

Basic User Requirements for Mobile Work Support Systems - Three Easy Steps

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Abstract. Due to shortage of time and resources in the early phases of mobile work support development processes, it is necessary to develop a 'quick and clean' method for user requirements modelling. The method consists of three easy steps that anyone with an interest in human factors should be able to complete: (1) The explication of a common vision, (2) observations in the field, and (3) problem oriented focus group processes. The method is designed to generate results that may serve as a foundation for more comprehensive later stage system modelling. As an illustration of the method, a case of use is presented: The development of an electronic delivery guide (EDG) for the newspaper deliverers of a major Norwegian newspaper distribution.

1 Introduction

Mobile work support systems are aids and devices that enable mobile workers to do their job in an effective and efficient manner. What may be expected from a mobile work support system is that the worker, wherever he or she may be, is enabled to:

- retrieve necessary information.
- save notes and input.
- communicate with the right people.

Organisations with a mobile workforce embrace mobile ICT as a welcome solution to the challenge of increasing the efficiency and effectiveness of the individual workers, and the corporate flow of information alike. Pen and paper are replaced with stylus and PDA, paper-based order forms and instructions are traded for intangible bit-streams, and the social call of the nearest leader is substituted with brief phone calls. However, the new tools introduced in the old ways of the workers must fit the needs and characteristics of those that will be using them. The development process leading to new mobile work support systems must include proper user requirements modelling, and user evaluation of early implementations.

1.1 The Problem of Time and Resources

In spite of the importance of adequate user requirements modelling, this part of the system development process is easily overlooked [1]. There may be two causes for this. One: Not enough time; the ICT business sector is characterised by an increasing demand for shorter product development time. Two: Not enough resources; development activities that are directly oriented towards implementing code are often prioritised at the cost of user involvement. Consequently it is necessary to rethink the way the basic user-oriented work in the development process is conducted. There is a need to refine user centred methods and techniques in a way that makes them simple

and time-saving. To use the words of Wichansky [2], what is needed is a 'quick and clean' (as opposed to 'quick and dirty') framework for user involvement.

The early phases of a new work support system based on mobile ICT will most likely be a replacement of an old work support system that may or may not include electronic devices. Of course, new work support systems may be introduced in synchrony with a revolution of the existing organisational structures, but just as likely the new system will initially imply only a modest evolution of the old ways. The reason for this may be as follows: Someone higher up in the company has agreed that new mobile ICT represents interesting opportunities for the enterprise. At the same time there is no guarantee that this new technology will prove to be beneficial. The competitors probably have not started using the technology yet, and who wants to be the first to introduce a potential disaster. As a consequence one decides to go for a short-term, low-cost pilot project where mobile ICT is introduced to a small part of the organisation. No major organisational changes are involved, the dedicated development team is small, and most important in regard to the present paper: There is no organisational incitement to initiate resource-consuming modelling efforts. What is needed, from the short term perspective of the development team is to get this first system version to work - fast. Even so, the results of this first introductions may have important bearings for the future development of mobile work support in the company and the importance of user requirements modelling is paramount; even though the company CEO may see it differently.

1.2 Basic Assumptions

The user requirements of a new work support system will be dependent on the actual implementation of the old system, and the benchmark 'acceptable low' of the user requirements will be that the new system does not make the users workday more difficult. If the mobile workers are to consider the new mobile work support system a success, it must at least be as efficient, effective and reliable in use as the old system. This implies:

- The new system must provide as efficient and effective access to all necessary information as the old system.
- The input mechanisms of the new system must be as efficient and effective as those of the old.
- The new system must provide the same opportunity for necessary communication as the old.
- The new system must be as reliable as the old.

Making any system comply with the four principles above demands user requirements identification. When time and resources are short, it is necessary to make this as simple as possible. One favourable aspect of the situation may be a small sized development team, which loosens the demands on the formality of the requirements, and the success of the requirements work is more dependent on a good dialogue with a few persons.

