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Usability Work in Agile Systems Development Practice: A systematic review

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Abstract. In this paper we present the results of a systematic literature review of the recommendations in the existing research literature on usability work in agile systems development. The review contributes by summarizing the literature in light of seven claims about how to integrate usability work into an agile development project. By analyzing the claims we show how the previous literature provides grounds, warrants, backing, rebuttal, and qualification with regard to each of them. From this comprehensive overview of the literature we then discuss a research agenda with a particular focus on how situational factors for the claims must be researched and how this must encompass identified rebuttals and qualifications.

Keywords: agile systems development, interaction design, user experience design, usability work.

1 Introduction

Agile methods are increasingly used for information systems development (ISD). This trend is stimulated by today's dynamic business environment (Conboy, 2009) and the growing preference among practitioners for these methods due to their perceived effectiveness (Williams and Ferguson, 2007). However, agile methods have been challenged with regard to their lack of focus on system usability and usability work (Jokela and Abrahamsson, 2004). This contradiction has led to sustained research interest in the phenomena (Silva da Silva et al., 2011).

Recent criticisms on user-centered design in agile development include contentions about the methodological claims being grounded on anecdotal evidence (Hussain et al., 2009a; Silva da Silva et al., 2011). Further, that researchers have largely ignored situational factors and their influences on methods-in-use in positing solutions to the phenomena (Ferreira et al., 2011). In tandem, differences between these theorized solutions have been found to be mostly superficial, as an examination of their structural foundation reveals them to be focused on common practices and artifacts (Silva da Silva et al., 2011).

If the suggested usability methods are assumed to consist of similar practices and artifacts, they could be expected to comprise similar recommendations on how usability efforts should be performed within agile development projects. Taking this proposition into account and viewing this against the backdrop of the highlighted criticisms of agile usability research, two questions emerge which motivate our review of the agile usability literature:

- What are the recommendations on how usability work should be executed within agile contexts?
- Are there situational factors that influence these and what is the nature of such influences?

The rest of the paper is structured as follows, in section 2, we discuss our conceptual background, section 3 details the review process, sections 4, 5, 6 details our analysis, discussion and conclusion respectively.

2 Conceptual Background

We base our review on the understanding of 'usability' within agile contexts as going beyond being concerned only with the attributes of a system, to also encompassing the work efforts through which such a system materializes (Jokela and Abrahamsson, 2004). Our stance is based on the logic that the three perspectives of usability; that is the product, process and experiential perspectives (Seffah et al., 2001; Balázs Polgár and Biró, 2011; Hertzum and Clemmensen, 2012), all find commonality in the means through which they materialize, which is through an exertion of work. This encompasses:

1. How guidelines or design heuristics are applied as in the case of the product perspective (Folmer and Bosch, 2002).
2. How processes are followed as in the process perspective (Gulliksen et al., 2003).
3. How user perceptions are measured as in the case of the experiential perspective (Bevan, 2009).

It is for this reason we have elected to use the term *usability work* as our working concept, which represents all the work practices (and practice abstractions) that relate to the above-mentioned perspectives, being conducted in software and systems development processes.

The issues surrounding agile methods and usability work stem from the assertion that agile methods hinder the performance of usability work (Jokela and Abrahamsson, 2004). This has been linked to the manner in which it has been implemented so far. An example is the process of acquiring just-in-time system requirements, which has been identified as hindering the in-depth exploration of user requirements (Blomkvist, 2005; Chamberlain et al., 2006). Such observations have resulted in a plethora of solutions existing in the form of guidelines and methodologies (Ferreira et al., 2011) and which form the main focus of our review.

3 Review Methodology

Silva da Silva et al. (2011) recently reviewed a body of knowledge with a particular focus on the development of a theoretical construct for the integration of user-centered design (UCD) and agile methods. Our review distinguishes itself from this work in three ways to seek answers to the research questions posed above. Firstly, we seek to identify the recommendations on the integration of usability work and agile methods. Secondly, we go beyond this to identify also situational factors influencing the integration and examining the nature of such influences. Thirdly, we have broadened the scope to usability work instead of user-centered design, for reasons highlighted in the preceding section.

