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SocioTechnical Soft Systems Methodology

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a sociotechnical approach to Soft Systems Methodology

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Abstract

The main purpose of this master thesis was to explore how Task Technology Fit (TTF) could complement the Soft Systems Methodology (SSM). In the course of examining SSM and TTF a new model called the SocioTechnical Soft Systems Methodology (STSSM) was created. STSSM encompasses the view of Soft Systems Thinking and it is based on the qualitative research method of Soft Systems Methodology and the quantitative research method of the Task Technology Fit questionnaire. Both methods are adapted to the new model by including some elements as they are, changing others, and excluding those elements that will not be beneficial to the model of STSSM. The master thesis not only includes a detailed account of this new model, but also gives the reader an insight into SSM and TTF. The model itself requires that it is performed in real life, and the only way to assess if it is a suitable methodology of inquiry was to actually go through the activities in a real situation. This was done in the form of a three-day Case Study in England, where the investigating part of the model was tried out. The abundance of material gathered in this short period of time, speaks for the suitableness of the model in any investigative situation of a sociotechnical nature.

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1 Introduction

There are many different ways to approach a situation that is perceived to be problematical. Organizations of today are surrounded by different forces that create a need for a structured way of coming to terms with these forces. One approach would be to focus on creating a better understanding between the supplier and user of a product, activating both parties in the process. Involving two different organizations and a product between them, calls for an approach that would entail both a social aspect as well as a technical aspect. The qualitative approach of Soft Systems Methodology complemented with the qualitative approach of Task Technology Fit will most likely be beneficial in the problem situation where two different organizations share a common denominator but have different interests.

Fundamental changes, such as technological, sociological, governmental and legal changes, as well as different business forces, like globalization and connectivity, are stirring up turmoil in the business environment. This volatile environment puts pressure on organizations to react if they are to stay in business. It is no longer enough just to work harder and faster. To stay competitive in the global market place, organizations will have to adapt to the environmental changes and adjust accordingly. Information Systems (IS) and Information Technology (IT), also known as IS/IT, provides the opportunity for organizations to react constructively to the changes in the business environment. (Scott Morton et al., 1991)

As to the political changes over the last years, there has been a change in the regulatory and governmental roles. Governments meddle with world markets through taxes, regulations, trade agreements and financial policies, which has resulted in a new competitive climate and a new set of rules for competition. (Cortada, 1998) Deregulation in various markets has created a tougher competitive climate in which organizations must fight for their survival. For instance the deregulation of Telia's monopoly on the access network in Sweden has made it possible for other telecommunication operators to use their network. This has resulted in harder competition on equal terms, which puts pressure on the Telecom organizations.

An increasing trend toward recession in the global market affects the overall economical environment of the organizations, which in turn puts pressure on the organization to increase revenue while reducing cost and enhancing productivity.

The living standard of the people in the Western World has risen over the last decades (Cortada). With better living come more demands on the environment. According to Maslow (in Bolman & Deal, 1997, p. 129) people are driven by different needs, where some are more basic than others. The need for food is dominant in the starving person's life, whereas people with enough food activate other needs as well. Better living standards include not only the way we live, but also the technology surrounding every day life, which makes life a lot easier. With a rise in living standards there is room for needs such as belonging, self-esteem and self-fulfillment that would not be present if the basic needs were not met. This has a sociological effect on what expectation people have on quality, concerning both quality of the working life as well as environmental quality. These expectations put pressure on the organizations to create value in the work place. To create a working environment that is stimulating and where the workers can further develop themselves as human beings, as well as increase demands to manufacture products that are undamaging to the environment. (Scott Morton et al.)

Another strong influence on an organization is the competitive climate in the business environment. Most organizations experience an increasing competition on the market where the competition can take many forms. On one market the most competitive factor can be price, on another it can be product variations, on yet another it can be service and so on. It is of utmost importance to continuously scan the business environment for knowledge of the changes and to adjust the organizational strategies accordingly. It is not possible to have one basic strategy. A company has to be able to work with different strategies and be prepared to modify them whenever necessary. The globalization of the economy forces companies to face more competitors than before, each of which might introduce new products and services to the market. Competitive pressures will therefore intensify, as organizations understand what it takes to compete in a global economy. As the advanced organizations continually improve their operations by focusing and managing their critical competencies, the price of staying in business will continue to rise. (Cortada; Hammer & Champy, 1993; Magoulas & Pessi, 1998)

Yet another driving force on the organization is stronger and more refined demands from the customers, partly due to that the level of knowledge is much higher than before. This is mainly a consequence of the customers having access to exceedingly more data. As a result the balance of strength between the supplier and the customer has turned. The customer informs the supplier of what they need, when it is to be delivered, how they want it to be delivered and how much they are willing to pay. Every customer insists to be treated as an individual, both the industrial customer and the consumer. It is no longer possible to talk of the customer as a homogenous group, every customer’s wants and demands has to be met in accordance with their specific needs and personal tastes. The customer of today is more value conscious as a result of both the vast product information and the rich selection of product options and features that they have access to. This puts pressure on the organizations to integrate the customers’ needs and desires into their own organizational culture if they want to stay competitive. (Hammer & Champy; Roth, Julian & Malhotra in Grover & Kettinger, 1995, chap. 17)

Technological innovations and advancements have forced the organizations into the information era where information is as important as the products themselves. IT is greatly influential due to the fact that it can affect both the production, as in producing goods or services, and the coordination activities. Improved connectivity is made available through the advances in IT, enabling new forms of interorganizational relationships and enhanced group productivity. IT has matured and is continuously demonstrating that it provides means for the organization to compete successfully in a turbulent and competitive marketplace. It allows the organizations to control their global capabilities by providing a forum for collaboration. With this technology it is possible to create products and services by using the finest and most creative minds in the organization, no matter where they are located geographically. IT will continue to develop and this will have effects on both time and distance shrinkage as well as connectivity, the ability to connect people and tasks within and between organizations. (Cortada; Scott Morton et al.)

IS/IT can be seen as a competitive tool and as such it is as important to the producer as it is for the user of the technology that it is of high quality. Organizations that manufacture and provide IS/IT have previously been concentrating on improving the technological edge, but today there is also a great need for understanding and including the people that uses the technology. Just delivering products that have a technical advantage is no longer enough; products also need to be easy to use and to fit in with the work practices and activities of the customer and the professional user (Bevan, 1999). Creating sound products has to include creating customer-value and as such it is up to the organization to have an awareness of their customers needs. Organizations must treat the creation of customer understanding and value as vital, to be able to stay competitive on the global market. (Roth, Julian & Malhotra)

1.1 Ericsson Microwave Systems

Ericsson Microwave Systems is one of Ericsson's largest centers for Telecom Management that provides management solutions for Network Operators and Service Providers in the telecommunications market. Ericsson's main objective is to secure investments for leading Telecom Operators worldwide by providing network solutions, from the network elements to systems and applications for operation and maintenance.

There has been a change of paradigm in the field of telecommunications during the last decades. Since the deregulation in the Telecom market the number of actors in each market has increased. From being an era of state-run monopoly operators, where the networks tended to be planned and constructed for mainly political and strategic reasons and where the subscribers had to buy the services offered – the deregulated telecommunication market is now considerably more complex and dynamic, where everything is completely market-oriented. An Operator will not construct a network without a market analysis to determine which services are going to be profitable. This will affect the supplier of the technology needed to construct a network that meets the demands the different services put on the network. The supplier of Telecom equipment have to adapt to this situation by shorter lead times, shorter time to market, lower prices and innovative products as well as systems and applications to run the network. (Eriksson & Orrhage, 2000)

The telecommunication market has recently suffered from the unpredictable slow-down in economic growth worldwide, particularly in the US and in parts of Europe. As a consequence sales are slowing in the Telecom industry as operators are postponing infrastructure investments. This has combined with a lower demand for mobile phones resulted in an economic downturn, which consequently puts additional requirements on the entire telecommunication industry. The Telecom Producers have to address the changing market conditions by reacting flexibly and quickly. Success will depend on how well the organization adapts to the situation in comparison with its competitors.

The Telecom Operators of today operate in a very competitive market. Not only do they compete with other Telecom Operators, but also against suppliers of Datacom services, as the convergence between Telecom and Datacom is becoming a reality. Telecom end-users demand an increasing level of service for less money. To stay ahead of competition, service providers and operators have to deliver new services, functionality and top quality at a lower cost.

The relationship in the telecommunication field is of a very complex nature since it involves three different types of actors: Telecom End-user, Telecom Operator and Telecom Producer. The End-user purchases and uses communications and/or data services from a Telecom Operator. The Telecom Operator provides communications and/or data services. They may operate networks, or they may integrate the services of other providers to deliver a total service to their customers, the Telecom End-user. The Telecom Producer develops and supplies the technology of the Telecom network and its use as well as related services for their customers, the Telecom Operators. These actors put different demands on the technology and the service it result in. The technology (both hardware and software) has to be advanced and effective to use, yielding economic advantages for all parties involved.

Telecom Management Systems are developed with the objective to improve the Telecom Operators' way to run and maintain their network elements in accordance with their work processes (and if possible improve the work processes as well). The Telecom Management System collects data from the network elements to manage the network as well as provide billing data. The system may help the Telecom Operator to achieve improved efficiency of its operations and effectiveness through better managerial decisions.

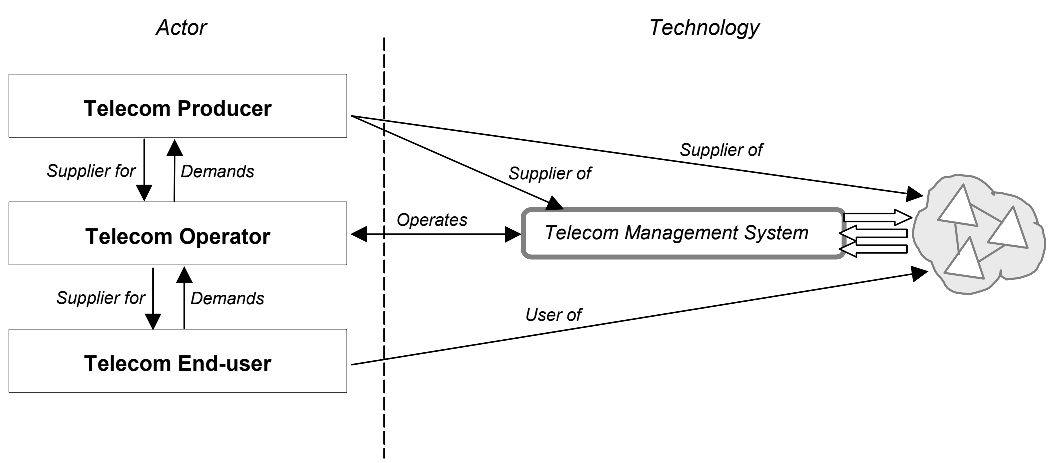


Figure 1 *The relationship between actors and technology in the telecommunication field.*

As shown in figure 1 there is a dependency-relationship between actor-actor where all strive for efficiency, which is caused by the supply/operation/use of the technology. The producer of the network elements and the Telecom Management System want their customer to be satisfied with their products and services in order to increase their revenues. The owner and Operator of the network also want their customer to be satisfied with their products and services in order to increase revenues. The Telecom end-user wants to use the Telecom services without hassle at the lowest possible rate.

The part of the Telecom Management System that effectively operates and manages the network elements is called the Operations Support System (OSS)[1]. The rapid developments in the field of IT facilitate the development of appropriate OSS, as a result of the fact that computers of today are very effective and that capable operating systems, like UNIX, make a suitable environment. OSS provides the means for a centralized operation and maintenance of the network elements via remote control where the Operator quickly and effectively can run and modify the network. An effective OSS provides economical advantages in two different areas: it provides for an increase in revenues as a result from improved utilization of the network and in savings because of the simplicity of implementing new services. (Olsson et al., 1996)

The OSS is designed to give the Operator an overview of the network as well as functioning as a tool for detecting and taking action to solve the problem at hand. The OSS can receive all fault information directly from both the traditional switched network elements and the network equipment from any vendor. It integrates the native network equipment configuration and command handling tools into one single Operator environment. This gives the Operator a good overall picture of the problem situation and provides access to all equipment-specific information that is needed to understand and act upon the actual problem.

As a Telecom Producer Ericsson has previously focused mainly on the technical side of the OSS. To deliver a system with all the functions needed to give the Operator an overall view of the network that also provides access to all network equipment. Today, this is not enough. How the system is being operated in real-life, how the system is perceived and what knowledge of the system the operators have – is just as important as the technical side of the system.

On the basis of the need to focus on the customer and create customer value and awareness, it is important to understand how the OSS is used in the operators' work process. Ericsson is now looking for a way to improve their customer-knowledge concerning these aspects. Ericsson seeks to improve their understanding of how much knowledge the Operator has of the system, the system functionality and if the design of the system is suitable. There is also a need to determine the work process of the operators of today. Understanding the work process of one or several Telecom Operators might provide the base for helping those customers who request Ericsson to provide suitable work processes aligned with the opportunities and possibilities that the OSS can offer.

[1] From now on we will only refer to the operating and maintaining system of the network elements as the OSS.

1.2 Problem Domain

The system development of the OSS was performed in collaboration with one single Operator (Telia, former Televerket) who had the monopoly on the Swedish market. Telia is a large Telecom Operator and their work processes might slightly differ from the ones of a smaller or even larger Operator. Hence, the computer system (the OSS) is based on work processes and a context that might not look the same in every situation. As mentioned before, Ericsson is a technical organization where the computer systems have been developed basically on a so-called technical approach, where focus has been on the technical characteristics of the systems. The softer issues of how the environment that the computer system exists in, has previously taken a secondary position to the functionality of the system. This underestimation of the significance and complexity of the human element in how the computer system is used might have resulted in systems that are not optimal. Another issue that is of the utmost importance is the previously stated fact that organizations have to comprehend the increasing complexity in the market place as well as understand the customer and what knowledge they have of the computer systems they use. These are issues that Ericsson has come to realize and is now tempting to resolve. As a technical organization they do not really know how to approach this 'social situation', where both the technicality of the system and the complexity surrounding it needs to be explored.

In trying to create an understanding of the world's complexity Systems Thinking can be applied. It embodies the idea of thinking about and making sense of some part of the real world, and doing so by means of the concept of a 'system' (Checkland, 1993; Lewis, 1994). Systems Thinking is a process of achieving a more accurate representation of the world by examining the system and comparing it to reality (Dahlbom & Mathiassen, 1993).

Ackoff and Emery (1972, p. 18), for example, defines a system to be:

> A set of interrelated elements, each of which is related directly or indirectly to every other element, and no subset of which is unrelated to any other subset. … although a system may itself be part of a larger system it cannot be decomposed into independent subsystems.

Checkland (1993, p. 3) defines the term system as follows:

> The central concept of 'system' embodies the idea of a set of elements connected together which form a whole, this showing properties which are properties of the whole, rather than properties of its component parts.

Lewis (p. 43) makes the same distinction of the system as a whole:

> The notion of 'a system' arises from the need to be able to investigate complex situations in a holistic way that takes account of the possibility of emergent properties. A basic definition of a system is then of a set of inter-related components *organized* together to form an entity that, as *a whole*, has *emergent properties* that belong to no single component or subset of the components of which it is formed.

Wilson (1984, p. 20) relates his definition of a system as a whole to the relationship between the elements:

> … the system is first of all a set; i.e. it contains elements that have some reason for being taken together rather than some others. But it is more than just a set, it also includes the relationships that exists between the elements of that set.

The conclusion that can be drawn from the above definitions is that the information system is only a part of a bigger system, the organization. It is not possible to study an Information System without studying the people who uses it and the process it is being used in. The IS that is to be investigated should not be viewed as purely a computer system - a collection of data processing procedures and machinery, but as a complex combination of both machines and people. This implies that due consideration must also be given to the varied ways in which the people that operate and are affected by the IS perceive the situation. (Avison & Fitzgerald, 1995; Lewis) The accounts of wholes in the systems thinking are called 'holons', proposed by Koestler (1967). It entails seeing relationships and inter-connections, the complete picture as well as the parts. To perform system thinking is to compare some constructed abstract wholes, so called system models, against the perceived real world in order to learn about it. This is why it is better to use the term 'holon' for the system models and leave the word 'system' as a more general term. The holistic approach enables handling more complexity and engenders more insightful options for action. (Checkland & Scholes, 1990; Gill, 2001; Wallis, 2001) This holistic thinking is based on Aristotle's dictum that the whole is greater than the sum of its parts (Avison & Fitzgerald; Checkland, 1993; Lewis).

1.2.1 Hard and Soft Systems Thinking

System Thinking exhibits two different kinds of system approaches, 'hard systems thinking' and 'soft systems thinking' (Checkland, 1993; Checkland & Holwell, 1998; Dahlbom & Mathiassen; Lewis). The definition of 'hard' and 'soft' center around the assumption made about the 'systems' concept and how it is used to represent the real world (Checkland, 1993).

In the hard systems approach it is assumed that reality is itself an ordered, stable system. The emphasis of the hard systems thinking lies in that it is possible to make a clear, exact, true and objective representation of the world. The system exists in the world just for us to discover and analyze. (Dahlbom & Mathiassen) The hard approach emphasizes the particular and the precise in a specific area and tends to look at the area from a single viewpoint (Avison & Fitzgerald). The 'real-world' is made up of systems pending to be identified and classified. If two individuals examining the same situation reach dissimilar conclusions about the systems, then this must be a result of inaccurate observation. One set of conclusion can in principle be shown to be closer to reality and thus be a more accurate representation of it. (Lewis) Hard systems thinkers believe that the world consist of systems that can be 'engineered' to achieve their objectives. To analyze a perceived problem in the hard systems approach is to engineer improvements in the real-world systems by discovering optimal solutions for it. (Ibid.; Checkland & Holwell) A goal is assumed in hard systems thinking. The analyst uses the methods to change the system in some way, in order to achieve this goal in the most effective way. The hard systems thinking is related to the 'how' of a problem (Avison & Fitzgerald).

The hard systems approach encompasses an ontological view on the concept of a 'system'. It is used to label objects in the real world, and analysis is based on the idea that the world is made up of systems and subsystems. (Lewis)

Hard systems thinking assume that the perceived world contains holons. In following hard approaches the analysts think in terms of holons as though they exist and as such they can be engineered. (Avison & Fitzgerald; Checkland & Scholes)

The hard systems thinking considers the organizations to be logically arranged, goal-seeking mechanisms (Lewis). Organizations are 'systems' that have needs of information, which can be filled by IS/IT. Organizations are seen as goal-seeking entities and the role of information is to provide an aid for decision-making. (Checkland & Holwell)

The basic assumption of the soft systems approach, on the other hand, is that there are always several, equally possible perspectives of the world. The world is shaped by our experience of it and as such it is subjected to the background, education, culture and interests of the person perceiving it. The world we live in - is the world we perceive. In the soft systems thinking there is no 'right' perception of the real world. The strategy for expressing different perspectives in the soft systems approach is to engage people in debate with the purpose of reaching some sort of agreement of the problem situation and possible solution. (Dahlbom & Mathiassen) In the soft systems approach it is assumed that the objectives of the system are more complex than an achievable and measurable goal. The systems are thought to have purposes rather than goals. An understanding of the situation can be achieved through debate with the actors in the system. The weight lies on the 'what' as well as the 'how' of the system in the problem situation (Avison & Fitzgerald).

Soft systems thinkers consider the world to be problematical but assume that the process of investigating it can be organized as a system (Checkland & Holwell). It is the use of the concept of a 'holon' as an epistemological device for *thinking about* the world that allows soft systems thinkers to explain why different interpretations of 'the problem' exist. Systems ideas are employed as a means of inquiry and are based upon a paradigm of learning rather than optimization. (Checkland & Scholes; Lewis) To soft systems thinkers, systems are perceptions of the world that we modify and improve when faced with other perspectives, new experiences, and by learning. A methodology must be developed in the soft systems approach with the purpose to aid the understanding of perspectives that differ from our own. (Dahlbom & Mathiassen) A soft thinking methodology can therefore be seen as a holon itself, which make use of *models* of holons in the discussion and comparison of the models with the perceived world (Checkland & Scholes).

The soft systems approach considers organizations to be complex and changing entities whose nature is repeatedly redefined by the people in it. The perception of the organization and the environment is shaped, defined and re-defined, by the constant interaction of roles, norms and values. (Lewis) The soft approach takes a more social view of organizations and sees them as relationship-managing entities (Checkland & Holwell). Organizations are considered to be 'open systems' and it is therefore important to look at the relationship between the organization and its environment (Avison & Fitzgerald).

In light of the distinction between the soft and the hard systems thinking, it is almost obvious that the best way to approach the problem situation Ericsson is facing, is from the soft perspective. This conclusion can be drawn from the very nature of the problem situation: The need of better understanding the customers and how they use the OSS:

- Firstly, different organizations are involved.
  The telecommunication field involves relationships between the technical-supplier and the service-provider. These are all dependent upon people, either within organizations or as an individual. All these people have their own perception of reality and it is vital to come to a mutual agreement how the problem situation is to be perceived. The soft thinking encompasses the idea of discussing the situation, which will lead up to an agreement of how it is to be perceived. This is an advantage due to the cultural factor of the situation. The telecommunication field reaches over the entire world and the cultural factor is not only of the organizational kind, but is also dependent on the country the organization is located in. The different worldviews, strongly influenced by culture, will be even more complicated to define than if all were based on the same cultural base. The hard thinking of 'one true perception of the world' would not be feasible to attain in this social situation. Another issue that must be factored in is the matter of language barriers. Since the Telecom market spans over the entire world it involves using a common language like English to communicate. A big part of the world does not have English as their first language and this adds to the difficulty of agreeing on how the world is to be perceived in a certain situation.

- Secondly, the computer system already exists.
  The hard system approach focuses on the 'how' of a problem. This would not be a sufficient base for investigating the existing system and the effect it has on the people in the Telecom Operator organization. Nor would a hard approach come to terms with the complexity in this ill-defined situation. The knowledge insufficiency can be classified as a 'soft problem'. The hard approach of engineering a solution cannot solve this type of 'softer need', since it is a matter of investigating something that is not really defined by the Telecom Operators to be a problem to begin with. This would imply that the need to understand the situation involves examining the 'what' as well as the 'how'. The investigation should therefore be performed from a soft systems approach. Every attempt to investigate an existing computer-system in an organization will be dependent on both the people using the system as well as the people performing the analysis, which makes the results unpredictable and situation specific. Another factor that is influential for the results is the fact that customers' use different versions of the system as well as systems of other vendors. Making it very important to create an overall understanding of the customer before the actual analysis of systems use can take place.

- Thirdly, Ericsson's customers are not of a homogenous nature.
  Adding to the difficulty of analysis is the fact that the customers can be of very different sizes. The larger Telecom Operators can have over thousands of employee's whilst the smaller ones can consist of about twenty people or so. Naturally this will effect the variation of worldviews

and the possibility to agree on the 'one true perception' of it, as assumed by the hard systems approach. The basic idea of the soft systems thinking is by discussion and learning, agreeing on how to perceive the world. It is therefore essential to perform the analysis of the situation with a group of people that represent all aspects of the organization involved. There could also be discrepancies in how 'susceptible' an organization is. The established firms have a lot more experience and procedures that the analyst has to take into account before leading any investigation. It could even be that the established firms are more "stiff" and can have resentments towards being 'investigated'. Whereas the start-ups, those that are brand new organizations, can be more open and willing to participate in discussion of how they work and use the system. The start-ups might even be interested in an investigation that not only will improve the computer-system-related issues, but also develop the work-processes themselves. It is important that the systems approach taken is of a flexible nature, so that the analyst quickly can adapt to the situation at hand.

- Lastly, there is the subject of the 'actor-levels' (discussed in section 1.1). Ericsson develops and supplies the hardware and software (and associated services). The Telecom Operator uses these products to supply a service of telecommunications. The end-user purchases the telecommunication service. Ericsson has realized the need to improve their understanding of the customer and whishes to improve on it. It is therefore important that the organization to be investigated, the Telecom Operator, also understands the benefits from such an investigation. Improving the situation between the technical-supplier and service-provider will most likely increase the effectiveness of the network operation for the latter. No matter if the solution is of a technical or a softer nature. This will in turn improve the situation for the Telecom end-user by making telecommunications services more effective. In this process it is vital for both the technical-supplier and service-provider to bear in mind the wants and needs of the end-user, since it is one of the strongest forces in the Telecom field. If they do not buy the Telecom service, then there would be no need for the other two parties. To approach this situation it is therefore better to base the investigation on the soft systems thinking of learning and participation, since it is very beneficial to learn about the situation together in order to create a solution that is acceptable to all parties. With the purpose of coming up with suggestions for change that are both feasible and desirable, it is important to involve representatives from management as well as computer-systems users in the analysis.

1.2.2 Methodology

To investigate the IS in its organizational context it is advisable to follow a methodology, a collection of procedures, tools, techniques and documentation aids that will help in understanding the situation. Methodology is defined in Webster's Dictionary (Webster's Dictionary, 1993) from two different angles:

> 1: a body of methods, procedures, working concepts, rules and postulates employed by science, art or discipline. 2a: the process, techniques, or approaches employed in the solution of a problem or in doing something: a particular procedure or set of procedures.

> 2: a science or the study of a method: a branch of logic that analyzes the principles or procedures that should guide inquiry in a particular field.

The former definition makes an important distinction between 'methodology' and 'method'. A methodology represents a structured set of guidelines, which enables an analyst to derive ways of lightening the expressed concern about a situation. Methodology is neither a method nor a technique. (Avison & Fitzgerald; Checkland & Scholes; Wilson) Where a technique tells the 'how' and a philosophy tells the 'what', a methodology will include components of both the 'what' and 'how'. (Checkland, 1993) If the methodology is to be applicable for the variety of real-world concerns, it has to be very flexible in terms of its structure and application. Using a methodology may involve using techniques, but it is the methodology that determines if a specific technique is suitable or not. (Wilson)

Every time a user in the light of a methodology perceives a problem situation, and uses the methodology to try to improve the situation, three components are closely linked: the user; the methodology, and the perceived situation. Methodology in that situation will lead up to a 'method' of the specific approach adopted. The methodology is hence reduced to a method uniquely suitable to that particular situation. (Checkland, 1993; Checkland & Scholes)

If the analyst can adapt a methodology in a coherent way to the concepts being used in particular problem situation, it will enable the analyst to stay problem oriented during the entire analysis of a situation. This will provide a better base for producing results that will be appropriate for the specific, unique situation at hand. (Wilson) To put it into the words of Checkland and Holwell (p. 156):

> Tackling real-world problems is so difficult that any generalized and tested methodology is worth carrying in your intellectual baggage, not to apply slavishly by rote but to use flexibly as a set of guidelines.

The best way for a methodology to work is through an explicit framework of guidance for sense making, and not as a prescription to be followed blindly. To be guided by this framework will lead up to processes that can be both described and recovered by others. (Ibid.) This increases the chance of producing results appropriate for the specific situation being investigated. In the field of IS-research there are many different types of methodologies where some emphasize the human aspects yet others aim to be scientific or pragmatic. (Avison & Fitzgerald; Checkland, 1993; Wilson)

A lot of systems methodologies focus on the technical side. By underestimating the importance and complexity of the human element, these methodologies might result in solutions that are not ideal. (Avison & Fitzgerald) Investigating IS in its context involves studying the relationships and functions of the IS within the organization. Three alternative views on the organizational role of an IS are distinguished: technical, social and sociotechnical. The main characteristic of the technical view is that the IS is seen as a technical artifact. The fact that the artifact may have different organizational/social consequences is more of a reflection than it is something to be concerned about. Any problems caused by the IS is primarily attributed to human resistance or to a poor technical quality of the IS. The social view, on the other hand, mainly regards the IS as an organizational and social system. The social view does not see the IS as just a support system for the organizational activities, but as an essential part of the infrastructure, control, coordination and work processes of the organization. The social view considers social disinterest as a cause to any implementation problems that might arise. The sociotechnical view is positioned between these two extremes and acknowledges that an IS incorporates both a technical subsystem and a social subsystem. The main reason for any implementation problems is accredited to the misfit between these technical and social subsystems. The sociotechnical view aims to give equal weight to social and technical issues (Mumford, 2000). A sociotechnical approach acknowledges that organizations have a wide range of goals which, in order to survive, have to interact with the surrounding social and technological environments. Individual and groups are also perceived to have their own needs and values, and these must be met in order for their willingness to satisfy the needs of the organization. In this network of relationships, technology is an important variable that affects both the ability of the organization to interact with its business environment as well as the ability to meet the personal needs of the individual or group. (Mumford & Weir, 1979) Conclusively it can be said that the technical view focuses on the technical quality of the system, the social view focuses on the desirability and feasibility of change as major qualifications for implementation, and the sociotechnical view focuses on the fit between the technical and social subsystems. (Iivari & Hirschheim, 1996)

Whatever view the methodology encompasses, the systems analyst should perceive the organization as a whole. A mixed group of people performing the analysis, not just computer-oriented people, is more likely to understand the organization and come up with sound solutions to problems. This would also broaden the viewpoints from which the problem situation is being examined. (Avison & Fitzgerald)

Methodologies that focus on human and social subsystems that are present in a problem situation are called Systems-oriented methodologies. These categories of methodologies are concerned with ill-structured problem situations, so called soft problem situations. These methodologies are used as an attempt to provide rich descriptions of a problem situation and at the same time increase the understanding of the situation. (Galal & Paul, 1999) Examples of such methodologies include ETHICS (Effective Technical and Human Implementation of Computer-based Systems) developed by E. Mumford and M. Weir at Manchester Business School, and SSM (Soft Systems Methodology) developed by P. Checkland and his colleagues at the University of Lancaster's Department of Systems.

