

# Exploring the role of usability in the software process – a study of Irish software SMEs

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**Abstract.** This paper explores the software processes and usability techniques used by Small and Medium Enterprises (SMEs) that develop web applications. The significance of this research is that it looks at development processes used by SMEs in order to assess to what degree usability is integrated into the process. This study seeks to gain an understanding into the level of awareness of usability within SMEs today and their commitment to usability in practice. The motivation for this research is to explore the current development processes used by SMEs in developing web applications and to understand how usability is represented in those processes. The background for this research is provided by the growth of the web application industry beyond informational web sites to more sophisticated applications delivering a broad range of functionality. This paper presents an analysis of the practices of several Irish SMEs that develop web applications through a series of case studies. With the focus on SMEs that develop web applications as Management Information Systems and not E-Commerce sites, informational sites, online communities or web portals. This study gathered data about the usability techniques practiced by these companies and their awareness of usability in the context of the software process in those SMEs. The contribution of this study is to further the understanding of the current role of usability within the software development processes of SMEs that develop web applications.

**Keywords:** Software process improvement, Software process, Usability, SME

## 1 Introduction

Since the introduction of the Internet, web applications have moved beyond information sharing to a point where most traditional standalone applications have a web-enabled version [1]. Today the term web applications represent anything from information portals to online communities. This study focuses on web applications as Management Information Systems (MIS) accessed via a web browser with a central database backend. It focuses on the following definition of a web application proposed by [2]: “*These new web applications blend navigation and browsing capabilities, common to hypermedia, with ‘classical’ operations (or transactions), common to traditional information systems*”. This study does not consider in its scope E-Commerce sites, informational sites, online communities or web portals.

With the growth of the software industry, many development process models have emerged, such as the waterfall, iterative and agile models. Companies are also placing an increasing emphasis on the importance of compliance with standards such as ISO 9001 or the use of best practice models such as the Capability Maturity Model Integration (CMMI). But despite the number and variety of models and frameworks, there is evidence that SMEs find it difficult to adhere fully to any one model or set of standards [3].

Recently there has been a call for new development process models that address the unique requirements of web application development [4]. Such requirements include a short development lifecycle and a shorter shelf life of new functionality. They must also keep pace with the rapidly changing technology on which they rely. There are general guidelines available on what a web application process should incorporate. Suggestions include combining the activities of traditional models with those of hypermedia design models [5]. Alternatively, an incremental process is recommended, incorporating activities that address the needs of web application development [6]. Despite these guidelines, there is evidence that most web development is still largely ad-hoc and researchers liken it to the early days of traditional software development [7, 8].

ISO 9241-11, a guidance on usability, defines usability in terms of measurable objectives, stating: *“the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”*. Guidelines for web usability include: the degree of visual quality, degree of customization, tracking user activity, and degree of proactivity [5]. However, usability guidelines for the web focus almost exclusively on web sites and fail to identify usability issues unique to web applications. Even web application developers are confused about usability standards and whether they should conform to web site standards or Windows standards [19].

User-Centred Design (UCD) is an effort to involve the user in all stages of a software development process. There are many UCD models, such as ISO 13407 or industry models such as IBM's. Much research to date on the practice of UCD in companies assumes that a reasonably defined development process exists in the first place. For this reason, the significance of this study is that it investigates whether a well-defined development process indeed exists and if so, whether usability practices are incorporated into that process.

## **1.1 Research Aims**

This study examines SMEs understanding of usability, what usability techniques they currently practice and how well they believe usability is represented in their development process. It analyses the software development process SMEs claim to use and looks at whether the process is actually followed in a typical project. By comparing results across several case study companies, this study investigates whether common issues and attitudes exist and how their practices compare to software development models and usability standards. By investigating the typical development process and what usability techniques are being used, the aim of this study is to set the groundwork for further investigation into whether SMEs find it

difficult to follow software development process models and UCD models when developing web applications. Accordingly, the objectives of this study are to:

1. Explore the software development processes in practice by SMEs that develop web applications.
2. Investigate the SMEs understanding of usability and assess their level of commitment to it within the development process.
3. Investigate the gap between the development processes practiced by SMEs developing web applications and the proposed software development process models, standards and best practices.
4. Investigate the gap between usability awareness and practices among SMEs and usability standards and UCD guidelines.
5. Gain an understanding of why SMEs do, or do not, integrate usability into their web development process.

