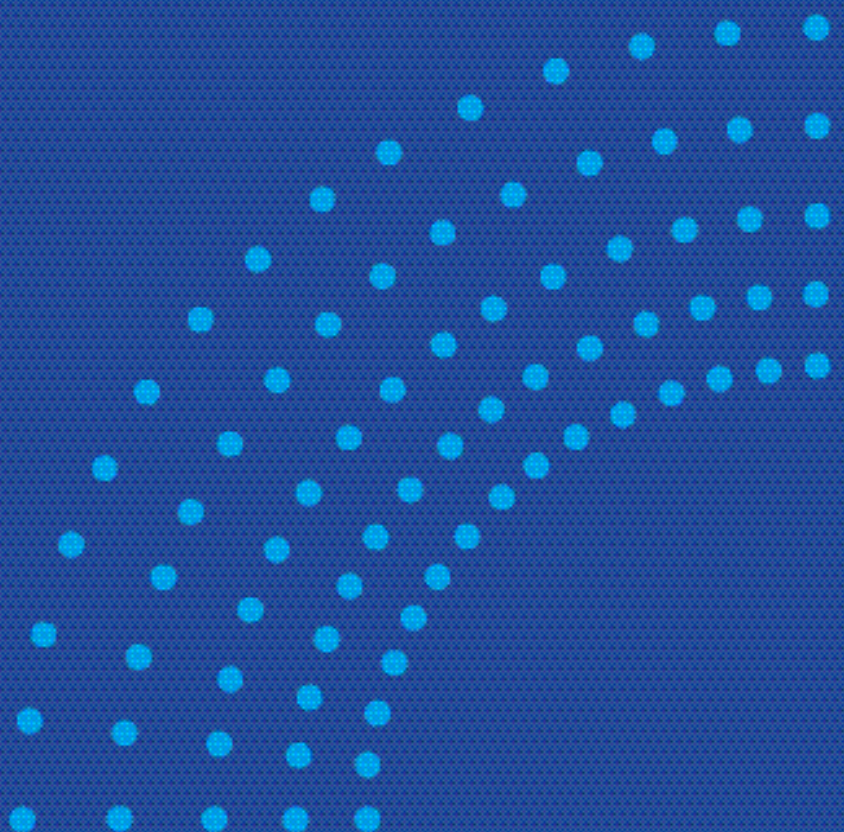


Master thesis in Informatics

A study of workforce management

Agneta Söderpalm Appelblad & Stefan Lönn
Göteborg, Sweden 2004



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ABSTRACT

The purpose of this master thesis is to examine the domain of workforce management of mobile workforces. A market inventory of workforce management systems and case studies of how workforce management is practiced have been made. The observations from these studies have been used to develop a number of design implications for the workforce management module in the Ericsson Trouble Management solution. A subset of the design implications have been implemented in the Ericsson workforce management module.

A key function in a workforce management system should be to relieve the pressure of the workforce manager. The case study shows that the prerequisite for well functioning mobile workforce management is a good technical infrastructure for both the workforce manager and members of the workforce. Essential functions of a workforce management system are to support the mobile workforce and the workforce administrator in two way communication. This will make reporting of accomplished tasks directly to the system possible instead of via the workforce administrator. In addition to these aspects the market inventory points out a number of features that exists in other workforce management systems. Some of the features presented are; automatic scheduling, future planning, schedule optimization, mobility support and technician workload presentation.

The report is written in English

Keywords: workforce management, mobile, field technician.

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1 Introduction

The conditions of mobile work in different settings have been examined in a number of studies for example Bellotti&Bly [1], Kristoffersen,Ljungberg [2]. In the first study the focus is collaboration between mobile workers. The second study focus on the special requirements associated with mobile field work in physically challenging surroundings.

Other aspects of collaboration in mobile work appears when one of the co-workers sits in a stationary work situation with access to printers, faxes and supporting computer system and the other is a mobile worker with little or no access to these systems. This is often the situation in what is called workforce management. However, workforce management often denotes the task of controlling a workforce in terms of working hours, location of work etc. The communication in that situation is of secondary interest. Studies of workforce management therefore often concern how to predict workload and allocate staff. No consideration has to be made to special demands on certain competence in the workforce. There is no need for two way communication between workforce manager and workforce. A typical setting for this kind of workforce management is a call center where a workforce manager allocates staff according to predicted workload.

A different type of workforce management is where the workforce manager administers a workforce handling tasks that demand special skills. Yet another aspect is administering of mobile workforces. Also, this kind of workers often needs to have access to information during the assignments. This kind of workforce management takes place for example in activities where staffs of field technicians maintain technical equipment geographically distributed.

The focus of this thesis is this latter meaning of workforce management. The aim is to examine how to design a system supporting the workforce manager in his or her work. The question we aim to answer in this study is

How to support management of mobile workforces?

The setting for our study is the telecom business and workforce managers administering workforces of field technicians performing maintenance work on network equipment.

1.1 Disposition

Section 2 presents Ericsson's current system for workforce management. Section 3 presents theories relevant for the area. Section 4 accounts for a number of related studies. Section 5 describes some of the commercial products supporting workforce management and lists the key features in these systems. Section 6 describes the methods used. Section 7 presents the case studies and in section 8 the results are analyzed. The discussion of the findings from the case studies is presented in section 9. A number of design implications are presented in section 10. Section 11 summarizes the whole study and the section is concluded by suggestions regarding future work.

2 Ericsson's workforce manager

The cause behind the making of this thesis was that Ericsson needed help to improve their workforce management system.

The workforce management module is part of a larger system called the trouble management (TM) solution. The main uses of the TM system are to gather information about telecommunication and computer networks and to react on events caused by failure in these networks. The workforce manager deals with the dispatching and assignment of work orders to technicians. When a failure occurs in the network a trouble ticket (TT) is created. A work order is later created with the information from the trouble ticket. A work order includes information about the problem and site information.

In order to solve the problem in the most efficient way it is imported that the work order is assigned to the most suitable technician. The workforce management system helps an administrator to find the most suitable technician based on certain information about the technicians.

The purpose of this thesis from Ericsson's point of view was to gain knowledge about workforce management systems in general and how these are used in practice. One desire that was expressed by Ericsson was to get design implications to improve their current version of the workforce manager.

2.1 Description of Ericsson's workforce manager

In order for the workforce administrator to select the best suited technician for a particular work order he or she search a database where the technicians' personal and work related information such as telephone numbers and skill are stored. Search parameters also include the geographical area within which the technician works. The technicians' availability is presented by an on/of duty state.

The solution has a web interface that makes the system accessible for technicians when they're on location. The field technicians can connect to the internet and view assigned work orders or report a finished work order directly to the system. The web interface is however not adapted with small screen devices such as hand held computers. Ericsson's workforce management solution is implemented in Action Request System (ARS) from Remedy.

3 Theory

This section presents the different theories used in this thesis to explain findings found in the case studies.

3.1 Workflow

Workflow theories deal with the issue of making work more efficient and to support various processes with information technology [7]. Workflow theory is based on Fredrick Taylor's thoughts on the rationalization of routine work.

Taylor's idea was to introduce scientific analysis of work in order to identify which parts of the process that could be improved.

There are three different domains in which to describe activities of an organization [8].

3.1.1 Materiel processes

Materiel processes are those processes where physical objects are moved or change state. The obvious example of such process is factory automation. This process has been the subject of several workflow improvements such as the introduction of industrial engineering.

3.1.2 Information processes

Information processes represents the flow of information that exists in an organization. The process explains how information is moved and stored. The development of various information technologies such as data flow analysis, database storage and retrieval and network communication has had a dramatic impact on the information process.

3.1.3 Business processes

The main element of all business processes is the agreement between a performer and a client which "is a request for the supplier to perform some particular actions, in return for which the customer is committed to perform other actions" [8].

3.2 Action Workflow

Medina-Mora and Winograd has developed a framework called ActionWorkflow™ which can be seen as a tool for identifying and to describe business processes in an organization. Action workflow is a subset of workflow theory. The ActionWorkflow is based on the language/action perspective which states that the primary dimension of human cooperative activity is language [10]. And therefore cooperative work is coordinated by the performance of language actions. When designing information systems with this perspective the major concern is the act of doing something and the recurrent patterns of interaction between actors. Such an interaction starts when a request

is made by a customer, then the performer makes a promise to perform according to the rules set up by the promise. To close the circle the performer reports back to the customer when the job is done.

This agreement between two parts can be illustrated with a workflow loop [Figure 3.1].

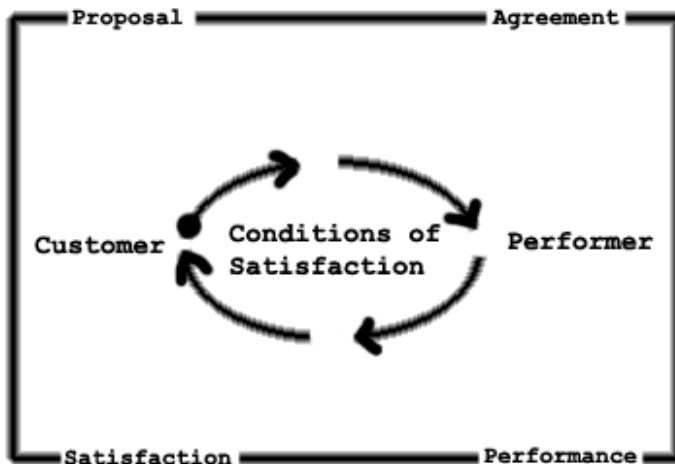


Figure 3.1 The ActionWorkflow Loop

The loop proceeds in four phases:

- Proposal

The customer requests completion of an action according to some stated conditions of satisfaction.

- Agreement

The two parties agree of the conditions of satisfaction.

- Performance

The performer declares to the performer that the action is complete.

- Satisfaction

The customer declares to the performer that the completion is satisfactory.

Every loop can be broken down into secondary loops which are connected in a network. These networks of loops form a schematic picture of processes in an organization.

Using the ActionWorkflow to map and illustrate the activities of a process makes the identification of faults or ineffective parts of the process easier.

An example of such faults can be that a certain activity lacks a customer or a performer.

Although ActionWorkflow is a powerful tool to use when identifying problems in an organisation one must be aware of some limitations with this method. As pointed out by Ljungberg [7] the framework of ActionWorkflow can be restrictive to the roles within an organisation. There is a risk that people are enclosed by the rules and their work may turn mechanical.

3.3 Mobility

As this report discusses the communication between a workforce administrator and a mobile workforce it is essential to define the different states of mobility.

Luff and Heath [6] present three kinds of mobility states in collaboration work. The grades of mobility, micro, local and remote are measured in how mobile the coordinated artefact is. Micro mobility refers to situations where collaboration between actors is coordinated with an artefact that is portable, manipulable and handlable. The micro mobility occurs within a limited space. Traditionally artefacts such as medical records have been the dominating coordinator of micro mobility. Remote mobility describes individuals who move around different physical locations who require access to information and colleagues [6]. Local mobility is movement in a specific domain such as an office space.

4 Related work

4.1 SOS alarm

An area that is closely related to workforce coordination and this thesis work is the work in call centres. Call centres can be found in a number of various domains such as telemarketing and alarm centres. Where there is a multitude of telephone calls that need to be addressed individually there is often a centre of coordination to handle this work. Many studies have been made on call centres to support the work with IT-technology.

The difference between the work at a call centre and the workforce administrator's work is that the administrator has to deal with issues like scheduling and dispatching of work orders to the most suitable person. The work at call centres often is more a matter of dispatching the call to a person within the call centre itself. In those cases where call centres actually dispatches and coordinates work to a mobile workforce the main issue is not to find the most suitable person but to make sure that a call is taken care of quickly.

An example of a study made at a call centre that handles this issue is Maria Normark's study on Swedish SOS Alarm [4]. SOS Alarm is a company that is responsible for managing telephone calls made to the emergency telephone number 112 in Sweden. The SOS operators receive, categorize, document, dispatch and monitor the incoming cases. The purpose of the study was to observe how the SOS operators work; how they coordinate the information and tasks between them; how the technology supports that work.