The name ETHICS is an acronym, but the methodology implies that it stands for a sound ethical position. It is a methodology based on the sociotechnical notion of user participation as a vital part of IS design. A sociotechnical approach to work design recognizes the interaction of people and technology and leads to designing work systems that have social characteristics as well as technical efficiency, which combined will yield a high job satisfaction. (Mumford & Weir) ETHICS has according to Mumford three principal objectives (as referenced by Brink, Heuvelman & Stronks, 2001). The first objective is to facilitate future users of a new system with a collection of analytical and sociotechnical design tools. The second objective is to ensure that users acknowledge the new systems to increase user efficiency and job satisfaction. The third objective of ETHICS is to increase user competence in the handling of changes (like introducing new systems) as a shared activity within the organization. Involving the user of the computer systems in the selection and evaluation of system alternatives should provide means for system-effectiveness by a closer fit in the application domain between the (technology and the social and the organizational factors) technology, the social factors, and the organizational factors. The sociotechnical approach acknowledges the interface between technology and people, which result in work systems that are both technically efficient and have social characteristics. (Avison & Fitzgerald) This means that beside the harder aspects of computer-system design, softer aspects like work-structure, working environment, ergonomics and organizational structure have to be taken into account. (Brink, Heuvelman & Stronks) This leads to an improvement of the working-life quality as well as job satisfaction. The latter is defined as the 'fit' between what the employee is seeking from work, job needs, expectations and ambitions, and the organizational job-requirements. (Avison & Fitzgerald; Mumford & Weir) The participation approach in the methodology concerns the involvement of those affected by a system to be part of the decisions concerning the design and operation of that system, so that the system will represent the view of all parties involved. The ETHICS methodology perceives the development of computer systems as an organizational issue with focus on participation in the process of change. (Avison & Fitzgerald) Briefly ETHICS involve a set of steps that must be taken in designing and implementing a new work system. Technical and human needs are taken into account at each step in order for the system to be designed to specifically meet both technical and human objectives. The first step of ETHICS involves a diagnosis of the needs of the social system with a focus on long-term job-satisfaction needs. The outcome of this diagnosis will be used as a base for setting objectives, developing strategies and for designing sociotechnical systems. Step two involves design the systems, step three systems monitoring and the final step is that of post change evaluation of the effectiveness of the systems-design approach. (Mumford & Weir) The way ETHICS is used varies according to the demands and needs of specific situations, but the most commonly used approach is to follow the steps in order. This would most likely require a time frame of several months to complete. (Mumford)

SSM is intended as a methodology to explore, question and learn about ill-structured problem situations or messes. It is basically a general systems improvement method that helps identify opportunities for constructive change by encouraging a better understanding of a problem situation among the involved actors, including the analysts. Since SSM falls under the soft systems thinking, the analysts are perceived as actors involved in the problem situation and not as an outside observer providing objectivity. SSM attempts to provide help in getting from finding out about the situation, with emphasis on people's perceptions of reality, to taking action to improve the situation. This is achieved by the construction of relevant system models. Using the idea of a 'human activity system'[2], generally described as human beings

[2] A more detailed account on 'human activity systems' are can be found in Appendix 2.

undertaking purposeful activity, the methodology accepts that any real-world purposeful human activity can be described in various ways within many different worldviews. Each system model can only be true to one simple and fixed worldview. Consequently, several models are used to explore the problem situation under various perspectives. The practical work of constructing the models provides experience. This can be used to draw conclusions, which encourages discussion and debate about possible improvements that can lead to recommendations for change. SSM activates the people involved in the situation in a learning-cycle, which is preferably never-ending. It is a process that allows the participants to learn and build up knowledge about the situation by using systems concepts as a base for discussion, which makes it possible to improve the situation. It is important to remember that the models are not models *of* anything; they are models *relevant to discussion* about the situation. They are simply devices to stimulate, feed and structure the discussion. The SSM process can be tailored to the particular needs of each situation, which makes it possible to adapt the investigation to the situation at hand. Each situation is unique and the methodology must be tailored to fit the situation as well as the style of the analyst using it. (Avison & Fitzgerald; Checkland, 1985; Checkland, 1993; Checkland & Scholes; Checkland & Holwell; Lewis; Wilson)

1.2.3 The benefits of SSM

ETHICS is a method for designing work systems where equal weight is given to both technical and human needs. The method is based on a set of principles that should be used to assist the systematic and integrated design of both the technical and human parts of any system. The aim is for increasing both technical efficiency and job satisfaction. ETHICS is to help ensure that the technology is used in a positive way in order to enhance the quality of working life for the employees of the organization. (Mumford & Weir) ETHICS assimilates the sociotechnical view that the technology must fit closely with the social and organizational factors if the system is to be effective. The idea of ETHICS is to get information from the employees by using techniques such as interviews, questionnaires, checklists, tables and lists of results. (Brink, Heuvelman & Stronks) The diagnosis of the needs of the social system is focused on the 'fit' between the job needs of the employee and job requirements of the organization, which are obtained by filling in questionnaires. (Mumford & Weir) ETHICS is used to improve the situation between organizational objectives and the objectives of the employees. By increasing job satisfaction, both parties are bound to benefit. The issue seems to be the relationship between management and employees, and this is one of the reasons that ETHICS would not be the best choice of method for approaching the situation Ericsson is facing. The essence of this situation is to improve the relationship and understanding between two different organizations, and although using ETHICS would yield a lot of information we felt that it was not the optimal choice. The other fact that speaks against using ETHICS in this situation is that it was specifically created for applying sociotechnical thinking to the *design* of computer-assisted work. The four stages of ETHICS are developed in order to provide a set of steps that must be taken in the design and implementation of a new work system, where only the first stage is that of investigating into the situation. Since it also requires the participation of all stakeholders in order to improve end-user involvement in a systems design project, it has proven to be a method that takes a considerably long time to complete. Most of the design groups using ETHICS have required a time period of several months to complete the different stages of the method (Mumford). Even though ETHICS is a sociotechnical method, the stages involves a very thorough investigation into every little aspect of systems design and as such it would not be an appropriate method for approaching Ericsson situation of an investigation into the circumstances of their customers, the Telecom Operator. As a design method, the end product of ETHICS is the implementation of a new computer-system and this is not the objective of the investigation.

SSM on the other hand emerged from an action-research process of several years into the difficulty of situation analysis. In general, SSM focus on understanding the problem situations, rather than developing solutions. (Avison & Fitzgerald) SSM is basically a systems improvement technique that is useful in identifying opportunities for change by enabling a better understanding of a problem situation among stakeholders. (Bustard, He & Wilkie, 2000) SSM provides all those involved, including the analyst, means to understand and deal with the problem situation. The analysts are not just objective bystanders in the situation but are actors who are just as involved as those of the client and the problem owner. (Avison & Fitzgerald) A process of tackling real-world problems in all their richness has been formally expressed in SSM. This enables lessons to be learned and also provides users with means to know what they are talking about. (Checkland & Scholes) The main idea of SSM is to take purposeful action into human situations that are regarded as problematical and is organized around a process of inquiry, which leads to improvements of the situation. (Checkland, 1985) Although the focus of SSM lies on the softer issues of a situation, the social aspects, it would be the better methodology to approach the situation of learning more about the customers, how they use the OSS and what knowledge the customer have of the system. The main reason is simply because that each situation is most likely unique. No Telecom Operator looks exactly like another, and the methodology used to investigate each new situation should be very flexible and focus on an understanding that might lead to improvements, instead of a new computer-system.

The very nature of the problem situation that Ericsson is facing, also speaks for using SSM. Ericsson have realized that they need to improve their own knowledge of how the customer works and uses their computer-systems, but they do not really know how to go about filling this need. According to Wilson (Wilson, p. 94) the problem immediately becomes soft if there is any uncertainty about what is needed. As such, SSM would be an excellent means to try to solve this soft problem situation. Some of the benefits of using SSM in this type of circumstances are highlighted in the next section.

1.2.3.1 Problem Situation

The very nature of the problem situation is one where the computer-system already exists. It can therefore be argued to be a type of manufacture-problem situation. As such, systems that exist in reality transform raw data from the network elements into information that the Operator uses to form an understanding of the situation and take necessary corrective action. Creating an understanding of how the computer-system is being used and what knowledge the users have on the system, can be classified as to making a performance analysis. To evaluate the performance of these systems, this type of problem situation requires, according to Wilson (1984), the use of soft methodologies and its human activity systems concept. Even though the problem is being approached with soft systems thinking it is from a position towards the harder end of the problem spectrum. It will probably not be difficult to come to an agreement as to what the human activity systems to be modeled are. SSM will provide a suitable collection of systems concepts to carry out this performance evaluation. Do to the fact that SSM probably will be approached from a harder aspect in this case; the version of SSM that can be used to inquire into the problem situation is one of a more sequential nature.

1.2.3.2 Action Research

SSM is a form of action research and it includes a set of principles that guide action in an attempt to manage real-world problem situations. It is useful in undertaking purposeful action in order to change real situations constructively, which can result in improvements to the problem situation. (Checkland & Scholes) Although experts brought in from the outside can do inquiries into the problem situation, the best results can be reached if people in the problem situation itself perform the analysis (Checkland, 1985). The essence of action research is such that the analyst becomes a participant in the action and in the relevant group of people exploring and discussing the problem situation (Checkland, 1993). Since the problem situation and the environments in which they exist in, are dependent on the circumstances they are in, and the analyst does not control the way the action develops, the results are unpredictable and situation-specific (Avison & Fitzgerald; Wilson). Both Ericsson and the Telecom Operator are part of the problem situation. It is therefore beneficial to approach the investigation through action research where both parties are actively involved in the investigation.

1.2.3.3 Learning-cycle

The practical work that action research entails, provides an experience that can be used to draw conclusions and to modify the ideas that progress during the analysis stages. SSM provides means for all actors, including the analyst, to understand and to manage the problem situation. The analyst is thought of as being involved in the problem situation as much as the other participants of the analysis. They are not seen as external objective observers and as such they too are participants in the problem situation. The practical work will give experience that can be used to make conclusions and to modify these ideas. (Avison & Fitzgerald)

SSM can be seen as a learning system. It is a process of operating an endless cycle from experience to purposeful action in order to learn and understand an organization. It is an idea involving the people within the situation in a model-based stream of analysis. (Checkland & Holwell; Checkland & Scholes)

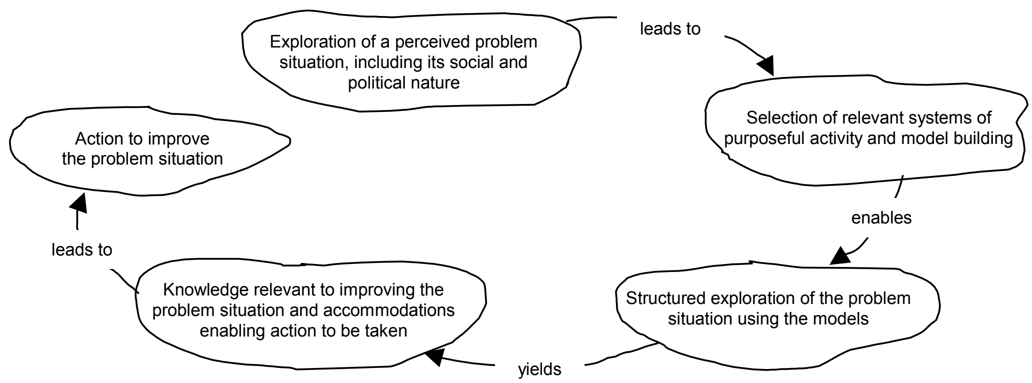


Figure 2 *The formalized structure of soft systems methodology as a learning system (Checkland & Holwell, p. 160).*

The core of SSM as a learning system (as shown in figure 2) is to formulate some models that hopefully will be relevant to the real-world situation. Setting and comparing these models against perceptions of the real world will enable debate leading to decisions of purposeful action to improve the part of life that is under investigation. The principle is first to find out about the situation in the real world. This will make it possible to choose the relevant human activity systems and to build models of them. The models are then used to question the real-world situation in a comparison stage. The debate initiated by this comparison is then used to define purposeful action that could improve the original problem situation. All steps have made it possible for the analysts to build knowledge that is relevant to improving the problem situation. Taking action to improve the situation will affect the original situation, which makes it possible to start the cycle all over again. (Checkland & Scholes)

As mentioned before, Ericsson is as much a part of the problem situation as the Telecom Operator is. This conclusion is based on the fact that it is Ericsson who develops and supplies the computer-system that the Telecom Operator uses in their daily operation of the telecommunications network. Since the analyst leading the investigation will be at least one representative from Ericsson, it is important that this person creates a knowledge of the situation together with the representatives from the Telecom Operator. Together they will debate and discuss potential improvements. This knowledge that the participants have learnt from one analysis can later be used as a base for analyzing another situation. The learning-cycle not only involves learning about the problem situation, but also learning about the use of SSM. Because SSM is a methodology, every use of it will probably bring about methodological lessons adding to those that are learnt about the situation of concern (Checkland & Holwell; Checkland & Scholes). The idea of action research is to combine the improvements of the real world with learning from the very process of achieving these changes (Wilson).

1.2.3.4 Flexibility

One of the key benefits of SSM is that it is very flexible and can be adapted to any problem situation in the real world. Checkland & Scholes formulate this idea as they draw conclusions from a series of action research studies (Checkland & Scholes, p. 8):

> SSM is not necessarily a methodology for carrying out a special highlighted study, but can be applied to any situation in which purposeful action to bring about improvement is sought.

The way that SSM is adapted and applied to a problem situation by any user will never exactly be like any other user's version. All users must find a version they feel at ease with. This indicates that the very use of SSM is very flexible and is dependent on the analyst and the very nature of the problem situation. The approach is applicable to any problem situation resulting in that SSM develops and changes every time it is used. (Ibid.) As mentioned before (see section 1.2.1) the best way to approach the problem situation Ericsson is facing, is through soft systems thinking. This is based on the nature of the problem: there are different organizations involved, the computer-system already exists, the customers (the Telecom Operators) are not of a homogenous nature and the relationships of the different actor-levels. Since Ericsson has many different customers it is important that the methodology the inquiry into the problem situation is based on, is flexible and easy to adapt to the circumstances at hand, both that are attributes of SSM.

1.2.4 The limitations of SSM

The very things about SSM that is beneficial can sometimes also be causes of limitations. SSM, more than most methodologies, is very dependent on the particular interpretation by those who use the approach. It can be difficult to teach and to train others in both systems thinking and in the modeling of the human activity systems, especially if the analyst is relatively inexperienced in using SSM. It might take a while before the participants start thinking in systems terms. This might cause the result to be 'thinner', than it would be if the approach to investigating the knowledge of the OSS, how the computer-system is used and how the Telecom Operator works, was more in the form of direct questions and answers.

The process of SSM is iterative and the analyst that leads it is not expected to follow a fixed set of procedures. This can present problems. It can be difficult to know when a stage in the study has been completed. There is a risk that the final version of the models might be political compromises and do not represent possible ideological conflicts between the different parties in the problem situation. One of the main fundamental ideas of SSM is that it should locate these issues and represent them in the models as well. If too many compromises are made, then the holons will not represent the true nature of the complexity in the problem situation. (Avison & Fitzgerald)

Even though the use of the methodology gives a better understanding of the problem situation, it can be difficult to achieve an agreed statement of the problem situation. The iterative process of debate and modification should draw out the different ideologies and conflicts and it can be complicated due to cultural issues mentioned in section 1.2.1. It is important to discuss the way the reality should be perceived together with a group of people that represent *all aspects* of the organization involved. A large Telecom Operator is usually made up of a lot of departments based on functionality, and can as such be located in different areas. Gathering the representatives can therefore be very difficult. If the participants in the study are not representing all sides of the organization, the 'whole' is more difficult to establish.

The discussion and debate around the problem situation and potential improvements is necessary to get the whole picture. This would include representatives from management as well as from the people with direct use of the computer-system. This might cause some limitations at the same time it is beneficial. Management may possibly have an intimidating effect on the representatives from the lower levels of the organization. To speak your mind in front of the boss, is not always that easy. Some may think that it is better to stay quiet and let others do the talking. This might cause the final version of the models to represent something that is not entirely the true representation of reality.

Another limitation of SSM, in this particular problem situation, is that its strongest characteristic is also one of weakness. The inquiry has to involve the existing computer-system. Since SSM emphasize on the notion of researching and characterizing the human activity system, it does not offer an obvious connection to technical design issues (Galal & Paul). SSM is also a methodology that is based on a social view (see section 1.2.2) of the organizational role of an IS. This entails that focus is on the desirable and feasible changes, as the major characteristics for implementation of a computer system. Since the computer system already exists, it is also important to explore how well this system fits the tasks performed by the people of the organization. This would signify that a sociotechnical view of the situation would also be beneficial in order to improve the situation. Just the social approach of SSM would not be as extensive as a combination of both a social and a sociotechnical view, which could deepen the understanding of the situation.

1.3 Problem statement

One approach in tackling this type of problem the limitations of SSM can cause in the inquiry of the problem situation can be to complement it with another method. It is a relatively novel idea in the field of IS/IT-research to attempt mixing methods. Lane and Oliva (1998), for instance, present an example in their 'Holon Dynamics', which is a synthesis of Soft Systems Methodology and Systems Dynamics. Bustard, He and Wilkie (2000) is another example of mixing methods, in the linking of Soft Systems Methodology and Use-Case Modeling.

Ericsson has previously had a strong technical view on the OSS and is still very interested in the technical side of an inquiry into the softer issues of the problem situation. It is therefore advisable to try to find a method that entails a sociotechnical view, and that can supplement SSM. A sociotechnical approach requires the technical to be given equal importance to the social (Mumford). By means of SSM an answer to the question of 'what' can in principle be reached, but as far as the OSS is concerned it might not give a sufficient base for determining the 'how'. To bring about feasible and desirable improvements, the discussion and debate has to be supported with the information 'of the many'. This would suggest looking for a method that could provide a quantitative view as well as a qualitative. Questionnaires can be employed, which can be used without any further qualitative interpretation of the researchers in a quantitative analysis. This dual-method approach will enable a richer investigation into each specific problem situation.

Information technology, the OSS in this case, has to meet the needs of the organizations, groups, and individuals that use it. Goodhue and Thompson (1995) have developed a theoretical base for a method of 'meeting needs' called Task Technology Fit (TTF). This method captures how well the technology, the functionality of the computer-system, matches the needs of the task that is being performed (Dishaw & Strong, 1998). If a technology has the functionality needed to complete the required actions for the task, then the result should be a better performance. Improved performance should also be the consequence of an individual having the appropriate knowledge and experience needed to use the technology. (Goodhue, Klein & March, 2000) The technique of investigating the TTF is through a research questionnaire that can be customized for each situation.

The purpose of this master thesis would therefore be to approach SSM from a sociotechnical view by trying to complement it with another method, that of the TTF-questionnaire. This would entail creating a version of SSM that can be practicably assessed in reality in order to deliver a methodology of both a qualitative and a quantitative base that Ericsson can use in future investigations.

Hence, the research questions this master thesis addresses are:

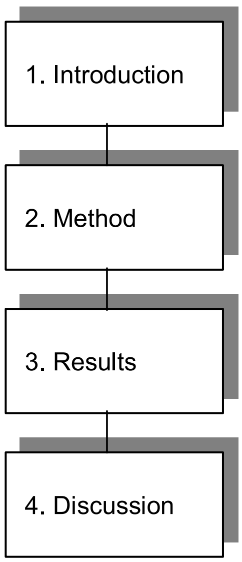
1.
How can Soft Systems Methodology be complemented by Task Technology Fit?

2.
Is this modified version of Soft Systems Methodology an appropriate method for this type of problem situation?

We will try to find a solution to the first question by means of finding support for it in literature in the field. The second question will be approach through a Case Study, where this new version of SSM will be performed together with a Telecom Operator.

1.4 Disposition

This thesis is divided into four main parts namely: Introduction, Method, Results and Discussion. Lastly, the References used and Appendices are presented.



Part 1 provides a background to our study.
We also explain the problem domain leading up to the problem statement.

Parts 2, the method section describes the phases of the research method: the literature study, the practical assessment and the evaluation phase.

Part 3, the result section, is divided into two parts. The first part is an account of the model, STSSM. The second part presents the results from the Case Study.

Part 4 presents a discussion around the appropriateness of STSSM. Recommendations for future use of the model are also presented.

2 Method

A variety of methodological approaches can be taken when conducting a scientific investigation. Decisions of which approach that best fits a specific situation can be based on how much knowledge exists on a certain problem area prior to the investigation. Research approaches based on the extent of knowledge are those of exploratory, descriptive or hypothesis testing (also called explanatory) investigations. (Eriksson & Wiedersheim-Paul, 1997; Patel & Davidsson, 1991)

Exploratory investigations are appropriate for ill-structured problems and for circumstances where there are uncertainties on what research model is suitable for a specific situation and what characteristics and relations are important. (Eriksson & Wiedersheim-Paul) The main purpose of an exploratory investigation is to gather as much knowledge as possible concerning a specific problem area. This entails analyzing the problem situation based on several points of view. When conducting an exploratory investigation a number of different methods of information gathering can be used. (Patel & Davidson) A typical characteristic of the exploratory investigation is that it has to be flexible in order for it to be adaptable to the results and knowledge that is assimilated during the study. (Eriksson & Wiedersheim-Paul)

Descriptive investigations are useful when a problem is relatively well structured, but there is no intention of investigating why the problem exists in the first place. (Ibid.) Descriptive investigations are mainly performed in problem areas where a certain amount of knowledge already exists that could have been used to create models prior to the investigation. In a descriptive investigation only the essential aspects of a problem area are explored and these aspects can be described separately or in combination with other aspects. These descriptions can be of either past or present events. (Patel & Davidson) In the center of the descriptive investigation lies the fact that the goal is known, but not the means to achieve it. A well-structured plan is needed for this type of study in order to reach exact answers. (Eriksson & Wiedersheim-Paul)

Hypothesis testing aims at investigating cause/action relations between variables. (Ibid.) The knowledge base in these problem areas is very extensive, making it possible to formulate specific theories. The hypothesis testing assumes that there is enough knowledge within the area in order to derive assumption on relationships in reality based on those theories. The assumptions are called hypothesis and it expresses connections where a specific factor is the cause of another. In order to test the hypothesis, the investigation has to be structured in such a way that there is no possibility of factors other than those expressed in the hypothesis affecting the end result. (Patel & Davidson)

Due to the unstructured and ill-defined nature of the research problem, the best way to investigate the situation was, according to the description above, the exploratory approach. The fundamental idea of the exploratory method is according to Patel and Davidson (1991) to gather as much knowledge as possible on the problem area. As a consequence of there not being a defined problem statement, the first step would naturally be to build as much knowledge about the situation as possible in order to define the very nature of the problem and from there investigate possible solutions.

Based on the exploratory approach the research method was designed as presented in figure 3. The first phase of the method is called the Literature Study and is composed of the iterative stages of creating an understanding of the problem and the collection of necessary data. The final stage of the Literature Study involves the model building. The ill-structured problem called for a phase of trying to understand Ericsson's situation due to the very nature of the situation being that there was neither an exact definition of the problem, nor a way to resolve it. In order to understand the problem area we had to start the Literature Study by reading up on the field of telecommunications. While reading, the understanding of the situation matured, leading to a realization that more data collecting was required. This iteration between phases was pursued until we possessed a base of knowledge rich enough to specifically formulate the problem statement. Once the problem had been stated - we could move on to the stage of trying to solve it. Hence, the data collection continued with an extensive literature study on systems methodologies. The solution to the problem was believed to be a model of how to inquire into the situation of the customer. Where the methodology would involve SSM complemented with TTF. First, we approached this model building by exploring what methodology would best suite the situation. Hence, the iteration between the model building, understanding the problem and data collection continued, as shown in figure 3.

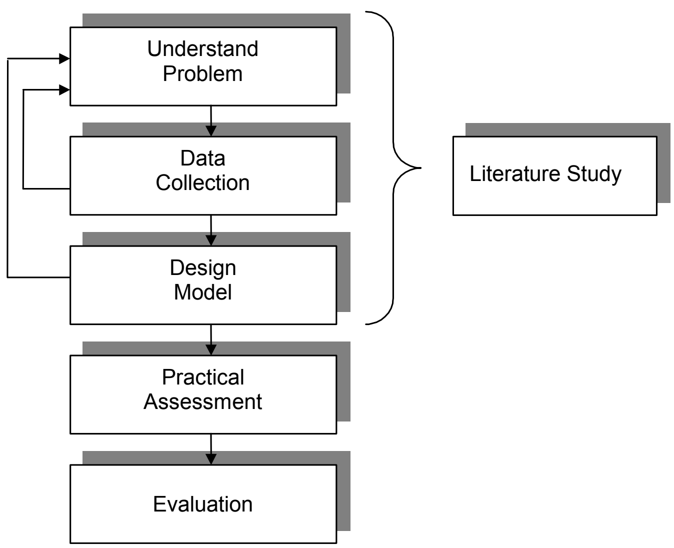


Figure 3 *An overview of the design of the research method.*

Once the model of how to inquire into the situation of the Telecom Operator was designed, the research moved onto the second phase called the Practical Assessment. This phase involves examining the model in real life by undertaking a Case Study where a major part of the activities of the model are pursued. The last phase of the research method is that of Evaluation. This phase is for evaluating both the results from the Case Study as well as how the model performed in reality.

2.1 Literature Study

The choice of literature should be based on how to best create a comprehensive picture of the problem area. The aim is to study the problem from more than one point of view. (Patel & Davidson) The extent of the literature study is based on the amount of material available and how well defined the problem statement is. It is also dependent on how well acquainted the analyst is with the subject. Knowing when to stop reading is just as important as finding the literature (Merriam). The knowledge gathered from the literature study concern partly theories/models, and partly knowledge from previous studies within the field. This combination of knowledge will be helpful in finding out the essence of the problem area in order to make a successive delimitation of the problem area. (Patel & Davidson)

One thing to remember when performing the literature study is that it is not the amount of information that is important, only that the information is suitable for the problem. The search should not only be of a systematical nature. New thoughts and ideas can be gained by just browsing through magazines and books, or unsystematically searching through databases. It is also sensible to start off the literature study by primarily looking for information that already exists. A literature search can provide an orientation in a new area of investigation, provide an understanding of how similar problem areas have been approached in the past, provide material for the current problem to be used in a new context, etc. No matter what the reason is for performing a literature study, it is important to use an effective method of researching the literature. This method should be adapted to the problem situation as well as to the analyst(s) performing it. (Eriksson & Wiedersheim-Paul) The most commonly used sources of information are those found in books, records, databases, articles found in scientific magazines, bibliographies, and the Internet. (Patel & Davidson)

To be able to understand the problem situation it was, as mentioned before, important to first create an understanding of the telecommunications field. Since neither of us has any experience in this area, we had to perform an extensive data collection of internal material from Ericsson, such as brochures, articles, system documentation, internal documents etc. We also interviewed Ericsson personnel from various departments. This material was analyzed and assembled in documents and pictures to help us better understand it. This naturally led to the realization that we needed more material. First when our understanding of the problem area was believed to be extensive enough, it was possible to state the problem. The problem statement was aided by the drawing of a rich picture of how we perceived Ericsson's situation to be, see Appendix 1. The picture served as a base for narrowing the area of concern to be: two different types of organization with a knowledge-gap between them that needs to be filled - how to fill this gap being the essence of the problem. Ergo, the solution to the problem, a model of inquiry, required further literature study on systems methodologies. Once a suitable methodology was narrowed down, the reading became more specific and extensive. Our focus was how to modify and adapt the methodologies chosen to fit the situation. This involved designing a new model of investigation. The phase of Literature Study took a major part of the entire investigation.

2.2 Practical Assessment

The new model of SSM complemented with TTF, which was designed in the phase of the Literature Study, was tried out in reality in order to asses whether it is a methodology suitable for the type of problem situation Ericsson is facing. This phase of Practical Assessment was performed by means of a Case Study. The model itself requires that it is performed in real life, and the only way to assess if it is a suitable methodology of inquiry, is to actually go through the activities in a real situation. This would naturally be in the form of a Case Study, where a Telecom Operator is to be investigated just the same way as Ericsson would do, if they were to use the model.