## **2 Usability and Web Development Processes**

Although usability is gaining widespread recognition, confusion exists as to what is meant by the term usability [9]. For some it focuses on the User Interface, dealing with issues such as user of color, pleasing layout and consistent terminology. For others it deals with the software's overall structure, how productively it allows the user to complete their tasks and how easy it is to learn [10]. This study adopts the definitions put forward by the ISO (ISO 9241-11) which defines usability as: "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use".

The process by which one achieves good usability in a product is known as User-Centred Design (UCD). This is also referred to as usability engineering or human-centred design. Many UCD design models put forward and all contain the key element of involving the user in all stages of the development process [11]. This is in contrast to a traditional software development process, which only involves the user in specific stages of the lifecycle, such as requirements analysis and acceptance testing.

Studies have shown that user-centred design techniques are still underused among development teams [12] and most usability issues are only detected during testing and after deployment [13, 14]. Of those practicing UCD, one investigation revealed that the majority of methods in practice were informal, low-cost user-centered design methods. The most commonly used methods were iterative design, usability evaluation, task analysis, informal expert review, and field studies [15]. Obstacles given for not implementing UCD techniques include a lack of awareness of usability across the company, lack of usability experience, poor management support and marketing pressures [16]. Another reason given is the fact that UCD techniques are developed in isolation from the software engineering community and real company environments and thus do not take into account how well they will work in terms of team buy-in, and resources [17].

## **2.1 Web Development Processes**

Many current software development models have been criticized as not meeting the unique requirements of web application development [7, 4] and accordingly there is a need to develop new models that address the needs of web application development [4]. The absence of a well-defined model for web applications has been explained by two causes. Firstly, the scope of how a web application is defined varies greatly. Secondly, the web's legacy is as an information platform rather than an application platform [8].

There are some general guidelines available on creating a development process for web applications. [5] suggests combining the activities of traditional lifecycles with those suggested for hypermedia. [6] suggests an evolutionary, or incremental, process which addresses the needs of web application development through the following activities: formulation, planning, analysis, modelling, page generation, testing and customer evaluation. Finally, many agree that regardless of the type of application being developed, the basic principles of software engineering should always apply. Good design, solid testing and change control should all be used as they are historically proven to work [18, 6].

## **2.2 Role of Usability in Web Development Process**

Web application usability goes beyond interface design and interaction issues specific to web pages. This study has found that research on usability standards for the web focuses almost exclusively on web sites and there is a lack of usability standards for web applications and developers admit to defining standards as they go. They also express confusion as to what standards they should conform to, those for web sites or traditional applications [19]. In the absence of clear recommendations, this study looks at how web applications share characteristics of both traditional applications and web sites.

Web application front ends are accessed via a browser, just as web sites are. As far as usability for the user interface is concerned, web applications can borrow from guidelines common to web sites. Web applications share other usability issues with web sites, such as: download times, browser preferences and access via different devices, such as PDAs [11]. On the other hand, web applications may differ from web sites when it comes to the importance of learnability. Learnability may be less critical in web applications compared to web sites as they are likely to be accessed on a more frequent basis. There is also a greater chance that some degree of training or documentation is available for web applications compared to informational web sites [20].

There is little evidence available on the level of usability being delivered in real web applications today and how today's end users feel about usability standards. This may be put down to the reluctance of companies to allow such information to become public. But usability concerns for web sites focus on the UI and interaction issues dealing with information, such as searching.