Our focus on usability work influenced how we selected papers from the body of knowledge used in the Silva da Silva et al. review and the subsequent literature search we carried out in Scholar Google and Scopus. All in all, 38 papers in (Silva da Silva et al., 2011) dealt with the issue of how usability work should be conducted in connection to an agile systems development approach. We have updated this list and added 11 papers to the 38 selected from the Silva da Silva et al. review. The 49 papers we have reviewed are listed alphabetically in figure 1. The search terms include: usability, user centered design, agile, Scrum, XP, user interface, human computer interaction, which are effectively the same search terms used in Silva da Silva et al., 2011. Search on Scopus from 2011 yielded 3 additional papers. Further 8 papers were added by searching the reference lists of the already included papers.

The analytical lens employed to integrate the literature is the Toulmin model (Toulmin et al., 1984). Table 1 provides an overview of its concepts and how these were particularized to our data. The model provides a concise framework to assess the argumentative structure of the recommendations identified in the reviewed literature. Further, through the observed qualifications and rebuttals, we could identify pertinent situational factors and explicate the nature of their influences. We applied content analysis in a stepwise manner (Hsieh and Shannon, 2005) to identify themes related to concepts of our selected model. This led to the identification of common recommendations and for each recommendation their grounds, rebuttals and qualifiers. Our findings are presented in the next section.

Table 1. The analytical lens based on Toulmin et al. (1984)

Elements of an argument	**As described by Toulmin et al. (1984)**	**In this review**
Claim (C)	Assertions put forward publicly for general acceptance	A recommendation for a usability work practice in agile systems development as advocated by the authors
Grounds (G)	Specific facts relied on to support a given claim	Assertions used to support the recommendation
Warrant (W)	The chain of reasoning that connects the grounds to the claim	Theories, principles, assumptions being appealed to by the authors
Backing (B)	Generalizations making explicit the body of experience relied on to support the warrant	Source (s) of the warrants (from empirical evidence, body of knowledge)
Qualification (Q)	Statements which limit the strength of the argument or	Account of situational factors which qualify the scope of

	which propose the conditions under which the warrant is true	recommendations
Rebuttal (R)	Extraordinary or exceptional circumstances that might undermine the force of the supporting arguments	Account of situational factors which refute the recommendations made

