

Requirements for the Integration of UE Methods in SE Processes from the Perspective of Small and Medium-sized Enterprises (SMEs)

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Abstract. This article describes the collection and derivation of requirements for the integration of usability engineering (UE) methods in software engineering (SE) processes from the perspective of small and medium-sized enterprises (SMEs). An exploratory, not generalisable survey of 11 typical SMEs was carried out in order to register their special needs.

1 Introduction

The gap between established software engineering (SE) methods and methods for the determination, assessment, and increase of usability of software systems has not been closed. In both areas, established methods and tools are employed (Law, 2003). The integration of well-known usability engineering methods (UE) into current working practices of software design companies has not been successful from the scientific perspective (Baumann, 2004; Harrison, 2004; Kohler, Leidermann & Birk, 2003; Seffah, 2004). In systems development, the designer, scientists, and engineers have to enter into a dialogue. Only in close collaboration and with interdisciplinary methods can the transfer of principles, knowledge, and objectives be assured in development projects.

The following exploratory survey had the objective to ascertain the nature of an interdisciplinary approach in German small and medium-sized enterprises and to determine their requirements with regard to integrated UE/SE methods and processes.

This survey was carried out within the framework of the BMBF (Bundesministerium für Bildung und Forschung – Federal Ministry of Education and Research) project USEKIT. USEKIT is intended to provide, for SMEs in particular, methods for user-oriented software development. The main focus lies on interlocking the methods of software engineering and usability engineering.

In section 2.1 we will present the methodology used for the survey, in section 2.2 the characteristics of the SMEs and the derived requirements for technologies that integrate SE and UE are described.

2 Method requirements from the SME perspective

In a two-stage interview we questioned eleven German enterprises from various industrial domains. The objective of the first stage was the collection and evaluation of the current development processes in selected enterprises. Boundary conditions regarding the software engineering process were also researched. The purpose of the second stage of the interviews was the theoretical evaluation of individual UE methods.

The enterprises were selected in such a way to represent the widest and varied markets and software products. The statistical analysis of the evaluation was not the main goal.

2.1 Survey methodology

The software development process applied in the enterprises was surveyed free from hypotheses. As survey instrument we chose a combination of semiformal interview and scenario-based evaluation. The three stages of the survey are described below (see figure 1):

1. Initial interview: recording of the current SE processes, UE processes, and specific boundary conditions in the individual enterprises
2. Generation of scenarios: targeting the optimisation of product quality and risk reduction through the use of UE methods
3. Interview 2: carrying out a plausibility check of the scenarios selected

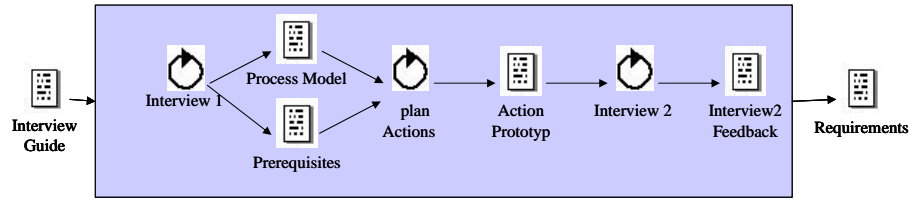


Figure 1: Three stages of the survey

While this method does not generate a generalisable picture, it succeeds in indicating the diversity in the enterprises.

2.1.1 Interview and interview guideline

In the first level of the survey, the characteristics of the development processes in the enterprises were explored free from significant assumptions. The questioning was carried out using a self-developed guideline and was equivalent to a semi-structured interview. The objective of the initial interview was to achieve a sufficiently detailed view of the current engineering processes in the organisation, to recognize potentials and deficits in the use of UE methods, and to describe concrete suitable actions.

The interview guideline was structured into the following categories:

1. General information about the organisation
2. General information about software development
3. Boundary conditions of software development
4. Software development processes
5. General usability questions

The interview focused mainly on those parts of the processes interview, concerned with requirements and tests. The results of the first part of the interview are presented in chapters 2.2.1 and 2.2.2.