### **3 Case Studies**

The case studies were restricted to companies that develop web applications. The definition of web applications presented in section 1 has formed the basis for selecting suitable companies. It was not limited to any genre of web application or to a geographical area. It was also considered immaterial if a company also developed traditional applications as long as a significant portion of development efforts focused on web application development. The primary source for identifying case studies was through the researchers contacts, with possible companies being assessed. Through this process, five companies were identified, who ranged in size from 15 to 2 software development staff. The job titles of those interviewed included Web Development Manager, Product Manager and Software Development Manager among others.

An interview guide was prepared for use in the semi-structured interviews which comprised both factual questions and open-ended questions designed to explore the interviewee's attitudes and opinions. It was designed to be semi-structured based on the assumption that additional questions would be asked depending on the direction in which the answers went. The guide was designed so that each interview would be completed within an hour, in order to ensure that interviewees would not lose focus. The five main topic areas covered by the interview guide were:

1. General background information about the company and its business sector.
2. The organization's software development process and its practice.
3. The organization's understanding and awareness of usability.
4. Usability Practices: Usability activities within the development process.
5. The interviewee's opinion of usability in relation to the company's products.

Detailed notes were taken during each interview and any additional questions that were asked were also noted. Each interview was also recorded on tape. After each interview, the tape recordings were transcribed and the interview notes were reviewed and documented. This material was then used as the basis for within-case analysis. The researchers looked for interesting findings or contradictory answers and wrote a summary of observations for each case. All five interviews took place over a two month period. After all of the interviews had been completed, the researchers began within-case analysis. After the within-case analysis was complete, cross-case analysis was carried out.

### **4 Analysis**

This section presents the cross-case analysis of the data collected during the case study interviews. It examines the findings of the interviews under the areas of Software Process, Usability Awareness, Usability Practices and Product Usability. Firstly, it looks at the software practices followed by the case study companies and compares them to recommended practices as discussed in the literature and whether they have adopted suggested practices for web application development. It then discusses the awareness of usability and investigate usability practices of the case study companies and examines the gap between their practices and suggested usability design techniques. Lastly, it discusses the opinions of the interviewees about

the usability of their products and examines the lack of evidence available on the level of usability of today's web applications.

#### **4.1 Software Process**

Of the five case studies, two companies use RUP as their development method, one uses an Agile approach and the other two use an internally developed process based on a waterfall style model. Only the two companies using RUP had a fully documented process. The company using an Agile approach had a partially documented process and the two companies using an internally developed process had not documented it at all. Analysis of the development process revealed that all five companies were knowledgeable and clear in describing the steps that they follow, regardless of whether it was documented or not. All but one of the companies believed the process was being followed in all projects. However, four out of five companies also cited deviations from the process.

An interesting finding was that three of the companies had recently undergone significant improvements to their processes. One company had hired a project manager with the responsibility of establishing a more structured, repeatable development process. Another set up a new test team and formalized the build process. It was evident that these companies were moving in the right direction while still being aware that they had more improvements to make.

None of the companies were following any of the available development models without having customized it to their needs. When describing their development process, all five companies reported having a Requirements Analysis phase at the beginning of the lifecycle. Much of the literature cites poor requirements as the cause of many subsequent problems in the software. But [21] believe that in web projects, clients do not have a clear enough understanding of their requirements at the beginning of a project for existing software processes to be effective. They believe that web development companies should adopt an iterative approach that incorporates client developer interaction and that assesses partial designs in order to clarify the client's requirements. Although only one company cited poor Requirements Analysis as a problem in their process, there appears to be a lack of awareness that a key advantage of the iterative design process is its ability to involve the end user early in the product lifecycle. Of the three companies following an iterative process, only two delivered interim software builds to the client. But both of these companies described the client as a distinct entity to the end user of the system. Delivery of the builds appeared to be more to meet the contract deliverable rather than a design tool.