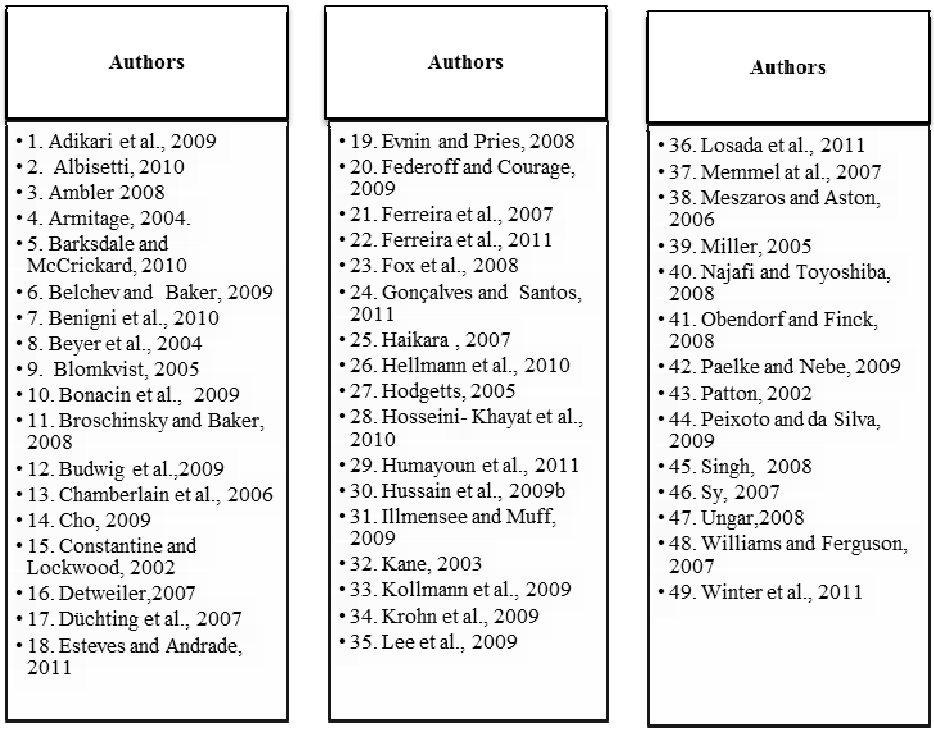

Figure 1. Data Sources

4 Analysis

Our analysis identified seven claims on the integration of agile and usability work. Following the concept centric approach advocated by Webster and Watson (2002), these claims are categorized based on what aspect of usability work they describe.

4.1 Work Execution

Claim 1: *Conduct some upfront design activities prior to project start* **(6,8,9, 11,13,16,17, 19, 23,25, 27, 30,31,34,40,41,45,46,48).**

Grounds: (1) Facilitates insight into use context, leading to increased understanding during the project lifecycle **(27).**

Warrants: User's goals, tasks and needs should all guide the development from the very beginning **(9).**

Backing: Principles of UCD **(9, 15).**

Qualification: (1) Feasible when there is an absence of time and budget constraints **(18, 23, 25, 27, 29, 31, 33)**. (2) Appropriate when it is certain it would reduce project risks **(21)**. (3) Would require that designers have high physical and mental resilience in order to combat the fatigue associated with this effort **(31)**.

Rebuttal: (1) End users are typically not able to contribute novel system design ideas **(15, 42)**. (2) Lengthy pre-release activities do not guarantee a usable system **(9, 42)**.

Claim 2: *Design low-fi prototypes as the basis for developing the system* **(1,8,9,10,11,13,16,17,23,24,26,38,41,42,45,47,48)**.

Grounds: (1) Cheap, expedites exploration and evaluation, increase user understanding of the user interface and usage **(9, 14)**.

Warrants: Throughout the development lifecycle, prototypes should be used to visualize and evaluate ideas and design solutions in cooperation with the end users **(9).**

Backing: Principles of UCD **(9,15).**

Qualification: (1) Suitable when used at the start of the project especially in situations where there are time and budget constraints **(18, 21, 29)**. (2) Suitable when the existing work structure is one which allows for seamless transmission of information between developers and designers, thus minimizing the lag between feedback and implementation **(13)**.

Rebuttal: (1) Abstract and too unstructured to guide system design **(37)**. (2) Limited capabilities for the user to evaluate **(21,39, 48)**. (3) Often results in impracticable designs **(21, 22)**.

Claim 3: *Perform testing in between iterations* **(3, 8, 9, 14, 23, 26, 28, 33, 39, 40, 42, 45)** ; *and with end users* **(8,9, 13, 16,17, 20, 33,35, 36, 38, 39, 40, 42, 45)** .

Grounds: (1) Enables refinements of the system being developed, reduces rework and increases buy-in **(26,45)**. (2) Only real users can articulate their needs **(17)**.

Warrants: None

Backing: None

Qualification: (1) Qualified by the ease of assessing end users **(32).** (2) Depends on the level of influence of time and budget concerns **(32).** (3) Depends on the organizational profile **(20, 49)**. (4) Not suitable for systems with volatile requirements as recommendations made in between iterations may end up being obsolete **(30).**

Rebuttal: (1) Higher tendency for usability defects to be introduced in later iterations **(32)**. (2) Cannot give the user a true picture of the system, as code generated during sprints is often too unstable to conduct tests on **(16)**. (3) Does not guarantee user representativeness since users become increasingly familiar with the prototypes being tested (**30**).