1.3 The Purpose of this Paper

The purpose of this paper is to present a quick and clean refinement of traditional methods for user requirements identification, particularly suited for mobile work support systems when time and resources are too scarce for in-depth modelling. The method consists of three easy steps that anyone with an interest in human factors should be able to complete, and should produce a set of prioritised user requirements necessary for the actual implementation of the system, compatible with the necessary business and technical requirements documentation.

The three steps of the method consist of methods belonging to most tool-boxes of user requirements identification [3,4]. However, the tailoring of these methods to comprise one single low-cost approach is an effort that we hope will enable more developers to include adequate user requirements engineering in the development process. The three steps are:

- Collecting a common vision through stakeholder interviews.
- Observing the old system in the field.
- Requirements identification in focus groups.

1.4 The Case: User Requirements for an Electronic Newspaper Delivery Guide

The methodological approach was developed in association with the collection of user requirements for an electronic newspaper delivery guide (EDG) developed by a Norwegian company for newspaper distribution. The EDG was to be implemented as a replacement of the paper based delivery guide used by the newspaper deliverers on their paper route. The old delivery guide included information regarding subscriber names, addresses and products to be delivered, as well as the order of delivery and a route map. Furthermore, the guide was subject to daily updates by way of paper forms attached to the packets of newspaper delivered at the regular drop point.

The old newspaper delivery guide system had several weaknesses: Its updating was cumbersome, costly, and depended on the conscientiousness of the workers. Also any input provided by the workers (written input and the particular sequence of the route) would be lost with the paper copy of the guide. At the same time the paper based delivery guide had several advantages: It was sturdy and could take a beating, involving being dropped in the floor, exposed to rain, used in cold weather etc.

The suggested new system implied an evolution of the old. Whatever information the paper deliverers got from the paper based delivery guide, they would in the future get from a PDA-like terminal, preferably with online connection to a central database. The early phases of development should not involve any major changes of the business processes of the organisation. Rather the paper-based work support system was replaced with an electronic one. The technology chosen for the first running version was a Compaq iPaq running PocketPC 2002, using Internet Pocket Explorer and GPRS data transfer via Bluetooth from a central database. The project period for the development and implementation of this first version was 6 months, at the end of which 25 newspaper deliverers should have permanently replaced their old paper-based delivery guides.



Fig. 1. Old paper-based and new electronic delivery guides

The plans for the first phase of the project included proper system modelling activities, but these were discarded for the time being due to pressure on time and resources. It was however realised that this new way of updating the delivery guides will enable a more flexible distribution system, that can enable the organisation to provide distribution of weekly or monthly magazines of nearly every kind in addition to the daily newspaper.

2 Step One: Explicate a Common Vision

Any system to be designed already exists as a figment of the customer's imagination. The commission given to the development team is founded on an idea of what kind of application the users of the system are to be provided and the effect it will have on the organisation. This basic idea of the customer may be contaminated with two problems:

1. The user aspects of the system have not been thoroughly analysed. The system in question may imply consequences that are unwanted or antagonistic relative to the users' work situation.
2. The idea is developed by the members of a group or organisational unit, and the different actors of the group have different conceptions of the system in question.

To conquer the first problem there is need for an explication of the customer's vision of the system. The quick and clean way to do this is through interviews with each actor in the 'customer group', in addition to reviews of relevant documentation. In the interviews the following is mapped:

- Users - including administrators, maintainers and end users.
- Context and organisational structure.
- Tasks to be assisted.
- Possible gains and risks for the different users when introducing the new system.
- System success criteria.

Through an explication of the customer's vision, possible mismatches between user needs and system concepts may be identified. And, just as important, this exercise ensures that user requirements are made an explicit part of the customer's vision of the system, which in turn will have bearings on the incorporation of user requirements in the overall requirements specification. The duration of each interview will typically be one hour.

