 Principal Findings

The goal of this literature review was to examine the current use of new usability inspection methods that have emerged to evaluate web artifacts. The principal findings of this study are the following:

1. Usability inspection methods for the web are emerging by: (a) evolving previous generic usability inspection methods and adapting them to the web domain; and (b) creating new specific evaluation criteria for the web. However, as these UIMs evaluate different usability dimensions depending on the basis they use, none of them can address all circumstances and types of web artifacts. Consequently, the efficiency and effectiveness of the method depends on what is being evaluated: (a) code, (b) prototyped or finished interfaces, or (c) models. A combination of methods could be used to enhance the evaluation results.
2. There is a higher number of UIMs for generic web applications compared to the number of UIMs for specific web applications. Generic UIMs focus on finding usability problems that can be applied to every web application but most of them do not provide feedback on how to treat a violation of usability. On the other hand, UIMs that evaluate specific types of web applications provide evaluators with more data regarding that type of application. This data enables inspectors and practitioners to focus on usability problems that can affect the usability of that specific web application but cannot be applied to all web applications.
3. The automation of the inspection process is not yet possible in techniques involving judging and human interaction. Consequently, techniques using model and prototype analysis are not being automated but enhanced by using tools to provide inspectors with means of reducing evaluation effort. However, UIMs that use code analysis to find inconsistencies in color or patterns are now being automated. Nevertheless, the evaluated usability aspects of these UIMs are less than the UIMs that make use of inspectors.

5.2 Implications for Research and Practice

The results of our literature review have implications for both researchers and practitioners. In this sub-section we will discuss suggestions for: (a) researchers planning new studies or suggestions of usability inspections of web applications; and (b) practitioners working in the web development industry and interested in integrating UIMs into their web development process in an effective manner.

For researchers, we discovered that most UIMs focused on different aspects not always present on every technique. New UIMs should take into account all existing usability aspects in order to include them, not duplicate them, and not confuse them; therefore allowing the UIM to provide more consistent and complete evaluations.

Our results show that there is a relationship between the type of evaluated artifact and their degree of automation (see Table 3). We noticed that most UIMs that make use of model and prototype analysis are not being automated. However, UIMs making use of code analysis are partially or fully automated. We therefore consider there is a shortage of UIMs able to automatically address usability when evaluating models or

prototypes of web applications. The main problem seems to be that most UIMs are not being able to evaluate usability application dependant factors without the intervention of an inspector.

Our findings regarding the evaluation of generic and specific attributes of web applications allowed us to determine that there is a small number of UIMs for specific web applications. The categorization made by this type of UIMs is focused on the context of use, allowing the evaluation of aspects not considered by generic UIMs. For instance, some papers (S05 and S24) categorize web applications within the subset they are evaluating and allow inspectors to filter usability factors in order to better address usability problems. We consider that there is a need for more UIMs for specific categories of web applications in order to increase accuracy regarding each type of web applications.

According to Fernandez et al. [3] most UIMs for the web are being employed in the requirements, design and implementation phase. We found out the actual UIMs mostly focus on the design and implementation phases. This can be observed in Table 3 as most types of UIMs basically make use of model, code or prototype analysis. Model analysis is mostly applied during the requirements and design phase while code and prototype analysis is carried out during the implementation phase. During our investigation we found out that most models analyses were carried out after all requirements were specified. Since correcting usability problems during the last stages of the development process can be a costly activity, new research should be oriented towards evaluating early web artifacts such as the requirement specifications.

Practitioners must consider that none of the presented UIMs is able to address all usability problems. However, they can be combined to improve evaluation results and find more usability problems. We only found one technique (S18) that addressed usability issues during the requirement elicitation phase. The other discussed UIMs can be mostly used in the design and implementation phases. Therefore, practitioners can apply these techniques in different development phases to increase effectiveness.

In order to improve efficiency many tools have been developed to enhance the speed of usability inspections. Moreover, practitioners can use HTML analyzers to automatically detect color or patterns that produce usability problems. Nevertheless, these analyzers cannot substitute inspectors to find more subjective and intuitive usability issues. Practitioners must bear in mind that each web application has its specific attributes and therefore UIMs must be adapted to fit users' expectations within a determined context of use. Consequently, in order to execute more consistent and complete evaluations, practitioners must consider all usability factors within the UIMs they apply. This information can be very useful in detecting usability problems and enhancing the evaluation results.

6 Conclusions

Different inspection methods have been proposed in the past decade to evaluate the usability of web applications. However, practitioners are not using them [4]. A possible motive for this lack of usage can be the small amount of information available

about them. Despite researchers' efforts to summarize the current knowledge in UEMs, these few existing reviews do not thoroughly describe the actual state of the new proposed UIMs. There is a need for a more organized identification of UIMs for the web in order to meet practitioners' needs.

This paper has extended a systematic mapping study on UEMs for the web by thoroughly describing UIMs used to examine web artifacts. From the initial set in Fernandez et al. [3] we selected 26 papers addressing new UIMs. We have created new research sub-questions to thoroughly analyze each of the selected papers in order to extract and categorize UIMs. The analysis of the results has allowed us to extract conclusions regarding the state of art in the field of Usability Inspection Methods.

The results show that the fully automated UIMs are based on HTML analysis. Model and Application/Prototype analysis still make use of inspectors and greatly depend on the evaluator's expertise. UIMs for the web are following the steps of generic UIMs like Heuristic Evaluation, Cognitive Walkthrough and are using perspectives to carry out inspections. Furthermore, some of them are focusing on specific types of web applications. As UIMs are being applied in later stages of the web development process the cost of reducing usability problems is high. However, new suggestions and approaches are being proposed to enhance the effectiveness and efficiency in finding usability problems in the early stages of the development process.

This analysis has shown that there are many solutions that can be applied regarding UIMs. Nonetheless, there is still room for improvement, particularly in the automation of these methods and including them in the early stages of the web applications development process. We hope that our findings will be useful in the promotion and improvement of the current practice and research of Web usability. We also expect to provide an outline to which usability evaluation methods can be applied in order to evaluate Web artifacts and how they are employed.

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