The concept of a Case Study entails performing an investigation on a limited phenomenon. A case can be a single individual, a group of people, or an organization. More than one case can be investigated, e.g. two organizations. A Case Study is based on a holistic perspective where the aim is for the information gathered to be as comprehensive as possible. (Merriam; Patel & Davidson) The empirical results do not necessarily have to be the most important aspect of a Case Study. It can just as well be used as a method of illustration. The Case Study is then used as a brief 'empirical test' in those investigations where other methods are dominant. The case will in those investigations only serve as a clarifying and pedagogic function. (Eriksson & Wiedersheim-Paul) As was the case of the research approaches, the Case Study can have different objectives. It can be of an exploratory, descriptive or explanatory nature. (Backman, 1998; Merriam) The objective for using a Case Study in this situation would therefore be of an exploratory nature. The aim is to see how well the model performs in reality, and the model would then be the dominant method of the Case Study.

2.2.1 Prepare Case Study

Once a decision has been taken of performing a Case Study, it is necessary to delimit possible cases and to choose a particular one. (Merriam) The Telecom Operator we were able to engage in the Case Study cannot be classified as a typical one. ETL NOC[3] is a part of the Ericsson organization and provides other Telecom Operators with the service of managing their networks. Even if the case of ETL NOC might not be the optimal case, we felt that the Case Study would produce enough material for evaluating our model of inquiry.

The Case Study of how the model would perform in reality had to be preceded by a stage of gathering knowledge of the chosen case. Parts of the model is to be modified and adapted to each particular situation and as such we had to read up on ETL NOC and the version of OSS they use. This involved contact via email and phone in order to get documentation containing the necessary organizational information. We also sent our contact a brief introduction to the problem area and the basics of the model (see Appendix 3).

[3] ETL NOC – Ericsson Telecommunications Limited, Network Operation Center

We felt that it was necessary that prior to 'the real thing' try out the model internally to gain experience in the different activities of the model. This was done by performing a number of activities together with representatives from Ericsson, who simulated the role of the Telecom Operator.

2.2.2 On location in Burgess Hill, England

Because of the limited time frame and the lack of knowledge of Ericsson routines and authority on our part, only parts of the model were tested on location. The basic idea of the model is for making improvements into the situation. Due to the fact that we are not employees of Ericsson, we did not have the authority to actively introduce any changes into the problem situation. The major idea with the Case Study was then to try the investigating part of the model on ETL NOC and from this material propose areas in which changes could improve the situation. Those proposed areas of change were to be handed over to Ericsson, so that they could follow up the investigation by contacting ETL NOC.

Over a period of three days the model was tested at ETL NOC in Burgess Hill. Every night before going on location, a great deal of time was spent preparing for the activity of the model that was to be undertaken the following day. We had in advance decided that one of us would lead the workshop/interviews while the other managed the tape recorder (making sure that all that was said was recorded for later analysis) and transferred pictures from the whiteboard to paper. This division of labor was based on the fact that for the person leading the interviews to be susceptive to the participants' views and opinions, this could only be achieved if the worrying about the information being lost was taken away. That way, the person leading the interviews could follow events as the came along by 'freely' listening to the participants and being open for whatever lines of inquiry that was needed. The fact that it might be confusing for the interviewee to have to people asking questions was also an issue. The building of trust between interviewer and interviewee is essential for the outcome, and it is more difficult to build this trust when there is not a one-to-one relationship between them.

The first day at ETL NOC was set aside for the first part of the model. To create a better understanding for the organization and to form a base of questioning, we first observed the operators 'in action'. This was followed by a workshop with representatives from the different function areas, as well as representatives from management. In all there were 6 representatives from ETL NOC in attendance. The workshop was kicked off with an introduction to the model and the purpose of the workshop. The introduction-document to the problem area and the basics of the model (see Appendix 3) was also distributed. The questionnaire included in the model (see Appendix 4) was also distributed at this point. In order to have a richer base for evaluating the model; the entire workshop was recorded on tape. This way all that was said would surely be part of the analysis of the results. The aim of this part of the model was to create a common picture of the situation. The picture was created on a whiteboard in order to involve all participants in the discussion. Once all participants agreed that the picture represented their situation, it was redrawn on paper.

The following day a new part of the model was carried out, involving interviewing a single representative of one function at a time. Since the representatives had not attended the workshop a short introduction was necessary. Again, everything was recorded and the results from the model activity were drawn on paper. The first half of the third day was also carried out in this fashion, with the exception of a representative from management wanting to make some changes to the models of the previous day. The representative from Network Surveillance (that had created it in the first place) accepted these changes. The latter part of the third day was spent on showing the material created during the workshop and interviews to management. The questionnaires were also collected at this point.

2.2.3 Follow up at Ericsson

The model is to be used by Ericsson, and we felt that it would be important for the evaluation of the model to get feedback from them on the material gathered at ETL NOC. The material from the Case Study was presented to our supervisors at Ericsson, directly followed by a discussion.

2.3 Evaluation

The Evaluation phase is for evaluating how well the model performed in reality. This phase is based on the results from the previous phases of the research method.

3 Results

In the attempt to answer the research question: '*How can Soft Systems Methodology be complemented by Task Technology Fit'*, a new model called STSSM was created. STSSM stands for SocioTechnical Soft Systems Methodology, and it encompasses the view of Soft Systems Thinking[4] based on the qualitative research methodology of Soft Systems Methodology and the quantitative research method of the Task Technology Fit questionnaire. The methodologies are adapted to the situation by including some elements as they are, changing some elements to better fit the circumstances and excluding those that will not be beneficial to the model of STSSM.

Since the model of STSSM is a version of SSM approached from a sociotechnical view by the complement of the Task Technology Fit questionnaire, the first parts of the result section involves a presentation of the two methodologies. The examination of SSM and TTF is done by exploring what parts are suitable for STSSM. A section of what has been modified or excluded from the original, as well as what has been added to STSSM will follow after each presentation of the methodologies. The final part of the result section is a presentation of the Case Study for testing STSSM in practice, the practical assessment of the model.

3.1 Soft Systems Methodology

SSM was specifically developed in the 1970's to cope with normal situations in which people have their own perception of the world by making judgments using their own values. The methodology enables users to descriptively make sense of a complex situation and it allows for lessons to be learnt. The emphasis of SSM lies in an organized set of principles that guide action in the attempt to manage real-world problem situations constructively. (Checkland & Scholes) SSM is usually concerned with ill-structured 'soft' problem situations with which managers at all levels in an organization have to deal with. Social reality in human groups is not fixed but will change over time. Research into these human institutions seeks understanding and learning rather than optimization. It is therefore important to find out how these particular people, with their specific history, presently perceive their world. (Checkland & Holwell)

3.1.1 The different approaches to SSM

Most users of SSM will start with a step-by-step version to the approach of how to use SSM. As the user becomes more accustomed to using SSM, the experience will grow and it can be used more flexibly. Experienced users of SSM are much more problem situation oriented than the beginners are. They do not start an investigation by thinking about the methodology itself and how to apply it, but instead stay focused on the problem situation itself. The activities of SSM are then used to make sense of the very experience. SSM might even be used as an aid in carrying out the study of a problem situation at the same time as dealing with the content connected to the information support required by people performing the tasks in the organization.

[4] A brief orientation into the basics of soft systems thinking can be found in Appendix 2.

(Checkland & Holwell) The base of this difference lies in an approach of either mentally starting from SSM or mentally starting from what is to be done. The former approach is to use SSM to structure what is done. The latter is to start from what is to be done and making sense of it by applying it to SSM. (Checkland & Scholes)

Due to these different approaches, a distinction is made between the two ideal types, being opposite sides of a spectrum of how SSM is used. At one end of the spectrum the term 'Mode 1' is used for the approach of using SSM to structure inquiry. At the other end is 'Mode 2' where SSM is used to make sense of the experience. SSM is used to provide a coherent way of describing the problem-solving involvement in the problem situation. Neither 'Mode 1' nor 'Mode 2' are descriptions of actual use, but they are rather concepts of the use of SSM. The Mode 1 approach is relatively clear and explicit, whilst Mode 2 is harder to describe because the way SSM is used is exclusively adapted to both the situation at hand and the particular investigators involved. Novices tend to use SSM through the approach of Mode 1, where the experienced users move towards Mode 2. (Ibid.; Checkland & Holwell)

3.1.2 The inquiring process of SSM

The process of SSM is an organized and formalized version of what humans perform daily when thinking purposefully. This process always starts by focusing from the perceived reality on a subject, chosen among a number of possibilities, considered to be the most 'relevant'. From this subject, sentences are constructed. By comparing these with other sentences, to perceived reality or to both, it is possible to formulate arguments that form a base for decisions to act in certain ways. In the methodology of inquiry into complex problem situations, SSM basically expresses this kind of meaningful and organized thinking. (Checkland & Tsouvalis, 2001)

The idea of SSM is to perform purposeful action in human situations that are considered to be problematical. It is an organized inquiry process that is based on system models to determine appropriate action into the real situation. SSM acknowledges the fact that whenever a purposeful human activity is described, the interpretation must be included since it is humans that both perform the action and describe it. The subjectivity cannot be separated from the process of modeling systems. Therefore, there cannot be any 'right' or 'wrong' descriptions, only a number of possible descriptions based on different worldviews. (Checkland, 1985)

The methodology provides means of systems thinking about the real world, which makes it possible to move from finding out about to taking action in the real world. The emphasis is on people's perceptions of reality, on their thoughts and beliefs of objects they perceive in the real world rather than the actual objects. (Checkland, 1993)

SSM is a collection of procedures, techniques and documentation aids that can be used to inquire into any ill-structured problem situation. It is important to stress the fact that SSM is a methodology, a principle of method rather than a method. It has to be adapted by its users both to the demands of the situation and to their own ideas and viewpoints. The users have to build a knowledge-base of the principles of SSM so that it is possible to approach the problem situation with a version of SSM that both fits the situation at hand as well as being comfortable for the user. It is a process of learning how to approach SSM and find suitable versions of it that feel appropriate for the users. Only then, is it possible to adapt it to the situation. But everybody has to start somewhere, and usually this entails using SSM as a step-to-step process following the different activities of SSM. (Checkland & Holwell)

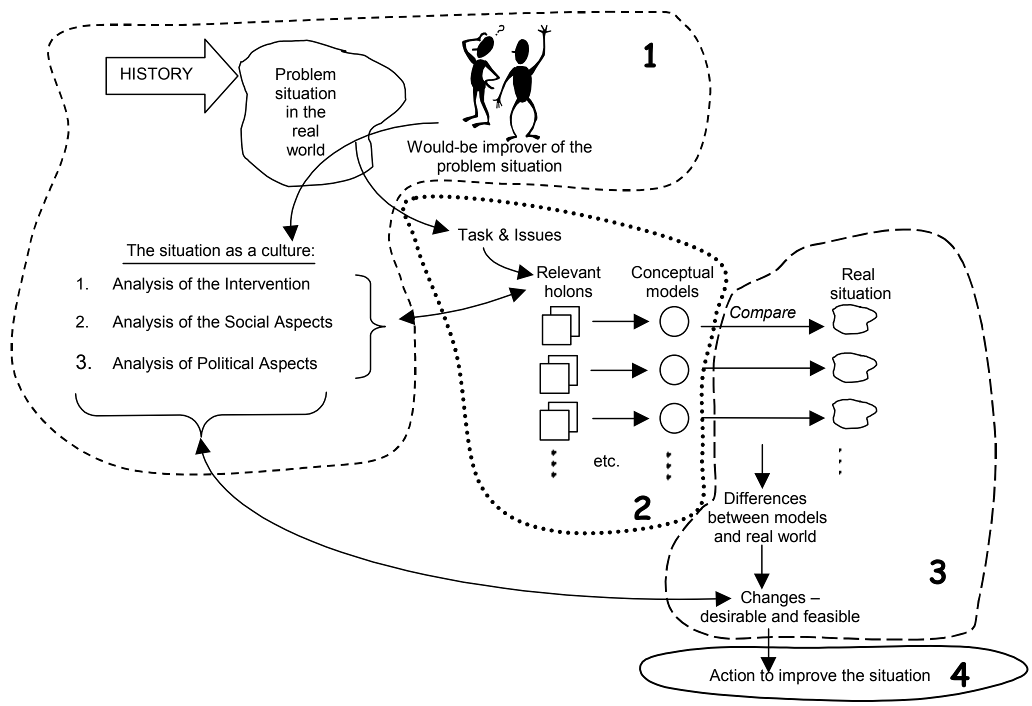


Figure 4 *The four main activities of SSM (adopted from Checkland & Scholes, pp. 28 and A15).*

As shown in figure 4, the process of SSM can be divided into four main activities. Firstly, it is a question of finding out about a problem situation, which includes cultural and political aspects. Secondly, formulating some purposeful activity models relevant to the problem situation. Thirdly, discussing the situation by comparing the models to the real situation and establishing recommendations for changes that would improve the situation. Lastly, taking action for improving the problem situation. (Checkland & Scholes)

3.1.2.1 Finding out about a problem situation

When exploring and finding out about a situation it is important that neither the worldview of the analyst nor a specific structure is imposed upon the situation. (Checkland, 1985; Checkland, 1993) Although it is not possible to totally separate the questions being asked from the analyst, it is vital that the questions should not lead the investigation in a predefined direction. The exploration process should be flexible and adaptable to the people and the circumstances of the problem situation. (Checkland, 1993; Wilson)

It is important to gather as many perceptions of the problem situation as possible from a number of people involved in the problem situation. As a tool for this gathering of views, it has been found useful to make the initial expression of the problem situation by building up of the richest possible picture of the problem situation under study. (bid.)

3.1.2.1.1 Rich Picture

The particular technique often used in SSM is the drawing of Rich Picture Diagrams, where a pictorial representation of the problem situation is created. These pictures are used to provide a model for thinking about the system. Using a picture makes it easier to ensure that no discrepancies exist in how the different participants of the investigation view their work situation. (Avison & Fitzgerald) Pictures are very useful since they can be absorbed as a whole and work as a support for holistic thinking about a situation. (Checkland, 1993)

The function of the finding out about the problem situation is to display the circumstances of the situation so that a range of possible and relevant choices can be revealed (Checkland, 1993). The greatest value of the rich picture lies in the process of creating it rather than the resulting product (Lewis). The rich picture can help in sorting out the basics of the situation, both in clarifying the thinking of the individuals and in decision making. It is also a helpful tool for explaining the fundamentals to all interested parties. The rich picture can be considered to be the abstraction of all that is known about the problem situation. (Avison & Fitzgerald)

3.1.2.1.2 Cultural Analysis

In addition to the rich picture of the problem situation, other frameworks can be used, which can help making the understanding of the situation as rich as possible. These frameworks are part of the cultural analysis and involve three analysis stages. The analysis of Intervention (Analysis One) is an examination into the nature of the intervention itself in accordance to the roles of the 'client', the 'would-be problem solver' and the 'problem owner'. The analysis of the Social Aspects (Analysis Two) identifies the roles, norms and values of the people involved. The analysis of the Political Aspects (Analysis Three) is concerned with issues such as how power is expressed in the studied situation. (Checkland & Scholes)

3.1.2.2 Building purposeful activity models

Systems models in SSM are not representations of anything in the real situation. They are accounts of concepts of pure purposeful activity, which are based on the world-views of the people of the problem situation. These models are not models of anything; they are models relevant to discussion about the situation, used to inspire questions in the discussion of the real situation and the desirable changes to improve the situation. (Checkland & Scholes)

The process of building purposeful activity models involves the selection of relevant human activity systems[5]. From these relevant human activity systems a number of models are built, which are based on different worldviews. It is not possible to say that one representation, a model, is more correct than

[5] A more detailed account on 'human activity systems' are can be found in Appendix 2.

another is. There cannot be a 'correct' representation, since they only represent a number of ways of perceiving the real world. (Checkland, 1985)

3.1.2.2.1 The EROS model

To further fuel the discussion and understanding of the problem situation, the real-world expressions of concern can be set against a simple model. This model is an emblematic picture of the problem situation in general, where problem issues can be structured and grouped according to which element in the model they address. The building of this simpler model of the problem situation is a way to introduce the idea of building models of purposeful activity systems and using them to structure discussion in a way that is easy to understand. The discussion will help generate ideas for relevant systems to be modeled. (Checkland & Scholes)

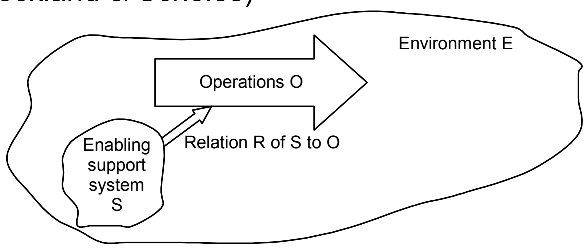


Figure 5 *The rudimentary EROS model of operations and enabling support (adopted from Checkland, 1985, p. 825; Checkland & Scholes, p. 64).*

The concept of this very general basic model, called EROS is shown in figure 5. The elements of EROS are the operations (O), existing in an environment (E), which need the help from enabling support functions such as (S). (R) is the relation between (S) and (O). (Checkland, 1985)

3.1.2.2.2 Task and Issues

The relevance of any human activity system is always based on a subjective choice of its importance to the problem situation. To be able to build the activity models, decisions has to be taken as of what the primary tasks and main issues are. (Checkland & Scholes)

There are occasions, especially in information systems analysis, where it is valuable to perform a primary task analysis in order to model a version of the problem situation that closely corresponds to the perceptions of reality. There are certain sets of activities that are performed by the people within an organization. These tasks can be precisely associated to either an organization as a whole or to an established task carried out by a section, department, or division of the total organization. (Checkland & Tsouvalis; Wilson) These primary tasks describe 'something to be the case' by real objects of the organization. Searching for primary tasks is a way of finding answers to what is essential to the problem situation. (Avison & Fitzgerald)

The issue-base systems express 'something to be the case'. Issues are topics or matters of concern that represents the unstated question marks that exists in the problem situation. The process of finding out what these issues are may lead to a debate in which these issues might be resolved right away. The important thing is that the issues are understood and that they are made aware of. Issues are significant because they might cause problems that can spread throughout the organization, and if they are not resolved; they might have a negative effect on the improvement action in the problem situation. (Ibid.)

The difference between relevant primary task and issue-based system is not definite nor is it easily defined. Primary tasks are those that can be seen in the organization while the issue-based systems are more of mental processes of the people within the organization. Both the primary tasks and issue-based systems are useful as a basis for selecting and defining relevant purposeful activity systems to be modeled. (Checkland & Scholes)

3.1.2.2.3 Relevant Holons

Components called human activity systems can be identified within the issues and primary tasks (Avison & Fitzgerald). The human activity system is a specific kind of holon that is made up of a set of activities linked together in accordance with their dependent relationships in order to make a purposeful whole. The people involved in the situation make subjective choices as to what human activity systems are relevant in the problem situation. (Checkland & Holwell; Checkland & Scholes) To build a model of human activity systems, a clear definition of the purposeful activity to be modeled is required. A root definition is a precise description of a human activity system that expresses 'something to be the case'. (Checkland, 1993; Checkland & Scholes; Checkland & Tsouvalis) All people involved in a problem situation have different views on the organization they work in, which are based on their perceptions of the environment. Root definitions are very useful in exposing these different views. Although these differences might not be resolved, it is valuable to depict them, and by doing so clarifying the problem situation. (Avison & Fitzgerald)

The root definitions are constructed around an expression of a purposeful activity. Any purposeful activity can be expressed in the form of a transformation process in which an entity, the input, is changed or transformed into a different state or form of that same entity, the output of the process. (Checkland & Scholes) This implies that the set of activities enclosed in the human activity model, represents that interconnected set of actions needed to transform certain input into output (Wilson).

The root definition is a description that summarizes the basic nature of the human activity system where each description is based on a specific worldview. As a consequence, it is important that the root definition embrace all aspects of the human activity system. (Avison & Fitzgerald) Six characteristics have to be included in a well-formulated root definition. The first letter of each characteristic forms the acronym CATWOE. *Customer*: Who are the victims or beneficiaries of the transformation process? *Actors*: Who would do the activities of the transformation process? *Transformation process*: What input is transformed into what output? *Weltanschauung*: The worldview that makes the transformation process meaningful. *Owners*: Who could stop the transformation process? *Environmental constraints*: What are the elements outside the system that are taken as given? Each of the elements of the CATWOE can be used as a base for asking relevant questions about the human activity system. (Checkland, 1985; Checkland & Scholes; Lewis)

Every root definition is based on a specific worldview. As mentioned before, no interpretation can be said to be wrong, it is only possible to disagree with a specific interpretation. One of the most important characteristics of the human activity system is the aspect of numerous, possible and valid perceptions. The way the system is described, is a direct consequence of the Weltanschauung. The term Weltanschauung is a German word for the concept of a worldview, which enables the observer to ascribe meaning to what is perceived. (Wilson) The Weltanschauung stands for the values of the beholder and refers to everything that is taken for granted (Avison & Fitzgerald).

The structure of CATWOE suggests that a root definition could be expressed as *' a system to do X by Y in order to achieve Z'*. In this definition the transformation process will be the means Y. Z is associated with the owner's long-term aims. It is important that the means, Y, chosen actually works in producing the output, Z. It is very useful to keep the XYZ-formula in mind when writing root definitions. (Checkland & Scholes)

The transformation process, the CATWOE, root definitions and XYZ-formula prevents the thinking from being too narrow, and encourages the decision process whether or not to build further models. (Ibid.)

3.1.2.2.4 Conceptual Models

The conceptual model is a model of the human activity systems and as such, its elements are activities that can be found by extracting all the verbs that are implied by the root definition. The list of verbs should be arranged in a coherent order and for each root definition, there must be one model. By assembling 7 $\pm$ 2 activities structured according to logical dependency, the system can be modeled as a whole entity. The reason for this number being the suggestion made by Miller[6] that the human brain only has a capacity to cope with this amount of concepts simultaneously. All activities in the model can become a source of a root definition to be expanded at the next resolution level. The purpose of the conceptual model is to accomplish what has been defined in the root definition. Thus, the conceptual model is a model of the root definition and not a model of anything else. (Avison & Fitzgerald; Checkland & Scholes; Checkland & Tsouvalis; Wilson)

Even though conceptual models are structured in terms of logic, inconsistencies can be found. To overcome this, a technique of measuring performance has been introduced. It suggests that when modeling the activities of a root definition, three criteria have to be fulfilled, the so-called 3 E's. A first criterion checks whether the selected means work, the criteria called *efficacy*. A second criterion, *efficiency*, checks to see whether the transformation process is being done with a minimum use of resources. The third criterion, *effectiveness*, asks whether the transformation process is meeting the long-term-aims. Is it the right thing to be doing? (Checkland & Scholes)

Building a conceptual model should not be too difficult considering that the groundwork has already been done in the root definition and the CATWOE. It

[6] As referred to by Checkland & Scholes, p. 38.

would simply entail assembling the activities required to change the input into the output, ensuring that all activities required by the other CATWOE elements also are covered. These activities should be linked according to whether or not they are dependent upon other activities. The final stage of the modeling would entail checking the models against the three E's. (Ibid.)

The conceptual models can serve as a foundation for information systems modeling and recommendations for improvements to the human activity system. It is therefore important that both the developer and the users of the information systems understand the conceptual models even if they can be very complex. It must be remembered that the models are representations of the complexity of the real world. (Avison & Fitzgerald) Although the complexity might make the modeling more difficult, the use of more complex models can be positive since it may add to the discussion when comparing the models to the real world. The downside to complex models are that increased complexity might lead to a thinking of models as parts of the real world, rather than models relevant to discussion about improvements in the real world. (Checkland & Scholes)

3.1.2.3 Discuss feasible and desirable changes

Models are built only as a means to an end. They are used as a base for a coherent and rational discussion of how to improve a situation that is perceived to be problematical. That discussion is organized around comparing the models, which are based on different worldviews, to real-world perceptions of the problem situation. The aim is not to improve the models, but to find an adjustment between different interests in the problem situation. The adjustment should involve making improvements into the original problem situation. (Checkland, 1993; Checkland & Scholes)

The comparison of the problem situation to the conceptual models should be done together with involved participants in the problem situation. The objective is to generate a discussion of possible and desirable changes that can be introduced into the problem situation in order to bring about improvements. (Checkland, 1993)

Four different methods of comparison have frequently been used. The methods being informal discussion, formal questioning, historical reconstruction, and model overlay. (Checkland, 1993; Checkland & Scholes; Wilson) All four methods help to assure that the comparison is deliberate, rational, and justifiable. It may be helpful to use any of these comparison methods or to carry out comparisons using various methods. (Checkland, 1993)

The method of informal discussion concerns a general debate about the nature of the models. Strategic issues tend to be raised during this kind of discussion because the questions asked about present activities are more in the nature of why it is performed in the first place. It is therefore appropriate to view this method of comparison as a general approach, making inquiries as to what features of the conceptual model are particularly different from reality, and why this is. (Checkland, 1993; Wilson)

The second method of comparison, formal questioning, is the most commonly used. The models are used as a basis for inquiring into the real world. Answering those questions stimulate discussion in a way that seems appropriate to each specific situation. The discussion may be performed by a group of people in one place at one time, or by interviewing a single person, with dialogues distributed over a period of time. The filling of a matrix can serve as a base for this type of model defined questioning. (Checkland & Scholes) It can be seen as a process of asking questions. Does the activity exist? How is the activity done at present? Who is responsible for doing the activity? Is the activity done well or badly? Do the relationship exist? In what form do they exist? (Wilson) The system models are used to bring about discussion of change where questions are written down and answered systematically. This can be used to provide enlightenment to the perceived problem situation. (Couprie, Goodbrand, Li & Zhu, 2001)

The method of historical comparison entails reconstructing a sequence of events in the past according to a conceptual model. The sequence of activities is done either mentally or on paper, and the aim is to write a scenario, which can then be compared with some real-world events. It is a method that ought to be used with care. There is a danger that it might be viewed as a criticism of past performance, rather than a way of learning from it, and as such it may lead to resentments from the participants. (Checkland, 1993; Checkland & Scholes; Wilson)

The final method of comparison, model overlay, entails structuring the conceptual model in such a way that it closely reflects what exists in the real situation. By literally overlaying the model of what really exists on top of the conceptual model, using transparent paper will instantly make any discrepancies obvious. The method of direct overlay of one model on the other will evidently reveal any mismatches between the two. Any mismatch would be a direct stimulant for discussing possible changes. (Checkland, 1993; Wilson)

The objective of the comparison is to stimulate debate about potential changes that might be made in the perceived problem situation. (Checkland, 1993) This discussion should generate a set of recommendation for change. However, it is quite unrealistic to expect that all changes will be acceptable. The changes must be ‘systematically desirable’ and they must also be accepted by the unique culture of the problem situation. If they are acceptable in this fashion, the changes are said to be ‘culturally feasible’. (Lane & Oliva; Wilson) The comparison will lead to discussion of possible changes that can be of three kinds, where any combination may be appropriate in a particular situation. The changes that are possible can entail changes in structure, in procedure or in attitudes. Changes of both structural and procedural kinds are comparatively easy to identify and implement. Once made, such changes can have unanticipated effects within the organization, but at least the implementation itself is a definite undertaking that can be designed. The third kind of change that of attitude, is more difficult to bring about. It is possible in principle to intentionally try to undertake this attitudinal change within the organization, but it is difficult in practice to achieve the exact results intended. The discussion of desirable and feasible changes should be together with people in the problem situation that care about the perceived problem and who wishes to do something about it. (Checkland, 1993)

3.1.2.4 Taking action to improve the problem situation

SSM is basically a general improvement method that by encouraging a better understanding of a problem situation helps to identify opportunities for change. The building of human activity systems stimulate discussion and debate about possible improvements which will lead up to recommendations for change. (Bustard, He & Wilkie) The aim for the discussion around comparing the models of human activity systems to reality is to reach at some changes that may be initiated in the problem situation. The new problem situation will then include the implementation of those changes. The process of implementation can also be tackled using SSM. (Checkland, 1985)

3.1.3 Adaptation of the elements of SSM to the model of STSSM

The model of STSSM is based on SSM with the complement of the TTF-questionnaire. As such there are not that many modifications made to adapt SSM to the model of STSSM, with the exception of four issues. Firstly, the way to approach SSM has been stated (as opposed to the possible approaches that can be taken). Secondly, the cultural analysis will not be included. Thirdly, the analysis of the primary task and issues will not be performed as an individual activity. Lastly, one method (out of four possibilities) has been selected for the comparison of the models to reality.

3.1.3.1 Approaches to SSM

The most common approach of how to use SSM lies somewhere between the two extremes of Mode 1 and Mode 2 (as described in section 3.1.1). This is also where the model of STSSM approaches SSM. The idea of the STSSM is to use SSM to structure inquiring into a situation where two different organizations are part of the problem situation. Both the Telecom Operators and the supplier of the computer system (developed and supplied by Ericsson in this case) are more inclined to have a technical view on things. The soft systems thinking is only just beginning to enter into this technical world. As such it is easier to perform a soft systems investigation with the approach of both following a procedure, using techniques in a more organized manner, and only when it feels comfortable use the method more freely and adapting it to each situation as the investigation advances. Ergo, the approach of STSSM will fall somewhere in-between Mode 1 and Mode 2.