When a call to SOS alarm is made the operator tries to find out what has happened and from the given information tries to prioritize the event. All information is stored in the CoordCom system that is used by the operators in the call centre. The next step in the SOS alarm process is to find an available ambulance and to dispatch it. CoordCom gives the operator a list of available ambulances with additional information about its status and current position. The operators often collaborate when dealing with a high priority case. At these situations one of the operators tries to talk to the caller and find out as much as possible about the incident while the other operator acts like the dispatcher. The dispatcher in this case "listens in" on the conversation via the CoordCom system and dispatches the resource according to the given information.

Normark's study shows that the largest problem in the operators works are the difficulty to interpret the caller's information; this is a problem that is not apparent in the workforce administrator's work. The CoordCom system should be seen as a communication and information storing system. It should not be designed to actively do categorisation and analysis of the case. This is something that distinguishes CoordCom from workforce management systems. In workforce management system a prominent feature is to automate and give support to the administrator. This may have something to do with the nature of the tasks being handled. One might not trust a system to make decisions in a life and death matter.

4.2 Workforce management systems

In this report a comparative study is made over different workforce management systems on the market. Kungle [3] has made a similar study on workforce management systems at several call centres. Whereas this thesis only studies what features different management systems has to offer, Kungle makes an effort to find out how these features work and whether they are as efficient as the companies that develops management systems wants you to believe. Kungle concludes that “workforce management systems are a mixed bag, working well for scheduling and as an assist to the entire call centre management process, but limited in modelling and forecasting capability and in the ability to deal accurately with advancing technologies such as skill-based routing”. This conclusion is important to bear in mind in order to get a balanced picture when studying commercial workforce management systems.

4.3 Other studies

A large domain that borders to the focus of this thesis is the domain of CSCW. CSCW deals with designing IT support for collaborative work. One example of studies made in this area of research is Luff and Heath's [6] study on the London Underground where the activities of the stations mobile workforce and the people in the operating centre were discussed. The difference between the study made by Luff and Heath and this thesis is that this thesis focus more on centres of coordination than on the mobility of the workforce.

5 A market inventory

The main purpose with a workforce management system is to help the personnel at a Network Operation Center (NOC) in delegating work orders to the right person in a workforce. These systems are used in a lot of different fields such as logistics and telecommunication. In the past these systems have built on telephone communication between NOC personnel and field technicians. This however is about to change with the introduction of new software solutions.

In this section three commercial workforce management systems are presented. The solutions are described and analyzed with the intent to illustrate how they support the workforce administrator and the field technician in their daily work. The review includes products from three companies, Click Software, Telcordia and Intergraph.

The analysis has its focus on the following key points.

- Features

What are the solutions' major features and how do they support the administrators and the technicians in their work?

- Organisational issues

What kind of organisations are the products most suitable for?

Does a company benefit from the use of such solutions regardless of how the organisation is structured?

- Technology

What kind of technology is used in the different solutions and what other technology is it compatible with?

5.1 Benchmarking

In the following section products from three different companies will be described. The products are presented with the focus on which features they offer.

5.1.1 Click Software

Click Software provides solutions for field service operations that help companies to improve their efficiency. Click Software's target group extends over a number of different areas such as medicine and telecommunications. Like other companies in the same business domain Click Software offers a complete system for managing of personnel. Their Service Optimization Suite contains several modules that can be purchased separately or as one unit.

A big part of Click Software's solutions focuses on the possibility to plan for future workload. Statistics are collected from finished work orders by the Analyze module to be available to users of the system. Parameters such as travel time to and from a work site and how long a job did take to finish are saved by the system. This information can be compiled to identify periods with high or low service workload. The basic idea is to let different departments of a company review the statistics and based on this create scenarios using the Forecast module. This allows the company to view what impact future decisions has on the workload of field technicians.

The scenarios are then compared with each other and the most plausible is picked. The chosen scenario is mapped against the company's resources using the Plan module. This gives an indication of how a future workload stands against a technician's availability. This process prepares the workforce administrator in dealing with peaks in the workload. These steps underlie the process of managing and scheduling of work orders.

Schedule is the name of Click Software's workforce manager. This system allows the workforce administrator to plan both simple jobs and more complex jobs that extends over several days and requires a number of different resources. The prime function of Schedule is the possibility to facilitate the workforce administrator work by letting the system itself to a certain level plan and dispatch work orders to a technician. In order for the module to create a plan it must be fed with information about work orders and technicians. Additionally the user sets a number of parameters which affect the outcome of the schedule. A few examples of such parameters are technician's travelling time, work order priority, technician's experience etc. When all parameters are set the system calculate the most optimized schedule i.e. all technicians are assigned to work orders in the most efficient way. The greatest benefit with automatic scheduling is the reduction of workload for the workforce administrator who only need to view and correct possible errors in the schedule.

To make the communication between the workforce administrator and field technician easier, Click Software has developed a module for wireless transmission of work orders called Mobile. The Mobile module allows automatic assignment of work orders to field technicians. The technician can read, change and file work orders using a mobile device (PDA, mobile phone, pager). The system supports most major networks including CDMA and GSM.

5.1.2 Telcordia

Telcordia Technologies is a global provider of telecommunications network software and services for IP, wireline, wireless, and cable. The Telcordia portfolio includes solutions, products and consulting services that help customers meet their business objectives. This study focuses on Telcordia's scheduling system (Force).

Telcordia's solution has a similar focus on automatic scheduling as Click software's system. The system automatically organizes the work orders according to the parameters set by the user. Scheduling can be done in four different ways.

- Initial – Every technician gets all work orders assigned to them at the beginning of the day.
- Dynamic – The system reorganize the schedule when unforeseen work is added during the day.
- Demand – The workforce administrator can request that the system makes a new optimized schedule.
- Trial – The workforce administrator can make a forecast of a schedule by letting the system do an optimization of a suggested work day.

Both the Telcordia and Click Software solution include the standardized technology Geographical Information System (GIS) in their solutions. GIS is a system for

assembling, storing, manipulating, and displaying data which contains physical locations and information about those locations.

Using this technology in a scheduler helps the workforce administrator in calculating travel time and travel cost to and from sites. Another advantage is that this technology gives the workforce administrator a clear overview over all sites and work orders that are currently active. Note that this technology uses static maps and does not support real time update.

To support field technicians Telcordia has developed a module called Tech Access System. Using a mobile device the technicians has access to information about work orders, customers, network status, workload etc.

5.1.3 Intergraph

Intergraph is a company that specializes in map handling (GIS) and GPS technology. One of their solutions (InService suite) uses this technology to manage mobile workforces. InService is a complete workforce manager but the focus lies on real time location of technicians. InService lets the workforce administrator view in real time where a field technician is located on a map. Using GPS gives yet another dimension to the selection process of a technician. Knowing exactly where a technician is located the workforce administrator can more accurately choose the right resource for a job. GPS can also help the technician with traffic information and travel routes.

5.2 Discussion

5.2.1 Features

Both Click Software and Telcordia have products that focus on the automatization of planning and dispatching. These products make the work of the workforce administrator if not redundant so in any case less important. The big advantage for a company with the introduction of a system like that is the economic benefit of staff reduction. An automatic system lets one administrator handle a larger workforce. The administrative staff can therefore be reduced without the reduction of the technician workforce. The remaining personnel of the operation centre acts like a manual backup in case anything goes wrong in the automatic process. Using a basic system without an automatic scheduler drives the workforce administrator to a much greater extent to use his own judgment when selecting the most suitable technician. This may mean a greater workload for the workforce administrator but can also mean a more flexible and accurate scheduling depending on the administrator's competence.

The second important feature in Click software's and Telcordia's products are the future workload forecast function. Simulation and building scenarios require however relatively similar job assignments. You can not predict the future if every job is different and takes different time to finish. For a company where the workforce works on-call duty and has several different kinds of assignments the forecast may therefore not be reliable.

Unreliability in the forecast feature is also noted by Klungle [3] who states that a forecast becomes increasingly inaccurate with a shorter time period. A forecast made over a short time period may cause operational problem such as over and under staffing and poor customer service.

Map functions that use GIS and GPS technology can be an efficient help for both personnel at an operation centre and for field technicians. Within businesses where technicians travel to new sites every day e.g. reparations at private addresses can travel directions supplied in real time by a GPS be useful. In smaller companies where field technicians work within a limited geographical area and where the sites are already known to the field technicians a GPS solution may on the other hand seem redundant.

The same arguments apply for the use of GIS-systems. GIS can be an asset when calculating travel time but it depends again on how the workforce is organized. If the number of sites that the field technicians have to travel to is static then the travel time will rarely change. From the workforce administrators' point of view a GIS-system can give a good overview of the field technicians' daily routes and this adds to the parameters that makes the schedule more accurate. The greatest gain for a company using GPS/GIS technology is the reduction of travel time and cost for the technicians.

5.2.2 Organisational issues

The review indicates that systems with automatic functions and map handling probably are more justified for large organizations. These functions make it easier for the administrators to handle larger workforces. In organizations with smaller workforces the technicians have greater responsibility and they often take care of much of the planning and scheduling within the workforce itself.

A real time GPS system that keeps track of every member of the workforce is probably best utilized within organisations with a very small time marginal such as the police force and medical services.

5.2.3 Technology

All of the studied solutions have a module for communication with a mobile workforce. The greatest limitation for this module to be used in an efficient way is technology. Concerning which technological equipment that is most suitably for field work the alternatives is not that many. The device to use when supporting the field technician in his work that is proposed by the systems developers is the handheld computer. Its greatest advantage is its size and its mobility but it also has disadvantages. One problem that is pointed out by Kristofferson and Ljungberg [2] is that a field technician's hands are often used to manipulate physical objects, as opposed to users in the traditional office. This means that during work when the technician needs to use both hands the handheld computer's usability is limited.

Another aspect of technology is the possibility to integrate a new solution with an old one. If a system is not compatible with an already existing one it can be an expensive ordeal for the customer.

5.3 Summing Up

This section summarizes the results from the market inventory. These following features have been identified as vital parts of the products that were studied.

Automatic Scheduling

This feature allows the system, based on certain input from the administrator, to automatically plan and assign work orders to field technicians. This feature does not only reduce the workload of the administrators but it also lets them handle larger workforces.

Planning for the future

This feature is an instrument to find out what effect a change in future workload may have on the company. A forecast lets the company react to changes in the workload before they occur. This feature's accuracy depends on the technicians' tasks and the length of time period that the forecast is made over.

Optimization

A feature that is closely connected to scheduling is the opportunity to let the system optimize an already existing and planned schedule.

GPS/GIS

The use of GPS, GIS-technology and real time travel routing helps both the administrator and the technicians in their work. This feature can help the administrator to coordinate the workforce and the company benefits from travel cost reductions.

Mobility support

To support the field technicians and make the workforce system available out in the field all of the studied systems support communication between the technicians and the workforce manager via some sort of mobile device. This communication between the system and a field technician reduces the time it takes to perform administrative tasks and may also have other positive effects to the organization such as increased productivity.

Technician Workload

A feature that underlies both automatic scheduling and forecasting is the accessibility of information about the technicians' workload. For the workforce administrator to make an effective schedule the workforce workload must be available and presented in a comprehensible way.

6 Method

The following section discusses the choice of methods used to study the work of workforce management. The different methods are discussed to motivate the study made for this thesis.

Methods can be divided in two branches, qualitative and quantitative.

Quantitative studies are based on the collection of measurable data. The data is statistically analyzed to find relations that illustrate a problem or an activity.

Qualitative studies on the other hand deals with observing characteristics and prominent features in a certain phenomenon [5].

The greatest limitation with a quantitative study is that many things can not be measured. Typical examples of such things are thoughts and behaviour.

In a qualitative study the researcher often observe activities in a specific context and tries to create an understanding of what is going on. Often the main goal of a qualitative study is to find problems and weaknesses in a certain activity in hope to solve them.

The qualitative study also has its downsides. The difficulty in using a qualitative method is the way to gather, store and analyze information. Because of the non-restricted nature of a qualitative study the amount of data can be huge and often hard to interpret.

Some of the methods that can be said to be qualitative are interviews, observations and more or less structured conversations.

6.1 Observation

An observation is a study of people with the attempt to observe in what natural situations they meet and how they behave in these situations [5].

An aspect to observation is that the subject that being studied might feel uncomfortable and starting to behave unnatural which may distort the result of the observation.