2.1.2 Development of scenarios

Working hypotheses were generated from the results of this survey. The hypothesis included determining the UE methods and processes that could be used and the way the enterprises could employ them in order to be able to utilise improvement potentials. The hypotheses were based on evidence and explicit statements generated in the first interviews. The purpose was to present not only new but also modified UE methods that could lead to possible improvement or to a risk minimisation in the development process of the respondent enterprises.

In preparation for the second interview, concrete scenarios were developed. They included one or more actions such as:

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- Description of indicators gained from the interview
 - Description of the identified potential improvements and their risks for the enterprise
 - Concrete actions for the enterprise to obtain improvements through one or more UE methods

The actions were selected in such a way that they could be integrated into current development processes without major modifications. This seems to be an important prerequisite, as the cost of redesigning current processes may be an obstructive aspect for many SMEs. If the integration of UE methods is kept simple, there is less bias against UE integration in SME-specific processes.

For the respondents, it was important that a realistic assessment of the feasibility was made. Therefore the necessary steps for the implementation of the suggested actions were described. An estimate of the costs to be incurred in the introduction of methods and the implementation during current operations was made.

In the second interview, the actions developed were presented to the enterprises in the form of scenarios. In the following interview, the respondents were asked to evaluate whether the scenarios generally reflected the correct conclusions drawn from the results of the initial interview, whether they appeared generally coherent with regard to the cost estimation and, whether, in principal, the documented form of the proposed actions for the current working process was suitable.

Special attention was paid to the boundary conditions in the enterprise or to any other miscellaneous influences that could hinder or prevent an implementation. Where appropriate, the scenario and/or the documented activities were adjusted. In order to obtain generalised results, the respondents were requested to ignore enterprise specific conditions in their evaluation (e.g. "My superior is principally not interested in usability.")

2.2 Results

The followings section summarize the results of the survey, characterising the participating companies, their SD- processes and usability maturity, as well as their reaction to the actions and methods proposed by the scenarios.

2.2.1 Characterisation of the Enterprises

The number of employees varied greatly in the enterprises surveyed. However many of the enterprises had less than 50 employees. Thus the required personnel resources became an important constraint on the methods.

The staffs of the enterprises surveyed were mostly organised in interdisciplinary teams, their background was predominantly technological.

All these enterprises develop their software products in projects. They vary greatly in the time and cost expended. Typically, the developed systems were built for the business-to-business (B2B) sector.

In most cases, the target group for the software products was well-known and distinguishable. It was possible to identify a small number of users. Only two enterprises developed business-to-customer products (B2C). In this case, it was difficult to identify the typical user. The results of the survey showed that there was rarely direct contact to the end user. It was striking that enterprises specialised in individual domains. Often standard solutions were developed and customised. Table 1 shows an overview of the characteristics of the enterprises surveyed.

SME	Product or Project	Type of Product	Number of Staff	Number of Users	Qualifications of Staff	Development Cycle
1	Project, only used in DCAG branches	Web-based customer information system	32	70000	MBA's, more seldom computer scientists	Nine months to one year
2	Project for internal use	Definition and tool-aided support of processes in research	30	700	Computer scientists, economists, MBA's	Major phase approx. six months, with approx. 5-6 PJ and approx. 20 persons
3	Project/Programme/P project	Military systems for BWB; conventional WIMP and media projectors	400	40	Computer scientists, communication engineers, MBA's, economists, soldiers	Standard development, Every 4-5 years (90-100 PJ);
4	Product manufacturing within the project	Web-based workflow system for the support of updating management	25	3000	Teachers and trainers, psychologists, computer scientists, industrial engineers, MBA's	Release every 6 months
5	Product manufacturing within the project	Internet presence incl. content management system and Web applications	40	>10000	Designers, media designers, and engineers	Initial development 3.5 years, afterwards annual advancement
6	Project	Media software for Free TV support	Ca. 50	May 00	Engineers (Polytechnic, University) and career changers	Six months or longer
7	Both	Web-based system supporting strategic purchasing	30	1000-2000	Computer scientists, business economists, IT apprenticed professions, commercial training	Three to six months
8	Project	Public administration	Ca. 100	Oct. 50	Career changers with university degree, computer scientists	From two months up to two years
9	Both	Warehouse Management Systems (WMS)	80	3-300	Computer scientists, technicians, physicists	Irregular; code from project development transferred into general code basis
10	Both	ERP	26	150-300	Computer scientists, engineers	Irregular
11	Both	ERP	153	10-100	Computer scientists, mathematicians, or engineers	Standard development, every 2 years; customer project days to months