3.1.3.2 Cultural Analysis

The Cultural Analysis (as described in section 3.1.2.1.2) will not be openly carried out in STSSM. The idea is to capture the problem situation as a whole and identify areas that can be improved, whether it has to do with the social circumstances, the communication between the two organizations, or the technology itself. For the investigation to take place two organizations will be spending both time and money, and the time spent on performing the three analyses can be a little difficult to justify in the overall picture. It will not bring that much additional benefits to the investigation. The analysis of the intervention can just as well be captured while performing the analysis of the

CATWOE (see section 3.3.2.2). Neither the analysis of the roles in the organization, their norms and values, nor the analysis of political power will bring that much to the discussion of possible improvements. Therefore, it was decided that this analysis stage should not be included in STSSM.

3.1.3.3 Task and Issues

The primary task and issue-based analysis (as described in section 3.2.2.2) will not be openly performed in STSSM. They are incorporated into the activity of defining relevant holons, where both the primary task and issues are assimilated into the discussion of transformation processes of the root definition (see section 3.3.2.2).

3.1.3.4 Comparing models to reality

SSM presents four different methods that can be used when comparing conceptual models to reality (see section 3.1.2.3). The method of comparison that seems most appropriate to use in STSSM would be the comparing method of formal questioning. Following a predefined matrix of questions will stimulate the discussion of improvement in the situation (see section 3.3.3). The fact that it can be performed with a single person or a group of people is beneficial since it can be adapted to the situation at hand, the conceptual models and the participants of the interview, and still be performed in the same pattern whatever approach is chosen. A filled matrix will be an indisputable source for identifying possible changes, where all the activities of a conceptual model are written down and compared to reality, one by one.

3.2 Task Technology Fit

To add value, IS/IT (the OSS in this case) must meet the needs of the organizations, groups, and individuals who use it (Dishaw & Strong). The analysis of determining how well a computer system corresponds to the tasks will be much richer if the users who understand and perform the tasks are involved in the process. It is suggested that a Task Technology Fit could be the base for a strong diagnostic tool to evaluate whether information systems and services in a given organization are meeting user needs. The TTF model was developed with this intention in mind. (Goodhue & Thompson) The TTF model is of a more general character and addresses neither a specific task nor a specific technology. The fundamental idea of the TTF model is that the fit between task and technology is the degree of how suitable the software is for a particular task. (Dishaw & Strong) The TTF model is suitable for both mandatory and voluntary use situations. It sees technology as an instrument for a goal directed individual to perform a task. It is not the technology in isolation that affects the performance. Any given characteristic of a technology will have different bearing on performance, depending upon user-type or task requirements. (Goodhue, Klein & March)

Task Technology Fit is the relationship between task requirements, technology functionality, technology experiences and task knowledge (Benford & Hunton, 2000). Hence, the major features of the Task Technology Fit are the concepts of technologies, task, individual, utilization and TTF. Technologies are viewed as tools used by individuals when performing their task, in this specific case the technology is referring to the OSS. The task is generally defined as the actions carried out by individuals in turning inputs into outputs. Individuals may use technologies to support them in the performance of the tasks. The individual possesses characteristics (e.g. computer experience, training and motivation) that might have an impact on how easily and how well the technology is utilized. The behavior of using the technology in performing the task is called utilization. It is a matter of to what extent the technology has been integrated into each individual's work processes, or tasks. With these definitions in mind, the term TTF would be defined as the degree to which a technology assists an individual in the performance of his/her tasks. (Goodhue & Thompson)

There is good support for the suggestion that TTF affects performance, and that users can be relied upon to evaluate the underlying TTF successfully (Goodhue, Klein & March) TTF is a useful base for the development of an analytical tool for computer systems and services in a specific organization. Including both general constructs (e.g. user satisfaction, usefulness, or relative advantage) and more detailed constructs (e.g. data quality, locatability, reliability, etc.) increases the usefulness of such a tool. (Goodhue & Thompson)

3.2.1 Task Technology Fit Questionnaire[7]

The TTF measurement focuses on IT support for the decision making tasks performed by the user in order to change business processes and executing regular transactions. The TTF questionnaire was developed by Goodhue and Thompson (1995) and is to be customized to the organization in each problem situation by inserting precise acronyms and terms. This is done so that the names of systems and departments are identifiable to the respondents. In total there are 41 questions, where 34 questions concern the Task Technology Fit measures, 5 questions concern task characteristics measures and 3 concerns the individual performance impact measures. The questionnaire is divided into three different parts in accordance with these measurements.

The questions are structured so that the respondent has to rate how he/she perceives the statement/question to fit his/her situation. The scale ranges from 1 to 7, where 1 means that the respondent strongly disagree; 4 means that the respondent neither agree nor disagree; and 7 means that the respondent strongly agrees with the question or statement. This grading structure is based on the TTF-questionnaire found on the web site *Measure of Task-System Fit* (2001).

3.2.1.1.1 Part A. Task Technology Fit Measures

Task Technology Fit captures how well technology functionality matches or fits the needs of the task being performed. To be able to measure the fit, questions are constructed around eight components, or factors. The first five factors focus on meeting task needs for using data in decision making. The fifth also focuses on meeting the operational day-to-day needs, as does the next two factors. The last factor focuses on responding to changed business needs. To each factor there is also different dimensions that need to be measured. It is around these dimensions the questions will be formulated. (Goodhue & Thompson)
A list of the definitions of the different dimensions of the factors of task/technology fit measures can be found in table 1.

[7] The questionnaire of Task Technology Fit is directly adopted from the article *Task Technology Fit and Individual Performance* found in MIS Quarterly/June 1995 (Goodhue and Thompson, pp. 234-236).

Table 1 The dimensions of the Task Technology Fit measures of TTF (Goodhue & Thompson, pp. 234-236)

QUALITY	
CURRENCY:	Data that I use or would like to use is current enough to meet my needs.
RIGHT DATA:	Maintaining the necessary fields or elements of data.
RIGHT LEVEL OF DETAIL:	Maintaining the data at the right level or levels of detail.
LOCATABILITY	
LOCATABILITY:	Ease of determining what data is available and where.
MEANING:	Ease of determining what a data element on a report or file means, or what is excluded or included in calculating it.
AUTHORIZATION	
AUTHORIZATION:	Obtaining authorization to access data necessary to do my job.
COMPATIBILITY	
COMPATIBILITY:	Data from different sources can be consolidated or compared without inconsistencies.
PRODUCTION TIMELINESS	
TIMELINESS:	IS meets pre-defined production turnaround scheduled.
SYSTEMS RELIABILITY	
SYSTEMS RELIABILITY:	Dependability and consistency of access and uptime of systems.
EASE OF USE/TRAINING	
EASE OF USE OF HARDWARE & SOFTWARE:	Ease of doing what I want to do using the system hardware and software for submitting, accessing, analyzing data.
TRAINING:	Can I get the kind of quality computer-related training when I need it?
RELATIONSHIP WITH USERS	
IS UNDERSTANDING OF BUSINESS:	How well does IS understand my unit's business mission and its relation to corporate objectives?
IS INTEREST AND DEDICATION:	to supporting customer business needs.
RESPONSIVENESS:	Turnaround time for a request submitted for IS service.
CONSULTING:	Availability and quality of technical and business planning assistance for systems.
IS PERFORMANCE:	How well does the IS-supplier keep its agreements?

3.2.1.1.2 Part B. Task/Job Characteristics Measures

Part B of the TTF-questionnaire involves questions of task characteristics. The measurement would entail asking questions that fall under the dimensions of task equivocality and task interdependence.

3.2.1.1.3 Part C. Individual Performance Impact Measures

In Part C of the TTF-questionnaire the respondents will be asked what impact computer systems and services have on their effectiveness, productivity, and performance of their job. The measurement would entail asking questions that fall under the category of the performance impact of computer systems.

3.2.2 Adaptation of the TTF Questionnaire to STSSM

The questionnaire of TTF in STSSM is a result of an adaptation of the original questionnaire described in section 3.2.1. The structure is basically the same with the three parts of Task Technology Fit measures, task characteristics measures and the individual performance impact measures. Two supplementary parts have been added to the original questionnaire. Part D. involves the 'Utilization of the Computer System' and the Part E. of the questionnaire is for general questions and any comments that the respondents may wish to add. Compared to the original 41 questions, the number for the STSSM questionnaire is 60 questions in total.

Part A. includes 39 questions, Part B. involves asking 12 questions and Part C. has 3 questions. Part D. asks only one major question of how the computer system is utilized (though this involves answering sub-question concerning dependency) and the last part, the more general Part E. involves asking 5 questions. (The complete questionnaire for STSSM can be found in Appendix 4.) The questions were based on the questions of the original questionnaire and were modified to better fit the problem situation. 19 new questions were also added to provide a richer base for the discussion of recommendations for desirable and feasible changes.

The original questionnaire included negative questions as well as positive questions, but used the same scale of rating these questions. The original questions of the dimension of 'Right Data' can be used as an example of this mix of positive and negative questions. (Goodhue & Thompson, p. 234):

RDAT1 – The data maintained by the corporation or division is pretty much what I need to carry out my tasks.

RDAT2 – The computer system available to me are missing critical data that would be very useful to me in my job.

The first statement is an example of a positive statement and if the respondent agrees with this, the rating would be closer to a grade of 7. (Given the rating is a 7 for agreeing with the statement/question and 1 for disagreeing.) The second statement is an example of a negative statement. If the respondent agrees with this, that yes - critical data is missing, the rating would also be closer to a grade of 7. When analyzing and evaluating the results from all questionnaires, it would be quite difficult to see any patterns in the answers if the questions/statements were not proposed from the same position, of either strictly positive or strictly negative. Hence, it was decided that all the questions in the TTF-questionnaire of STSSM should only be proposed as positive questions/statements.

Apart from adding or modifying the actual questions of the different parts of the questionnaire, the following changes were also made (or added) to the original questionnaire of TTF presented in section 3.2.1.

3.2.2.1 Part A. Task Technology Fit Measures

The term 'ease of use' was replaced with the term 'usability' in the factor of 'Ease of Use/Training' of the original questionnaire. This modification was based on the fact that the growing demand for computer systems that corresponds to real user needs in a working environment puts pressure on the systems to excel in both technicality and ease of use. They also have to fit the work practices and activities of the user. The computer system has to include characteristics that support its ability to satisfy stated and implied needs of the user. The term 'quality of use' can be used to encompass a concept of a user's perspective on software that exhibits excellence in the actual conditions of its use. Quality of use is based on the fundamental notion that real people use real products in order for them to achieve tasks in the real world. This requires not only ease-of use interfaces, but also suitable functionality and support for organizational activities and work-processes. (Bevan)

Usability is a quality characteristic of the Extended ISO Model, which is a set of attributes that determine the efforts needed for the use of computer systems. It also includes assessment of such use, which encompasses whether the software is understood, learned, used and liked by the user, when used under particular circumstances. (Ibid.; Leung, 2001) Usability is the user's view of quality, and is measured in terms of result of using the software, as opposed to properties of the software itself. It can be employed to validate the extent to which the computer system meets the users needs. The values have a direct bearing in an organizational context, and even if it is not possible to change the software, improvements in quality in use can be achieved by changes to the hardware, the tasks, or by training the user. (Bevan)

The characteristics of usability can be broken down into the lower level quality sub-characteristics of understandability, learnability, operability, explicitness, customizability, luxury, clarity, helpfulness, and user-friendliness. (Leung) It is around these characteristics of usability that the questions of Usability/Training (former Ease of Use) have been formulated, with the exception of luxury. This characteristic did not seem to have any impact on the usability of the OSS, since the very use is of a mandatory nature and as such, luxury will not have any affect on its use. This resulted in the formulation of nine questions as opposed to the original two of the TTF questionnaire.

Another adaptation of Part A. from the original questionnaire was in the definition of the dimension of 'Timeliness'. We found the original definition "IS meets pre-defined production turnaround scheduled" relatively difficult to understand, so it was changes to "IS meeting scheduled operations".

For the factor of 'Relationship with Users' the dimensions and their definitions were somewhat modified to better fit the problem situation. Words like 'IS-supplier' were added and the approach of the questioning was turned more towards the relationship between the supplier of the computer system and the user of the same. (The original questions were directed towards the relationship of different departments within the same organization.)

3.2.2.2 Part B. Task/Job Characteristics Measures

In the original questionnaire definitions for the dimensions of the 'Task/Job Characteristics Measures' were missing. Hence, the definition to the dimensions was added as follows:

Task equivocality: How vague the task performed is. It is a matter of non-routineness.
Task interdependence: How dependent is the task to other business functions?

The characteristic measurement of 'Function Area' was also added in order to capture what specific function area of the organization the respondents work in. The definition of this measure is as follows:
Task function: To what function area do the task performed belong?

3.2.2.3 Part C. Individual Performance Impact Measures

In the original questionnaire definitions for the dimensions of the 'Individual Performance Impact Measures' were also missing. The definition to the dimension was added as follows.
Performance impact of computer systems: How well does the computer systems aid the performance of the individual?

3.2.2.4 Part D. Utilization of the Computer System

Part D. is an additional part to the original questionnaire of Task Technology Fit. It asks the question of how dependent the respondents are to the applications of the computer system.

In order for an information technology to have a positive impact on individual performance, the technology must be utilized and be of a good fit with the tasks it supports. It is suggested that Task Technology Fit could be the base for a strong diagnostic tool to evaluate whether information systems and services in a given organization are meeting user needs. The term 'utilization' can be defined as the behavior of using the technology in completing tasks. It is a question of to what extent the computer systems have been integrated into each individual's work processes, where utilization can be of either a voluntary or a mandatory nature. Measuring the utilization will reflect the individual or organizational choice to accept the computer systems. (Goodhue & Thompson) It is therefore important to connect the fit between the task and the technology to how dependent the respondent is of the different applications of the computer system. This will also provide a base for understanding what parts of the OSS is used in the organization.

The respondents will be asked to rate how dependent they are on the different applications of the OSS, ranging from 'Not at all' (0) to 'Very dependent' (3). Since the organizations that are to be investigated is likely to use different versions of the OSS, this part of the questionnaire will have to be modified to reflect the OSS that is used in each problem situation.

3.2.2.5 Part E. General Questions

Part E. has been added to the questionnaire as a base for placing the responses into context. Since the entire questionnaire is answered anonymously and the answers reflect the respondents' perception of reality, it is important to ask questions that can put the respondent into a context without threatening their anonymity. This would entail asking questions of what type of job (e.g. employment, title, and responsibilities) the respondent have in the organization. It can also be fruitful for the evaluation of the answers to see if the number of years on the job has had an effect on the way that the computer system was rated. This would also be true for the number of years working in the telecommunications field. The experience of the user in performing the tasks, that are included in the running and management of the

Telecom network, can affect the way the computer system is used. These connections can be relatively difficult to generalize, but during the analysis of the questionnaires it may be interesting to see if the experience of the user has had any effect on the answers of the respondents that are either very positive to the task-technology-fit or very negative.

A question concerning how much the respondent would consider to be a reasonable price for a service the supplier of the computer system can provide, was also added to the questionnaire. This was done after a discussion with one of our thesis supervisors at Ericsson, Mathias Ohlson. He articulated an interest in finding out how much the Telecom Operator's are willing to pay for the services Ericsson provides. The recommendations for change have to be desirable and feasible to both the parties involved. These are two different organizations that both aspire to increase profits. The process of implementation will eventually have a price tag on it, and it might be interesting to see how big a price tag the respondents of the questionnaires figure is reasonable. Users are assumed to be aware of the costs and benefits of technology, even when that use is mandatory (Goodhue, Klein & March). It might therefore be interesting to see if they are just as aware of the cost and benefits of the services surrounding that technology.

The last question of the questionnaire is just a free space for comments. Things the respondents might wish to add.

3.3 The SocioTechnical Soft Systems Methodology

For a successful study of the problem situation it is essential that the rudiments of Soft Systems Thinking and STSSM be explained to the participants of the study. Preferably sending them some information beforehand, but also giving them documents on the subject at the beginning of the inquiry.

The process of STSSM can be divided into six main activities, as opposed to the four main activities of SSM (see section 3.1.2). The TTF-questionnaire has been added in order to provide a richer base for discussing desirable and feasible changes to improve the problem situation. The main reason for this was to see how well the technology fits the task of the organization using the computer-system. Having a lot of people answering the questionnaire will also give a quantitative base for the discussion. The workshop participants are only representing a part of the organization and only their own views on the matter. Having representatives from management in the workshop, which is one of the ideas of SSM, might restrain some people from being totally honest. The anonymity that the questionnaire provides will probably stimulate more people to answer truthfully as to how they perceive the situation.

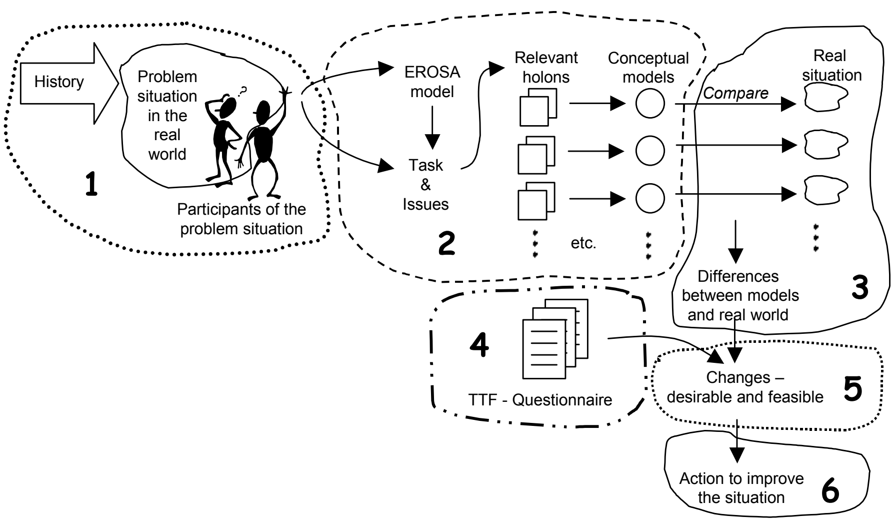


Figure 6 *The six main activities and the process of STSSM.*

Figure 6 presents the six activities of STSSM, which entails:

1. Finding out about a problem situation
2. Formulating some purposeful activity models relevant to the problem situation
3. Discussing the situation, comparing the models to the real situation by formal questioning
4. Answering the TTF-questionnaires
5. Discussing the gathered material (differences between models and reality, and questionnaires) establishing both
   a) changes which would improve the situation and are considered as both desirable and feasible

b) adjustments between any conflicting interests which will allow improvement action to take place

6. Taking action for improvement in the problem situation

STSSM is very adaptable to each problem situation that might be approached. It is also dependent on how experienced the analyst leading the study is. As a novice, it is recommended to follow the 6 activities as they are described in section 3.3.1 through 3.3.6. It is also recommended to test the method internally before performing the actual workshop in the real problem situation. (Going through the process of finding out about the problem situation up to building the conceptual models.) This 'trial run' is for providing the user of STSSM with experience that can serve as a base for the actual workshop. The richer the knowledge of how to use STSSM - the richer the results from performing the study.

3.3.1 Finding out about a problem situation

When exploring and finding out about a problem situation, the use of the word 'problem' might have a negative resonance for some people and as such be the reason for confusions as to what is to be investigated. (Checkland, 1993; Wilson) The word 'problem' is defined in Webster's Dictionary (1993) from two different angles:

> 1:a question raised or to be raised for inquiry, consideration, discussion, or solution.
> 2: that presents a problem; that is very difficult to deal with

The latter definition is the one most commonly associated with the word problem, but it is the former definition that one should bear in mind when finding out about the situation at hand. In that definition lies the opportunity to regard the problem as a possibility rather than something negative. Hence, an investigation into the problem situation ought to be regarded as something positive.

The complexity of human affairs always involves a complexity of numerous interacting relationships. The situation will be dependent on the specific history from where it originated. Because of the human nature of this history, there will be numerous accounts of the same. (Checkland & Scholes) It is therefore important to collect as many perceptions of the problem situation as possible from people involved in the problem situation. It has been established that building the richest possible picture of the problem situation under study, is a useful means to make an early illustration of the problem situation. (Checkland, 1993; Wilson) This picture building process will yield information and understanding of the situation without encouraging conclusions to be drawn by defining the problem circumstances in some particular way. (Checkland, 1985)

3.3.1.1 Rich picture

Elements of the rich picture diagram will include the people involved in the problem situation, the tasks being performed, problem areas, the environment, the owner of the system, and conflicting areas. A picture is 'worth more than a thousand words' and the drawing of such a diagram is an effective way of representing the issues and concerns of the different parties. The rich picture should be self explanatory and easy to understand. For an accurate picture, the finding out stage starts with a discussion of the structures, processes and issues of the organization that could be relevant to the problem definition. (Avison & Fitzgerald; Lewis) Elements of structure could for example be departmental boundaries, activity types (function types and the actors in them), product types, IS/IT, suppliers and customers, or physical and geographical layouts. Looking for elements of process is to look at ‘what is going on’. A different perspective of the situation may be gained by identifying the transformation processes occurring within it. It is a matter of, in more general terms, coming to an understanding as to what different transformation processes occur between the structures, in the organization as a whole and also between the organization and other foreign elements such as customers. The relationships between structures and processes represent the organizational climate of the situation. These processes should be represented in the rich picture. (Avison & Fitzgerald, Checkland, 1993) An example of a rich picture can be found in Appendix 7.

3.3.2 Building purposeful activity models

Systems models are used to cope with the complexity in day-to-day life. This appears to be sensible, since system ideas are concerned with relationships. The models are not representations of anything in the real situation. They are accounts of concepts of pure purposeful activity, which are based on the world-views of the people of the problem situation. These models are used to stimulate questions in the discussion of the real situation and the desirable changes to improve the situation. They are not models of anything; they are models relevant to discussion about the situation. The models are merely tools to stimulate, encourage and structure the discussion. (Checkland & Scholes)

The process of building purposeful activity models involves the selection of relevant human activity systems. The systems are relevant in the sense that involves taking purposeful action in a problem situation. From these selected human activity systems, a number of models are built, which are based on different worldviews. These worldviews are expressed in the different ‘root definitions’ of the chosen systems. It is not a matter of determining which models are ‘correct’, since they are mere accounts of a number of ways of perceiving the real world. (Checkland, 1985)

Due to the fact that humans interpret the world in different ways, there will be a number of possible relevant holons when examining the real world. The human activity system is a specific kind of holon that is made up of a set of activities linked together in accordance with their dependent relationships in order to make a purposeful whole. The relevance of a human activity system to any problem situation is a subjective choice made by the people involved in the situation. (Checkland & Holwell; Checkland & Scholes) The unpredictable nature of the human activity systems, such as different conflicting objectives, perceptions and viewpoints of the people, makes it quite difficult to model. (Avison & Fitzgerald) It is therefore necessary to construct several models of human activity systems and to discuss their relevance to real life (Checkland & Scholes).

3.3.2.1 The EROSA model

By setting the expressions of concern of the real world against a simple model will stimulate the discussion and understanding of the problem situation. This general emblematic picture of the problem situation provides means to structure and group the issues of concern around the elements in the model. The building of the model is also a simple introduction into the world of model building. (Checkland & Scholes)

An additional element has been added to the original EROS model of SSM (see section 3.1.2.2.1). The new element of the 'main aim of the organization' was included to further stimulate the discussion of why the organizational operations, enabling support systems and the relationships between them exist in the first place. Everything that is performed in the organization, and all that is within it, is there for one reason: to fulfill the objectives of the organization. By defining what this goal is and how to achieve it, stimulates the definition of what operations and support is needed. This will create a richer understanding of the situation and at the same time create an understanding of systems modeling.

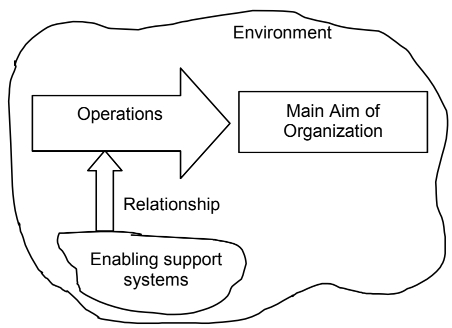


Figure 7 *EROSA - an emblematic picture representing the main aim of the system.*

The EROSA model of figure 7 can provide a general explanation of the relationships between the supporting systems, such as human activity systems and information systems, and the operations in the organization. These elements exist for one reason and that is to reach the organizational aim. The building of a simple model will enable each ideas for systems to be related as most relevant to the elements of the model; E, R, O or S. (Checkland, 1985). These elements should work together in order to achieve the additional element of A, the main aim. Hence, the complementing of the letter A to the model name will make the new name of EROSA, which is an acronym of the elements of the model. Building the EROSA model will stimulate the participants to slowly form views. The role of the analyst in this case, is to aid this process. The thinking in system terms and the ideas for relevant systems to be modeled should come from the participants of the organization. The analyst shall provide guidance and not provide the content of the model. (Checkland & Scholes)

3.3.2.2 Root Definitions

It is necessary to establish a clear definition of what purposeful activities are involved in order to build models of human activity systems. A root definition is a precise description of a human activity system that expresses 'something to be the case'. (Checkland, 1993; Checkland & Scholes; Checkland & Tsouvalis)

The first use of the root definition is to clarify the situation. A root definition is a kind of hypothesis about the relevant system, which might help the problem situation. The root definition states the main purpose of human activity systems. It is a precise description of the system that should capture its essential nature. Each description is derived from a particular view of reality. (Avison & Fitzgerald)

There are three tools that can be helpful in creating the root definition for each human activity system. These tools include the transformation process, the CATWOE and the XYZ-formula. Together these make up the necessary base for the formulation of the actual root definition.

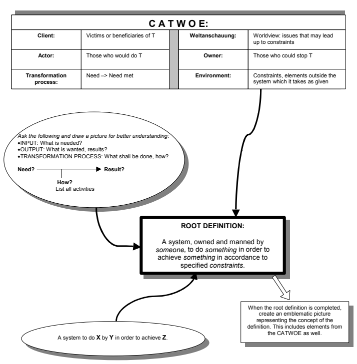


Figure 8 *The process of creating the root definition (see Appendix 5).*

The relationship between the root definition and the tools needed to define it is demonstrated in figure 8. This picture also includes a fourth element, the emblematic picture of the root definition. This is created after the actual formulation of the root definition, and its main purpose is to bridge the gap between definition and the building of the conceptual model.

The process of seeking root definitions that are relevant is about developing human activity systems that are purposeful and hence the objective (purpose) of these has to be clarified. What is to be defined is the particular transformation that will make it possible to fill this need. Considering a range of possible transformation processes and possible point of views, from which such processes could be described, helps the process of seeking root definitions that are relevant. (Wilson)

Every purposeful activity can be expressed in the form of a transformation process. This means that the set of activities contained in the human activity model represents the interconnected set of actions necessary to transform some entity, the input, into a different state or form of that same entity, the output of the process. The transformation process is demonstrated in figure 9. The inputs and outputs can be of a physical nature, but they do not have to be. The transformation process can also be of an abstract kind. (Checkland & Scholes; Wilson) This implies that the set of activities enclosed in the human activity model represents that interconnected set of actions needed to transform certain input into output (Wilson).

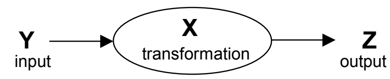


Figure 9 *The Transformation Process, which is enacted by the operation of the system.*

There are a number of things that is important to remember when describing a transformation process. It is vital not to confuse the entity to be transformed with the resources needed to make the transformation possible. A common mistake is to confuse the input, which becomes transformed into the output, with the resources needed to perform the transformation process. It is also important not to use verbs as inputs and outputs instead of entities. Actions cannot be transformed into something else, they may result in other actions, but that is not the same as being transformed into something. (Checkland, 1993; Checkland & Scholes; Checkland & Tsouvalis)

The transformation process is intrinsically connected to the analysis of the primary tasks. A primary task describes a shared or agreed view of tasks that exist in a problem situation. These tasks exist in that situation through a specific set of 'hows'. It is not important to determine whether or not the 'how' is appropriate, or if it is performed in an acceptable manner. The only important fact is the very existence of the task itself. (Wilson) The primary task analysis may be preceded by an issue-based analysis to determine what the primary tasks are. The issues-based analysis is concerned with the interpersonal relations and organizational behavior in a problem situation. (Avison & Fitzgerald) They do not describe a task or entity that can be found in the real world, but they do define the existence of an underlying issue (Checkland & Tsouvalis).

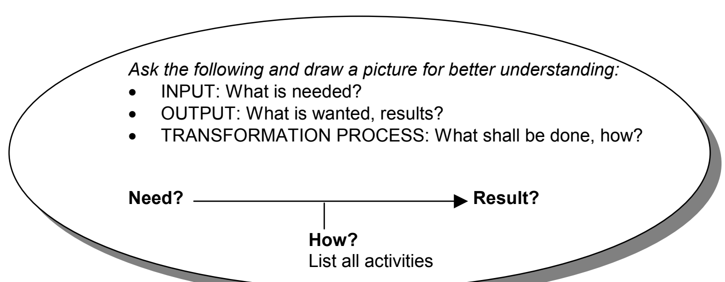


Figure 10 *Defining the transformation process for the specific situation.*

The defining of the transformation process, which can be guided by figure 10, starts with a discussion and definition of what is needed. It is a matter of finding out what the system (the transformation) will improve in the problem situation, the input. This is closely related to what is wanted - the result of the transformation process - the output. The last part of this process is to discuss and write down all the activities that would transform the input into output. The 'how' would be all the activities needed for the transformation process to take place.