Claim 4: *Designers and developers each work in parallel* **(8, 11, 12, 15, 16, 18, 20, 23, 24, 31, 33, 35, 36, 37, 39, 40, 46, 47)**.

Grounds: (1) Would enable designers perform their tasks ahead of the developers (**46**). (2) Eliminates the chances of developing designs that are not used, more cost effective, enables designers get more timely feedback and maximizes coding time **(39)**.

Warrants: None

Backing: None

Qualification: (1) Requires high headcount of designers **(3, 11, 12, 13)**. (2) More suitable for novel or large projects as opposed to rework on existing systems **(20)**.

Rebuttal: (1) In reality designer work is driven by agile developers' work and not vice-versa **(21)**. (2) Prone to design drift **(13, 21, 35)**. (3) May undermine consistency of the interface **(16)**. (4) Limits input from designer to a "just one pass role" **(4)**.

4.2 Work Organization

Claim 5: *Usability designers should be a part of the development project* **(1, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 27, 30, 31, 33, 35, 37, 39, 40, 41, 42, 44,45, 47, 48).**

Grounds: (1) Having a usability domain expert ensures that usability concerns are always at the fore **(17)**.

Warrants: Usability experts should be involved early on and continuously throughout the development lifecycle **(9).**

Backing: Principles of UCD **(9).**

Qualification: (1) Depends on whether this role is present in the organization **(3, 11, 13**).

Rebuttal: (1) Developers with some knowledge of usability work are also able to function in this capacity **(2, 38, 43)**.

Claim 6: *Usability designers should be fully integrated into the development team* **(3, 9, 11, 14, 16, 18, 20, 27, 35, 37, 39, 40,45)**.

Grounds: (1) Ensures that project team focus and self-organizing nature of agile teams is maintained **(27)**. (2) Necessary to share the results of user research and testing, and to clarify any misinterpretations of designs **(40)**. (3) Ensures usability concerns are always at the fore **(17)**.

Warrants: None

Backing: None

Qualification: (1) Depends on whether this role is present in the organization **(3,11,13)**. (2) Depends on whether management reveres the cross-specialization skills the designer would need to have to function in such a context **(3)**.

Rebuttal: (1) Undermines the quality of work from each of the disciplines **(21)**. (2) Designers may lose their objectivity and user focus as they begin to identify very closely with the goals and needs of their respective project teams **(16)**.

Claim 7: *End users or their proxies should be involved in the project life cycle* **(8, 9, 10,13,17, 38, 48)**.

Grounds: Enables end users express their opinions about activities, practices, tasks and usage context (**10**).

Warrants: Representative users should actively participate, early on and continually throughout the entire development process **(9)**

Backing: Principles of UCD **(9)**

Qualification: (1) Qualified by the accessibility of end users **(11, 39)**. (2) Depends on the organizational profile **(11,39)**.

Rebuttal: (1) Unable to cater for the different mental model of users regarding usability **(32)**. (2) Characterized by diminished user representativeness with increasing user involvement **(8, 32)**.

4.3 Summary of findings

The identified claims and their qualifications have been re-categorized based on the framework by Clarke and O'Connor (2012) of situational factors which influence the software development process. This has been done to relate our findings to existing research on these situational factors. For an overview of this, see table 2. We notice that none of the qualifications we have highlighted addresses the situational factor "Technology". The existence of this gap should be seen as an impetus for agile usability researchers to examine how considerations related to the technology employed affect the claims we have identified and in effect how usability work is executed within agile contexts.

As a progression from table 2, figure 2 represents a high level abstraction of the relationships between the seven identified claims, their rebuttals and situational factors.