Table 1: Characteristics of the respondent SMEs

2.2.2 Typical UE and SE processes

For the small and medium-sized enterprises interviewed, a broad variation of SE processes could be determined. A closer look at this variability, however, yields three main directions:

1. The current software process does not follow a procedure found in the literature, nor is there an underlying process model. It has grown through the course of the years from own experience, ideas, and solutions. Normally the process does not employ SE terminology.
2. The development process is derived from a procedural model: frequently, these are derivatives of the Rational Unified Process (RUP), the V-Model, or the Waterfall Model. In part, the software development process is not completely process oriented.
3. The process concept is given. It is typically a classical V Model process or a process that has been specially developed and implemented for these enterprises (in most cases, a version of the V Models).

What most of the SMEs' clients and suppliers regarded as paramount during the SE process was the collection and implementation of functional requirements, error tolerance, and the performance and stability of the system. However, the clients and suppliers had little or no understanding of UE activities as the following section indicates.

2.2.3 Usability activities in SMEs

Generally, systematic usability engineering is not required by the clients of SMEs: it is therefore not practiced. In summary, three basic directions can be identified in companies from the usability perspective:

1. Usability is neither an explicit objective nor a specific activity. Usability is neither required by the clients in the systems requirement documentation nor offered by the supplier. Technical feasibility stands in the foreground.
2. Systematic UE is not practised. The necessity is known however both from the follow-up costs for corrective actions required for previous projects that led to, in some cases, high start-up costs made up of the user costs for the product and from user feedback. Experienced developers have learned basic ergonomic principles that they intuitively employ in new projects. That these requirements are not systematically determined, supplemented, and examined is a problem. The knowledge that is stored only in the heads of the individual staff members becomes outdated or is lost through staff fluctuation.
3. The necessity and importance of usability efforts is well known. Usability is performed and even required by the customer. Some variations can be inter-

preted:

- In some cases, the user interface is created in cooperation with the customer. Because of this approach, products that comply largely with the perceptions of the user group are developed. The significance of the functionality is overshadowed by the nature and manner of the access.
- Some enterprises have integrated UE methods in their software development process and have their own UE procedure model. One is orientated by the implementation of control criteria (for example, conformity to expectations, functional adequacy, error tolerance, and self-descriptiveness). (*ISO 9241/11*, 1997) Different UE methods are used (for example, development of user profiles, execution of a task analysis, expert evaluation, and iterative walkthroughs with and without user, usability tests).
- Yet it is necessary to note that UE and SE are not interlocked. A transfer of UE process results takes place only through an intensive communication among all the key stakeholders.

The under-representation of UE activities results in part from the lack of knowledge with regard to usability (caused in part by missing qualifications) or lack of understanding for the utility (for example, saving of time through efficient handling). As a result, only the assumed additional costs or the higher time expenditure are assessed.

Deficits regarding the use of UE in SE processes are apparent on several levels:

- **Organisational** deficits: the organisational sector is ruled by a lack of understanding of the importance of usability.
- **Methodical** deficits: SE methods lack the extensions for the integration of UE aspects (Identification of Boundary Objects) (Star, 1990; Walenstein, 2003)
- **Boundary conditions** make the application of conventional methods impossible. Methods do not include adaptability information.

Basically the awareness of the need of UE integration in SE processes in SMEs is established. However, often the necessary know-how for handling the new (that is, for the enterprise) methods is missing. It is not enough merely to create or describe methods isolated from possible SE processes. Simple and easy-to-implement connections have to be emphasised or created in both the UE methods and the SE processes.

This lack of interlocking of UE and SE processes has led to many levels of improvement potential being identified. These are mainly essential organisational improvement potentials (understanding of the importance of usability) and methodical improvement potentials (integration of UE methods; see section 2.2.4).