The second problem to be solved through the explication of a common vision is that of possible mismatches between the visions existing in the heads of the different members of the customer group: The vision of the CEO does not match that of the CTO etc. To side-step this, the interviews are conducted with each representative of the customer separately. Individual differences in opinion may thus be uncovered, and may be made the focus of attention at an early developmental stage.

Based on the information from the interviews, a memo containing lists of items from each of the five categories above is generated. The items of the lists are described in prose text, and wherever there are mismatches in the information given by the different members of the customer group this is accentuated. The lists of this memo may be called the intermediate customer vision.

Following the interviews the members of the customer group are invited to a plenary presentation of the intermediate common vision. Differences in opinion are addressed, and a revised common vision is agreed on. In the case of unresolved disagreements, appropriate actions are defined. An explicit agreement on the common vision is important to ensure the customer's and development team's commitment to user requirements. The lists that are finally agreed on are to be reckoned as the explicated customer vision, and constitute the foundation for later user requirements.

The Case: Explicating the Vision of an Electronic Newspaper Delivery Guide

The development and implementation of an EDG was based on an old idea. A group of people at the newspaper distribution company had been thinking about the possible gains of making an electronic version of the paper-based delivery guide for several years, but obstacles like immature technology and the lack of basic funding had earlier been too great to surmount. Finally resources were allocated to a project that was to develop a first running version of the EDG. Technical and business requirements were taken care of by personnel within the project; the generation of user requirements were handed to an external organisation. The timeframe and resources allowed to identify user requirements implied that this was to be done "quick and clean". The explicating of the vision included the following steps:

- Review relevant documentation.
- Interview of half a dozen key persons in the EDG project and the distribution company.
- One plenary meeting where the explicated vision was presented and agreed on.

The interviews resulted in a general list of involved user groups and organisational units, tasks and intended gains. In the final plenary meeting a list of system success-

criteria was agreed on. The list later served as evaluation criteria for the first running version.

3 Step Two: Observe in the Field

If the minimum user requirements to a new system is implicitly decided by the design of the existing system, a successful introduction of a new routine for mobile workers demands that it is perceived as at least as effective, efficient and reliable as the old. Thus sorting out the user requirements of the new system involves understanding the old way of doing things.

In general there are two primary sources to the ways things are done; using concepts from the domain of organisational theory, these may be labelled tacit and explicit knowledge [5]. Explicit knowledge includes formal work descriptions, procedures etc. Tacit knowledge refers to the knowledge in the heads of the workers and their non-formalised daily routines. Major amounts of research on how to access the knowledge associated with the behaviour of workers in an organisation have been done, and the prescribed methods may involve complex methodological efforts way out of the range of the resources allowed within the paradigm of 'quick and clean'. What is needed is a simple and effective method for describing the mobile work that is to be supported. This work description may follow the pattern of traditional task analyses.

A traditional task analysis requires that one major task (getting the work done) is broken down in several sub-tasks that are described and again broken down in lower-level tasks [6,7]. This exercise is usually conducted without differentiating between those tasks that depend on work support and those that don't. The reason for this approach is that traditional task analysis is designed to analyse the total work situation of a user, e.g. when all the work is done through a stationary PC. However, in the case of mobile work support the situation is different; the users are not using their work support all the time. On the contrary, a lot of the sub-tasks the users are engaged in probably will be conducted without the need for any work support at all. This allows for cutting some corners in regard to the traditional task analysis, by an early identification of those tasks that demand work support and a focusing of attention on these. Consequently a task analysis for mobile work support systems should include no more than the following:

- Superficial description of sub-tasks and their sequence.
- Identification of those lower level tasks that require work support for information retrieval, information input, or communication.
- Minute description of the information, input or communication required in the lower level tasks identified in step 2.

The 'quick and clean' way to conduct a task analysis for mobile work support systems is that of observation by participation, validated through focus groups. One way of arranging an observation by participation may be that the user requirements engineer goes through on-the-job training, where she is given the basic training routine of the work in question. Information to be gathered:

- The sequence of tasks conducted by the user.
- The information that is used in carrying out particular tasks.
- The access and structure of the necessary information.
- The different kinds of notes and inputs made by the user during particular tasks.
- The users communicational needs.