The root definition is a verbal description that encapsulates the fundamental nature of the human activity system, where each description is based upon a particular point of view. It is therefore important that the root definition include all aspects of the human activity system. Avison and Fitzgerald (p. 117) have in simple terms expressed what is to be included in the root definition:

> To ensure that each root definition is well-formed, it is checked for the presence of six characteristics. Put it into plain English, these are *who* is doing *what* for *whom*, and to whom are they *answerable*, what *assumptions* are being made, and in what *environment* is this happening? If these questions are answered carefully, they should tell us all we need to know.

For each of the six characteristics of a well-formulated root definition there are more technical terms that can be used (as seen in figure 11). The first letter of each forms the acronym CATWOE. Each of these terms can be used as a base for asking relevant questions about the human activity system. (Checkland, 1985; Checkland & Scholes; Lewis)

C A T W O E:			
Client:	Victims or beneficiaries of T	**Weltanschauung:**	Worldview: issues that may lead up to constraints
Actor:	Those who could stop T	**Owner:**	Those who could stop T
Transformation process:	Need –> Need met	**Environment:**	Constraints, elements outside the system which it takes as given

Figure 11 *The elements of the CATWOE of the Root Definition (Checkland & Scholes).*

The presence of the characteristics of the CATWOE ensures that each root definition is well formed. At the heart of the CATWOE is the matching of the transformation process and the Weltanschauung that makes it meaningful. There will always be a number of possible transformation processes that can express a relevant purposeful activity, since it is dependent on different interpretations of its purpose. The other elements of the CATWOE provide ideas that each purposeful activity is performed by, can be stopped by, or affect someone. The system might also be controlled by some unspoken environmental constraints. Any root definition that takes these elements into account will be rich enough to be modeled. (Checkland & Scholes)

The term Weltanschauung of the CATWOE is a German word for the concept of a worldview that allows the observer to attribute meaning to what is perceived. The fact that numerous, probable and valid perceptions of real world events are possible, is one of the most important characteristics of the human activity system. The way the perception is described, is a direct consequence of the Weltanschauung. (Wilson)

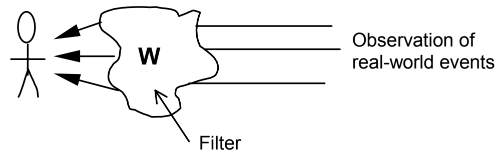


Figure 12 *The Weltanschauung functions as a filter for perception of real-world events (adopted from Wilson, p. 29).*

As shown in figure 12, the term Weltanschauung can be symbolized as a filter through which the observations of the real world are attributed meaning, which leads to specific actions based on that very interpretation. This filter is formed and is constantly being molded by personality, experience, culture, society and the actual situation at hand. An individual has a specific Weltanschauung that effects the interpretation of the world, and therefore it is only possible to make models that are relevant to, or about, the situation. Any action that is taken based on these models is dependent on that very Weltanschauung. (Wilson)

The structure of the CATWOE indicates that a root definition could be expressed as figure 13 demonstrates. In this definition the transformation process will be the means Y. Z is associated with the owner's long-term aims. It is important that the means, Y, chosen actually works in producing the output, Z. It is very useful to keep the XYZ-formula in mind when writing root definitions. (Checkland & Scholes)

A system to do **X** by **Y** in order to achieve **Z**.

Figure 13 *The XYZ-formula of the Root Definition (adopted from Checkland & Scholes).*

Once all the elements of the root definition are gathered, it is time to formulate the actual definition. A root definition encompasses the worldview that makes the activities and performance of the system meaningful. Any problem situation can be explored in terms of various and potential transformation processes. It will also be possible to make a number of root definitions. (Wilson)

ROOT DEFINITION:

A system, owned and manned by *someone*, to do *something* in order to achieve *something* in accordance to specified *constraints*.

Figure 14 *A very general formulation of a Root Definition.*

The general definition in figure 14 can serve as a model when formulating root definitions. Since writing these definitions will seem awkward at first, this model can be used as a base and where the CATWOE, transformation process, and XYZ-formula can be used to 'fill in the blanks'. The choice of words for the root definition needs careful consideration, and only words that are regarded as important should be included. The activities that are to be included in the conceptual model should be related to these words. (Wilson) It has been suggested that the root definition should include all the main activities of a conceptual model. Each activity in the model should be obtained from the words used in the root definition. By including these main activities, the root definition not only defines what the system is, but to a large extent also specifies what the system is expected to do. (Checkland & Tsouvalis) This might prove to be problematical though. If several transformation processes (activities) were to be included in the definition, it might cause a loss of richness that according to Checkland (1993, p. 292) will be gained when comparing the root definition, the 'being', with the conceptual model, the 'doing'.

It is generally useful to bridge the gap from definition to model via an informal pictorial representation of the concept of definition, a so-called emblematic picture. The main activity should be the focus of the picture and be surrounded by outer activities that fit with the CATWOE. In general, the aim is to express the main operations that bring about the transformation in a number of activities. The picture provides a better understanding of the situation that will make the discussion and modeling easier.

3.3.2.3 Conceptual models

The building of conceptual models that show how the different activities are related will complete the examination of the human activity systems. If the organization is to be aided by the analysis of the human activity system it has to illustrate the discrepancies between what *is supposed to happen* to achieve the objectives specified in the root definition, and what *actually is happening* in the real world. (Avison & Fitzgerald)

When developing a human activity system it is important to remember that the model does not describe what exists, but is a model of a perception of what exists. Thus, the conceptual model that is developed is only a model of the system described by the root definition. For the conceptual model to be that system, there is a need to define a minimum necessary collection of activities. (Wilson) While the root definition is a description of what the system *is*, the conceptual model describes the set of activities that the system must *do* in order to be that system. (Checkland, 1993; Wilson)

There are five tools that can be helpful in creating the conceptual model for each root definition. These tools include the root definition, the CATWOE of each root definition, the emblematic picture of the root definition, measurements of performance (3 E's) and a list of steps to follow when drawing the models. The relationship between the conceptual model and the tools needed to build it is demonstrated in figure 15.

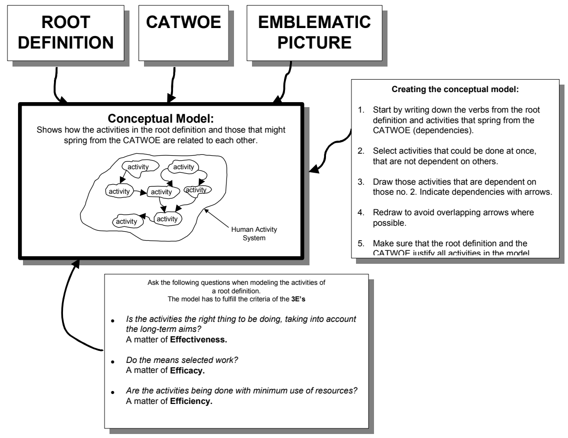


Figure 15 *The process of creating the conceptual model (see Appendix 6).*

As mentioned before, the root definition is an account of what the system is, while the conceptual model describes the set of activities the system must do in order for it to be that system (Checkland, 1993; Wilson). Consequently, the foundation needed to build the conceptual model can be found in both the root definitions and CATWOE. By extracting all the verbs implied by the root definition, the elements of the conceptual model can be defined. The emblematic picture can be used to start off the modeling and the discussion of what activities to extract from the root definition. The modeling will entail assembling the activities required to change the input into the output, while making sure that all activities needed by the other CATWOE elements also are covered. These activities should be linked in accordance to whether or not they are dependent on other activities. (Checkland & Scholes)

Once all the elements needed for the conceptualization of the activities are gathered, it is time to begin the modeling. The five steps in figure 16 can be used as an aid in the modeling process.

Creating the conceptual model:

1. Start by writing down the verbs from the root definition and activities that spring from the CATWOE (dependencies).

2. Select activities that could be done at once, that are not dependent on others.

3. Draw those activities that are dependent on those of no. 2. Indicate dependencies with arrows.

4. Redraw to avoid overlapping arrows where possible.

5. Make sure that the root definition and the CATWOE justify all activities in the model.

Figure 16 *A guide for creating conceptual models.*

The list of verbs should be organized in a logical order, and for each root definition, there must be one model. The system can be modeled as a whole entity by connecting 7 ± 2 activities structured according to logical dependency. All activities in the model can become a source of a root definition to be expanded at the next level of detail. The purpose of the conceptual model is to achieve what has been defined in the root definition. Hence, the conceptual model is a model of the root definition and not a model of anything else. (Avison & Fitzgerald; Checkland & Scholes; Checkland & Tsouvalis; Wilson)

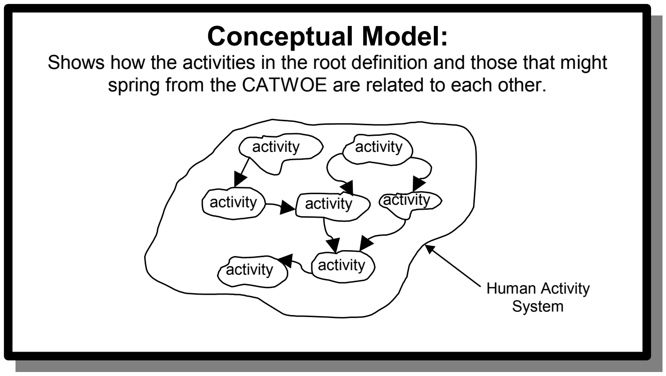


Figure 17 *The conceptual model.*

As shown in figure 17, the conceptual model is drawn as activities linked together to form a whole, the human activity system. The activities are drawn as 'clouds' or 'ovals' and the relationships are drawn as arrows linking them together with the name of the activities written inside. The human activity system is the whole entity and it is symbolized in the boundary enclosing all the activities and interconnected set of activities. (Examples of conceptual models can be seen in Appendix 9.)

Within the hierarchy of systems that are relevant to the area of concern, the root definition describes the emergent properties appropriate to the level of detail of what is taken to be the system. The building of the conceptual model entails the logical expansion the root definition into the activities that the system must do in order to be the system so defined. This conceptual model represents the minimum, necessary set of activities, at a particular level of detail, which the system must do to be the system of the root definition. (Wilson)

The root definition, the CATWOE and the conceptual model of the required activities of the system together, form a formal definition of the system. It might be useful to explore the system in greater detail, by taking the system modeling to a higher resolution level. As sub-systems are conceptualized, this greater level of detail provides means to better understand the original system that they are part of. (Lewis)

Once a conceptual model exists in the form like that in figure 17, it can be used to arrange questions into the situation. Before this inquiry into the problem situation can take place, the adequacy and validity of the models must first be checked. Due to the fact that the models are not descriptions of the real world but merely models of the root definitions, adequacy or validity cannot be checked against the real world. Their adequacy and validity is dependent upon each phrase in the root definition being linked to specific activities and connections in the model. It is also important that each feature of the model can be established to originate from the words in the definition. (Checkland & Scholes)

Although the human activity systems are structured in terms of logic, inconsistencies can be found in the conceptual models. To avoid these discrepancies the modeling of the human activity system should fulfill the three criteria of figure 18. These measurements of performance should be used to make sure that the human activity system could in principle survive in an ever-changing environment. (Checkland & Scholes)

Ask the following questions when modeling the activities of a root definition.
The model has to fulfill the criteria of the **3E's**

- *Is the activities the right thing to be doing, taking into account the long-term aims?*
  A matter of **Effectiveness.**
- *Do the means selected work?*
  A matter of **Efficacy.**
- *Are the activities being done with minimum use of resources?*
  A matter of **Efficiency.**

Figure 18 *The 3E's of performance (Checkland & Scholes).*

The criteria for the 3E's should in general be decided for the system to be modeled. This adds a useful richness to the comparison between the model and perceptions of the real world. Effectiveness, efficacy and efficiency, which are used for judging the in-principle performance of a human activity system, cover only the basic ideas of transformation. They can also be supplemented with other considerations if it seems appropriate in some circumstances. (Checkland & Scholes) *Ethicality* can be used as a fourth criterion, and it checks if the transformation process is a moral thing to do. Another criterion is *elegance*. It is a matter of whether the transformation process is aesthetically pleasing or not. (Checkland & Tsouvalis)

The conceptual model of the human activity system is mainly informal in that the meaning of each activity is described only by the text displayed in the model. The connecting arrows that imply the relationship between the activities are not named nor do they display any explanations of what they entail. However, these models do provide a framework for debate of how to improve an organization. They also serve as an aid in identifying activities that are lacking or are performed inadequately, thus placing focus on organizational improvements. (Bustard, He & Wilkie)

It is according to Checkland (1993) a question of judgment whether to continue the conceptual model building or whether the modeling can be considered completed. Once this decision has been taken, it is time to go on to a comparison between what exists in the real world and what is suggested by the relevant human activity systems.

3.3.3 Comparing the models to reality

The conceptual models are compared to the real world with the objective of having a well-structured and logical discussion about how to improve the perceived problem situation. That discussion is structured around the models in order to inquire into the perceptions of the circumstances of the situation. The comparison should be done together with participants of the problem situation that wishes to make the improvements happen, and who also have the authority to do so. (Checkland, 1993; Checkland & Scholes)

The method of comparison most commonly used, is called formal questioning, where the conceptual models are used as a foundation for inquiring into the real world. Answering those questions encourage discussion about improvements in the problem situation. The discussion may be performed by a group of people in one place at one time, or by interviewing a single person over a period of time. (Checkland & Scholes)

The comparison will be done formally through a tabular display, a matrix, that for each activity in a model indicate whether or not it exists, and if it does exists - in what form. The matrix should also include how these activities are linked together. (Ibid.; Wilson) An example of such a matrix for formal questioning when performing the comparison between the conceptual models and reality is demonstrated in figure 19.

Conceptual Model Name:				
Activity	**Exists when**	**How is it done**	**Support**	**Comments**
1.				
2.				
3.				
LINKS				

Figure 19 *The matrix for comparing conceptual models to reality.*

First the name of the conceptual model should be filled in the matrix. Since every conceptual model is to be compared to reality, it might be quite confusing and difficult to connect the answers to the correct model if it were not named in a proper fashion. A left-hand column lists all the activities in the model. The following column records the real-world manifestations, if they exists and under what circumstances. A third column adds value assessment about the activities in the real world, and how it presently is being done. The second last column is for describing what kind of support the activities carry. Whether it is computerized support, or any other support necessary for performing the activity. The last column is for any comments on the way that things are being done. There should be room for anything that might concern the present 'how'. This is all written in a language that is suitable for the situation and consists of the proposed changes together with the real-world evidence that support the recommended changes. It is this last column that is the source for the ideas about desirable and feasible changes to the problem situation. Lastly the relationships between the activities should be listed. This would entail all possible relationships, and preferable with a short description as to under what circumstances these links occur. (Checkland, 1993; Wilson) An example of a filled matrix can be seen in section 3.2.1.6.

3.3.4 TTF – questionnaire

To add value, information technology (IT), like the operation support system (OSS) in this case, must meet the needs of the organizations, groups, and individuals who use it. (Dishaw & Strong) Task Technology Fit (TTF) is a theoretical tool that can be used to capture how well technology functionality matches or fits the needs of the tasks being performed. TTF assumes that the utilization of a computer system is dependent upon the fit between three constructs: technology characteristics, task requirements and individual abilities. (Goodhue, Klein & March; Goodhue & Thompson) With this intent, the TTF-questionnaire is designed to encapsulate the general perception of the user's view on how well the computer system supports the tasks.

The questionnaire is divided into five parts. Part A. focuses on meeting the task-needs for using data in decision making, using data meeting the operational day-to-day needs, and how the system responds to changed organizational needs. It is a matter of measuring the Task Technology Fit. Part B. focuses on the task characteristics, such as non-routineness and interdependence. Part C. focuses on how the individual perceives the impact of the OSS on their productivity, effectiveness and performance in their tasks. Part D. focuses on how the individual perceives dependency of the IS in his/her work routines. The last part of the questionnaire, Part E., is reserved for more general questions.

The respondents are asked to rate the questions of Part A. to Part C. from 'I strongly agree' (7) to 'I strongly disagree' (1) based on how the respondents perceive the statement/question to fit the situation. In Part D. of the questionnaire the respondent will be asked how dependent he/she is on the applications of the system in their work-routines. The scale ranges from 0 to 3, where 0 stands for 'Not at all dependent'; 1 stands for 'Not very dependent'; 2 stands for 'Somewhat dependent', and lastly where 3 stands for 'Very dependent' of the application. In Part E. the general questions involve questions of: Job title; Number of years on current job; Number of years in the telecommunication field; What might be considered to be a reasonable price tag for services the computer systems supplier might provide; and lastly, space is reserved for anything the respondent might like to add. The complete questionnaire of Task Technology Fit for STSSM can be found in Appendix 4.

3.3.5 Discussing Feasible and Desirable Changes

The results from the comparison between the real world and the conceptual models, the filled matrix, and the filled questionnaires on Task Technology Fit, will serve as a foundation for a discussion about change. This discussion is carried out in the real world of the problem situation with actors who are concerned with improvements taking place in the situation. Ergo, the discussion ought to involve people in the problem situation who care about the perceived problem and want to do something about it. (Checkland, 1993) The actors concerned in the current situation would be representatives from both Ericsson and the Telecom Operator. It is important that representatives from management should be included, so that the changes are anchored in the organization from the start.

The models of purposeful human activity systems that the conceptual models represent are selected according to somebody's perception of what *might be* relevant to the problem situation. They are not models *of* the problem situation. Any recommendation for change coming out of the discussion, set off by comparing the real situation to the conceptual models, can only be claimed as being desirable, not mandatory. It is not very likely to expect that all the recommended changes will be acceptable. (Checkland & Scholes) The recommended changes must meet two criteria in order for them to be implemented. They must be both desirable and feasible. The changes must be desirable on the basis of system analysis, as a result from the knowledge base that was built whilst performing the selection of root definitions, and the building of the conceptual models. They must also be culturally feasible based on the uniqueness of the problem situation, the people within it, their mutual experiences and their notions. Changes will be implemented in a human culture and as such it will affect and modify that culture. The changes will be implemented only if they are seen as meaningful within that culture, meaning within the organizational worldview. What is culturally feasible is often altered by the discussion itself since norms and values are exposed in the discussion, making the deciding on what is meaningful an iterative process in itself. That is why the changes have to be both desirable and culturally feasible in a sense that they are regarded as meaningful within the culture of the problem situation. (Checkland, 1985; Checkland, 1993; Checkland & Scholes; Wilson)

Desirable and feasible changes might take different forms, and any combination may be suitable in a specific problem situation. Changes of three kinds are possible: changes in structure, procedures or attitudes. Structural changes are those made to that part of reality, which in short term do not change. Theses might have the characterization of organizational groupings, reporting or structures of functional responsibility. Changes of a procedural nature are those made to the dynamic elements, e.g. the processes of reporting and informing, all the activities and tasks that are relatively fixed, and things like education and training programs, etc. Both changes of structure and procedure are relatively simple to specify and implement, since the implementation process is of an explicit character and as such is easy to design. This is not the situation with the last kind of change, that of attitude. The term is intended to encompass things such as changes in influence and changes in the people's expectations on what is considered to be 'good' or 'bad' behavior. Theoretically it is possible to try to make changes in people's attitudes, but in reality it might be not be so easy to achieve the anticipated results. (Checkland, 1993)

It is important to realize that the changes should be desirable and feasible for both the Telecom Operator and the supplier of the computer system, Ericsson. The discussion around these changes is preferably held at the same location, with representatives from both parties, but it can just as well be held on separate locations. The fact that the collected materials from the inquiry (root definitions, CATWOE, conceptual models and filled matrix) are materials that can be copied and distributed enables the discussion to be in separate locations. Having access to the same material can serve as a base for discussion, even though the participants of the discussion do not reside on the same location. The filled questionnaires must be analyzed before the discussion of possible changes might take place, and due to the enormous amount of data, this might take some time to complete. Conclusions have to be drawn based on this data and organized in a suitable manner, so that they will fuel the discussion and narrow areas of improvements.

3.3.6 Taking action to improve the problem situation

The definition of how the implementation process should be designed takes place once a set of acceptable changes has been assembled. It is a matter of determining what actions are necessary to improve the problem situation. An examination of alternative 'hows' should have been made during the evaluation of whether the recommended changes are desirable and feasible or not. Action that will lead to improvements must also be related to whatever structural or procedural changes are necessary to meet the recommendations for change. (Wilson)

STSSM does not in general support the implementation activities other than the fact that the fundamental idea of the entire process of inquiry into the problem situation is the emergence of ideas for improvements in the situation that was considered to be problematical to begin with. The improvement action can only take place once changes that are desirable and feasible for both parties have been agreed upon. The improvements might involve changes in the way the Operator performs their task, the knowledge the Operator have of the computer systems or the order in which the work processes of the Operator occur. Changes might also involve changing the implementation process of the computer systems. This would entail making changes within the supplier of the systems, Ericsson in this case. Changes might also involve the actual computer systems technical solution. The important thing to remember when action to improve the situation will take place is that the changes have to be suitable to all parties in keeping with the organizational procedures.

3.4 Results from the Case Study

The Case Study was carried out at ETL NOC[8] in Burgess Hill, England. ETL NOC is an organization that provides the service of running and maintaining their customers' network. The results from the Case Study are arranged in two parts. In the first part the results are presented according to the activities performed of the qualitative part of the model of STSSM, with reference to the pictures and models in Appendices 6 - 8. In the second part, the results from the TTF-questionnaires are presented in statistical diagrams and tables.

3.4.1 STSSM

An observation of the NOC premises and the operation of the network initiated the process of STSSM. The aim was to create an understanding for how they worked and how the work-situation for the operators looked like. The results from the observation will be presented before the resulting material achieved when performing the activities of STSSM.

3.4.1.1 Observation

The NOC is staffed around the clock. They work in shifts and use email to inform the next shift and pass on network errors (opened trouble tickets). Most communication is done verbally and requests for support is usually done by first directing a question to the correct level, and then creating a trouble ticket before sending the formal request via email. Often solutions are reached quickly, where all levels are active in the discussion when necessary. This way of doing things is based on the size of the organization. At present, the customer base is not that large, which enables all levels of network support to be located in one room. The OSS that the NOC uses is based on XMATE and NS applications. The NS is the large platform supported by XMATE, the heartbeat of the switches. The NS is a platform on top of that. There seems to be confusion as to the names of the OSS-applications that they use. When they say XMATE, they are referring to the applications of ISM Alarm and ISM Monitor.

The NOC supports some customers' platforms by the BMP, an Ericsson's billing platform that has been bought by ONETEL.

The Network Surveillance function has access to 6 computers, with different applications running parallel. These are XMATE; WinFiol (one window per customer/network); NOC email (group account in MS Outlook), Billing Platform, TXD 3.01 (simple web-based configuration handler for CUSTOMER ONE); Alarm list for ANS-elements. The applications most used for monitoring the switches are WinFiol, AXE's and for the AXD's an application in Netscape is used. They do not seem to trust XMATE to show the alarms in real-time. Sometimes the application does not show the 'clears' (when a fault has been fixed). Occasionally the data is not reliable, since certain alarms that have been established to exist, by direct communication with a switch, are not included in the alarm list. XMATE have also been known to display data that do not exist at all.

[8] ETL NOC – Ericsson Telecommunications Limited, Network Operation Center, sometimes referred to as 'the NOC'

3.4.1.2 Rich Picture

The main objective of the NOC is running and maintaining the Network effectively, meeting the Service Level Agreement (SLA) of the customer. The rich picture created by representatives of ETL NOC can be seen in Appendix 7.

The NOC are running and maintaining a network of 9 switches in total, which is composed of the networks of 5 customers. The networks are distributed throughout Europe. The CUSTOMER ONE network is made up of 2 AXD and 2 AXE located in the south and middle of England. The CUSTOMER TWO (CUSTOMER TWO) network is composed of one AXE, which is located in London. The ONETEL network has one AXE in London and one in Paris. CUSTOMER FIVE's network is made up of one ANS in Oslo. The network for the CUSTOMER THREE is at the moment composed of one AXE, and due to the recent events on the Telecom Market that customer base does change over time. It's not static. The NOC is also adaptable to take on customers on short term. They might be asked to 'baby-sit' something for the weekend, a couple of weeks or up to six months.

The customers have differences as far as skills are concerned. What kind of service the NOC is to do for the customer, depends on if they have their own engineers or not. For those customers that do not, the NOC does all the network service, but some customers will eventually train their own people. ONETEL is an example of this and as a result the workload for these networks have diminished from being all-time service to just being off-hours surveillance.

The Service Level Agreement (SLA) is a commercial document, which outlines the service the NOC is to provide for the customer. For each customer these contracts are drawn up, covering all the running of the network and the services that the NOC is under contract to provide. There is one separate SLA for each customer (and two for ONETEL). It is always the SLA between the NOC and the customer that is the base for the commercial agreement between the customer and ETL NOC. Behind the SLA there is also a Working Level Agreement (WLA).

The ETL NOC is made up of four major function areas, NOC Management, Network Surveillance, Operational Support and Field Maintenance. The gap between function areas is not that wide, leading to a lot of interaction between them. The Network Surveillance is divided into three roles, Customer Reception & SPOC, Network Surveillance and 1st Level Support. Due to the size of the network they manage and the size of their workforce, one person presently possesses all roles. The Operational Support is made up of the Configuration & Data, and 2nd Level Support. The most commonly used term in the NOC for the Network Surveillance function is simply 1st Level Support, and for the function of Operational Support the term 2nd Level Support is used (Level is sometimes referred to as Line). As a consequence, we will use these terms instead of the more formal ones.

Apart from the main objective of the NOC, each function area has its own set of objectives, where all are working for preventative and correct maintenance of the network (the objectives can be found in Appendix 7). All parties, except Field Maintenance, can gain immediate access to the OSS applications, and the ANS have a direct line into the 1st level support.

Network Surveillance is the customer's initial contact. They are the ones who attempt fixing the problem first, and if it is not possible they will contact Field Maintenance or the 2nd Level Support, depending on the nature of the problem. Problems that are hardware orientated should go to field maintenance, e.g. fault changes, monitoring equipment, reset modems etc. This is called corrective maintenance. Field engineers are also involved in preventative maintenance. All preventative work is advertised in advance to the NOC. Controlled escalation and workflow is the most common means of communication between the function areas. The Field Maintenance does not have access to the OSS or the NOC systems. They get work orders via email or phone and give feedback on work done in the same manner.

3rd Level Support is placed outside the NOC, in Daten Park. They can dial in directly to each switch individually. They do not have access to the NOC server or operating platform. ONETEL is a single module with a connection to each switch, one line from London and one line from Paris. CUSTOMER ONE has four lines 2 AXE and 2 AXD. CUSTOMER TWO have one line that also dials in to the ANS. The support for the ANS is Ericsson Finland.

Ericsson is the supplier of the network elements AXE and AXD. Ericsson supplies the ANS elements as well, but a 3rd Party (an external company) converts the switches. Another supplier is called WESTEL, who supply a switch for protocol conversion for one of the customers' support.

The trouble ticket system that is used is called REMEDY. The NOC get requests via email from the customers and that information is transferred off the email onto REMEDY.

3.4.1.3 The EROSA model

To fuel the discussion of possible human activity systems, the main aim of ETL NOC were discussed and the model of figure 20 was agreed upon. The discussion that followed the modeling of the EROSA was mainly focused on the computer support systems, and issues surrounding them.

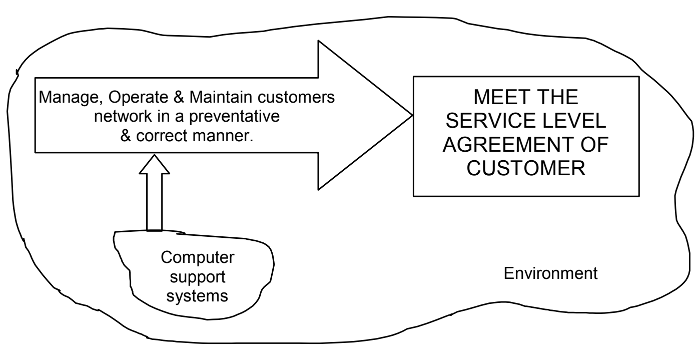


Figure 20 *The EROSA model of the ETL NOC, 2001-06-11.*

The network is run and maintained by using the supporting computer systems. The majority of the systems documentation is electronic, with not too many copies stored in folders and binders. They are used daily by thousands of technicians and engineers, but the people would need to have a certain level of schooling to use them.

New employees are usually brought in from the same industry as the NOC, so that they are already trained in network management. There is some training involved though, mainly training them up to the right skill-level, where the training consists of partly formal training and partly educate-on-the-job-work with somebody doing the work already. It is dominantly Ericsson equipment that is maintained, but not to the exclusion of other equipment. If the customers have other equipment they want to be maintained, there would be specific training involved as well.