This is an argument to use hidden observation. Unlike an open observation where the subject of the study is informed about the researches work, a hidden observation takes place without the knowledge and approval from the subject. A hidden observation can therefore seem insulting for the people involved. From a purely practical point of view the hidden observation requires that the researcher can move freely in the domain in which the study takes place without seeming suspect, something that can be extremely difficult to achieve.

Considering these aspects, an open observation is more easily performed and from an ethic point of view, less controversial.

Traditionally the choice of field to study in can be problematic, it is important to choose a field that is geographical limited and that contains the areas to study [5].

In this study this aspect of making observation was not an issue mainly because it was made in a small office with a small number of persons to study.

6.2 Interviews

Even though it is common practise to keep informal conversations with the subjects during an observation it is often a good idea to make more elaborate interviews to get a more balanced picture. Sometimes the observation is not enough, the actions and thoughts of a subject must be explained. Interviews are however not unproblematic. A common problem is that when asked about his or hers activities the interviewee tend to describe it as it “should” work and not how it actually works.

Another problem is how structured an interview needs to be. If the interview is too structured the interviewee may not feel free to answer the questions in his or her own way. On the other hand if it is totally unstructured the interview might turn in to a meaningless chat. An unstructured interview must not be confused with an informal conversation. Unlike an informal conversation an interview is prepared in advance, the level of structure may vary but it is still more than a spontaneous chat. A rule to have in mind when preparing for an interview is to be flexible and be open to add or remove questions during the interview. An interview can often be disturbing to the subject while he or she is working and should therefore be conducted at a later moment.

To get a complete picture of the situations observed it is important to interview people from different levels of the organisation observed. In many organisations people might be “afraid” to speak their mind because they are concerned that someone above them in the company hierarchy might “overhear” what they say. The common practice for the researches is therefore to point out that the results from the interview is confidential.

For the purpose of this thesis making interviews is a good way to get an overview over activities in different parts of the organisation. As the goal of the thesis is to come up with design implications that will support people in the company, interviews are an excellent way to get to hear opinions and suggestions on the system from the user’s point of view.

6.3 Realization of study

As this thesis has its focus on the work and routines of a workforce administrator a quantitative collection of information is limited and therefore not suitable for purpose of this thesis. To get a clear and fair picture over the workforce administrators’ and technicians’ tasks and routines a combination of observation and interviews were conducted. Two observations at two different times were done at the office of the workforce administrators. Their work and routines were studied and informal conversations were held to explain certain activities.

To get the technicians’ view on things several informal conversations as well as telephone interviews with technicians on the field were made. The informal conversations were held with the technicians as they came into the office to pick up or drop off work

orders. To get an overview over the company's different sections an extensive interview with a departmental manager were held.

A number of interviews were also made with an additional company with similar work tasks. These interviews were made over telephone and via email correspondence. The interviews were made with people from different levels in the company hierarchy. The interviews were followed up with complementary questions to make sure that the given information was accurate and sufficient.

The interviews and observation were open and the people involved were informed about the purpose and goal of this thesis.

7 Case studies

In order to see how workforce management is applied at companies working with mobile workforces two case studies have been made. For the first case study, at a support service company, presented in section 7.1 a number of interviews with the staff and observations of the workforce administrators were made. The second case study, accounted for in section 7.2, was made through of a number of interviews conducted by mail.

7.1 The support service company

In the following section the result of the observations and interviews made at a company providing support services for telecommunications companies is presented. The studied organization and the workforce management software used today are described. Focus lays on what the work orders in the workforce management software look like and how they are used.

7.1.1 Background information

The company performs implementation of network services i.e. network services commissioned by a second part. Among the services performed is maintenance on data and telecom networks. The division of the company studied in this report works with urgent error handling and installation assignments. The staff consists of the supervisor, two workforce administrators and 36 field technicians. The task of the workforce administrators is to receive the incoming commissions from clients and assign and distribute these to the field technicians. The field technicians are grouped in three different expert groups. The main task for the field technician workforce is network development but error handling in networks is also carried out.

7.1.2 The observation

The observation was conducted at the office located in the centre of the city. That day, Caroline and Linda, workforce administrators, David, the supervisor and fourteen field technicians were on duty. Most of the field technicians were out on commissions during our observation. The entrance of the office is located in the middle of a corridor. All employees sit in open-plan offices separated by corridors. The workforce administrators sit at the end of the corridor in a room through which the field technicians has to pass to get to their open-plan office. The supervisor sits in an open-plan office at the other end of the corridor together with the administrative staff.

7.1.3 Task processing

A large telecommunications company is one of the clients. When an error occurs in the client's network that requires a field technician to correct it, the support service company is engaged.

7.1.4 Two types of commissions

The commissions handled are urgent error handling, so called service commissions, and installation jobs. Service commissions will be handled within 24 hours and installation commissions within 96 hours.

Communication between customer, administration central and field technician

The picture below shows the flow of a commission through the organizations. The focus of this report is on the communication between the support service company (SSC) and the field engineering (FE).

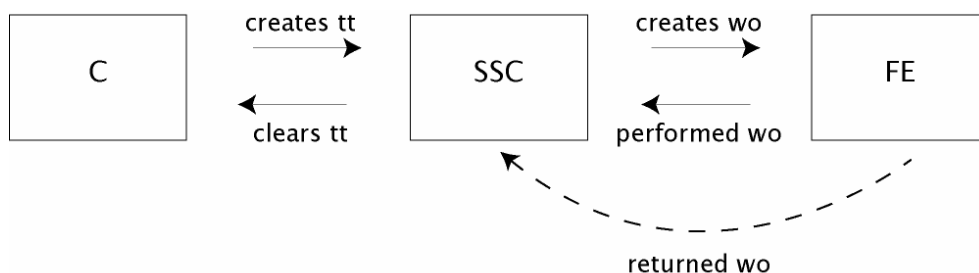


Figure 7.1 Task processing at the support service company

C – owner of the network, NOC

SSC – support service company administration central

FE – field technicians

An error occurs in a telecom or data network of an operator (C). The network operation central (NOC) at the client's (C) is informed either by a customer reporting it or by an automatic alarm from the network. A trouble ticket (tt) is sent to the administration central at the support service company (SSC). The workforce administrator at the administration central receives the trouble ticket and creates a work order (wo). The workforce administrator assigns the work order to a field technician (FE). The field technician performs the assignment if possible. If the technician can not perform the assignment it is returned to the workforce administrator. When the assignment is completed the field technician reports the job done to the workforce administrator at the administration central (SSC), normally over the phone. The workforce administrator clears the trouble ticket in the system, i.e. reports the cause of the matter, what was done to correct it and the time the error was corrected. The client (C) can then log on to the system to see what was done.

7.1.5 System

The major client and the company studied use a joint system that mediates communication regarding commissions. The client's NOC personnel create trouble tickets in the system. The support service company workforce administrators receive it, create work orders and assign the work orders to the field technicians.

7.1.6 The system work order

A work order consists of the information from the trouble ticket and possibly additional information about infrastructure, site information etc. Due to this extra information a work order may contain several pages of information. One of the field technicians says “We often need a lot more information about the equipment than the client provides. Caroline or Linda normally looks up this info for us and enclose it in the work order or we do it ourselves. This is one of the reasons why it’s best to have a work order in print, because of the amount of information. PDA’s, mobile phones, all those portable things aren’t any good to display all that data.”

7.1.7 How a work order is handled

When a work order is created it is assigned to the field technician appointed to perform the task. Since the system is not used by the field technicians on location, the work orders are mediated to the field technicians either by phone or by distribution of a printed copy of the work order. Caroline says “I phone the guys when I have a new job for them and we agree on how to get the work order to them. If they are here in the office I just give the work order to them”. When an assignment is completed, the field technician reports to the workforce administrator about the measures taken and the time of the completion. The report is given over the phone or by hand writing on the printed work order and returned to the workforce administrator when the field technician returns to the office. One of the field technicians, who just returned from an assignment, enters the room and gives Caroline a piece of paper. It is the work order for the assignment that has just been performed. Caroline: “I enter in the system what they say was done, or like now what he has written on the work order, and when it was finished. The client can then look up the facts about the commission in the system. Still, they mostly call me to get the report. I guess it’s easier to call me than to log on to the system.”

7.1.8 How to assign a field technician for a task

The following section describes the different criteria used when assigning a task to a specific field technician. Since this is an important task for the workforce administrator the descriptions are relatively detailed.

7.1.8.1 Choice of field technician based on competence

The staff of field technicians is grouped into three different expert groups. In addition some of the field technicians have specific competence about for example Cisco routers, older network equipment etc. Individual competence is not documented in the system. Therefore, the system cannot be of any guidance to what specific field technician within each group should be chosen for each assignment. When asked about what she based her decisions on concerning which field technician to choose for an assignment Caroline answered:

“Basically, all field technicians can do the same things. But I know them fairly well by now and know what kind of tasks they have done before so if there is a commission demanding some special knowledge I normally know who I shall appoint. Also I know

what kind of jobs they prefer. I try to make them happy as far as possible” she says and smiles.

As Caroline says, each field technician should be able to perform all kinds of assignments given to his expert group. Sometimes though, a certain field technician may be more suited for an assignment depending on individual competence, prior experience on that site etc. The field technicians sometimes know more about their colleagues’ competence than the workforce administrator does and may therefore return an assignment to the workforce administrator with recommendations on what other field technician to assign as better suited for the task.

7.1.8.2 Choice of field technician based on geographic location

Each week two field technicians per expert group work with service commissions and the rest of the group work with installation commissions. Since there are only two field technicians working with service commissions, the workforce administrator assigns the field technician currently available and does not consider where in the district he or she is located. This implies that the field technicians sometimes must drive a long way to perform a job. If a field technician currently working with installation commissions is in the area of a service commission, this field technician may get assigned to perform the task instead if he or she is available. The indication to where a field technician is currently located is by the latest performed assignment. Installation commissions are if possible assigned to field technicians living nearby in order to avoid long driving distances.

7.1.8.3 Choice of field technician based on workload

During our visit, Caroline receives a commission for an installation. The client wants the job done by the end of the next month. Caroline looks in the digital calendar for the field technicians and sees that Göran’s schedule is almost empty for that week. She schedules the assignment in his calendar. It is a routine assignment so no skill out of the ordinary is needed. Since it is an assignment planned several weeks ahead Göran’s schedule for that day is empty. That way, Caroline doesn’t have to take driving distance from other jobs into account either. The workforce administrator normally schedules the installation commissions one to two weeks ahead. This is done with the help of the field technicians’ digital work calendars. The workforce administrator makes an estimation of how long the task will take and according to this puts together each day’s work load. Again, differences in competence are not crucial to the choice of whom to assign. Instead, the objective is to distribute the work load as evenly as possible amongst the field technicians and also consider where in the region they are located to avoid unnecessary driving. If the field technicians want to switch assignments with each other, for example depending on earlier experience on a particular site, they do these swaps by phoning each other. Service commissions are queued on the two field technicians currently assigned for those tasks.

7.1.9 If a problem occurs on a commission

The workforce administrator is responsible for seeing to that a commission is completed within the agreed time. If a task assigned to a field technician risks not being completed in time the workforce administrator must find out why the task is not completed. In that case the workforce administrator calls the field technician to see if he or she needs help from another field technician and why the assignment does not proceed as planned.

“Normally, I don’t have to worry about that because they call me or some of the other guys before there is a risk of passing the deadline. Still, I have the responsibility if something after all should go wrong.”

7.1.10 Communication from the workforce administrator to the field technician

7.1.10.1 Distribution of work orders

Installation commissions are, as mentioned earlier, scheduled in advance by a workforce administrator. Field technicians working with installation commissions can thus themselves print out work orders for scheduled assignments whenever they are in the office. Service commissions demand immediate action. Since the field technicians mostly are not in the office during the work day the workforce administrator normally phones the field technician to give the work order information orally.

7.1.10.2 Problems in the distribution of work orders

Both the workforce administrators and the field technicians consider the communication of work orders between them to be a problem. When a work order contains a lot of information it is not practical to deliver it over the phone. Instead, the workforce administrator tries to fax the work order to the field technician. Earlier, a fax could be sent to the network station closest to the reported problem. Today however, as an effect of savings at the operators, the availability of fax machines has gone down. The company has considered installing printers and faxes in the field technicians’ cars but found it to be too expensive. Other techniques such as laptops with a GPRS connection are not always reliable or practical. One of the field technicians says “Sometimes you get a phone call in the middle of a job about another job you’ve been appointed to do. You then have to let go of whatever you were doing and write down the new information on whatever you have at hand, usually the first work order “.