The observer should also take photos or video-clips for later presentation in the focus group of step 3. The information gathered is to be collected in a systematic work description. The what, where and how of the tasks are to be described briefly; the tasks explicitly associated with necessary information retrieval, note-taking, or communication are elaborated.

The resulting task analysis is to be validated in a focus group, where a representative selection of the workers in question are participating. The validation is conducted as a walk-through of the sequence of tasks. When the validation is finished and there exists one agreed-on task analysis, the same focus group is used in step 3 of the method.

The Case: Analysing the Task of Paper Delivery

The future users of the EDG are currently equipped with a work support system consisting of a paper based delivery guide, a mobile phone and a paper form on the pack of papers indicating the subscriber changes and delivery complaints of the day. To conduct a 'quick and clean' task analysis two observers followed two newspaper deliverers on their daily route. The observers were given the introduction routine for new paper deliverers, and assisted in delivering the papers. Data were collected in the form of notes and photographs.

The observation resulted in the following list of sub-tasks:

- Picking up the papers at the drop-point.
- Delivering the papers:
 - In areas of detached houses.
 - In areas of non-detached houses.
 - In areas of 'high-rise buildings'.
- Communicating with the 'district leader'.
- Updating the delivery guide.

The list of tasks was elaborated in regard to the sub-tasks that depend on work support. One example of a task broken down in sub-tasks is given below.

Picking up the papers at the drop-point

Find packs of paper belonging to the route; the reference number of the route is given at the front page of the delivery guide

Count papers; the number of papers is given on the paper forms on the packs

Check changes in the delivery guide; new or stopped subscriptions are given on the paper forms on the packs

Check for messages or complaints; given on the paper forms of the packs

The task analysis was validated in the first part of two subsequent focus groups, one with a representative selection of newspaper deliverers and one with a representative selection of district leaders.

4 Step Three: User Requirements through a Focused Group Process

The final step of the 'quick and clean' path to user requirements of mobile work support systems is to elicit the requirements on the basis of the explicated vision of the new system and the task analysis of the old. The bulk of user requirements is already given through the task analysis of step 2, in particular if the new work support system represents a mere evolving of the old ways. However a new system also represents an opportunity for more efficient, effective and reliable work support, also as seen from the users' point of view.

Knowledge related to the possible improvements in regard to existing work support may be stored in different places, but is certainly exists in the heads of the users. Their knowledge represents a prime source to the different small or large frustrations and difficulties of an ordinary workday. Some of these frustrations may be linked to the lack of work support in the old system. Given that we are right in locating the key to possible improvements of work support in the everyday knowledge of its users, the challenge is to elicit this knowledge. So, how does one reveal possible improvements from users? One could always ask 'how can we improve your current mobile work support?', but chances are that this will not turn out to solve the problem. Our suggestion is to elicit user knowledge not through focusing on (technological) solutions, but through focusing on their problems. If you want to get inside the problems and difficulties of a particular work situation, put the workers employed in it together in a group and get them to talk. The final methodological step of the 'quick and clean' process to user requirements is problem-oriented focus groups.

Traditionally, focus groups are not reckoned as a particularly valid instrument for identification of user requirements [7,8]. The users are taken out of their workplace and may therefore not be reliable sources to their actual ways of work. Also the discussions of the focus groups are easily biased. However, the use of focus groups as the third step in a quick and clean methodology for user requirements identification for mobile work support systems is quite adequate. Due to the earlier steps there already exists a task analysis, based on observing the users in the field. This ensures that the moderator of the focus group knows the workplace of the users first hand. Furthermore, the users are reminded of their work through a task analysis validation with both verbal descriptions and pictures from the workplace. It may also be added that the discussions are focused through the structure of the sub-tasks, which should minimise bias. However, in order to minimise the risk of seriously biased results, it is recommended to conduct two separate focus groups with different persons.