Software upgrades can cause some problems before they are assimilated into the work processes of the NOC. It might be difficult to get everyone trained and get the new software to work perfectly straight away. There is usually a window of time before everything is working smoothly. Normally the customer is already in place and the running of the network is done parallel to the training. The ideal would be to train everyone, get the systems in and then bring in the customer, but it never works that way, especially with new technology.

New software upgrades are sometimes perceived as having too much focus on technical perks rather than being adapted to user needs. The system developers are believed not to take consideration to the real world and how people actually do the job, due to the fact that the systems are developed in a test-scenario, not in real-life operation. The fact is that if the users do not accept the systems, they will not be used in the operation of the network.

The NOC does not have a 100% confidence in the base systems. It actually took them a very long time to find out who the supplier of the systems were for part of the equipment. The equipment was inherited from Sweden and this resulted in a bit of a legacy problem. These circumstances have improved a lot, but if new technology is introduced there is most likely going to be problems again.

There seems to be a feeling within the NOC that the communication between them and the supplier of the systems, Ericsson in Sweden, could be better. Whenever there is a software problem or an upgrade, the 'Ericsson people will put something on to cure the fault'. The fault will be explained to some degree, but not enough to create a feeling of safety for the users. Since the NOC is running networks for other parties, the training on new software will be performed on the side, parallel to the day-to-day operations. These circumstances can presently be handled within the NOC, since it is not a large Operator. If the operation center increases in size, the dependency on the systems to work between units within the NOC will also increase. At the moment they rely very much on human-interface to cover up either the shortfalls of the system, or the way that the system is not used as it should. If a systems failure occurs, the NOC is still so small that they can 'bluff' their way through or manage by dialing into the switches directly.

The NOC is supposed to work as a showcase for customers, with the aim of displaying a network run and maintained successfully with the support of the OSS. ETL NOC is to be a showcase for customers setting up their own operations, so that they can come and see via the NOC operations the 'excellence' of the systems. That never really happened at ETL NOC because the intangible nature of the support element of the systems.

3.4.1.4 Root Definitions

Root Definitions were created for the human activity systems that were believed to exist at ETL NOC. The root definition of ETL NOC was created twice in order to get a varied image of that human activity system, which is the major system of the NOC. Since the variation was not that extensive between the two, further definitions of that same human activity system was not necessary. The emblematic picture for bridging the gap between the root definition and the conceptual model was only performed on the first root definition (see Appendix 8). It was found to be more confusing than helpful, so for the following interview sessions it was left out. Each root definition is presented directly following the transformation process and the CATWOE used to create it.

Transformation Process a) of ETL NOC:

Need? Need to monitor & maintain the customer network → **Result?** Need met

How?
Network Surveillance
Configuration & Data
2nd Level Support
Field Maintenance
NOC Manager

C: ETL NOC, Customer
A: ETL NOC, (Customer)
T: Need to operate & maintain customers network → need met
W: Customers Service Level Agreement
O: ETL NOC
E: Customer current climate

Root Definition a) of ETL NOC:
A system, owned and manned by ETL NOC, to operate and maintain the customers network keeping with the service level agreement (& working level agreement) of the customer. The operation, maintenance and management of the network is done by the means of Network Surveillance, Configuration & Data, 2nd Level Support and Field Maintenance.

Transformation Process b) of ETL NOC:

Need? Need to operate & maintain the customer network → **Result?** Need met

How?
Network Surveillance
2nd Level Support
Configuration & Data
Field Maintenance
NOC Managing

C: ETL NOC, Customer
A: ETL NOC, (Customer)
T: Need to operate & maintain customers network → need met
W: Service Level Agreement
O: ETL NOC
E: Computer system operated; clients requirements

Root Definition b) of ETL NOC:
A system, owned and manned by ETL NOC, to operate and maintain the customers network, in accordance with the Service Level Agreement of the customer. The operation should be performed by experienced engineers doing Network Surveillance, 2nd Level Support, Configuration & Data, Field Maintenance and Management.

Transformation Process of Network Surveillance:

Need?	How?	Result?
Need to provide effective & timely support for customers	Real-Time Surveillance Fault Logging/update logbook Task allocation (TT) Routine Maintenance Works order administrations Emergency procedures SPOC (Single Point Of Contact)	Need met

C: ETL NOC, Customer
A: ETL NOC, (Customer)
T: Need to operate network → need met
W: Customers Service Level Agreement
O: ETL NOC
E: Customers current climate

Root Definition of Network Surveillance:
A system, owned and manned by ETL NOC, to provide effective & timely support for the customers needs in keeping with the Service Level Agreement. The support should be performed via the following activities: Real-time surveillance, fault logging, updating logbook entries, task allocation, routine maintenance, works order administrations, emergence procedures and SPOC (Single Point of Contact, any media the customer uses to add requests outside the SLA).

Transformation Process of Real-Time Surveillance:

Need?	How?	Result?
Need to correct faults as they come	Monitor incoming alarms Ack. alarms that are important Take action on major alarms Use various commands on AXE10 Check Log file Raise Ticket Ack. emails/ and act on them	Need met

C: ETL NOC, Customer
A: ETL NOC, (Customer)
T: Need to correct faults from network → need met
W: Customers Service Level Agreement
O: ETL NOC
E: Customers current climate; trustworthy computer support

Root Definition of Real-Time Surveillance:
A system, owned and manned by ETL NOC, to correct faults and yield any incoming issues in keeping with the Service Level Agreement. However, if the computer is down little work can be accomplished. Monitor incoming alarms and separate the unimportant alarms from the major alarms (e.g. if we are receiving alarms from a switch that is currently not being monitored). Take action to resolve the major alarms via commands on the AXE 10 or AXD. We also need to check the log file any current work to keep inline with our Service Level Agreement, we would then need to raise a ticket from any unresolved issues and acknowledge incoming email from customers and act on them.

Transformation Process of Routine Maintenance:

Need?	How?	Result?
Need for routine maintenance	Check for routines for SLA Enter commands on AXE 10 Carry out routines i. daily ii. weekly iii. monthly iv. yearly tasks on switches	Need met

C: ETL NOC, Customer
A: Network Surveyor
T: Need for routine maintenance of network → need met
W: Customers Service Level Agreement
O: ETL NOC
E: Trustworthy computer support; Real-time communication with network elements of customer

Root Definition of Routine Maintenance:
A system owned by ETL NOC and manned by Network Surveyor, to check hard and soft copies of foldes for daily, weekly, monthly and yearly routines to be carried out on customers switches for their Service Level Agreement. Then process these routines via entering commands on the AXE 10.

Transformation Process of Trouble-Ticket:

Need?	How?	Result?
Need for a record (recording events)	Alarm raised Data change Raise Trouble Ticket Carry out commands on AXE 10 Email data people Email customer Close Trouble Ticket	Need met

C: ETL NOC, Customer
A: Network Surveyor, Manager
T: Need for recording events → need met
W: Need for keeping records of work done
O: ETL NOC
E: Computer system!

Root Definition of Trouble Ticket:
A system owned by ETL NOC and manned by Network Surveyor & Manager, to keep a track-record of alarms raised and work required by a customer, e.g. Data changes on the switch.

Transformation Process of 2nd Level Support - Switching:

Need?	How?	Result?
Need to solve network problems and possible provide solutions (new ways of doing things) Assistance!	Switching Assistance	Need met

C: Customer, NOC people
A: 2nd Level Support of NOC
T: Need to solve network problems and possible provide solutions and assistance → need met
W: Service Level Agreement
O: ETL NOC
E: Customer Level Agreements!

Root Definition of 2nd Level Support - Switching:
A system owned by ETL NOC and manned by 2nd Level Support to provide solutions for network faults. Assistance is provided in conjunction with Service Level Agreements and Working Level Agreements.

Transformation Process of 2nd Level Support – Configuration & Data:

Need?	How?	Result?
Need to change routings, add new telephone numbers and additional equipment to the customers network	Build data files Load files to NE Putting in new routes B-number analysis Investigate data problem Test & verify call completion	Need met

C: ETL NOC, Customers
A: Configuration & Data of the NOC
T: Need to change routings, add new telephone numbers and additional equipment to the customers network → need met
W: Service Level Agreement
O: ETL NOC
E: Customer Level Agreements!

Root Definition of 2nd Level Support – Configuration & Data:
A system, owned by ETL NOC and manned by Configuration & Data engineers, to change routings, add new telephone numbers and additional equipment (Software and Hard ware) to the customer's network, in keeping with the customers Service Level Agreement. The idea is to complete the work in a secure manner so as not to affect the quality of service.

3.4.1.5 Conceptual Models

See Appendix 9 for the conceptual models of ETL NOC.

3.4.1.6 Comparison Matrix

Not all the conceptual models were compared to reality, using the matrix as a formal method of questioning. In those cases were the comparison between the conceptual models and reality would provide no additional data, the matrix was left out.

Table 2 Matrix of ETL NOC (based on root definition a) of ETL NOC)

	Activity	Exists when	How is it done	Support	Comments
1.	Network Surveillance	Yes	Monitoring incoming alarms on screen	XMATE AXE 10 (direct)	Real-time not always; sometimes not show clear; doesn't show certain alarms; shows lot of rubbish that's not there at all
2.	Ticketing	Yes	Log on and create short ticket, keeping record	Remedy	Fine
3.	Request for Data Change	Once/twice a day	Via email; raise ticket pass to Config. & Data people	NOC-email Remedy (Verbally)	Fine
4.	NOC Managing	Day-time + on call nights	Verbally Email Checks that is ok in NOC	NOC-email "being present"	Fine
5.	Request for help	When needed	Verbally Email	NOC-email	Fine
6.	Create 24 hours cover	4 on, 4 off / months in advance	Look on schedule Information from workers	Excel	Fine
7.	Ok! Closing	When needed	Verbally by phone Email	NOC-email	Fine
8.	Field Maintenance	Scheduled When needed	Go to site	Trentest (check equipment)	Fine
9.	Calling for help; pass on	When needed	Verbally by phone Email	NOC-email	Fine
10.	Configuration & Data	During day	Direct communication with switches	AXE 10	Seems to be ok
11.	2nd Level Support	All the time	Verbally Email Communicate with switches (Go on site)	NOC email AXE 10 WinFiol Suitable HW	Ok – Respond quickly
12.	Verbal request	When needed	Because of small network => all in 1 room		
13.	Effectively	All the time	According to SLA	All the above	Ok
14.	Corporate activities	When needed	Need a hand with something Knowledge not "in the house" Back/forth communication. Test while field worker's still on site	Phone Email Remedy	Ok – Quick response

LINKS:	
1 → 5 → Daten Park →14 → 13	General Alarm need from Daten Park
1 → 9 → 8 → 13	Site work needed on Alarm
1 → 12 → 11 → 7 → 1 → 13	2nd Level Support needed on Alarm
1 → 2 → 10 → 2 → 1 → 13	Configuration & Data needed on Alarm
3 → 1 → 2 → 10 → 2 → 1 → 13 → 1 → 7 → 1 → 13	Customer gives work order for Surveillance
1 → 5 → 4 → 5 → 1	Help need form NOC
4 → 6 → 1 4 → 6 → 10 4 → 6 → 11	Create cover work cover
11 → 8 →13	2nd Level need field work done

Table 3 Matrix of Network Surveillance

	Activity	Exists when	How is it done	Support	Comments
1.	Log fault / Start trouble ticket (TT)	When needed	If fault happens or customer requests	Remedy	Ok
2.	Routine Maintenance	Day-to-day	By entering commands just check the switches	AXE 10	Ok
3.	Emergency Procedures	In event of emergency	Switch crashed use commands following routine procedures	AXE 10 Email Verbally Electronic doc.	Ok Easy to follow
4.	Verbal escalation	When needed	Verbal Email	NOC Email	Fine
5.	Need met Provide effective & timely	All the time	In accordance with the SLA	All the support of NOC	Fine

6.	Work order	When needed	Email Phone TT-number is given as ref.	NOC-Email Remedy	Tine Field people raise their own
7.	Test to see if problem ok	When needed, after contact	Communicate with switches	AXE 10	Generally sorted
8.	Open logfile	When needed	Open via – special site with NOC details	Intranet / Netscape	Easy to follow
9.	Close TT	When solution is found	Close TT	Remedy	When fault is resolved
10.	Real-time Surveillance	All the time	Monitoring incoming alarms on screen in real-time	XMATE AXE 10 (direct)	Real-time not always; sometimes not show clear; doesn't show certain alarms; shows lot of rubbish that's not there at all
11.	Communication with customer	When needed	Verbally Email	Email SPOC	Ok
12.	Agreed for closure	After solution tested ok	Verbally Email	Email SPOC	Ok
13.	Acknowledge alarm	When needed	Without or with acknowledge TT	XMATE Remedy	Ok

LINKS:	
13 → 10 → 1 → 2 → 1 → 9 → 5	General Alarm
13 → 10 → 1 → 6 → on site → 7 → 1 → 9 → 5	More technical Alarms, site visit needed
11 → 10 →1 → 10 → 1 → 12 → 1 → 9	Customer rings up with problem on site
11 → 10 → 1 → 2 → 8 → 2 → 1 → 9 → 5	Customer request concerning general routine problems
6 → 8 → 1 → 2 → 1 → 10 → 11 → 12 → 1 → 9 → 5	General works order from customer
6 → 8 → 1 → 4 → Op. Support → 7 → 1 → 12 → 1 → 9 → 5	Works order from customer for more complicated problems
13 → 10 → 1 → 3 → 4 → Daten Park → 7 → 1 → 9 → 5	Emergency procedure

Table 4 Matrix of Real-Time Surveillance

	Activity	Exists when	How is it done	Support	Comments
1.	Monitoring	All the time	Screening alarms Choosing alarms	XMATE AXE 10	Real-time not always; sometimes not show clear; doesn't show certain alarms; shows lot of rubbish that's not there at all
2.	Perform commands on AXE 10	When alarm to check	Typing command Document–help	AXE 10 ALEX	Easy
3.	Raise Ticket	Yes	Log on and create short ticket, keeping record	Remedy	Ok
4.	Check log file	"up to you"	Checking to see if there's any work to be done/processed	Special website	Ok
5.	Email Acknowledge	When email arrives	When hear the email coming Group NOC	NOC Email	System open at the time
6.	Need met Correct faults as they come	When needed	With all the activities: Monitor incoming alarms Check log file Raise ticket Acknowledge emails and act on them	XMATE AXE 10 Special website Remedy NOC Email	
7.	Close ticket	When solution is found	Close TT	Remedy	Ok

LINKS:	
1 → 2 → 3 → 7 → 6	Monitoring alarms
5 → 1 → 3 → 4 → 7 → 6	Incoming email sent in by customer

Table 5 Matrix of Routine Maintenance

	Activity	Exists when	How is it done	Support	Comments
1.	Check routine folders	Daily, weekly, monthly, yearly	Check on special web site or hard copy in binder near you	Website Paper Document	Ok
2.	Carry our routines	Daily, weekly, monthly, yearly	Log on to switch sending commands – routines	AXE 10	Ok
3.	Need met		With all the activities: Carry our routines Check routine folders Enter commands	Website Paper Document AXE 10	
LINKS:					
1 → 2 → 3			Normal routine maintenance		

Table 6 Matrix of 2nd Level Support - Switching

	Activity	Exists when	How is it done	Support	Comments
1.	Request received	Yes	Phone (Verbal) Email Trouble Ticket	NOC-email Remedy	Pretty much ok From Network Surveillance receive TT, info. verbally
2.	Investigate request	Yes	Documentation Reading Email Talk to people involved	Email WinFiol	Gathering information ok Dependent of experience and how thorough email is
3.	Follow OPI's (Operational Procedural Instructions)	Yes	Documentation and general fault finding	ALEX Dynatext Plexview - complx WinFiol	Testbed access would be great! Depends on experience
4.	Decision process (can 2nd level support solve it)	Yes	Make a decision, do we need help - can 2nd Level Support solve the problem or not.		Depends on experience and OPI's
5.	Add info. to trouble ticket	Yes	All along the way	Remedy	Ok The functionality is fine
6.	Make changes and test if fault is cleared	Yes	Commands Changing (goes via Field Staff) Test changes	WinFiol WinFiol / XMATE	All see on XMATE is alarms cleared or not WinFiol is ok
7.	Pass on	Yes	Email Phone Trouble ticket	Email Remedy	Ok Work order or work flow
8.	Confirmation	Yes	Email Phone Trouble ticket	Email Remedy	Ok
9.	Raise TT	Sometimes	Normally get TT via request but customer call for random checks (spot 1/10 problems) Starts investigation	WinFiol (random) Email Remedy	Ok
10.	Clear fault	Email TT		Email Remedy	Ok
11.	Close TT	TT	Close it in TT	Remedy	Ok
LINKS:					
1 → 2 → 5 → 2 → 3 → 5 →3 → 4 →5 → 4 →6 → 8 → 10 → 11			Fix request directly		
1 → 9 → 2 → 3 → 5 → 3 → 4 → 5 → 4 → 6 → 8 → 10 → 11			Fix request / start TT directly		
… 4 → 7 → 4 → 6 → 8 → 10 → 11			Request fixed through other party		
… 4 → 7 → 4 → 6 → 8 → 10 → 2 → **…**			Request NOT fixed entirely through other party → new loop		

Table 7 Matrix of 2nd Level Support - Configuration & Data

	Activity	Exists when	How is it done	Support	Comments
1.	Receive request from NOC	Constantly, mainly day but CUSTOMER TWO nights.	Email + TT Number + Attachment	NOC Email → All personnel receive all jobs.	E-mail works perfectly Format good Better if it was structured by importance
2.	Open / save attachment	Constantly, mainly day but CUSTOMER TWO nights.	Save on LAN under customer: CUSTOMER ONE; CUSTOMER TWO	Shared drive Excel; Word	If there is a mistake, it's theirs. Already exist. Copy / paste work
3.	Build data file	Constantly, mainly day but CUSTOMER TWO nights.	CUSTOMER ONE mostly copy & paste CUSTOMER TWO build manually the routing cases	WinFiol	Impressed by WinFiol Has got limitations, buffer size could be larger, does what it's meant to do. Switches keep logging off, switch inactive, when load switch caused by FIREWALL. BIG PROBLEM! Contact them! – Causing few hick-ups!
4.	Log on to switch	Constantly, mainly day but CUSTOMER TWO nights.	Know from request witch one.	WinFiol	Impressed by WinFiol Has got limitations, buffer size could be larger, does what it's meant to do.
5.	Load files	Constantly, mainly day but CUSTOMER TWO nights.	Highlight everything, press arrow = all done	WinFiol	Impressed by WinFiol Has got limitations, buffer size could be larger, does what it's meant to do.
6.	Save log file	Constantly, mainly day but CUSTOMER TWO nights.	WinFiol allows you to save file directly on LAN / customers	WinFiol	Direct log file to LAN easy – all done
7.	Test and Verify	Constantly mainly day but CUSTOMER TWO nights.	Log on to switch and make a few tests or phone directly, only CUSTOMER ONE	AXE 10 Phone	Dial # 08 number to see if it goes to the call centre
8.	Update routing record		Mainly with CUSTOMER TWO, using new carriers and routes. Know what's in service	NOC-Homepage Internally	Keeping record
9.	Forward mail to NOC		Email got TT number in it and lines of data.	NOC-email	Lines of data used for billing customer.
10.	Help request for 2nd Level	Only if test runs bad / or data doesn't load	Switch problem Verbal request		Due to fact of network size
11.	Receive ok from 2nd Level		Tell that all ok		

LINKS:	
1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9	Normal
1 → 2 → 3 → 4 → 5 → 6 → 7 → 10 → 2nd Level → 11 → 7 → 8 → 9	Switch problem, data doesn't load

3.4.2 TTF-Questionnaire

The aim of the questionnaire is to strengthen the sociotechnical approach of investigating into the problem situation. The sociotechnical approach requires a comprehensive picture of what tasks are performed, and in so doing, what technical support is needed. The questionnaire is designed to capture how the existing OSS is perceived by the users, and how it fits with the tasks being performed. It is an attempt to connect the activities, the social aspect, with the existing computer system, the technology (the OSS). Some of the questions are concerned with how the quality, usability, reliability of the computer system is perceived. Other questions are more directed at the tasks and how dependent they are of the computer system. General questions of how long the respondent have been working on the current job, as well as in the telecommunications field, were also included in the questionnaire. These are means to try to see if there is any connection between them and the attitudes on system use.

Unfortunately, the number of questionnaires that were answered is very low, only 6 were returned out of the 20 that were distributed. Even 20 are a low quantity of questionnaires, but ETL NOC does not have more employees at the moment. As a consequence, the empirical results might not be all that representative of a typical Telecom Operator. But since the focus of this master thesis is not on the empirical results, as much as on how the model of STSSM performed, the 6 questionnaires will provide an adequate base for both proposing areas that would benefit from improvements, and discussing the performance of the model. The results of the questionnaires will be presented in accordance to its component parts.

3.4.2.1 Part A. Task Technology Fit Measures

The Task Technology Fit captures how well technology functionality matches or fits the needs of the task being performed. The computer system has to include characteristics that support its ability to satisfy stated and implied needs of the user. It also includes assessment of such use, which encompasses whether the software is understood, learned, used and liked by the user, when used under particular circumstances. The questions were constructed around eight factors. The first five factors focused on meeting task needs for using data in decision making. The fifth also focused on meeting the operational day-to-day needs, as did the next two factors. The last factor focused on responding to the relationship between the NOC and the supplier of the computer system.

The results from the questionnaire were first assembled in a tabular form (see Appendix 10). This way of assembling the responses demonstrates the distribution of the individual questions. It might be interesting to see what particular questionnaire is connected to the extremes of those who ‘strongly disagree’ with a statement/question and those who ‘strongly agree’. The questionnaire is used as a base for the table so that it will be easier to locate a specific questionnaire amongst all the other. Once the particular questionnaire is located, it is possible to see what system this specific respondent is using. Another connection that can be drawn is if the experience of the respondent has any effect on the perception.

The diagrams of part A. are generally composed of a category axis (X) that displays one factor (of eight in total) and its dimensions. The factor, e.g. ‘QUALITY’, is the average of the responses to the dimensions. These dimensions, e.g. ‘Currency’, ‘Right Data’ and ‘Right Level of Detail’, are in turn the average of the responses to the dimensional-questions. The value axis (Y) displays the amount of responses for each factor/dimension. For those factors that are only made up of a single dimension, the diagram will only display the factor (since they are one and the same).

3.4.2.1.1 Quality

The first factor of the Task Technology Fit is that of ‘Quality’. In order to measure the quality of the computer system, three dimensions have to be evaluated. The dimension of ‘Currency’ concerns whether the data is current enough to meet the task needs. The dimension of ‘Right Data’ is a matter of maintaining the necessary fields or elements of data. The last dimension concerns whether the level of detail is an appropriate level. This dimension is called the 'Right Level of Detail'.

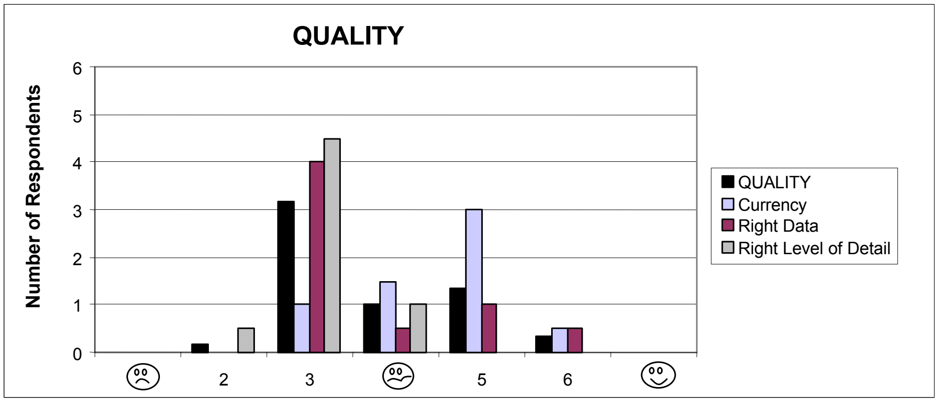


Figure 21 *The results for the Quality factor, and its dimensions.*

Figure 21 shows that the quality is perceived to be somewhat low, with the dimensions of 'Right Level of Detail' and 'Right Data' pulling down the attitude towards the overall quality. Both 1st and 2nd Level Support (including the respondent with the 'Network Intelligence Engineers' and the 'Network Support Engineer' position at the NOC, see section 3.4.2.5) seems to believe that the OSS do not maintain data with a level of detail that is appropriate for them to perform their tasks. There seems to be an overall negative attitude towards the data of the network elements provided by the OSS. The general opinion of whether the OSS is missing critical data to perform the tasks seems to be low. Only one out of six respondents is satisfied with the available data. On the other hand, the data is in general believed to be current enough to meet the needs of the user.

3.4.2.1.2 Locatability

The second factor of the Task Technology Fit is that of 'Locatability'. In order to measure the locatability of the computer system, two dimensions have to be evaluated. The dimension of 'Locatability' concerns the availability of the data, and how easy it is to locate it. The second dimension that of 'Meaning', is a matter of determining what data elements in the OSS means.

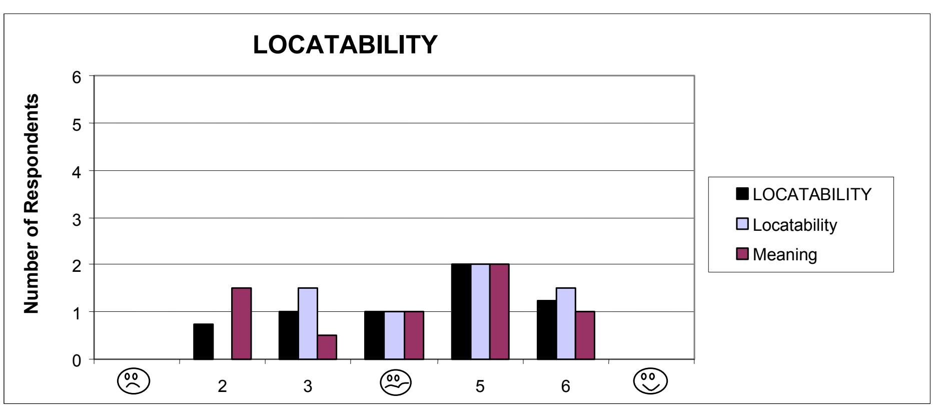


Figure 22 *The results for the Locatability factor, and its dimensions.*

The factor 'Locatability' of the data supplied by the OSS is very scattered in the diagram of figure 22, although it is leaning towards a positive attitude. The distinction between the two dimensions can be said to be that locatability seems to be a little bit better than the meaning of the data. Ergo, the data is easy to find in the OSS, but it is not always self-evident what the data means.

3.4.2.1.3 Authorization

The third factor of the Task Technology Fit is that of 'Authorization'. This factor is made up of a single dimension, and that is for evaluating if the user feels that his/her authorization is adequate for the data needed to perform the task. It also involves whether it is perceived to be easy to get the authorization that the respondent needs for doing the tasks.

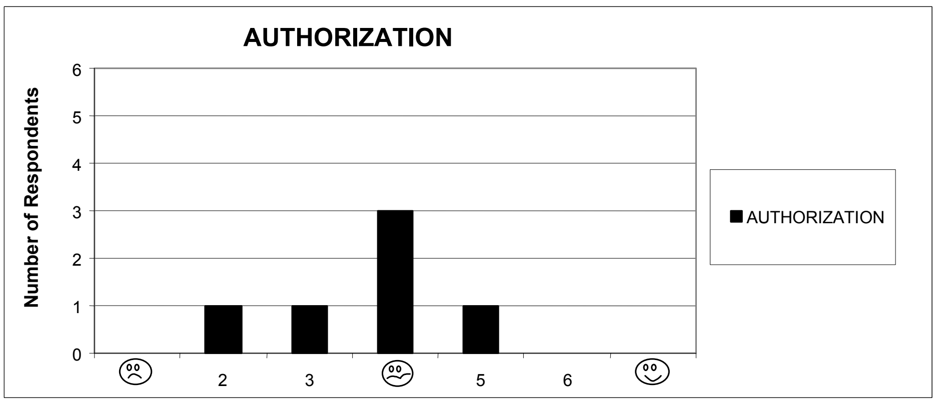


Figure23 *The results for the Authorization factor, and its dimensions.*

The authorization factor, in figure 23, seems not to be an issue of importance since the majority does not seem to have spent a lot of time reflecting whether their authorization is affecting the availability of the data they need for performing their tasks. When consulting the specific questionnaires, it is revealed that the respondent with the most negative attitude (rating 2 in the diagram) has the position of 2nd Line Support. The respondent has been working 23 years in the field in which the last year at ETL NOC. The negative attitude might be a cause of the respondent having more authority in previous jobs and comparing these to the authority he/she has at the NOC.

3.4.2.1.4 Compatibility

The fourth factor of the Task Technology Fit is that of 'Compatibility'. This factor is also made up of a single dimension, and that is to evaluate if the user feels that data from different sources can be consolidated or compared without inconsistencies.