2.2.4 Requirements of UE methods

Different concern-specific scenarios were derived from the surveyed company characteristics. These scenarios presented the introduction of individual or multiple methods, the associated costs, and the expected benefits. The following constraints for the methods could be derived from the feedback given by the respondents.

Requirement 1: Closeness to typical working style

The results of the interviews showed that people in companies had a certain working style, a culture. Most enterprises had a more technical background, where UE principles are not known. The presentation of different methods showed that those requiring an intense communication with the user tended to result in higher bias. The reason for this might lie more in the organisational and less in the (programmer-specific) task range. Usability methods are often accompanied by completely new activities that are very different from the typical programmer formats (e.g., ManPages). The transfer of usability principles into the development processes would be more successful if known methods from the SE process could be “enriched” by UE aspects. Methods concerning client involvement were often rejected: it is difficult to persuade the client to write specific requirements for the SME so that lower consolidation costs accrue. Regarding objectivity and reliability, methods should be optimised such that they can be employed without help of experts.

Requirement 2: Support for scalability / adaptability

Before the method is applied, an estimation of the effort is necessary. This effort has to be given relative to an existing environment with pre-existing artefacts, processes, resources and methods. This also means that a micro-invasive integration (not altering the entire SE process) into the pre-existing context may be done.

The advantages of using UE methods are not of a binary nature: some of them are expected to be scalable, for example, performing a usability test with only one person yields a certain understanding of the perspective of users even though the method would favour a larger empirical foundation. This means that UE methods would be much more widely accepted in the SE world, if information about their scalability were at hand.

Requirement 3: Estimation of risk

“No-Go-Criteria“ (e.g. because of time pressure) are desired. The risk to apply an unknown method is too high for a company, if the responsible person can not estimate the consequences, the benefits, the goodness and the probability to be successful.

Requirement 4: Support for introduction

Guidelines on how to initiate the process to intertwine methods with preexisting processes are necessary. These could be: initial efforts and best practices.

Requirement 5: Estimation of goodness

Methods should be optimized with respect to their objectivity and reliability, in order to be applicable by non- experts.

Requirement 6: Support for introduction

Guidelines on how to initiate the process in order to intertwine methods with pre-existing processes are necessary. These guidelines can embrace initial efforts and best practices.

Requirement 7: Expected value and contribution

Methods shall be able to solve short term and actual problems. The “incubation¹” time might be a relevant factor for the acceptance of a method. Companies on a rather low maturity level hesitate to invest in methods that do not solve actual project specific problems and whose benefit and value is not proved. Methods that have the goal to grow and mature are rather accepted in larger companies with resources for growth.

The value and the benefit shall be recognizable and empirically proved, also in relation to efforts to be spent. The value and benefit is not only a matter of financial metrics, but also includes the rather process oriented aspect of impact, effect or contribution: The expected results shall be known and anticipated.

Other requirements

“Good“ methods increase the motivation of the developer (satisfaction with the result) and act as an “enabler” of creativity. All in all, such methods are more likely to be accepted, if they serve as communication instruments, reduce development costs, and improve aesthetic aspects of the product.

These requirements should be considered when we talk about the development of methods and their integration into preexisting processes. In summary they show the necessity of a flexible and value centered approach for the selection of usability methods within software engineering.

3 Conclusion

The development of methods is not completed with instructions and guidelines. Rather, methods must include the intentions, cultural principles, and manageability of the (that is, justification for the) recommended scaling. In a critical situation, the risk

¹ Pharmaceutical term that refers to the time from the moment of exposure to the development of symptoms of a particular infectious disease. In our context the time between method application and the first contributions to value.

of employing unknown UE methods in SMEs is too high if management is unable to balance the consequences regarding the quality and possibility of success.

Through continued method research (and method development) and standardisation of characteristic method indices, a professional handling and risk-minimised implementation of methods for an assured use in SMEs should no longer be a handicap. Moreover, not only is client bias lowered, clients also learn to value the employment of UE methods.

This demand provides a foundation for methods and their characteristics for the method developed within the framework of USEKIT.

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