The participants of the focus group should be a representative selection of the general user population, a moderator, a referent, and (preferably) representatives from the customer and development group. The users are encouraged to present whatever problems they may experience in their daily work, without worrying whether or not

the problems they present are relevant in regard to the new work support system. However, the discussions should follow a certain structure:

- Reach a common understanding of the tasks involved.
- Identify present problems.
- Discuss requirements and possible solutions.
- Prioritise the problems.

Reach a Common Understanding

A common understanding of the tasks involved is reached through the validation of the task analysis presented in step 2. The moderator of the focus group conducts a walk-through of the work, structured according to the sub-tasks identified in the task analysis and presented through verbal descriptions and photos taken during the observation. The participants of the focus group are encouraged to criticise the task analysis, and a final task analysis is agreed on.

Identify Problems

Each of the different sub-tasks identified in the final task analysis is assigned one poster-size sheet of paper on the wall. The moderator goes through the sub-tasks one by one. The participants are first encouraged to elaborate in detail on what the different tasks involve and are then asked what problems they may experience when conducting the task. Identified problems are jotted down on post-it notes, and posted on the sheet of paper assigned to the particular sub-task.

Discuss Requirements and Possible Solutions

When all sub-tasks have been treated, there is a summary discussion of the problems that has been identified and what user requirements these imply. The participants of the focus group are invited to think loud around the shaping of the requirements, but the final revision of the requirements must be done after the focus group. The moderator also initiates a short discussion on possible solutions to the different problems.

Prioritise the Problems

Finally the participants of the focus group are asked to assign all identified problems a priority value from 1 (not important) to 3 (very important). The priorities are written by each participant directly on the post-it note on each sheet of paper. The sum average of the priority values is interpreted as the measure of priority, and the final list of requirements is sorted on the basis of the priority assigned to the identified problem associated with the requirement.

The process results in a validated list of tasks and associated present work support. In addition a prioritised list of present user problems, new system requirements and suggested design solutions are generated.



Fig. 3. Focus group participants posting sub-task-related problems

The Case: Eliciting User Requirements from a Room Full of Newspaper Deliverers

In the case of the EDG, two problem-oriented focus groups was conducted. One with four newspaper deliverers, another with four of their nearest leaders ('district leaders'). The participants were assigned to a group on the basis of employment status; as we wanted input from both groups, and it was reckoned that the paper deliverers would speak more freely when their immediate leaders were not present. The focus groups progressed fairly similarly, thus only the group of the paper deliverers will be referred in detail.

The focus group started with an initial presentation of all people present, followed by a presentation of the purpose of the meeting. Then a walk-through of the task analysis of newspaper delivery was conducted. The work of a paper deliverer was in the task analysis divided into three sub-tasks, each with three to four lower level tasks requiring mobile work support. Each sub-task with lower level tasks was presented by way of PowerPoint, including textual bullet points and pictures from observations in the field. The participants were invited to ask questions and freely criticise the way their work was presented; be it that sub-tasks were missing or distorted. Afterwards each of the three sub-tasks was assigned a poster on the wall and discussed. The newspaper deliverers explained in detail what they did during the different sub-tasks, and for each sub-task the moderator guided their discussion over to concrete problems associated with particular tasks. The participants in the group of paper deliverers were not particularly eager to write down their experienced problems themselves; this was done continuously by the referent who also posted the notes on the appropriate sheet of paper on the wall.

Working out the full set of problems related to each sub-task was met with great enthusiasm from the participants, and was also the most time consuming activity of the workshop. After summarising the problems related to each task, possible user requirements following from these problems were discussed. Finally possible solutions were briefly debated. The latter activities were more difficult for the participants of the group than working out the set of problems. A few ideas and

suggestions for possible requirements and solutions to problems were generated, but the user requirements team had to work out most of the user requirements afterwards.