The literature suggested that web application development can be likened to the early days of traditional software development, when applications were mostly being developed in an ad-hoc manner. But this study has revealed that all five case studies have a defined development process. Although the process may not have been documented in two cases, all of the companies were able to clearly describe the steps involved in their process and believed it to be a clearly defined, repeatable process. They were also able to acknowledge deviations from the defined process. These findings suggest that although there appears to be a need for a process suitable to

small companies developing web applications, practices are more formal than anecdotal evidence suggests.

## **4.2 Usability Awareness**

All of the companies had very little awareness of usability standards, with only one company having a good knowledge of usability. Most of the companies believed usability was well represented in their development process and that usability awareness was good throughout the company. It emerged that two companies had a limited understanding of usability awareness, citing look and feel as the primary element. The other three companies had a deeper understanding, describing usability as the need to support the user tasks. An interesting finding was that those companies that showed a deeper understanding of usability were also the ones doing business on a tender basis. It is possible that in order to win tenders, companies must ensure that they respond to the client's needs. It is also possible that during the development process, the client has much deeper involvement compared to those companies who are selling their application on an off the shelf basis.

Analysis of users needs showed that the most commonly reported need was intuitive use. Two companies remarked that having to do as few clicks as possible was important for their users, while another phrased this as fast use. Other needs cited were easy navigation, quality of information and responsiveness. One company observed that their users simply like what they are used to. This is an interesting challenge when developing web applications because it is possible that users are used to desktop applications but have less experience with web applications. This is reflected in the fact that one company said that their biggest challenge was delivering more and more complex functionality via the web and still trying to maintain a high level of usability. The challenge is to develop a web application that delivers a high level of ease of use and learnability so that it becomes irrelevant to users that they achieve their goal in a slightly different way to before. The researchers also believes that novice users may benefit greatly from education from the development company on the advantages the web brings before assuming that the client wants a mirror image of the desktop application functionality.

Only one company reported that awareness of the user needs and their IT skills was poor. They acknowledged that this was reflected in the fact that they were still delivering new functionality with poor usability. Most of the companies felt that awareness among staff of the client needs grows with the experience of working on a project and through good requirement specifications.

Analysis of how the interviewees defined usability supports the evidence that confusion still exists as to what is meant by usability. For some usability refers to the UI and for others it means how productively the system allows users to complete their task. Two companies defined usability in terms of the UI and the other three defined it in terms of supporting the user's task. It is encouraging that three companies defined usability as the extent to which it supported the user tasks. But only one company mentioned efficiency as an element of usability. This is particularly interesting in terms of web applications because efficiency has been cited as one of the most important aspects of usability for the web. Also, none of the companies remarked on

effectiveness or satisfaction as key elements of usability. Most of the companies have reached an understanding that a system should enable a user to reach his goal but they lack the awareness of the fact that it should enable them to do so in as productive and pleasing a manner possible.

Rather than dismissing those who defined usability primarily in terms of look and feel as having a poor understanding of usability, it is worth looking at the fact that most of the companies did not mention look and feel at all. Although industry definitions make it clear that usability is much more about the look of a product, [5] cites the 'degree of visual quality' as a key element of usability for web applications. This finding supports the observations by [19] who noted that developers are confused about whether they should conform to web site or traditional application standards. It is encouraging that three of the companies described usability in terms of reaching user goals but the importance of look and feel for web applications cannot be dismissed. This raises the need for a clearer definition of usability for web applications, one that embraces the need to support the user goals yet recognizes the visual elements web applications share with web sites.

Analysis of how the companies described the usability needs of their user shows a contradiction with their definitions of usability. For example, when describing their understanding of usability, no companies mentioned efficiency or productive use. But when discussing the needs of their user, two cited the most important element as efficient use of the product. Another example is that although two companies defined usability in terms of look and feel, none regarded it as a usability need for their users. Yet most companies recognized it as a key element in attracting new customers. The most common usability needs cited centered around ease of use, although it was described in different ways. One company described it as learnability, another as ease of use and two as intuitiveness. This is interesting when compared to claims by [20] who suggested that learnability is not as important in web applications compared to web sites because the user would be more likely to have undergone training or have documentation available.