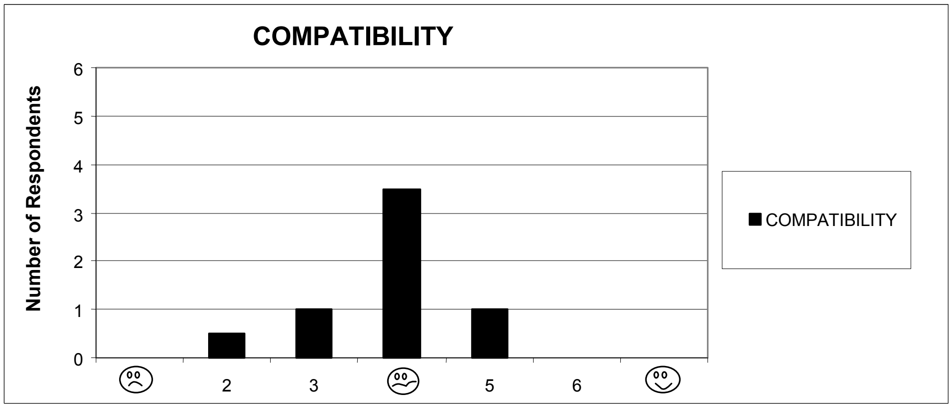


Figure 24 *The results for the Compatibility factor, and its dimensions.*

The conclusion that can be drawn from figure 24 is that the major part of the respondents does not have a particular opinion of the compatibility of data, with the exception of a single respondent. Looking at this particular respondent's questionnaire, no conclusion can be drawn from his/her experience (2 years in the field, with 6 months at the NOC). The job is in Network Surveillance and this does not seem to have a real bearing on the answer.

3.4.2.1.5 Usability / Training

The fifth factor of the Task Technology Fit is that of 'Usability and Training'. In order to measure this factor of the computer system two dimensions have to be evaluated. The dimension of 'Hardware & Software Usability' concerns the ease of doing what the task require, using the system hardware and software for submitting, accessing and analyzing data. The characteristic of usability have been broken down into the lower levels of understandability, learnability, operability, explicitness, customizability, clarity, helpfulness, and user-friendliness. The second dimension, that of 'Training' is a matter of whether the respondent feels that he/she is getting quality computer-related training when needed.

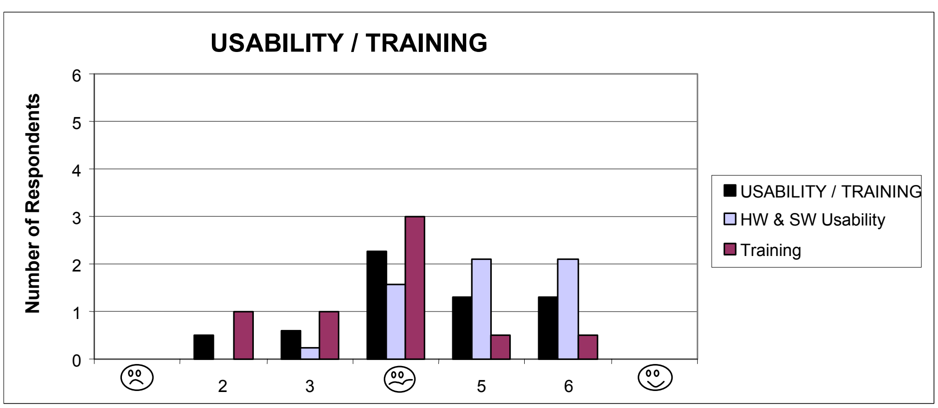


Figure 25 *The results for the Usability/Training factor, and its dimensions.*

The diagram in figure 25 suggests that the hardware & software usability of the OSS is believed to be really good, but that the 'Training' dimension could be improved. Although the majority does not seem to have formed any specific opinion on the training aspect, those that do – seems to feel that the training on the systems can be better or more frequent to better fit their task requirement. No particular conclusion can be drawn from the extremes by looking at the specific questionnaires.

3.4.2.1.6 Production Timeliness

The sixth factor of the Task Technology Fit, is that of 'Production Timeliness'. This factor is made up of a single dimension, and that is to evaluate if the user feels that the OSS is performing scheduled activities.

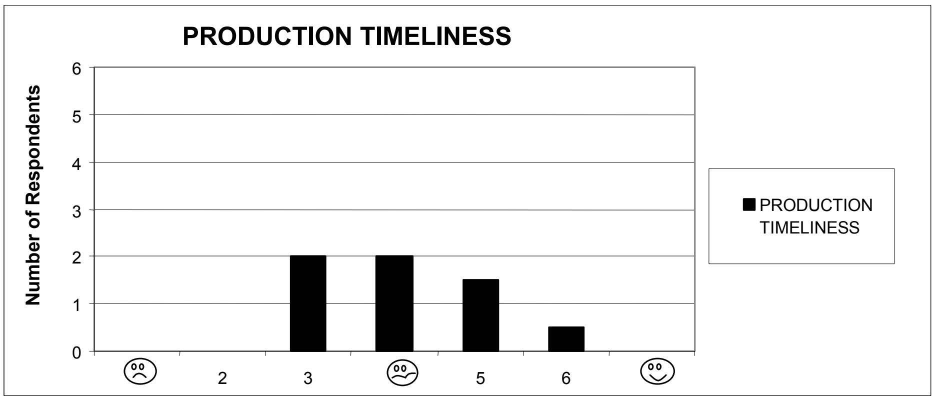


Figure 26 *The results for the Production Timeliness factor, and its dimensions.*

Figure 26 reveals that the opinion of the factor 'Production Timeliness' seems to be concentrated around no specific attitude towards the scheduled activities of the OSS. This might be because the respondents do not really schedule any events for the OSS to perform. No specific conclusion could be drawn about the respondents with the positive attitude when looking at the specific questionnaires.

3.4.2.1.7 Systems Reliability

The seventh factor of the Task Technology Fit is that of 'Systems Reliability'. This factor is composed of a single dimension, and that is to evaluate if the user feels that the OSS is reliable. It is matter of dependability and consistency of access and uptime of the system.

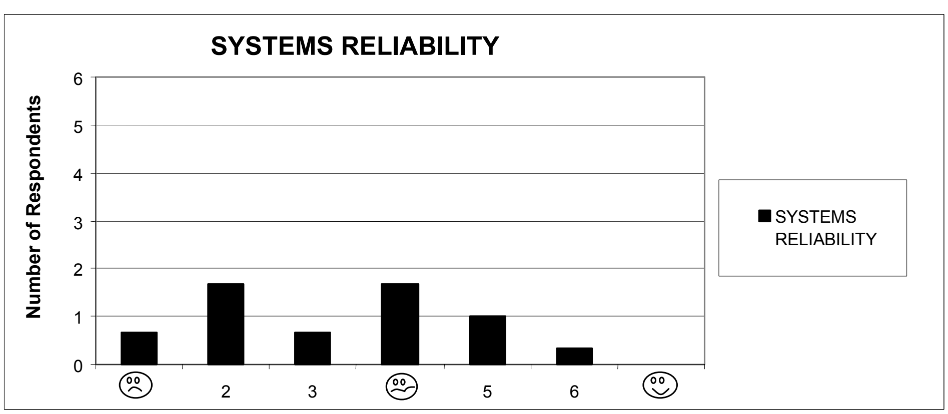


Figure 27 *The results for the Systems Reliability factor, and its dimensions.*

Since the systems reliability factor of figure 27 is connected to what applications the respondent is using, we felt it necessary to include what those are, and also connect the respondent to a task (function area of the NOC). Those respondents, who rated the systems reliability negatively, work in the function area and use the applications of the OSS as shown in table 8.

Table 8 The function area and application dependency of the 'negative attitudes'

Function Area:	Very dependent on:	Somewhat dependent on:
2nd Level Support	WinFiol	Graphical Alarm, Command Handling, MCT, PS, ISM Alarm, ISM Monitor
1st Level Support	WinFiol, ISM Alarm, ISM Monitor	MCT
1st Level Support	WinFiol, Graphical Alarm, Log Manager	ISM Alarm, ISM Monitor

Although the negative attitudes concern the systems in table 8, it does not seem to be WinFiol that is the least reliable. Looking at all of the questionnaires, it is revealed that those who have a positive attitude towards the reliability of the systems in general, are not very dependent on ISM Alarm and ISM Monitor. The conclusion is therefore that it is those applications that seem to be the least reliable of the OSS.

3.4.2.1.8 Relationship with Users

The last factor of the Task Technology Fit is that of ‘Relationship with Users’. In order to measure this factor of the computer system, five dimensions have to be evaluated. These concern the relationship between the supplier of the computer system and the user of the same. The dimension of ‘Understanding of Business’ is a matter of how good an understanding the supplier of the OSS has of the NOC business, and has developed the OSS accordingly. The second dimension, that of ‘Interest and Dedication’, is a matter of the interest and dedication the OSS-supplier seems to have of supporting the NOC business needs. The dimension of ‘Responsiveness’ concerns the request handling of the supplier. The fourth dimension, ‘Consulting’, is a matter of the availability and quality of the technical assistance the supplier provides. The final dimension, ‘IS Performance’, is that of how well the OSS-supplier keep their agreements with the NOC.

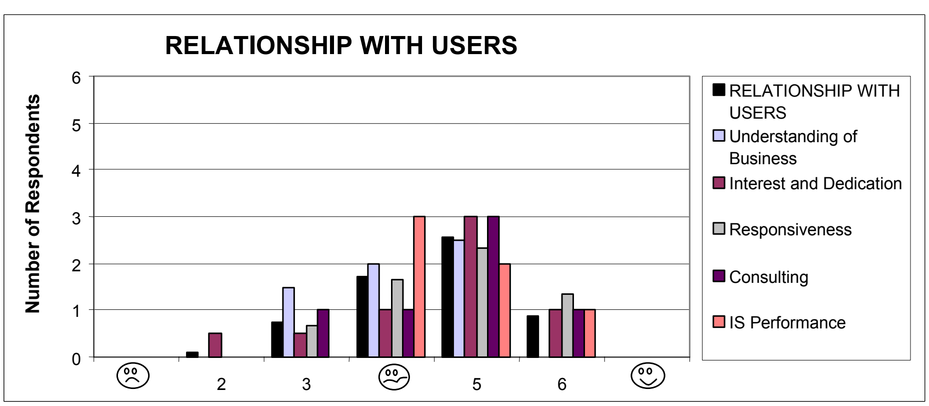


Figure 28 *The results for the Relationship with users factor, and its dimensions.*

Figure 28 suggests that the opinion of the relationship between the supplier of the OSS and the NOC seems to be mainly a positive attitude. No specific conclusions could be drawn when trying to connect the attitude with the experience of the respondents.

3.4.2.1.9 Task Technology Fit Measures

Task Technology Fit captures how well technology functionality matches or fits the needs of the task being performed. The eight factors that are used to measure fit have been separately discussed above. In order to see the whole picture of how the Task Technology Fit is perceived in ETL NOC, all factors are assembled in Figure 29.

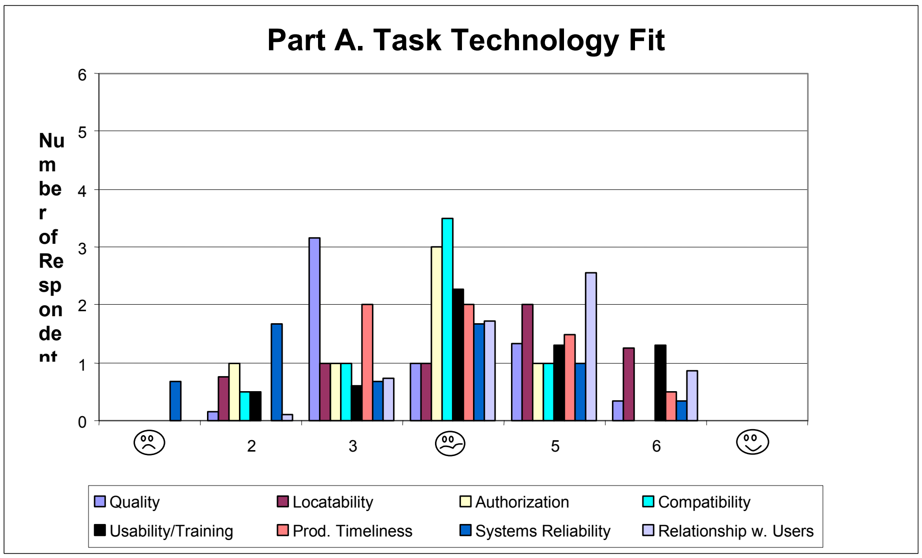


Figure 29 *The Task Technology Fit of ETL NOC.*

To be able to measure the fit, questions of the questionnaire were constructed around eight factors, where the first five ('Quality', 'Locatability', 'Authorization', 'Compatibility', and 'Usability/Training') factors focused on meeting task needs for using data in decision making. The fifth also focused on meeting the operational day-to-day needs, as did the next two factors ('Production Timeliness' and 'Systems Reliability'). The last factor ('Relationship with Users') focused on responding to changed business needs.

The factor that seems to be received with the most positive attitude is the relationship between the supplier and user of the OSS. This was quite surprising, since the discussions around the problem situation at the NOC revealed a few negative remarks on the dealings with the supplier of the OSS (see section 3.4.1.3). The overall quality of the OSS does rate somewhat low, depending on the negative attitude of the respondents concerning the level of detail and accuracy of the data maintained by the OSS. The data is relatively easy to locate in the OSS, but it is not always clear what the meaning is. For the factors of 'Authorization' and 'Currency' there seems to be little reflection on how much effect the authorization has on what data is available to the respondent, and how compatible the data from the different network elements are. The usability of the OSS is rated quite high while the training can be improved, which makes the factor of 'Usability/Training' to be rated quite positively. The factor of 'Production Timeliness' seems to imply that the respondents have no specific attitude towards the scheduled activities of the OSS. 'Systems Reliability' is the factor that is the most scattered in the diagram. The applications 'ISM Alarm' and 'ISM Monitor' seem to be the reason for this unreliability (see section 3.4.1.1.7).

3.4.2.2 Part B. Task/Job Characteristics Measures

Part B. of the TTF-questionnaire concern questions of task characteristics. The dimension of 'Task Equivocality' is to find out how vague the task performed is. The dimension of 'Task Interdependence' concerns how dependent the tasks the respondents perform are of other functions of the NOC. The dimension of 'Task Function Area' concerns the very nature of the task and to what function area of the NOC it belongs.

Table 9 Task Equivocality

	Strongly disagree			Neither agree/ disagree			Strongly agree
I frequently deal with well-defined, routine problems.					3	3	
I frequently deal with ad-hoc, non-routine problems.					4	2	
Frequently the problems that I work on involve new forms of decisions.		1	1	1	1	2	

As shown in table 9 the tasks the respondents perform are very varied. They are of both a well-defined, routine and of an ad-hoc, non-routine nature. All alarms from the network elements have to be taken care of, and these are naturally of a very diverse nature. There is also a need to perform preventative maintenance, which can be seen as very routine work. The nature of the decisions taken seems to be more varied.

Table 10 Task Interdependence

	Strongly disagree			Neither agree/ disagree			Strongly agree
The problems I deal with frequently involve more than one business function.			1		3	2	
The problems I deal with are not dependent of any other business function.	1	1	1	3			
A major part of the problems I deal with are frequently escalated to another level of decision-makers.			3	1	1	1	
A minor part of the problems I deal with are frequently escalated to another level of decision-makers.		1	2	1	2		

Table 10 shows how the respondents rated the questions concerning how dependent their tasks are of other function areas of the NOC. In general the function areas involve a lot of interaction between levels. The responses to the escalation questions are quite spread out, which is probably a direct result from the varied nature of the problems (as shown in table 9). When the respondent is unable to resolve a problem in due time, it is to be escalated to the next level of network support.

Table 11 Function Area

	Strongly disagree			Neither agree/ disagree			Strongly agree
The tasks I perform involve fault recognition, fault isolation, fault reporting and logging.	1				1	1	3
The tasks I perform involve installation of network equipment, setting of states and parameters and configuration of network capacity.	1	1	2	1	1		
The tasks I perform involve collection, buffering and delivery of operating statistics; network optimization according to the operating statistics received.		2		2	2		
The tasks I perform involve collection, buffering and delivery of charging and accounting information.		2	1	1	1		1
The tasks I perform involve administration of authorization functions, handling of simultaneous use of an OSS, protection against intrusion.	1	2	1		1	1	

Independent of what support level the respondent belongs to, the task of monitoring alarms is an essential aspect of the NOC, as shown in the first question of table 11. In general it seems that the respondents seldom go on site installing new equipment. Comparing the results of the table to the individual questionnaires, there is no real surprise to see that the job title the respondents have named, more or less coincides with the rating of the function areas.

3.4.2.3 Part C. Individual Performance Measures

In Part C. of the TTF-questionnaire the respondents were asked what impact the computer system (the OSS) and surrounding services have on the effectiveness, productivity, and performance of their job. The responses to the questions concerning these issues are presented in table 12.

Table 12 Performance Impact of Computer Systems & Services

	Strongly disagree			Neither agree/ disagree			Strongly agree
The operation support system has a large, positive impact on my effectiveness and productivity in my job.		1		1	2	1	1
The operation support system and the services surrounding it are an important and valuable aid to me in the performance of my job.		2			2	1	1
I feel that the knowledge I have on the operation support system is sufficient to have a positive impact on my job performance.	1	1		1	1	1	1

The negative responses are revealed to come from two individuals, when comparing these to the specific questionnaires. One of them has only worked at the NOC for 6 weeks, and the responses might reflect the inexperience of using the systems. The other respondent answered ‘Network Support Engineer’ on the question of job title, a title that can in principle mean that the respondent works in either 1^{st} or 2^{nd} level support. Not being able to determine to what function area the respondent belongs, makes it difficult to draw any conclusions as to how dependent the respondent is of the OSS connected to performance.

3.4.2.4 Part D. Utilization of the Computer System

Part D. is a matter of determining how dependent the respondents are to the different computer system applications in their work-routines. The diagram in figure 30 shows the degree of dependency of the applications.

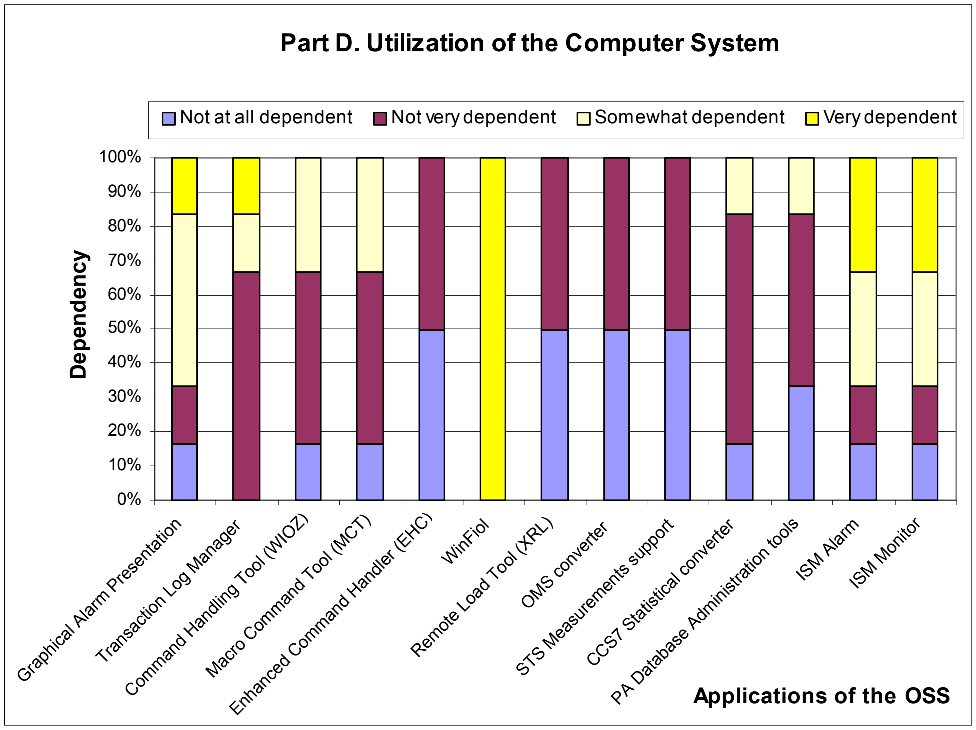


Figure 30 *The utilization of the OSS at ETL NOC.*

All respondents are very dependent on the application WinFiol in their work-routines. The applications of ‘Enhanced Command Handler (EHC)’, ‘Remote Load Tool (XRL)’, ‘OMS Converter’, and ‘STS Measurements support’ are rated 50-50% between not at all dependent and not very dependent. In general, the dependencies of the applications depend on the nature of the problem, and all applications are used one way or another.

3.4.2.5 Part E. General Questions

Part E. of the questionnaire is a base for placing the responses into context. For instance asking questions of what type of job the respondents have in the organization. The question of experience is an attempt to see if the number of years on the job at the NOC and working in the telecommunications field has had an effect on the way that the computer system is rated. The five questions and responses of the general questions is presented below:

What is your position within your company? (Employment, Title, Responsibility etc.)

The responses for what the respondent’s position within ETL NOC is varied a little bit more than was expected. The responses were Network Surveillance, Network Surveillance Engineer, Network Intelligence Engineer, 2nd Line Support Engineer, 2nd Line Support, and Network Support Engineer

When the question was written, it was in an attempt to figure out what types of tasks were connected to the rest of the questionnaire. We thought that the respondents answer could easily be connected to what function area they are working in, but there can be no such clear distinction made from all the alternatives presented by the respondents. For instance, the title of 'Network Intelligence Engineer' cannot, in our opinion, be classified explicitly to belong to either 1st or 2nd Level Support.

Number of years on current job:
The responses for how long the respondent have been working on the current job varied between, 6 weeks, 6 months, 1 year (3 respondents), and up to 2 years.

All respondents seem to be fairly new at the current position in ETL NOC. The respondent who has only been employed 6 weeks on the current job places his/her answers mostly in the middle, with no real opinion on the Task Technology Fit. For the rest of the respondents it is difficult to draw any conclusions to whether the respondents who worked 'longer' at the current position have a more positive attitude towards the Task Technology Fit. The difference in experience is not that wide between one year on the job compared to 6 months.

Number of years in the Telecom field:
5 years, 2 years, 9 years, 12 years, 23 years, 21 years

The years of experience seems to have a bearing on the respondent's individual answers to the specific questions, but cannot be generalized.

What would you consider a reasonable price for a service from the system supplier?
Only one respondent answered this question, and he/she found £ 40/hour to be a fair price.

Anything that you would like add?
None answered this question.

3.4.3 Proposing areas for improvements

The basic idea of the STSSM model is to make improvements in the problem situation. Since we do not have the authority to actively introduce any changes, we can only propose areas in which change might be beneficial in the problem situation. These proposed areas of change, as well as the material presented above, might serve as a base for discussion between Ericsson and the ETL NOC. Any action to be taken in the problem situation is something that needs to be an issue between the two parties involved.

Comparing all the results presented above, we found four areas in which changes might lead to improvements in the problem situation: the application WinFiol; the reliability of XMATE (ISM Alarm and ISM Monitor); training; and relationship between Ericsson and ETL NOC.

The most serious area of concern is the application WinFiol, which in general is perceived in a positive light. During the interview with a representative of Configuration & Data function, it was revealed that there is a problem with the loading of files onto the switches. When loading files, the switches keep logging off. It seems that the systems perceives the switch as being inactive, and turn off the connection. The files are not destroyed, but this is causing a few 'hick-ups' for the 'Configuration & Data – guy'. When logging on to a switch, the switch is locked for others and a copy of that switch is loaded at the NOC. It is this copy that is used for building the data file. If the switch is logged off, someone else can access the switch and load new data on it, making the copy at the NOC outdated. This would cause a problem with the loading of the new data file. This problem with WinFiol did not exist before the installation of the firewall, some time back.

The NOC seems to have a reliability issue with the base systems. The observation revealed that they do not seem to trust XMATE to show the alarms in real-time. Sometimes the application does not show the 'clears' (when a fault has been fixed). Occasionally the data is not reliable, since certain alarms that have been established to exist, by direct communication with a switch, are not included in the alarm list. XMATE have also been known to display data that do not exist at all. This issue was confirmed in the responses of the questionnaire, where it was revealed that those who have a positive attitude towards the reliability of the systems in general, are not very dependent on ISM Alarm and ISM Monitor (those applications usually referred to as XMATE). Those who are dependent on these applications, revealed a negative attitude towards systems reliability. There is also a concern that the OSS does not maintain data with a level of detail that is appropriate to perform the tasks and that critical data for performing the tasks is missing occasionally.

The training aspect is an area with possibilities for improvements. Software upgrades can be the cause of problems, since it is difficult to train all employees and running the network simultaneously. Since the NOC is running networks for other parties, the training on new software will be performed parallel with the day-to-day operations. It might take some time before the new software is assimilated into the work processes and everything is working smoothly. At the moment, the NOC basically rely on human-interface to cover up either the shortfalls of the system or the way that the system is not used as it should. Although the majority of the NOC do not seem to have strong opinions on the training aspect, those that do – seems to feel that the systems training can be both improved and more frequent.

The relationship between ETL NOC and Ericsson is an issue of diverse meaning within the NOC. During the discussion around the Rich Picture, it was revealed that the NOC have a system legacy problem with the equipment inherited from Sweden. Although the circumstances have improved, it still seems to be an uncertainty as to what part of Ericsson the NOC is to turn to whenever there is an equipment problem. When help do arrive for software problem or upgrades, the 'Ericsson people will put something on to cure the fault'. Although the problem is explained, the explanation is not enough to create a feeling of safety. This perception of the relationship between the

NOC and Ericsson was not corroborated in the responses of the questionnaire, where the general opinion is leaning towards a positive attitude. Improving the communication between the parties in the problem situation can only be beneficial.

4 Discussion

The main purpose of this master thesis was to explore how the Soft Systems Methodology (SSM) could be complemented by Task Technology Fit (TTF), and how appropriate this modified version of SSM is, in the type of problem situation Ericsson is facing, as described in the introduction section. The complementing of the methodology was done theoretically (in the first part of the result section) and the resulting model is called the SocioTechnical Soft Systems Methodology (STSSM). In order to evaluate the appropriateness for the situation, a major part of the model was tested in a Case Study at ETL NOC. The model itself requires that it is performed in real life, and the only way to assess if it was an appropriate model of inquiry in this type of situation, was to actually go through some of the activities in a real situation.

Due to the recent events in the Telecom market, the Telecom Operator we were able to contact cannot be classified as a typical one. ETL NOC is a part of the Ericsson organization and provides other Telecom Operators with the service of managing their networks. This was not an ideal base for this study; the empirical results would have been more optimal if the subject (case) had managed its own network. We did try for months to engage other Telecom Operators in the investigation, but we did not get any results. One reason could have been that due to the present state of the market, they did not whish for any one to look into their organization. We approached them through Ericsson and this probably added to their concerns. However, though the case of ETL NOC might not have been the ideal case, we felt that we would produce enough material for our evaluation of the appropriateness of STSSM.

For the Case Study we had only three days available to perform the workshop/interviews to test parts of the model of STSSM. It might have given an even deeper insight into the problem situation if we had more days to our disposal, but we felt that we would be able to produce enough material during these days in order to evaluate our model.

We had a bit of bad luck as to the quantities of questionnaires returned to us. After distributing twenty copies, we were only able to collect six on departure. We were promised that the remaining questionnaires would be mailed to us, so we held off the analysis of the questionnaire for quite some time. The waiting was prolonged by the repeated promise that the questionnaires would be sent to us. Due to lack of time we finally had to perform the analysis on the questionnaires available to us, lessening the quantitative aspect of the empirical material.

Any written down description of a Case Study will be defenseless against comments, which implies that it could have been done better, more accurate, or that some other approach would have been more effective. But the intention of the Case Study was to illustrate the usefulness of the model of STSSM by means of describing the resulting material of the process (both in writing and pictorial representation). This description is an attempt to communicate something of the experience gained by performing the study, although the experience is by far richer than any description of it can ever be.

The description as well as the experience gained by going through some of the activities of STSSM, is to serve as a base for evaluating the appropriateness of the model.

4.1 The appropriateness of the model of STSSM

To *fully* evaluate the appropriateness of an approach taken, all steps of the methodology ought to be performed, and all parties would have to come to an agreement as to the outcome. Wilson (p. 85) has eloquently pointed out the essence of deciding on a methodology's appropriateness in the following statement:

> All that can be asked is, 'Was the methodology appropriate for that analyst in that situation?' The answer is, yes, if individuals concerned in the situation agree that a useful outcome was achieved.

It is not possible for us to say that the model is 100% appropriate for this situation, since it is the parties involved in the situation that will have to complete the activities leading to improvements. This would entail taking action in the situation. Only then can the parties agree on whether it was an appropriate model or not. Until then, all we can do is to communicate our opinion of the appropriateness of the model in this type of situation, based on our experience of using STSSM in the Case Study of ETL NOC and following it up at Ericsson.