Taking the Requirements Further

Based on the 'quick and clean' activities of the three-step identification of user requirements, a written report is produced and handed over as a final delivery to the customer. The report is an important document as a starting point for in-depth modelling activities, and valuable for the customer as documentation. Even so, the immediate value of the user requirements work depends on the communication of user requirements to the key persons of the development team. Allowing for the fact that the development team is of limited size, this may be done as presentations, workshops, or informal dialogue between the human factors experts and the system developers. This communication shall ensure that the user requirements are taken into consideration when developing the mobile work support system, and it may also work as a lever for selling in more extensive modelling work at the next stages of development.

The user requirements are also to be used as criteria of evaluation when testing the first version of the system on users in the organisation. The description of 'quick and clean' evaluation of mobile work support systems will follow in a later paper.

The Case: Further Work with the EDG

In the EDG project, user requirements were communicated to the development team through presentations and discussions. This dialogue was regarded as useful by the developers, and the identified user requirements had important bearings on the design of the PDA application as the system front-end.

When the first running version of the EDG was introduced, several user evaluations were conducted, including focus groups, observations and questionnaires. The limited size and scope of the present paper prevents a detailed presentation of the evaluation results, but the overall impression was that the users were truly happy with their new mobile work support system. In an adapted version of the IBM satisfaction measurement questionnaire PSSUQ [9], the EDG was rated as easy to use, easy to learn and pleasant to use (as opposed to difficult to use, difficult to learn and unpleasant to use). It was rated as neither increasing nor decreasing work efficiency, but it was generally held that it would increase work effectiveness by helping the newspaper deliverers to avoid customer complaints.

5 Discussion

As a response to limited time and resources available in mobile work support system development processes, a 'quick and clean' three step method for basic user requirements modelling has been presented. In addition it has been presented a case where the method has been successfully used. It has been argued that the method is to be regarded as a substitute for more time-consuming and thorough modelling efforts, and that it should generate a result that may be deployed in modelling work later on in

the development process. The method may also be a useful first step in promoting the importance of modelling work to the development team and company administration. One important aspect that should be discussed is that of validity. How to be confident in a method that produces user requirements based only on a few interviews, observations and focus groups? The main argument in defence of the method is its multi-method approach. All three basic methods utilised have major flaws when it comes to validity, both internal validity and generalisation. However, when they are used together they will serve as each other's sources of triangulation, and the skewed results that may be produced with one method should be corrected with one of the others. Also the focus of attention when using the methods is on the work support system of today 'as is', and not the new system. The user requirements of the new system are generated as the sum of requirements and problems belonging to the old and familiar system. Only when the requirements and problems of the old system are established, the users are asked about requirements, wishes, and wants for the new.

Taking this method further will involve its integration in a complete framework for system modelling and evaluation. The next steps will be to focus on the evaluation method for the first running version of the system and the integration of comprehensive system modelling techniques in the later developmental stages.

References

1. Vredenburg, K., Mao, J., Smith, P.W., and Carey, T.: A survey of User Centred Design Practice. CHI letters, Vol. 4-1. (2002) 471-478
2. Wichansky, A.M.: Usability testing in 2000 and beyond. Ergonomics, Vol. 43-7 (2000) 998-1006
3. Maguire, M.C.: User-Centred Requirements Handbook (Report D5.3): HUSAT Research Institute, UK (1998)
4. Inuse. A practical handbook on user-centred design for assistive technology. HUSAT Research Institute, UK (1996)
5. Nonaka, I., and Takeuchi, H.: The knowledge-creating company. New York: Oxford University Press (1995)
6. Wickens, C.D., Gordon, S E., and Liu, Y.: Human Factors Engineering. NY: Longman (1997)
7. Usabilitynet [Online 20.06.2002] Available at: <http://www.usabilitynet.org>
8. Nielsen, J.: The use and misuse of focus groups. [Online: 20.06.2002] Available at: <http://www.useit.com/> (1997)
9. Lewis, J.R. (1995). IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use. Journal of Human-Computer Interaction., 7(1), pp. 57-75