7.1.10.3 How the problem of distribution is handled

The field technicians interviewed preferred to have the work order printed on paper. One way of dealing with the problem of infrastructure is for example to drive to a petrol station in the area and ask to receive a fax there. Or to drive back to the office and get a copy of the work order there. “Sometimes it is actually better to go back to the office, even if is several kilometers away, since it is only at the office we can access the extra site specific information” says one of the field technicians.

Reporting completed commissions

There is often no time pressure on installation commissions. Therefore, the reports on closed installation commissions are normally given, orally or in writing, by the field technician to the workforce administrator when the field technician returns to the office. Closed service commissions, however, must be reported immediately since the time is crucial. The fastest way for the field technician to report a closed service commission is to phone the workforce administrator to give the information.

7.1.10.4 Problems in reporting a completed commission

When the workload is heavy it can be difficult for the field technician to get through to the workforce administrator on the phone. The workforce administrator can also have trouble handling all reports which may result in delays of the closing reports into the system. Also, the workforce administrator gets disturbed in his or her work when having to answer the phone. According to the workforce administrators interviewed, the clients also often phone to get the report on a closed commission despite the fact that the information is available in the system. This puts even more load on the workforce administrator and hinders the field technicians to get through on the phone. Caroline says “On busy days it can be very difficult since I don’t have time to report back to clients because of all phone calls. And reporting back as fast as possible is very important since it is the basis for our statistics about solved cases.”

7.1.11 Technical support for field technicians

The support service company has tested computer support for field technicians at two different locations during a short period of time. Below is a report of the findings.

7.1.11.1 Purpose of the test

The purpose was trying to find a solution to the problem of distribution of work orders to field technicians on location. The functionality sought was ability to fax or email work orders directly to the field technician on location.

7.1.11.2 The solution tested

The solution tested was a handheld computer integrated with a mobile phone. The staff at both locations found the solution satisfying concerning network coverage and use in field. However, a connection to the system handling work orders did not exist. Since a new system was going to be introduced no effort was put in developing a connection between the current system and the handheld computer. The possibility of sending information via fax or email was used but not that of distributing work orders directly to field technicians in the field. The supervisor tells us “The network coverage was surprisingly good and we used it for mailing the work orders. But as the guys probably already told you, information on a screen is no good in the field”

7.1.11.3 Rejected solutions

The possibility of installing Mobitex printers in the field technicians' cars was also examined. However, this was considered too expensive and also not a satisfying solution since the Mobitex printer only prints a small strip not suitable to display work orders. As earlier mentioned the solution to install printers in the cars was considered too expensive.

7.1.11.4 Future support

The new system that will be introduced during autumn 2003 replacing the current system does not support a handheld solution either. A possibility considered is to develop such a solution. Developing a web interface to the system has also been considered. This would make it possible to receive work order information and give reports on completed assignments directly in the field. According to the supervisor, a web interface to the new system has high priority but has to, like everything else be compared to other needs in the company. The problem of what technical equipment to use also remains.

7.1.12 System support for workforce administrators

The following section describes needs concerning computer support expressed by the workforce administrators.

7.1.12.1 The need for and problem with description of competences

According to the supervisor and the workforce administrators support for categorizing field technicians by competence is a big need. It would be of great help for new workforce administrators but also for locating field technicians with a special competence stationed at other offices. However, the reason to why such categorization is not made has to do with the problem of how to describe competence and skill and not with scarcities in the system. Today, there are no guidelines for how to categorize competence within the company. The categorization must be made in the same manner at all the company's offices to be of any use. The supervisor again: "I have no reason to categorize the competence of my own staff but I would like to see the competence span at other offices. But since all offices has their own method of describing skill or don't use skill categorization at all I wouldn't know what to search for." In order to find the right competence one must know what to search for. How detailed shall the descriptions of competence be? Until a standard is set for how to handle the categorizations no descriptions are made.

7.2 The telecommunications company

In the following section the results from the interviews with staff at a major telecommunications company is presented.

Section 7.2.1 describes the studied organization. Section 7.2.2 describes the processing of a task through the organization. Section 7.2.4 presents the software used for communication of tasks and work orders. Section 7.2.6 describes how work orders are

assigned field technicians and section 7.2.7 describes how the communication between the network operation central and the field technicians is managed. Section 7.2.8 accounts for the technical support available for field technicians.

7.2.1 Organization

The company studied is a telecommunication company providing fixed and mobile telephony, data network and internet services. Network maintenance is performed by the company themselves but also by external parts, mostly in the sparsely populated areas. The operators at the network operation central receive the reported problems from the customer support, prepare work orders and distribute them to the staff of field technicians. A group of operation experts may be consulted by the NOC operators depending on the nature of the problem. The field technician workforce is in the big city areas grouped in two different expert groups, mobile telecom networks and fixed telecom/data networks. In the sparsely populated areas no difference in competence within the technician workforce is made. The main task for the field technician workforce is network error handling but network development is also made.

7.2.2 Task processing

Communication between customer, NOC and field technician

The picture below shows the flow of a commission through the organization. The focus of the study is on the communication between the NOC and the field engineering.

C – customer

CS –Customer Service

TCS – Technical Customer Support (TCS)

NOC – Network Operation Central (NOC)

(FETS – Field Engineering Technical Support)

FE - Field Engineering

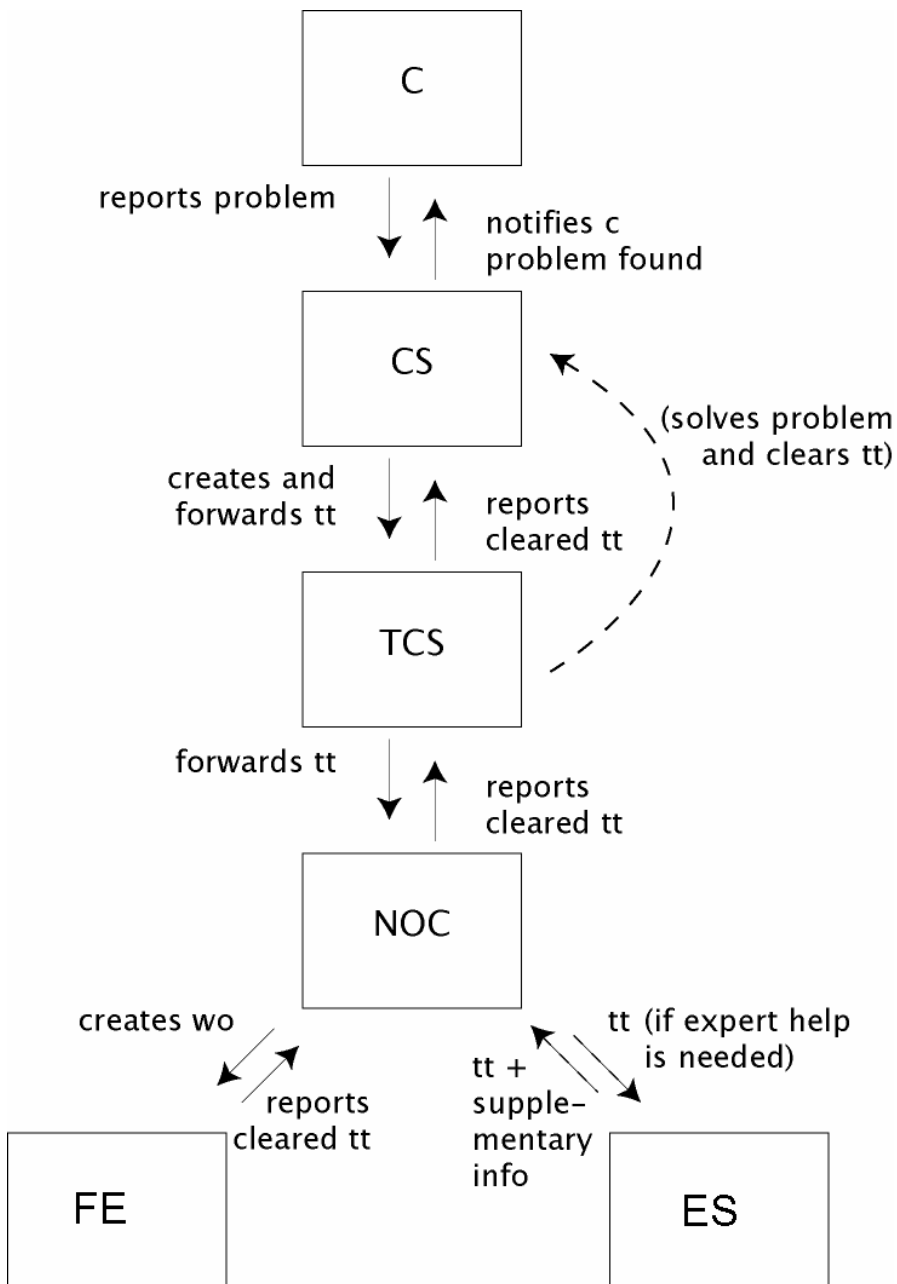


Figure 7.2 Task processing in the telecommunications company

A client reports a problem to the Customer service. There, a trouble ticket (tt) is created concerning the problem and forwarded to the technical customer support. If measures need to be taken by field technicians the tt is forwarded to the NOC. Depending on the nature of the problem the operators at the NOC either contacts a group of experts for additional information or directly creates a work order (wo) which is distributed to the group of field technicians. The field technicians perform the job, clear the trouble ticket, i.e. reports the problem solved, and reports back to the NOC. If the technician needs extra

information or help with the problem the expert group can be contacted again. The cleared trouble ticket is then passed back through the organization.

7.2.3 The interviews

The interviews were conducted via mail. The questions concerned the work of receiving, performing and reporting commissions. In case an answer to a question was inadequate, a new mail was sent with follow-up questions. The people interviewed in this study are the head of the staff of field technicians in the north of Sweden, a number of field technicians working with mobile telecom network in Stockholm and the head of the mobile telecom network NOC in Stockholm.

7.2.4 System

Communication of trouble tickets and work orders are handled through a computer system. The system is used by both operators at the NOC and by field technicians at the local offices. In the system the reported problems are announced, structured and logged. The assignments in the form of trouble tickets are then assigned to the head of the geographically responsible group of field technicians. That person in turn assigns it to a field technician in the group. Daniel, the head of the field technicians in the north of Sweden, says “We use the same system at the local offices and in the field as they do at the NOC. I think that is an explanation to why there is never any problem with the flow of information. The info we get is correct, which helps us do a good job. Using the same system eliminates the risk of information getting distorted”. The system is also used as a database of the field technician workforce with information of where the different groups of field technicians are based.

7.2.5 The system work order

A work order in the system consists of a description of the problem, time of reported problem, history of related problems, affected equipment, how customers are affected, proposed action and if necessary additional comments. “The NOC provides us with all info we need concerning the equipment. We never need to look up any info ourselves before going out on a job. It works very well” says Peter, one of the field technicians.

How a work order is handled

When a work order is created it is assigned to the group of field technicians based in the area of the reported problem. Notification of the new work order is made by phone to the field technicians at the local office who then get the details of the work order through the system. “We also get notified by SMS but this is of course a more uncertain way of notification since we don’t know if it has been received” Daniel says. Urgent work orders are notified field technicians on location by phone. They may then access additional information via a laptop and a GPRS connection. When an assignment is completed it is reported back from the field technicians at the local offices to the NOC via the system. Urgent matters are reported over the phone by the field technician on location to the NOC.

7.2.6 How to assign a field technician for a task

The field technician workforce is grouped geographically. No difference in competence is made between field technicians in the workforce database even though some field technicians may possess expert knowledge in a certain area. When a work order is created the NOC contacts the field technician on duty in the geographically responsible group. This person is then responsible for assigning the task to the best suited field technician and see to that the work order is performed. "There isn't normally a problem with competence and who may be best suited. All our field technicians are very competent. If some difficulties should arise, the expert group can be contacted" says Per, the head of the mobile telecom network NOC in Stockholm.