### **4.3 Usability Practices**

Only two of the five companies had internal staff dedicated to usability design practices and one of these was a part-time employee working from home. A third company used external consultants to conduct usability evaluations of their product during its initial development. Three of the five companies gathered usability requirements as part of requirements analysis. In two of these companies, they do not explicitly refer to them as usability requirements, rather they were gathered as part of the general task requirements for the user. These were the same companies that defined usability in terms of supporting the user's tasks. It is difficult to see how the user can explicitly provide all of their usability requirements without ever referring to them as such.

In terms of the overall product design, three of the companies had a formally established software design team in place and the other two had lead architects responsible for product design. They were responsible for the overall vision and direction of the product. It is of concern that there was no mention of usability being



represented at this level of design. It appears that usability tasks are being practiced at grassroots level and are of less concern during the high level design of products. This suggests that usability is not a concern at the upper management level yet management support is critical for it to grow in importance. Although all five companies considered themselves to be offering a good level of usability, only one of the four companies had a management driven approach to practicing usability techniques.

Two of the five companies claimed to do usability testing, with one reporting that that this was done as part of Acceptance Testing. The researchers believes that there is a lack of understanding as to what usability testing is and it is confused with User Acceptance Testing. Two companies required that the client must sign off on the product based on acceptance testing. This is a positive step although not an efficient means in catching usability issues at the end of the project lifecycle.

When asked who was responsible for usability in the end product, two companies cited the client. This is interesting considering the fact that these companies never explicitly discuss usability with the client, so it is difficult to see to what degree they are responsible. Although all companies demonstrated a degree of collaboration with the client during Requirements Analysis, only one company sought approval from the client on the final set of requirements. The most interesting observation was that none of the companies openly discussed usability requirements with their clients but incorporated it into the task requirements. This suggests that companies expect their clients to be able to represent their usability needs without having explicitly referred to usability.

The lack of UCD practices was apparent across all of the case studies, regardless of whether they developed bespoke applications or software for sale to multiple customers. The findings revealed that the three companies developing bespoke software were the only ones who claimed to gather usability requirements. However, the evidence on overall usability practices in this sample size did not suggest that the nature of applications being developed had any bearing on the level of UCD techniques being practiced.

Analysis of the development process has shown that three of the companies are following an iterative process, which is encouraged by UCD experts as a critical factor in ensuring good usability in the end product. But during their iterative design phase, only two companies provide early prototypes to the clients for analysis. Evidence shows that finding usability issues at the end of a project life cycle is the most inefficient way to resolve them. For this reason, it is worrying that most of the companies are not involving their users from the early stages of the design process. It appears that between Requirements Analysis and Acceptance Testing, there is very little interaction between the client and the development team.

It should also be noted that there was almost no distinction in any company between client and end user. One company noted that the client might review the requirements despite the fact that they are not necessarily knowledgeable about the end user's needs. It was clear that these companies recognised the fact that they had to please the client first and foremost. But this assumes that the client will represent the end users needs and if the end user is not happy with the end product, it is unlikely that the client will take responsibility.

The evidence suggests that meeting usability needs is considered by companies to be a part of good functional and U.I design, rather than a set of independent tasks. These companies have not adopted specific usability techniques in their development process. This supports the evidence that UCD techniques as criticized as unsuitable due to the fact that they were developed outside the field of software development. Despite not using usability techniques, most of these companies demonstrated a belief that they are supporting the usability needs of the user through good task analysis. [21] believe that web-based applications place increased emphasis on user interactions. It suggests that the nature of web applications means that there is already more focus on the user experience compared to developing traditional applications.