Table 2. Factors influencing the software development process mapped to the claims' qualifications (CnQm denotes the m^{th} qualification of the n^{th} claim)

Situational factor	Description and considerations	Mapping of qualification
Business	Strategic and tactical business considerations- time constraints, project drivers	C1Q1, C2Q1, C3Q2
Personnel	Constitution and characteristics of personnel - team size, team capability	C1Q3, C4Q1
Requirements	Characteristics of requirements- degree of risk, requirements feasibility	C1Q2
Operation	Operational consideration and constraints - number of users outside the organization, organizational policies,	C2Q2, C3Q1, C7Q1
Organization	Organization profile - structure, size	C3Q3, C5Q1, C6Q1, C7Q2
Application	Characteristics of application under development- type, complexity	C3Q2, C4Q2
Management	Management constitution and characteristics - governance structure, project planning capability	C6Q2
Technology	Profile of technology being used for the development process- knowledge of technology, familiarity	None

5. Discussion

The agile usability literature has been criticized for providing overtly rationalized solutions to problems and concerns, and for presenting an impression of balance and harmony (Ferreira et al., 2011). Previous reviews (Sohaib and Khan, 2010; Silva da Silva et al., 2011) on a subset of the literature we review here have also followed this pattern by developing integrated methods and frameworks based on observed commonalities. Our work deviates from this path by summarizing seven claims made about usability work practices and examining the hitherto reported validity of these claims with the Toulmin model (Toulmin et al., 1984).

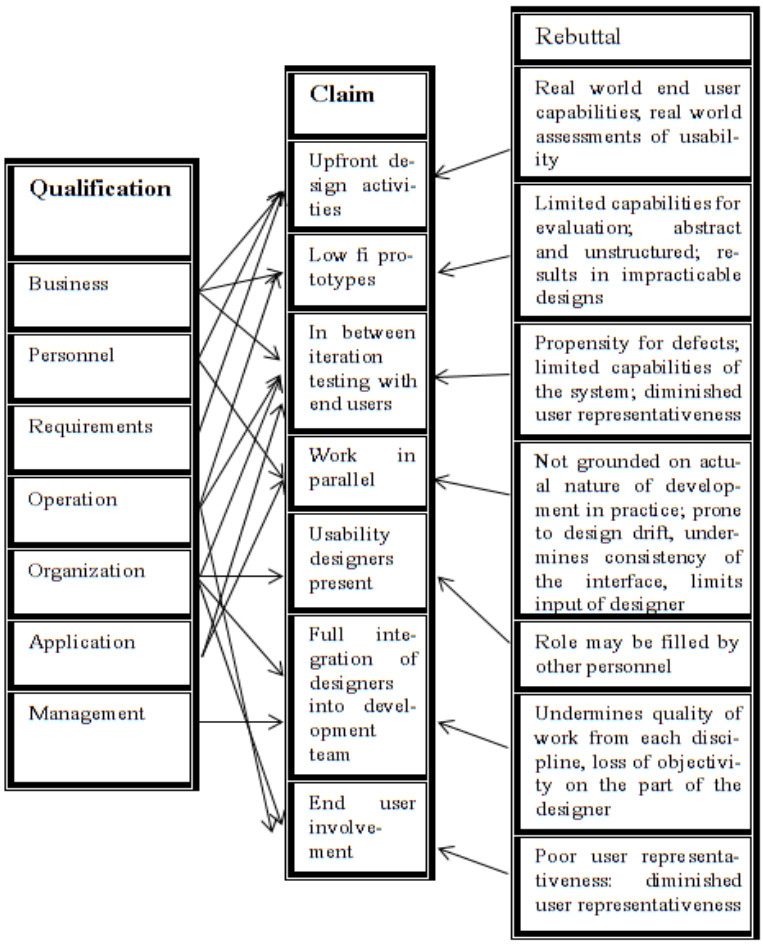

Figure 2. Factors, claims and rebuttals

By particularizing the model's concepts in our examination of these claims, we have been able to identify key situational factors which affect the validity of these claims by rebutting or qualifying them. Thus, our findings extend the ongoing discussions within agile usability research beyond the present focus on the lack of empirical studies (Silva da Silva et al., 2011), and calls that have been made for the exploration of the relationship between situational factors and methods in use (Ferreira et al., 2011), by providing cogent reasons as to why these observations are justified. Further as some of the identified claims are based on knowledge derived from the wider usability literature, their weak grounding underscores the need for a re-examination of the theoretical form of usability work. It has been asserted that the ideas of practice characterized in the theoretical form are obsolete (Norman, 2006; Scott, 2009), whether this is responsible for the weak grounding observed is another issue that should be investigated.