7.2.7 Communication between NOC and field technician

7.2.7.1 From NOC to field technician

Both the operators at the NOC and the field technicians have access to the system where the trouble tickets and work orders are created. The system contains all necessary information regarding each assignment. The field technicians can access the system either at the local office via a LAN connection or directly on location via a lap top and a GPRS connection and thus get notified of new work orders. For urgent assignments notifications of work orders are made by phone or SMS directly to field technicians on location. Distribution of information to field technicians is not considered to be a problem according to the persons interviewed.

7.2.7.2 From field technician to NOC

When the field technician has carried out a work order it is reported through the system by the field technicians themselves. For urgent assignments the report is given by phone, either to the staff at the local office during office hours or to the NOC directly. The report contains the time when the work was completed, diagnosis of the problem and measures taken.

7.2.8 Technical support for field technicians

Technical support for the field technicians mainly consists of laptops, pagers and mobile phones with a GPRS connection. The field technicians have mobile phones with a number of different subscriptions in order to as far as possible be guaranteed to have a network connection."It is very important that we continually introduce new and hopefully better communication equipment. The communication works well today but we need new inventions as well. Everything can be improved" Daniel says. LAN connections and the system are available at the local offices where the field technician workgroups are based. Support for positioning of technicians via GPS have been examined but rejected. Some field technician workgroups also have access to a solution that provides possibility to access the system remotely in the field. Other workgroups have the intention of introducing this solution to be able to report directly from the field. Development of SMS notification for work orders is of current importance. Knowledge systems available for field technicians on location is also about to be developed. The attitude is that the current technical standard must not be a hinder for technical innovations that may be of use for the field staff.

8 Analysis

To understand the problems and identify the needs in the two organizations we use the theory of Action workflow and apply the action workflow loop to identify the breakdowns in the communication.

We recall the action workflow loop and its terminology according to Medina-Mora and Winograd.

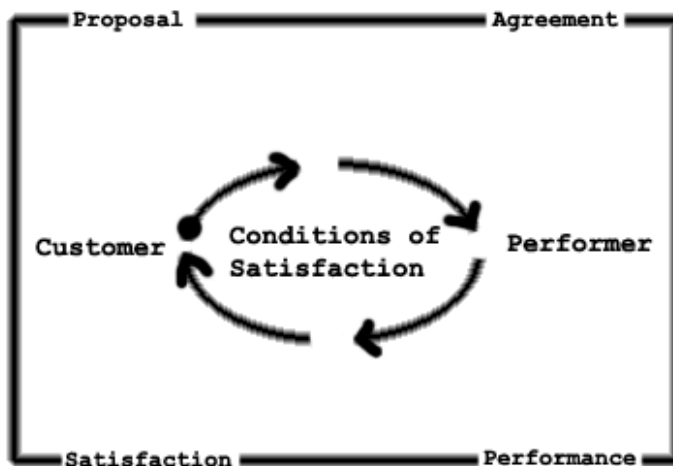


Figure 8.1 The Action workflow Loop by Medina –Mora et al.

8.1 The support service company

The following section analyses the findings from the case study at the support service company. The section begins with a short summary of the organization and its conditions of work.

8.1.1 Background information

The support service company provides services for a number of external customers and works with support of equipment that is not their own. Most of the commissions are scheduled maintenance work. The company has to a large extent to adjust to the customers' routines. This affects the possibilities of the field technicians to follow their own routines. It influences how information can be distributed between workforce administrators and field technicians. Also, the staff gets affected by economical lowering both at the customers' side and in their own organization. This has also led to that well functioning routines in communication and distribution of information between operators and field technicians has had to be changed.

8.1.2 Technical infrastructure

As an effect of savings at the operators, the infrastructure of faxes, printers etc have worsened. One of the main needs at the support service company is a better technical standard for field technicians. This would facilitate reliable routines for distribution of information to both workforce administrators and field technicians.

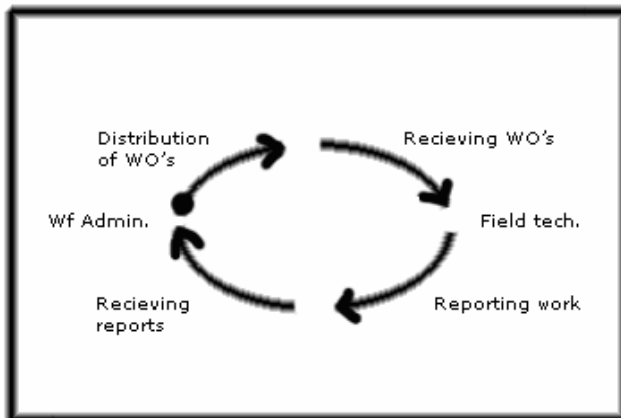


Figure 8.2 Potential breakdowns in the action workflow loop between workforce administrator and field technician caused by poor infrastructure

Illustrating with the action workflow loop the problems in the infrastructure results in breakdowns in each phase. Both the workforce administrators and the field technicians agreed that this problem of delivering information both ways was the main hinder in the daily work. The workforce administrator cannot be sure to get through to a field technician with the inquiry about whether he or she can accept the commission and the field technician can't agree to the conditions of the commission. This can be translated to breakdowns in the proposal and the agreement phase. After the work is performed the field technician cannot deliver a full report on the work and the administrator cannot receive the report which can be breakdowns in both the performance and satisfaction processes. Before the infrastructural prerequisites exist, improvements in software, for example to enhance information retrieval and reporting of closed cases, will have little effect.

8.1.3 Support suitable for field technicians' working conditions

There is a problem of dealing with the amount and format of the work order information under the working conditions of the field technicians. Most field technicians interviewed considered that a handheld computer would not be suitable to display a lot of information. A laptop in the field or even in the car would not work either because of the size of the laptop, sensitivity to differences in temperature etc. The field technicians also preferred having work orders printed on paper in the field. The main reason for this is that a paper is easy to handle and also practical for making notes on about the performed work, new and changed information concerning the site etc. Applying the action workflow loop to the situation the breakdowns occur in the agreement phase between the workforce administrator and the field technician. The field technician can not receive and store the information in a satisfactory way.

8.1.4 Categorizing of competence

The possibility to see which field technician has a special skill does not exist in the current system. This causes a breakdown in the proposal phase of the action workflow loop since the workforce administrator lacks support for choosing a suitable field technician for a particular assignment. Skill categorization will be supported in the new system. However, as the supervisor pointed out, the problem of how to describe competence and skill remains. Today, there are no guidelines for how to categorize competence within the organization. Thus, the problem of skill categorization is not caused by lack of technical support or poor software but more of an organizational problem.

8.1.5 The workforce administrator workload

The support service company is a small organization with relatively few employees. The workforce administrator's task is to distribute work orders to the best suited field technician. She must be informed of the location, skill, availability etc of each of the field technicians in the workforce. The only system support available today for this information is the field technician's digital calendars. The workload of each field technician can with the help of the digital calendar be monitored and taken into account when assigning work orders. The digital calendar is a valuable support according to Caroline who used it frequently. Information about the current location and, as described above, skill of the field technicians is not available through any system. The workforce administrator has to remember this information or estimate the location of a field technician based on the previous assignment. This considerably increases the mental workload of the workforce administrator which possibly affects the quality of work and potentially causing breakdowns in the workflow. In order to make a good decision on what field technician best to choose based on for example location and skill, the workforce administrator has to recall these facts. This may not always work and a breakdown could occur in the proposal phase.

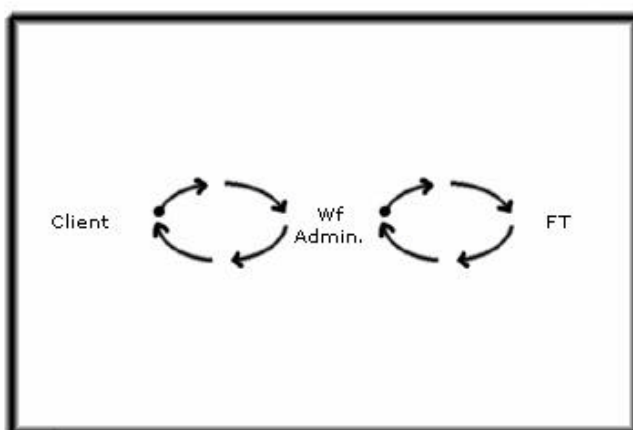


Figure 8.3 The workforce administrator workload may affect the workflow through the organization.

8.1.6 Two way communication

The study showed that one of the problems in the current system handling the work orders concerns the poor possibilities of communication between workforce administrators and field technicians. Support for two way communication is wanted. The current situation causes frequent breakdowns in all phases of the action workflow loop. For example, the workforce administrator receives a commission regarding a site. If this site is located near another site that a field technician is currently working on, there is no way for the workforce administrator to mediate the full work order to the field technician, only to notify the field technician about the new job. To get the full work order he or she has to find and drive to a location where a fax can be received. That is, mediating and receiving of work orders, the proposal phase and agreement phase, is affected. The same situation occurs when a field technician shall report to the workforce administrator so that she can close the case. If the time of the report is crucial, the field technician lacks possibilities other than phoning to report back to the workforce administrator. The phone call may be delayed because of the heavy workload due to clients wanting updates about commissions, other field technicians giving reports etc. This severely affects the performance phase and thereby also the satisfaction phase of the action workflow loop.

8.1.7 Field access to the system

Better possibilities to search and update information regarding assignments, site information and history of previous assignments are features wanted by the field technicians. The current system works as this kind of information channel for the clients but ought to provide the same support within the organization for field technicians. Having the system accessible in the field as well as having the ability to get the work order on a paper is important. It is also important to find a way to digitally file the extra information written down by field technicians on the work order. The action workflow loop, applied to the interaction between the field technicians and the information systems, is affected by breakdowns in the agreement and performance phase; the field technician can't extract information from systems in the field. Neither can they enter new information about performed work or new information concerning the sites.

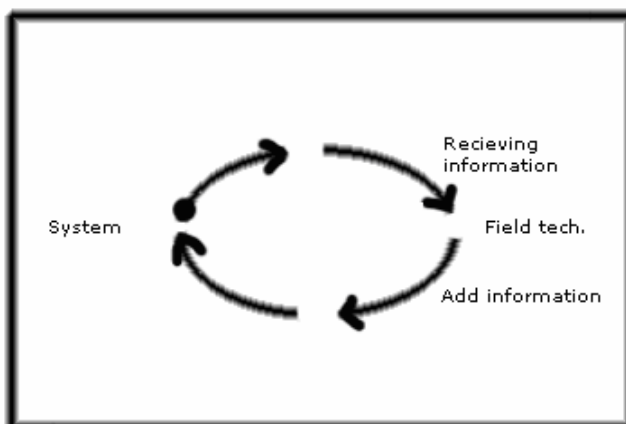


Figure 8.4 Problems of receiving and adding information from and to the systems results in breakdowns in the action workflow loop between the system and the field technician.

8.2 The telecommunications company

The following section analyses the findings from the case study at the telecommunications company. The section begins with a short summary of the organization and its conditions of work.

8.2.1 Background information

The telecommunications company's staff of field technicians maintains their own network equipment exclusively. The operations are mainly acute error handling.

8.2.2 Technical infrastructure

The telecommunications company has a good technical infrastructure. Distribution of information between NOC staff and the field technician workforce is therefore not considered to be a problem. Both NOC staff and field technicians on location have access to the same system. This also means that both parts can benefit from improvements made to the system. The action workflow loop illustrating the workflow between the NOC and the field technicians through the system works well without any breakdowns.

8.2.3 Communication between NOC and field technicians

Communication between the NOC, local offices and the field technicians on location works well both ways. Communication is enabled by LAN and GPRS connections, mobile phones and pagers. Information is mediated by the system, phone calls and SMS. No breakdowns is said to occur in the workflow.

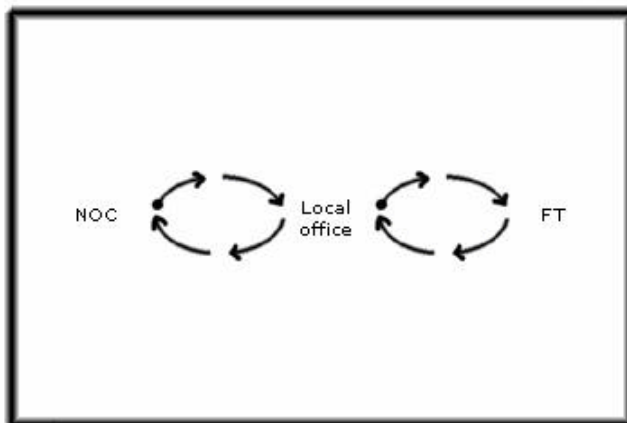


Figure 8.5 The workflow between NOC, the local office and the field technicians suffering from no breakdowns in the action workflow loop

8.2.4 Technical support for field technicians on location

The field technicians are well equipped regarding technical support. Lap tops and mobile phones provide the system support needed on location. The field technicians have a

number of different mobile phone subscriptions to as far as possible guarantee always having a GPRS connection. The field conditions are not mentioned as a hinder for use of the support systems on location. Thus, no breakdowns occur in the workflow between the system and field technicians.