#### **4.4 Product Usability**

All of the companies believed that usability was very important for attracting new customers. They unanimously claimed that the usability of their product was very good. However, it was outside the scope of this study to examine the usability of the products developed by the case study companies. For this reason, it was not possible to verify the claims made by the interviewees about the usability of their products. All five companies claimed that the usability of their product was better than the competition, another claim which could not be verified without assessing the usability of their products and their competitor's products.

This study found no evidence on the level of usability being delivered in web applications today. This has been justified by the fact that companies would naturally be reluctant to reveal negative feedback about their web applications. Accordingly, it was not possible to compare the opinions about the usability other companies products with those of the case study companies. As previously stated, this study also did not review the usability of the products developed by the case study companies as it was considered outside its scope. For this reason, it was not possible to compare the usability of the case studies products against those of other companies.

## **5 Discussion**

The cross-case analysis has revealed differences between current practices among SMEs and industry standards for software development processes and usability practices. The key gaps between these standards and current practices are outlined below:

- SMEs are not using a development process designed to meet the specific needs of web application development.
- There is little use of UCD techniques in the development process: Usability requirements are not gathered independently; No formal usability testing; No involvement of end user in design process; and little practice of usability evaluations.
- The SMEs definition of usability is limited and inconsistent.
- There is a need for a definition of usability specifically for web applications.

- Uptake of, and interest in, best practice frameworks is poor.
- There is a need for open discussion with clients and end users on usability requirements.
- There is little awareness of usability standards and they are considered too vague to implement in real projects.
- Few staff members with UCD experience.

Other findings of less critical importance were:

- The definitions of usability made no provision for 'quality in use', such as satisfaction or efficiency.
- No usability representation during high level design of products.
- Descriptions of usability contradicted their awareness of the end user's usability needs.
- Regardless of the process model, interviewees demonstrated a good understanding of their process and acknowledged deviations.
- SMEs were positive in the direction they were taking through recent efforts to improve their process.

## **5.1 Conclusions**

The findings show interesting similarities with our background literature review, which revealed that there were no proven process models available that met the specific needs of web development. This study showed that none of the companies were using a development process designed specifically for web application development. It also supported evidence that the use of best practice frameworks has been particularly slow among SMEs.

The literature also suggested that the practice of UCD techniques was slow, which was corroborated with the evidence from these case studies. The findings also uphold suggestions that web developers are confused about how to implement usability. Analysis of the interviews showed that the definitions of usability were inconsistent and that there is still a need for a definition of usability specifically for web applications. There was also very little awareness of usability standards. Also of concern is the lack of involvement of end users in the development process.

There were positive findings in that the companies were demonstrating recent improvements in their process and an acknowledgement of process shortcomings. Interviewees demonstrated a good understanding of their process, regardless of whether it was documented or not. There was also a unanimously high level of pride in the end product.

## **5.2 Limitations**

The primary limitation of this research is the small number of companies it analysed. It is difficult to draw firm conclusions from such a small set of case studies. However, it is still possible to draw tentative conclusions and a higher sample size of case study companies could be used to strengthen the validity of the findings. Further study would also benefit from a larger sample size of interviewees from each case

study company. This would enable the researcher to investigate whether the practices and opinions differ according to different perspectives within the same company.

This study did not look at the products developed by any of the case study companies in order to assess their level of usability. When investigating usability awareness and practices in a company, it would be of merit to also measure the usability in the end product in order to see if the level of awareness has any bearing on the usability on the end product.

### 5.3 Future Research

As the number and complexity of web applications grow, and user interactions with these systems grow, the need for research in web application usability increases. The background research revealed a need for further research in software process models and UCD models that cater specifically to web application development. But before a suitable model can be established, there is a need to understand the current practices among web development companies and the difficulties they encounter. The scope of the research into usability practices among web application development companies could be widened to a larger number of case studies, based on an increased timeframe. This would increase the validity of the findings and set the groundwork for developing a suitable process model and UCD model for web application development by SMEs

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