The following three propositions are based on our theoretical framework in figure 2 and further expound our discussions on the nature of influences of situational factors on the usability work claims identified.

- **Situational factors exist as modifiable factors which qualify these usability work claims and non-modifiable factors which rebut these usability work claims** – In figure 2, the factors identified as qualifying the usability work claims are seen to be factors that can be controlled by the organization, while the rebuttals highlight factors which are beyond the control of the organization.
- **Modifiable situational factors influence the efficiency of the recommendations** – These qualifications highlight the conditions under which these usability work claims might be made feasible and thus determine how efficient the process would be.
- **Non-modifiable factors influence the effectiveness of these recommendations** – This they do by highlighting considerations which would prevent the projected outcomes of these recommendations from emerging.

Relating these considerations to the realm of usability work in agile development, our framework in figure 2 in this regard forms a theoretically solid basis for further empirical examination of the phenomena, as it highlights situational factors that need to be taken into account during such examinations. Further, it reveals associations between situational factors and claims that should be empirically assessed and tested. This exercise is significant as it would enable development of usability work strategies that are aligned to the situational factors which characterize the particular organizations being investigated.

Our findings also extend discussions within the ISD literature on the situational factors influencing the development processes (Clarke and O'Connor, 2012), as we elucidate more on the nature of these influences. Further we introduce another dimension along which these influences might be examined beyond the present focus on modifiable factors that can be controlled by the organization.

A further observation is that despite the call by Kane (2003) for more work on the development of heuristic and style guidelines for interaction design for use in agile contexts, these issues have not been fully taken into account. We only observed one

paper which came close to examining this issue (Pexioto and da Silva, 2009). One of the papers examined, explicitly stated that they did not perceive that it was the role of usability work to specify system architecture (Singh, 2008).

In our current version, we searched the literature systematically with focus on articles published in 2011. We also focused on related articles that had not been covered by Silva da Silva et al. (2011) but had been noted in the papers we reviewed. As any systematic search suffers from the search procedure applied however it is designed, a possible outcome of the approach we employed is that key articles may have been overlooked.

An additional limitation of our analysis is that the claims we have identified are formulated in a non-operational manner. This is in part due to our attempting to describe these claims in a manner that concisely captures their essence and reflects the Toulmin's model depiction of a claim. It is also due to space restrictions. Moreover our overarching goal in identifying these claims was not to provide a prescriptive approach as to how agile and usability work should be integrated, rather it was to provide a platform for the analysis of these claims. This we have done by highlighting the various situational factors which could qualify or rebut these claims. However though our actions based on the preceding arguments may be deemed justified, we acknowledge the difficulties it poses to the operationalization of our findings; hence the need for further research and refinement.

5. Conclusion

In this paper we have provided insight into recommendations that have been made in the literature regarding how agile and usability work should be organized. Further we have employed the Toulmin model (Toulmin et al., 1984) to analyse the extent to which these recommendations have been validated in the systems and software development literature. The absence of a genuine practice perspective is demonstrated in the existence of rebuttals and the absence of warrants, which reduce the strength of these recommendations. This points to the need for a more situated approach to research on usability work in agile development and calls for a more informed and reflexive approach to an examination of these issues. Further the identified rebuttals and qualifications accentuate that there are other considerations, far beyond theorized views of usability work which also need to be examined. We have in this regard provided a framework in figure 2 that highlights situational factors whose influences need to be taken into account during such examinations. Our paper is however characterized by two limitations. Firstly that the subset of literature analyzed may not be entirely exhaustive. Secondly the non-operational manner in which our claims have been presented. These are issues we aim to resolve in future research.

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