8.2.5 Allocation of assignments and categorizing of competence

In the database of the field technician workforce description of competence is not made. The allocation of assignments is based on geographic location of the field technicians. Thus, the NOC staff does not have to consider field technicians differences in competence. New assignments are notified the head of the field technician workgroup responsible for the site. He or she then assigns the field technician best suited considering competence but also workload and availability. Also, there is an expert support group available for the field technicians to consult in case help is needed with a task. No breakdowns is said to occur in the action workflow loops.

8.2.6 System support

No specific need for technical support is expressed by the persons interviewed. Neither are any particular problems in the work mentioned. However, the development of new supporting systems has a high priority. It is stressed that the current technical standard and infrastructure must not to be a limitation for new innovations. Efforts are continually made to improve field technicians' access to supporting systems.

9 Discussion

In the following section the results of the analysis is discussed.

9.1 *The support service company*

9.1.1 Technical infrastructure

The staff at the support service company suffered from poor technical infrastructure. This is the cause of most of the problems and breakdowns in the workflow in the every day work. The problems concern for example the possibility to print a work order, access information directly via a system, give reports on performed assignments etc. The major cause of the problems is the infrastructure and can thus not be solved by a better system.

9.1.2 The paper as information carrier

The field technicians want to have the work order printed on paper. A piece of paper is the most practical information carrier for work on location. Both for information from the system, for example the work order, site specific information, as well as for information to the system, such as report on action taken on a site or new site specific information collected by the field technician on location. Handling papers is however difficult. To print information in the field is a problem but also to file information written down by the field technicians on paper. A solution to the latter problem would be to find routines in the daily administratively work to file notes written on the paper work order. Another would be to find an acceptable solution where the field technician can take notes digitally on location and that way store the information directly in the system.

9.1.3 Two way communication

This could be obtained by extending the functionality of the system. That way the field technicians could for example handle the closing of trouble tickets. This measure would also take some of the work load of the workforce administrators on busy days. Again, the problem of infrastructure appears. A solution would be to make the system handling the work orders accessible from a number of easily accessible spots, field stations for example. In this way the field technician can choose whether to download the information to a PDA, a laptop or print the info.

9.1.4 Reliable routines in the daily work

Many of the things considered a problem in every day work, for example the lack of finding a field technician by competence, problems in filing new information about sites etc is due to the lack of routines in the daily work. Thus, changes to the organization of work would probably solve some of the problems.

9.1.5 The workforce administrator workload

The workforce administrator has to keep track of a number of things concerning the field technician workforce such as current location, skill, previous site experience. This increases the workload on the workforce administrator potentially causing breakdowns in the workflow. This information could be mediated through systems for assignments scheduling, GPS modules or be delegated to a person in the field technician workforce. It may however in a small organization not be economically or organizationally possible to distribute responsibility differently or to introduce system support for these tasks. Few of the staff members would directly benefit from such an investment why it may be difficult to justify it. Unfortunately, if such investments are not made it may hinder a small organization from becoming more effective, growing or handle changes of staff.

9.1.6 Needs

Below, a list of features that would facilitate the work of workforce administrators and field technicians at the support service company.

- Infrastructure.
Technical infrastructure that enhances communication both ways.
- Guidelines for categorizing of competence.
- System access.
Access to the system on location for example in the car or at a field station.
- System support.
Support in the system for information about a field technician's work load, current location etc.
- Routines.
Routines in the administrative work for filing new location specific information or support in the system for filing this information on location.

9.2 The telecommunications company

The infrastructure at the telecommunications company is well developed. Different techniques are used in the communication. The organization is responsive to technical improvements and system improvements. Developing of new innovations to aid every day work has a high priority.

9.2.1 Allocation of assignments and categorizing of competence

The allocation of assignments to the best suited field technician is not mentioned as a problem. The backup of experts may be one explanation to why it is not considered necessary to locate expert knowledge in the field technician workforce.

9.2.2 System support

The motivation for finding new inventions to aid the field technicians in their work may be an effect of problems in the organization though not expressed. It may however also

be because it is in the organization considered important with technical development in general.

9.2.3 Needs

Improvements concerning supporting systems and technical infrastructure for both NOC staff and field technicians.

9.2.4 Method Discussion

The difference in the findings from the two case studies may to some extent be caused by the different methods of gathering the data. It was however not possible to conduct the studies differently because of the geographic distance to the persons and offices in the second case study. In order to compensate for the lack of observations at the telecommunications company, more follow up interviews were made to get as good view as possible of the work.

10 Design Implications for Ericsson's workforce manager

In this section the design implications for how to develop the Ericsson workforce management module is discussed. Based on the findings from the market inventory and the case studies a number of suggestions of future development are proposed. The findings from the case studies, particularly the one made at the support service company, revealed a lot of problems and situations causing insecurities in the every day work. However, these problems and situations mainly had to do with organizational issues and for which a computer system would not be a solution. The design implications are also developed with the existing workforce management system in Ericsson's trouble management solution in mind. Therefore, the design implications are made considering what is available today and what can actually be implemented in the future considering the platform. That is why some of the findings having a major importance in the analysis of the case studies may not have been taken into account in this section

10.1 Implemented design implications

A prototype has been developed to improve Ericsson's current workforce management system. This section presents the features that were implemented for the prototype.

10.1.1 Calendar function/Technician Workload

Based on the findings in the market inventory this feature was implemented because it is a prerequisite to other features that may be implemented in the future and for the administrator to be able to pick the right technician for a certain task. For the administrator to control and to create an efficient schedule the information about the technicians' availability is crucial. The technicians' current status as well as future workload is the base of every schedule. Prior to the development of the prototype, Ericsson's solution did only represent the technicians' current availability with an on/off duty status, thus leaving the administrator with very limited information. The obvious design implication is therefore to implement a tool that lets the administrator view the technicians' assigned work orders, working hours and other appointments. Although this update of the solution is not nearly as complex as an automatic scheduler it can improve the administrators work considerably.

10.2 Future development

This section presents the features that was not implemented for the prototype but may be an issue for future development.

10.2.1 Automatic Scheduling

Ericsson's solution lacks complex features like automatic scheduling and the forecast function. The market inventory showed that if Ericsson wants customers with large workforces it may be necessary to develop some kind of automatic scheduler that reduces the workforce administrator workload and lets him or her handle a larger workforce. For customers with a smaller workforce and a time marginal for work orders that are not that critical, the current state of Ericsson's solution is sufficient.

This feature was not implemented due the complexity of such a task.

10.2.2 Mobility support

Ericsson's solution offers a web published version of the system in order for technicians to access the system via a web browser. This function is however not optimized for devices other than PCs. This means that devices with a limited screen size are not suitable for this function. Concerning technology and what platforms for the field technicians to use the case study showed that a combination of laptop and printer is a good alternative. Problems concerning communications with a remote technician in the field are pointed out by Kristoffersen and Ljungberg [2]. But as explained in the case study all communication with the field technicians demands a well-functioning infrastructure. This feature was not implemented mainly because the focus of this study is the workforce administrator's work and not on the technician's.

10.3 Conclusion

The development of the prototype will support the workforce administrator in the work order assignment process. The calendar function lets the administrator have a better view over the technicians' workload and the procedure of finding the right technician is made easier. A calendar function may also be a step towards the development of more complex features such as automatic scheduling.

Though Ericsson's solution still lacks complex features the solution can be sufficient for companies with small to medium workforces. All of the mentioned features can be implemented in the future depending on customers demand.

11 Summary

The aim of this report is to examine the area of workforce management of mobile workforces. The question we wanted to answer with the study is

How to support management of mobile workforces?

The study showed that a prerequisite to well functioning workforce management is a good technical infrastructure. Without it no systems can improve or facilitate the work. Provided an infrastructure exists, important functions in a workforce management system are support for mobile access to systems used to handle work orders possibility to choose either paper based or computer based information a tool for the workforce manager to get an overview of schedules for the technician workforce.

A subset of the resulting design implications was implemented in the workforce management module in the Ericsson Resolution suite.

11.1 Future work

An evaluation of the implemented features in the Ericsson workforce management software should be made. A study on how to extend the possibilities of two way communication between workforce manager, the supporting systems and field technicians would also be of interest. Better support for two way communication will enable field technicians to handle more of the daily administrative work in the field. This would in turn take some of the work load of the workforce manager.

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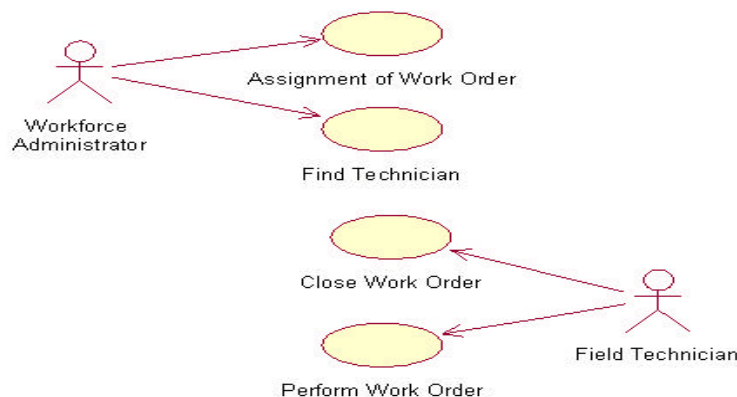
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13 Appendix

Implementation of a prototype

This chapter explains and illustrates the functions that have been implemented according to the design implications. These functions are integrated with Ericsson's trouble manager solution but they are still under evaluation and should be considered as prototypes. To have a better understanding of how the system works a short description of its users and their activities follows. The design of the prototype has the UML [9] framework.

The two main users of the workforce management system are the workforce administrator and the field technician. The administrator's main activity is to find the right technician for the right job and to assign the work order to him (see UC1 and UC2). The field technicians' interaction with the system involves performing the work order and finishing it by sending it back to the system (see UC3 and UC4).



[Figure Use Case Diagram]

The focus of this report lies on the activity of finding the right technician (see UC1). In the old version of the system the workforce management function enabled the administrator to find the right technician by searching for skill, region and on/off duty. This function has been improved with the development of the prototype. More information about the technician such as workload and secondary skill has been added to the search result. The result from the comparative study shows that Ericsson's solution lacks a proper tool to view the technicians' work schedule. The prototype has therefore been equipped with a calendar function which allows the administrator to view every technician's schedule i.e. what work orders and other appointments that already are assigned to the technician.

Assign Technician

The main activity of the workforce manager is to assign a work order to the most suitable technician. In order to find the right technician the administrator must search the workforce database using the workforce manager. The complete workflow from creation of a work order to dispatching it to a technician is illustrated in Collaboration Diagram 2. The prototype offers a more detailed list as a result from a search. This list now includes information about a technician's workload and secondary skill. A secondary skill has been added to refine a technician's area of expertise and to make distinction between different technicians easier.

By clicking the button Select Field Technician in the work order form the administrator is given the opportunity to search for a technician with specific attributes such as skill and working region.

Clicking this button will display the User Details form.

| Available FT | Login Name | Region | Skill | Secondary Skill | Workload | Avail Yes No |
|--------------|------------|--------|----------|-----------------|----------|--------------|
| | qstelon | West | Hardware | | 2 | Yes |
| | rt1 | East | Hardware | | 2 | Yes |
| | france | West | Hardware | | 3 | Yes |

1. Search

In the left part of the form, type in your search parameters in order to find the most suitable field technician for the current work order. There are three search parameters in the form, the field technicians' name, the field technicians' area of expertise (skill) and the region where the field technician works.

2. Search Results

The results from your search will be presented in the table to the right of the form. Each field technician is presented by name, skill, region etc.

3. View Calendar

By selecting a field technician from the table and clicking on View Calendar the user is able to see when the technician is available and when he is occupied.

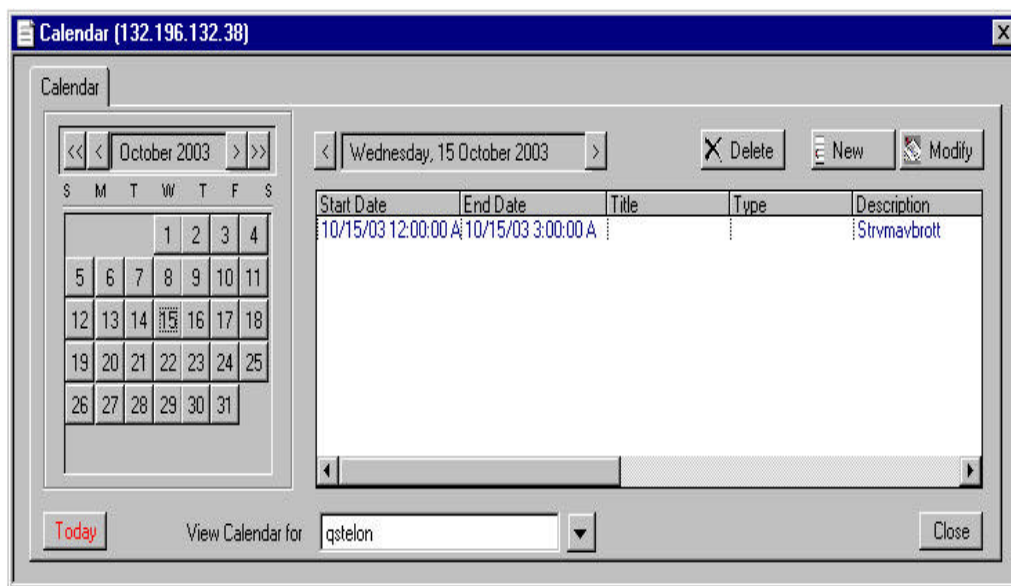
4. Save

By clicking Save the technician is assigned to the current work order. The technicians name, group and organisation appear in the corresponding fields in the Work Order form.

Calendar

One important parameter to consider when choosing the right technician is availability. Not only does availability play an important part in the process of assigning work orders but also when planning for the future and creating schedules that stretches over several weeks or months.

To make the technicians' availability and workload accessible for the workforce administrator a Calendar function has been implemented. The Calendar shows work orders and other appointments that already are assigned to the current technician.



1. View Workload

By selecting a date on the left part of the form you will be able to view the workload of the current field technician in the appointment table.

2. Appointment Table

This table displays information about appointments and work orders that has already been assigned to the technician. The information includes start and end time of the appointment, description and specific details about the work order such as site information.

3. New/Modify/Delete

To create, modify or delete an appointment click the appropriate button in the top right corner of the form. When the New or Modify button is clicked the schedule dialog will appear (see New Assignment).

New Assignment

Appointments are created by clicking the New button in the Calendar form. This displays the Schedule form.

The screenshot shows a window titled "Appointment (132.196.132.38)". The form contains the following fields and controls:

- Name:** A text box containing "qstelor" and a dropdown arrow. Buttons for "Cancel" and "Update" are to the right.
- Start Date:** A date picker showing "10/15/03".
- Start Time:** A time picker showing "12:00:00 AM".
- End Date:** A date picker showing "10/15/03 3:00:00 AM" and an ellipsis button.
- Reminder:** A dropdown menu showing "None".
- Alarm Time:** A text box and an ellipsis button.
- Title:** A text box.
- WO ID:** A text box containing "0000000000000008".
- Type:** A dropdown menu.
- Site Name:** A text box.
- Site ID:** A text box.
- WO Region:** A dropdown menu.
- Description:** A large text area containing "Strvmavbrott" and an ellipsis button.
- Status:** A dropdown menu showing "Current".

1. Create new appointment

An appointment is either associated with a work order or it can be created separately, which allows you to schedule other activities such as vacations.

An appointment contains information about start and end time; a description of the nature of the appointment and work order specific information.

If the appointment is associated with a work order it is already filled with information taken from the current work order. The information in the appointment is not static and can therefore be changed at anytime. When you have filled in the necessary fields click Add to save the appointment in the technicians' calendar.

2. Modify an appointment

To modify an appointment select an appointment and click the Modify button in the Calendar form. Change the details and click the Update button.

View Assigned Details

By clicking on the button Assigned Details the user can view the selected Technicians' details, such as full name, telephone numbers, skills, which work orders that already are assigned to him etc.

User Dialog (132.196.132.38)

| | |
|--------------------------|----------------------|
| Full Name Stefan L | Phone Number 111 |
| Login Name qstelon | Mobile Number 111 |
| Email Address | Pager 111 |
| Organization Ericsson | |

Field Technician

| | |
|----------------------------|-----------------------|
| Availability Yes/No Yes | Region West |
| Skill Hardware | Secondary Skill |
| Primary Skill Level | Secondary Skill Level |
| Workload 2 | |

Work Order List

| Title | Type | Region | Site Name |
|-------|------|--------|-----------|
| | | | |

Close

Other Diagrams

This section explains the other diagrams that can be found in Appendix.

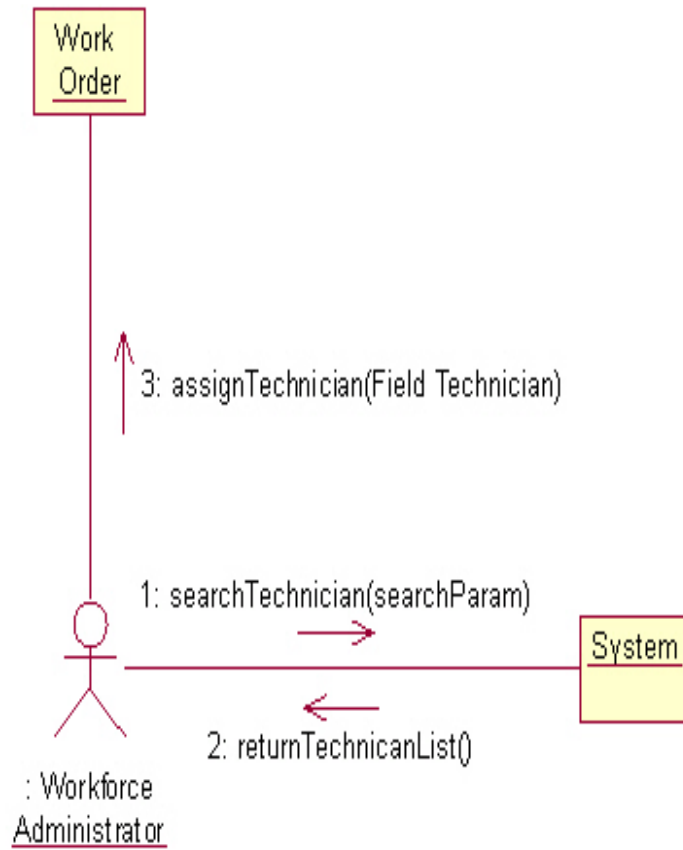
Class Diagram shows the classes/forms that are included in the prototype. The attributes represents the fields in the forms. The functions in the class diagram represent the different buttons that exists in the forms.

Resolution Form Collaboration Diagram illustrates how the different classes/forms are associated with each other and how these interact.

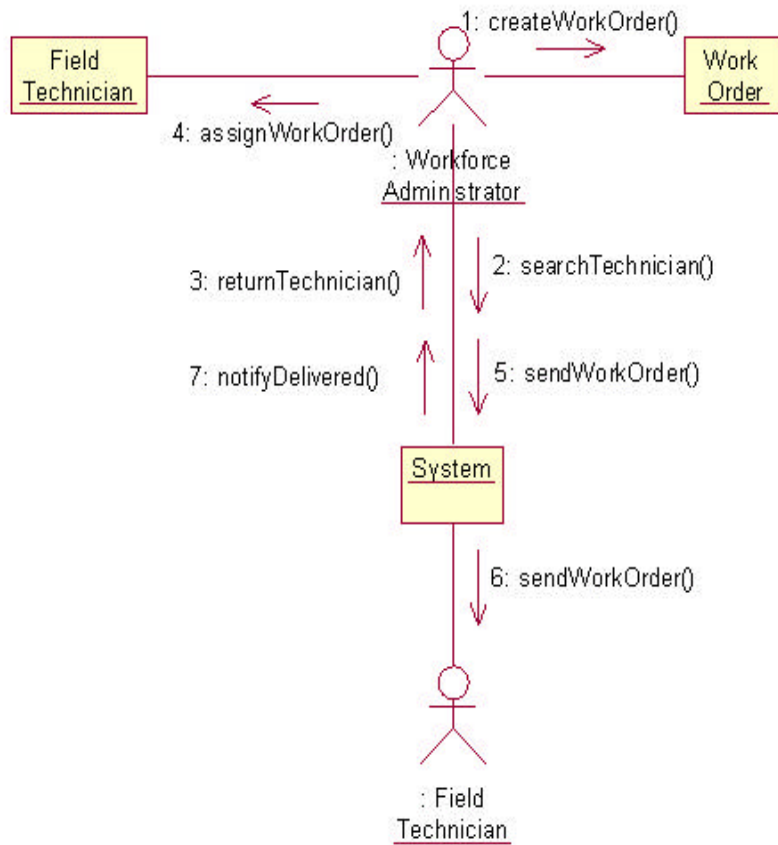
Collaboration Diagram 3 and 4 illustrates Use case 3 (UC3) and Use case 4(UC4).

Diagrams

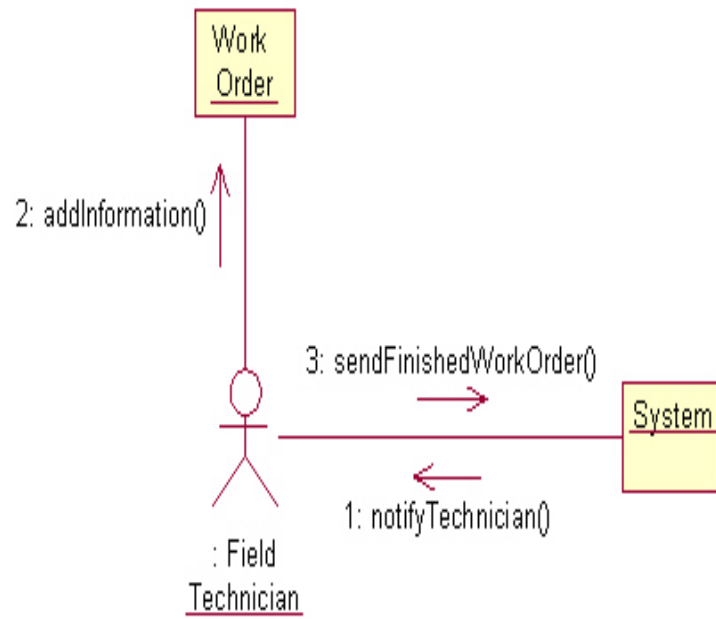
Collaboration Diagram 1: Find Technician



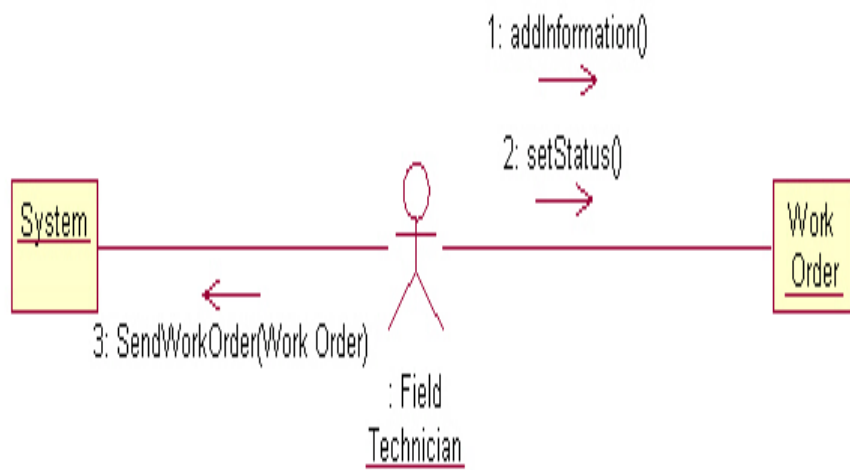
Collaboration Diagram 2: Assign Work Order



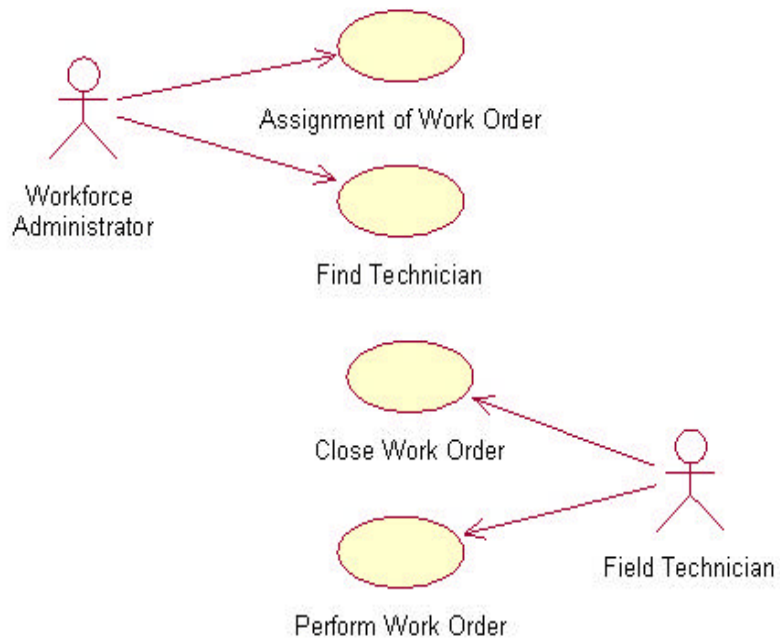
Collaboration Diagram 3: Perform Work Order



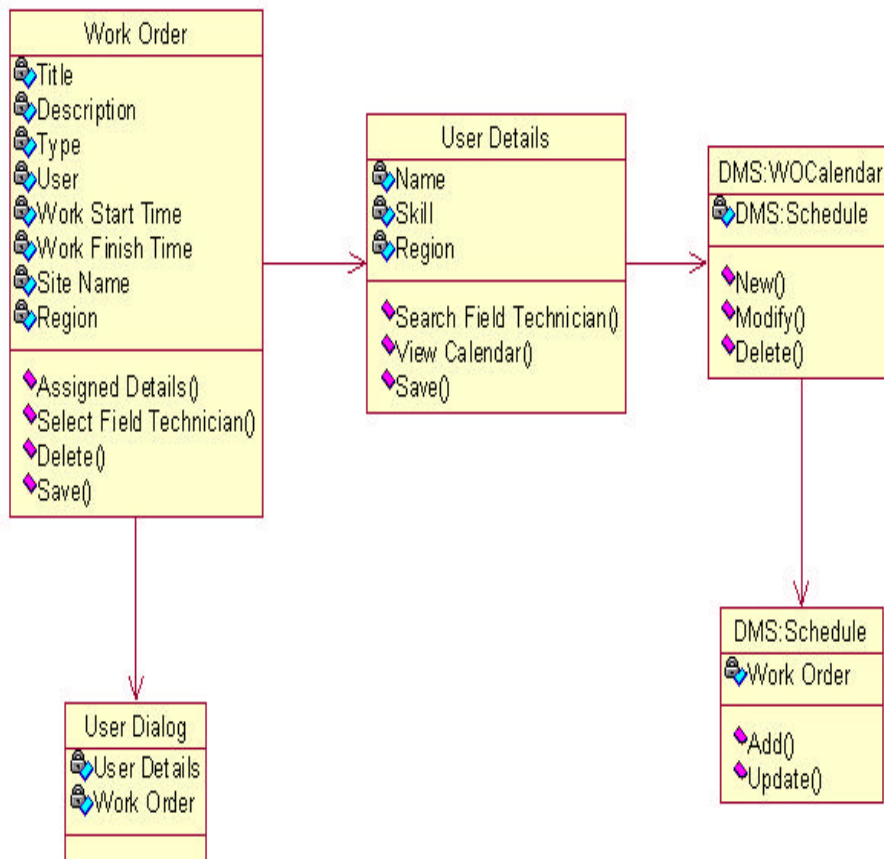
Collaboration Diagram 4: Close Work Order



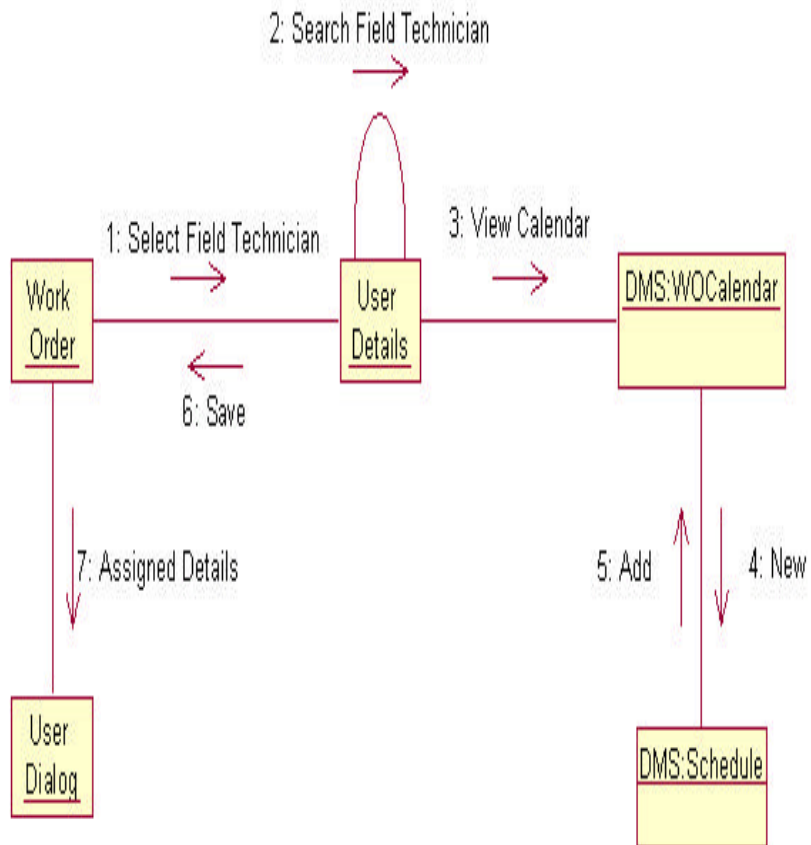
Use Case Diagram



Class Diagram



Workforce Manager Form Collaboration Diagram



Use cases

Use-Case Specification: UC 1: Find Technician

Brief Description

This use case occurs when a workforce administrator must find a suitable technician to assign for a particular work order. The workforce administrator searches the system for technicians with certain qualifications, which are needed to perform a certain work order in a satisfactory manner.

Actors

Primary actor: Workforce administrator

Flow of Events

Basic Flow

The workforce administrator searches the system for a suitable field technician by entering a number of search parameters to the system.

The system returns a list of technicians that matches the search parameters. The system also displays a list of return parameters, which describes the technicians' current status.

The workforce administrator picks the most suitable technician from the list.

The workforce administrator assigns the chosen technician to a work order.

Alternative Flows

2a. No matches found

The workforce administrator redefines the search parameters and tries to search again.

Special Requirements

- The field technician's working hours is synchronized with a digital calendar, which is accessible to the workforce administrator.

Pre-conditions

- A work order has been created and is ready to be assigned to a field technician.

Post-conditions

- A technician has been assigned to a work order.

Extension Points

None.

Glossary of terms

Search parameters

Name/organisation number of field technician

Skill of field technician – What skills does the technician possess. For a problem to be solved in an efficient manner it is important that the best technician is selected. By categorising the technicians into different areas of expertise the workforce administrator has the possibility to pick the most suitable technician for a particular job.

Experience level of field technician – What level of skill does a technician have. This is used to separate a novice technician from one with more experience.

Working region of field technician – Within what geographical area does the technician work.

Return parameters

Workload – How many work orders have already been assign to the technician.

Working hours of field technician

Availability – This field is filled in by the technicians to notify the workforce administrator about temporarily vacancy.

Use-Case Specification: UC 2 Assignment of work order

Brief Description

This case occurs when a trouble ticket is created and needs to be solved by a field technician. The workforce administrator creates a work order and assigns it to a suitable field technician.

Actors

Primary Actor: Work force administrator

Flow of Events

Basic Flow

The system places a trouble ticket in the workforce administrator's system view.

The workforce administrator views the trouble ticket.

The workforce administrator creates a work order and fills in complementary information such as priority, repair codes etc.

The workforce administrator searches the system for a suitable field technician. A suitable field technician is found by searching the system for certain parameters such as availability and skill.

The workforce administrator assigns the work order to the field technician. There may be more than one field technician assigned to the work order.

The workforce administrator sends the work order to the field technician.

The workforce administrator gets notified that the work order was properly delivered.

Alternative Flows

4a. No available field technician could be found

The workforce administrator places the work order in a field technician's work order cue.

7a. The work order wasn't delivered to the field technician

The system notifies the workforce administrator that the work order

Was not delivered.

The workforce administrator assigns the work order to another field technician or places the work order in the field technician's work order cue.

Special Requirements

The workforce administrator must be able to configure the graphical interface in order to view details of his/hers concern.

Pre-conditions

A trouble ticket was created and is available for the workforce administrator

Post-conditions

A field technician was successfully assigned to a work order

Extension Points

None.

Use-Case Specification: UC 3 Perform work order

Brief Description

This case occurs when a work order has been assigned and sent to a field technician. The field technician reads the work order from his mobile device or from a paper. The field technician solves the problem and reports it to the network operation centre by sending the work order with additional information to the system.

Actors

Primary actor: Field Technician

Secondary actor: Workforce administrator

Flow of Events

Basic Flow

The field technician gets a notification that a work order has been assigned and sent to him/her.

The work administrator gets notified that the work order was properly delivered.

The field technician views the work order.

The field technician performs the task.

The field technician adds complementary information such as site information notes about the assignment etc. to the work order.

The field technician reports the finished assignment by sending the modified work order back to the system.

Alternative Flows

3a. The field technician doesn't succeed in solving the assignment.

The field technician reports the reasons why the assignment couldn't be solved to the network operation central.

Special Requirements

In order to make the technicians work more efficient it is preferable that they have the possibility to be able to print work orders on paper.

Pre-conditions

A work order has been created and is assigned and sent to a field technician

Post-conditions

The field technician has successfully completed the assigned task and has reported it to the system.

Extension Points

None.

Use-Case Specification: UC 4 Close work order

Brief Description

This case occurs when a technician has completed or is unable to complete a work order. Depending on the success of the performance the technician sets the appropriate status of the current work order. To assist other technicians who might be confronted with a similar problem in the future the technician may add informal information to the work order before sending it back to the system.

Actors

Primary actor: Field technician

Flow of Events

Basic Flow

The field technician opens and views the current work order.
The field technician adds complementary information to the work order.
The field technician sets the status of the work order to “closed”.
The field technician sends the modified work order back to the system.

Alternative Flows

2a. The problem was not solved
The field technician sets the status of the work order to a deferred state.

Special Requirements

None.

Pre-conditions

The assignment has been performed as stated by the work order
The assignment was not performed and must be sent back to the system for reviewing.

Post-conditions

The report has been sent back to the system

Extension Points

None.

Glossary of terms

Complementary Information:

Status – This field shows the current status of the work order.

Informal Comments – This offers the technician the possibility to add informal information about a specific task or site which can be useful for other technicians when confronted with similar problems.

Time – When did the job start and when was it finished.

Spare parts – What spare parts were used when solving the problem.

Measure – What measures has been taken to solve the problem.

Abbreviations

| | |
|-------------|--|
| CDMA | Code-Division Multiple Access |
| GIS | Geographical Information System |
| GPRS | General Packet Radio Services |
| GPS | Global Positioning System |
| GSM | Global System for Mobile communication |
| LAN | Local Area Network |
| NOC | Network Operation Central |
| PDA | Personal Digital Assistant |
| SMS | Short Message Service |
| TM | Trouble Manager |
| TT | Trouble Ticket |
| WO | Work Order |