We believe the model to be appropriate for this situation since it involves both a qualitative and a quantitative method. The first part of the model created an extensive understanding of the situation and models of human activity systems that represented a limited group's opinion. This part of the investigation was also a combination of both the suppliers' (represented by our accumulated knowledge on Ericsson) and the users (the NOC) combined worldview. Since we, as analysts, were a part of the investigation, our experience and knowledge guided the discussion/interviews of the investigation. The worldview of the user is given in the way they interpreted the situation when discussing the circumstances around the way they work. It was also the first part of the investigation that most time was spent on, in order to cover most aspects of the situation. The second part of the investigation, the questionnaire, is a method for gathering the opinions of the many. We, as analysts, are not a part in this inquiry and therefore the responses were not guided in any direction. Thus, the questionnaire collected the perception on the situation solely based of the user of the system. The fact that the questionnaire is anonymous, provided means for gathering the respondent's honest opinion without the constraints of management 'looking over their shoulder' or leading the opinion in one direction or another. An example of the quantitative method complementing the results from the qualitative method is the fact that some issues revealed, when performing the activities of the first part of the model, were either confirmed or disputed by the results from the questionnaire. For instance the unreliability of the applications 'ISM Alarm' and 'ISM Monitor' (referred to as XMATE at the NOC), was stated in the observation, rich picture and model building. This was later confirmed by the responses of the questionnaire. The negative statements made about the relationship with the supplier in the discussion surrounding the rich picture, was not confirmed by the questionnaire. On the contrary, the major part of the respondents was leaning towards a positive attitude.

Not all customers are willing to pay extra for the changes an investigation might lead up to. That is why the model of STSSM is appropriate, due to the fact that an abundance of information can be gathered during a relatively short period of time. The first part of our investigation into the NOC provided us with a rich material base in just three days. When presented at Ericsson in the follow up, they were actually very surprised at how much information and knowledge we had gathered. This leads to another factor that makes the model appropriate in this type of situation. When performing an analysis in a situation, the analyst, as a representative from the supplier organization, can by being active in the investigation and in the discussions build a comprehensive knowledge base of the circumstances of the situation based on the worldviews of both parties. This makes the model particularly suitable for situations where two different organizations are parties involved in a problem situation.

Although our Case Study only involved the activities of the model leading up to a presentation of areas for improvements in the problem situation, we still see the appropriateness of the model used in different variations of the problem situation. STSSM is a tool for finding issues within the problem area that can be improved by taking action. Since both parties of the problem situation are to be involved in the analysis, the communication and confidence between them will eventually be improved, not to mention the understanding. The Telecom Operator will be given the opportunity to learn more about what can improve their effectiveness in managing and maintaining the network. They will also be given the opportunity to make their opinions heard, as well as be given a feeling that they are part of the systems that they use. The supplier of the OSS will in turn be given an opportunity to understand their customer and how the systems are used in real life. As well as an insight to what type of needs exists in performing the task of the network operation. The investigation will provide a base for making connections between what really exists and where the situation can be improved. The improvements do not necessarily have to be an expensive technical solution.

The model is also a tool for capturing soft *and* hard issues. STSSM can be used as a base for making technological improvements in the existing computer systems, or even serve as the base for developing new computer systems that better fit the needs of the users. The model can also be used for 'softer solutions'. By investigating the circumstances of the situation and building human activity systems, the situation can be improved without having to make changes to the technology. The problem does not necessarily reside in the technology but can just as well concern the knowledge surrounding it; both in the way it is being used and the way it is being implemented. Improving the communication between the two parties in the situation, both the party that develops and implements the computer system, and the party that uses it, can only be seen as beneficial. Even in those situations where a computer system does not exist, it will be appropriate to use STSSM to investigate into the situation. The investigative part of the model, excluding the questionnaire, can create a knowledge base for how to help the Telecom

Operator structure their work processes and what OSS would provide the best means to effectively run and maintain the network.

Another benefit from using the model to investigate into a problem situation is that the gathered and documented material gives a rich insight into the specific case. This material can also be used as an aid for performing an investigation in another case. The extent of the information in the material is also so ‘communicable’ (with all the pictures, models and descriptions) that people not involved in the investigation can understand and absorb it as well. This statement was confirmed by the amount of knowledge about the situation at the NOC that we were able to communicate to our supervisors at Ericsson. This also proves another benefit of the model. By performing a number of case studies using the model, Ericsson will have an information base that can be used to analyze their customer base, the different Telecom Operators, as a group. This base can be used to investigate into the possibilities of generalizing the work processes of the Telecom Operator, and create a ‘best practice’ as to how to implement and use the OSS.

In our opinion the Case Study confirmed our unspoken assumption that, ‘yes, the model of STSSM is appropriate to use in this type of situation’, and we have tried to relay the benefits that can be gained by its use. We did however feel it necessary to suggest areas in the model that can benefit from some minor changes based on our experiences during the Case Study.

4.2 Recommendations

After testing the model of STSSM in real life we would like to recommend improvements that can be made in some areas of the model. We would also like to share our experiences from the workshop and interviews, so that improvements in the way the model was used (as described in the method section) can be done in future investigations.

4.2.1 Recommendations for improving the model of STSSM

The emblematic representation that was supposed to bridge the gap between the root definition and the model building (see section 3.3.2.2) was perceived to be more confusing that informative. It did not bring an improved understanding of neither the situation nor the pending model building, although this might be a consequence of the nature of the problem situation.

The ‘Weltanschauung’ of the CATWOE (see section 3.3.2.2) is a very confusing term. Although the concept of the German word is explained to the participants in the investigation, it still seems to be a little confusion why the English term ‘Worldview’ is not used. During the entire process of this master thesis we never fully understood the benefits of using the term ‘Weltanschauung’, since there is in our experience just as much meaning in the term ‘Worldview’, although this might not have been the case 20-30 years ago when the CATWOE was constructed.

The 7-grade rating-scale of the questionnaire gives the respondents the opportunity of not really stating an opinion by either agreeing or disagreeing with the statement/question. It would be beneficial to the analysis of the results if the responses were leaning towards a positive or negative attitude. Ergo, an even-numbered rating-scale would facilitate the analysis of the material. This would exclude the possibility for the respondent to chose ‘Neither agree/disagree’, and as such forcing the respondent to be either a bit negative or a bit positive.

Two of the terms used for the dimensions of Part A. in the questionnaire were a bit confusing to the respondents and ought to be modified. The first dimension is that of ‘Currency’. The first reaction to this term is that it has to do with money. This is not the case. This term was found in the original questionnaire where the definition is to how current the data is. It would lead to less confusion if the term were replaced with the term ‘Current Data’. The second term is that of ‘Task Equivocality’. Since it is supposed to be used for measuring the routine of the task (if the task/problem is either ad-hoc or well defined) it would be less confusing for the respondents if the term ‘Task Routines’ was used instead.

The general question (in Part E.) of what job title the respondent have in the organization ought to be in the form of a multiple choice question, instead of the free space available today. The responses were too varied to exactly match with the known function areas, making the analysis more difficult. It also made the placing of the responses into context less concise. Then again, this should not have been so surprising, since an empty line is free to be filled in accordance with the respondent’s particular worldview.

The general question (in Part E.) concerning how much the respondent would consider to be a reasonable price for services provided by a system supplier, did not give much result. A single respondent answered, although in a populace of six this might not be so representative in the big picture. Then again, the question really does not provide an insight into the Task Technology Fit, and should therefore be excluded from the questionnaire.

4.2.2 Recommendations for using the model

Lastly we would like to share some of our experiences during the Case Study and recommend issues that we felt would simplify the process of using the model of STSSM.

As part of the preparation of the Case Study we sent a brief introduction-document to our contact person at the NOC. This document was meant to serve as an introduction to Systems Thinking and the aim of our research. The introductory document was also handed out at the beginning of the workshop of creating the rich picture. It would have been better if we prior to the actual workshop gave a ‘seminar’ on Systems thinking and the model of STSSM. That way the participants would have been more accustomed to both the thinking and the terminology, as well as to the different activities of the model. A seminar would also provide an opportunity for all involved to ask questions.

Another recommendation is to make sure that the participants of the workshop include those who will take part in the following activities of creating the root definition, models and comparing them to reality. This was not the case in our study, whereas we had to start each modeling session with explaining the rich picture and the basics of STSSM. This time could have been better spent on modeling.

It proved to be irreplaceable to record every discussion and interview, both during the Case Study and afterwards. Knowing that everything would be saved on tape, gave us more freedom to just go along with the discussion, without having to worry that the information would be lost. The recording made it possible for us to describe the situation according the perceptions of the NOC, and not only our interpretation of it. The tapes were transferred to writing and can serve as an information source in the future as well as it did during the assembling of the material. The tapes can also serve as another source of information, that of improving the analysts interviewing techniques. Listening to the tapes can give the analyst an opportunity to hear in what areas that he/she can improve the way to lead the discussion.

The last recommendation for future use of STSSM is to have something that can serve as a 'kick-start' of the investigation. Coffee and cookies for instance, can be a good way to start the workshop. Taking time to get to know each other before the actual work starts, will only lead to a better result.

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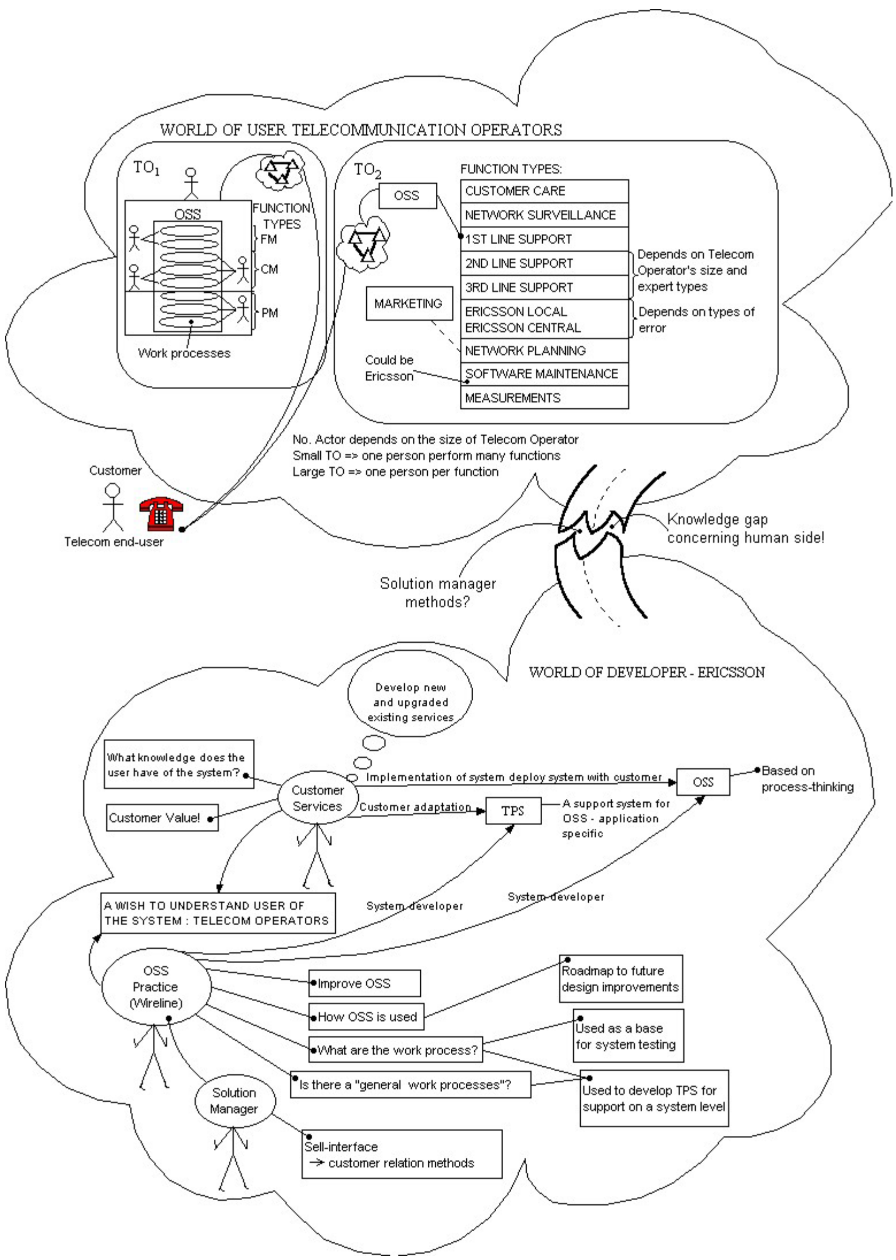
Appendices

Appendix 1 – The Rich Picture for capturing the Problem area

To be able to state the problem the method of drawing a rich picture was used to communicate our perception of Ericsson's situation: two different organizations where the knowledge-gap between them needs to be filled (symbolized by the broken bridge in the picture).



Appendix 2 – Theoretical Framework for Soft Systems Thinking

In order for future intervention in human affairs to be comprised of action as well as research, a well-defined methodological framework is needed. With this as a base, the researcher has to be flexible and let the situation lead the way as to what direction the study may take. (Checkland, 1985) Involvement in a problem situation is essential in action research. The analysts have in addition to learning about the circumstances of the situation, to be prepared to learn about the research subject of the very experience itself. In order to make these lessons possible it is utterly important to state an intellectual framework in advance. This is to be followed in the research in order to make sense of both the situation and the analyst's involvement in it. Checkland and Scholes (1990, p. 16) states that:

> It is with reference to the declared framework that 'lessons' can be defined. The action researcher thus has two hopes: that the framework will yield insights concerning the perceived problems which will lead to practical help in the situation; and that experiences of using the framework will enable it to be gradually improved.

Checkland and Scholes (p. 23) also encapsulates the very essence of systems thinking in the following paragraph:

> We engage with the world by making use of concepts whose source is our experience of the world. This process of engagement, usually unconscious as we live everyday life, can be made explicit. One way of doing so is embodies in so-called 'systems thinking', based on the idea of making use of the concept of a 'whole'.

Systems thinking can be seen as a means of understanding and explaining the complexity of the real world. Using the concept of 'systems' for thinking about and making sense of some part of the real world, opens up possibilities to discuss and debate things that might be seen as a problem situation. (Checkland, 1993; Lewis, 1994) Systems Thinking is a process of reaching a more truthful representation of the world by investigating systems and comparing them to the reality (Dahlbom & Mathiassen, 1993).

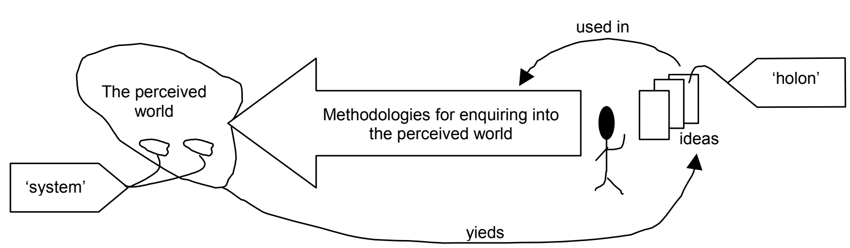


Figure 1 *The fundamentals of Systems Thinking (after Checkland & Scholes)*

The basic idea of Soft Systems thinking is demonstrated in figure 1. There are as many different perspectives of the world as there are people. The concept of systems is used as a means of inquiring into the perceived world. System ideas provide a way of thinking about any kind of problem situation. These systems are based on the concept of 'a whole', where the organization for instance can be seen as a whole. The relationship between an organization and its environment is also very important. Therefore it is imperative to look at 'the system' in terms of the wider system of which it is a part. (Avison & Fitzgerald, 1995) These systems are used as a base for discussing, and yield models of systems in the perceived world. These models are called holons and can be seen as an epistemological device for *thinking about* the world, which allows systems thinkers to explain why different interpretations of 'the problem' exist. A methodology must be developed in the systems approach to facilitate understanding perspectives that differ from our own. Soft thinking methodologies make use of *models* of holons in the discussion and comparison of the models with the perceived world. This whole process can be seen as a learning-cycle since the way we perceive the world is based on the personal experience of the observer. System thinking and methodologies provides means for creating purposeful thoughts about the world, and as such the very perception of the world is influenced. (Checkland & Scholes)

Perceived World

There are always several perspectives of the world since the world is shaped by our experience of it. As such it is subjected to the background, education, culture and interests of the person perceiving it. The world we live in - is the world we perceive. Therefore there can be no 'right' perception of the real world. (Dahlbom & Mathiassen) The world is considered to be very complex, problematical and mysterious, but it is assumed that the process of inquiring into it can be organized as a system. Consequently, the use of the term 'system' no longer applies to the world, but to the process of our dealing with the world. (Checkland & Holwell, 1998; Checkland & Scholes) Systems ideas are employed as a means of inquiry and are based on a concept of 'learning' rather than optimization. (Checkland & Scholes; Lewis) Systems are perceptions of the world that we modify and improve when faced with other perspectives, new experiences and by learning. (Dahlbom & Mathiassen) It is important to remember that the systems ideas is not a way of describing what exist but is a means of describing an interpretation of what exists or some thinking that is relevant to what exists. It enables the analyst to explicitly think about some real-world situation. (Wilson, 1984)

It is in the human nature to ascribe meaning to how the world is perceived. These meanings are founded on the observer's experience-based knowledge. Whenever there is a feeling that things could be better than they are; the perception of the world would be that of some problem requiring attention. (Checkland & Scholes) In soft system thinking, problems do not occur in a way that makes it possible to isolate them. They are often thought of as interactive incidents. Consequently, it is more accurate to approach the feelings of unease, not as a 'problem' but as a 'problem situation'. It is this part of the perceived world, the problem situation, that is to be studied and explored. (Wilson)

Holons

One of the principles of soft systems thinking is that the whole is greater than the sum of its parts. This covers the idea that the whole may display emergent properties. The properties of the parts have no meaning in terms of the parts of the whole. (Avison & Fitzgerald; Checkland & Scholes) The idea of the whole is an epistemological device, a theoretical concept that is used to describe and make sense of the real world. It would be better to use the word ‘holon’ to distinguish the theoretical concept from the systems of the perceived world, leaving the word ‘system’ to everyday language (Checkland & Scholes; Koestler, 1967). A holon is a special kind of model that organizes thinking by means of systemic ideas. (Lane & Oliva, 1998)

Human Activity Systems

In examining the real-world situations, the fact that humans interpret the world in different ways will never yield only one relevant holon. The ‘human activity system’ is a specific kind of holon made up of two sub-systems. One sub-system is made up of a collection of activities linked together according to their dependent relationships in order to make a purposeful whole. The other sub-system is one of monitoring and control so that the whole is adaptable to changes in the environment. (Checkland & Holwell; Checkland & Scholes)

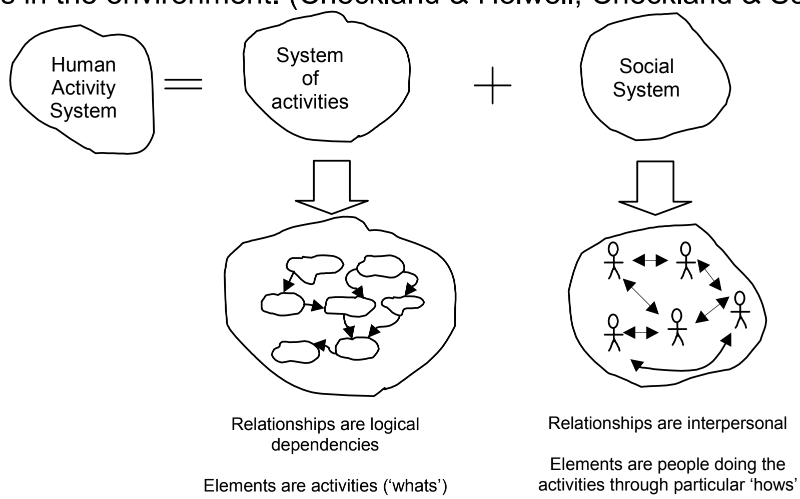


Figure 2 *The subsystems of the Human Activity System (adopted from Wilson, p. 25)*

As seen in figure 2 the human activity system can be divided into a system of activities and a social system whose boundary is concurrent with the boundary of the human activity system itself. The system of activities is made up of elements of activities whose relationships are logical dependencies. These elements can be used to define ‘what’ to change. The elements of the social system are the people doing the activities. These elements are the ones that defines ‘how’ that change may be implemented in real life and if that change is desirable and feasible. Therefore it is important to remember that although the human activity system usually is modeled as the system of activities, the related social system must also be defined.

Human activity systems are very complex. The human components may display different attributes when studied separately, than they would if their role in the whole system was examined. The human activity system recognizes the significance of people in organization as a whole. It is therefore vital to include the human aspect in order to make sense of the real world. This would entail including people in the model. The unpredictable nature of the human activity systems, different conflicting objectives, perceptions and viewpoints of the people makes it quite difficult to model. (Avison & Fitzgerald) It is therefore necessary to construct several models of human activity systems and to discuss their relevance to real life. Before modeling can commence, choices have to be made as to which human activity models are likely to be the most relevant in investigating the situation. Once this choice is made, it is essential to determine the perspective or viewpoint from which each purposeful activity model will be built. (Checkland & Scholes)

It is important to remember that human activity systems *do not ex*ist in the real world, they are holons, models to be compared with the world. These human activity systems provide a logical intellectual framework that can be used in order to understand and intercede in the rich and surprising unpredictability of everyday situations. (Ibid.; Lewis) The complexity of the models can never surpass the complexity of real purposeful action. By using the models as a base for relevant questions, they can be seen as mechanisms to explore real-world situations. The process of questioning should be made so explicit that it can be recreated by anyone interested enough to trail the process and see how it led to the reached conclusions. (Checkland & Holwell)

Appendix 3 – An introduction to STSSM

This introduction should be viewed as a brief explanation of the rudiments of SocioTechnical Soft System Methodology (STSSM), with emphasis on the models of purposeful activity systems as devices for exploring reality. It should also illustrate the aim of the workshop.

Ericsson has developed Telecom Management Systems, which are operation support systems (OSS), with the objective to improve the Telecom Operator's way to run and maintain their network elements in accordance with their work processes (and if possible improve the work processes as well). The OSS is designed to help the Telecom Operator to achieve improved efficiency of its operations and effectiveness through better managerial decisions. Focus has been on the technical side of the system; to deliver a system with all the functions needed to give the operator an overall view of the network that also provides access to all network equipment. Today, this is not enough. How the OSS is being operated in real-life, how well the technology fits the work process, how the OSS is perceived and what knowledge of the system the operators have – is just as important as the technical side of the system. To come to terms with these issues, Ericsson has initiated this master thesis with the aim of investigating the effects of the system and the work processes of a selection of their customers.

It is not possible to study an Information System (IS), under which category OSS falls, without studying the people who uses it and the process it is being used in. The IS is only a part of a bigger system (the organization) a system that is more than the sum of its parts. This holistic view is called Systems Thinking and it involves seeing relationships and inter-connections, the complete picture as well as the component parts. Due consideration must therefore be given to the varied ways in which the people that operate and are affected by the IS perceive the situation. To perform Systems Thinking, is to compare some constructed abstract wholes, so called system models, against the perceived real world in order to learn about it.

To investigate the IS in its context, it is advisable to follow a methodology, which is a collection of procedures, tools, techniques and documentation aids that will help in understanding the situation. SocioTechnical Soft Systems Methodology (STSSM) is an organized set of principles that guide action in trying to manage real-world problem situations based on the Systems Thinking.

The STSSM process can be tailored to the particular needs of each situation, which makes it possible to adapt the investigation to the situation at hand. The investigation that is the foundation of this master thesis, involves a form of workshop where representatives of the operators of the telecom network in discussion with the investigators draws up conceptual models of the relevant system to be compared to the real situation. This includes an investigation of what demands the task requirements of the Telecom Operator puts on the technology and the IS.

The process of SocioTechnical Soft Systems Methodology (STSSM)

The process of STSSM can be divided into six main activities:

1. Finding out about a problem situation
2. Formulating some purposeful activity models relevant to the problem situation
3. Discussing the situation, comparing the models to the real situation by formal questioning
4. Answering the TTF-questionnaires
5. Discussing the gathered material (differences between models and reality, and questionnaires) establishing both
   a) changes which would improve the situation and are considered as both desirable and feasible
   b) adjustments between any conflicting interests which will allow improvement action to take place
6. Taking action for improvement in the problem situation

Concerning the workshop with the Telecom Operators, the activities that will be undertaken are activities 1 through 4. Focusing on how the operators perceive the situation, and on this base build conceptual models that can be compared to reality, will provide a base for potential improvements in both product and implementation process.

Finding out about a problem situation

The particular technique used in STSSM is the drawing of Rich Picture Diagrams, where a pictorial representation of the problem situation is created. These pictures are used to provide a model for thinking about the system. Using a picture make it easier to ensure that no discrepancies exists in how the different operators of the network view their work situation. Elements of this rich picture diagram will include the clients of the system, the people involved, the task being performed, problem areas, the environment, the owner of the system and possible conflicting areas. A picture is ‘worth more than a thousand words’ and the drawing of such a diagram is an effective way of representing the issues and concerns of the different parties. The rich picture should be self explanatory and easy to understand. For an accurate picture, the finding out stage starts with a discussion of the structures, processes and issues of the Telecom Operator that could be relevant to the problem definition. It will also provide an impression of the organizational climate.

Building purposeful activity models

The process of purposeful thinking comes naturally to human beings. This process starts with focusing from our general perception of reality on the subject we consider to be the most relevant. We select a *subject*. We then construct sentences about this subject, *predicating* the subject. By comparing these predicates with the perceived reality, we can decide upon action. STSSM is simply a serious and organized way of how to perform this purposeful thinking by constructing purposeful activity models. These models are used to stimulate questions in the discussion of the real situation and the desirable changes to it. They are not models *of* anything; they are models *relevant to discussion* about the situation. They are simply devices to stimulate, feed and structure the discussion.

Every purposeful activity can be expressed in the form of a transformation process. This means that the set of activities contained in the human activity model represents the interconnected set of actions necessary to transform some entity, the input, into a different state or form of that same entity, the output of the process. The next step in STSSM is to model the relevant systems in a clear description, called root definition. Root definitions expresses that 'something is the case', and the core element is its transformation process, demonstrated in the figure below. The inputs and outputs can be of a physical nature, but they do not have to be. The transformation process can also be of an abstract kind.

Once the root definition is defined, it is time for creating models that show how the different activities are related to each other. As the root definition is an account of what the system *is*, the conceptual model is an account of what the system must *do* in order to *be* the system named in the definition. The relationship between the root definition and the conceptual model is therefore a matter of *being* and *doing*.

As a guide for creating the models three questions can be asked about the transformation process (T) of the root definition.
a) Is the T the right thing to be doing, taking into account the long-term aims?
A matter of *Effectiveness*.
b) Do the means selected work?
A matter of *Efficacy*.
c) Is the T being done with minimum resources?
A matter of *Efficiency*.

In the matter of the Telecom Operators, the main systems to define are those of the work processes. How does the operator perceive their working situation? What is needed to perform their tasks? Exploring and defining these, will lead to a picture of what kind of support they need to be able to perform their work effectively. This will later be compared to the existing support system.

Exploring the situation

Once the activity models are built, it is time to discuss the situation by comparing them to reality. The comparison will follow the form of formal questioning. A matrix with the activities and links in the different system models is used to compare these to the real situation. This comparison will also include a questionnaire for evaluating the Task Technology Fit. In addition to these questionnaires, there is also room for questions like what knowledge the operator has of the system and also discussions of possible improvements in the system and the implementation process.

Appendix 4 – The TTF questionnaire of STSSM

To add value, information technology (IT), like the operation support system (OSS) in this case, must meet the needs of the organizations, groups, and individuals who use it. Task Technology Fit (TTF) is a theoretical tool that can be used to capture how well technology functionality matches or fits the needs of the tasks being performed. TTF assumes that the performance impacts are dependent upon the fit between three constructs: technology characteristics, task requirements and individual abilities.

Technologies are viewed as tools used by individuals in carrying out their tasks, in this case referring to the operation support system.

Tasks are generally defined as the actions carried out by individuals in turning input into output. The relevant tasks are those of using data from the network (or other organizational data) in the decision-making and/or operation and maintenance of the telecommunication network and the network elements.

Individuals may use technologies to assist them in the performance of their task. Individual characteristics (like training, computer experience, and motivation) could have an effect on how easily and well the technology is utilized.

TTF is used in measuring to what extent the technology is supporting an individual in his or her tasks. It is the correlation between task requirements, individual abilities and the functionality of the technology.

Since the TTF perspective is applicable for both mandatory and voluntary use situations, it is a perfect tool to use for determining whether the operation support system (XMATE and NMS) in the organization are meeting user needs.

Questionnaire for TTF of XMATE and NSM

The questionnaire is divided into five parts, Part A. focuses on meeting task needs for using data in decision making, using data meeting the operational day-to-day needs and how the system responds to changed business needs. It is a matter of measuring the Task Technology Fit. Part B. focuses on the task characteristics such as non-routineness and interdependence. Part C. focuses on how the individual perceives the impact of the operation support system on their productivity, effectiveness and performance in their tasks. Part D. focuses on how the individual perceives the dependence of the IS in his/her work routines. (For a more thorough definition of the parts of the questionnaire see the definitions at the end of this document.) The last part of the questionnaire is for more general questions, for example job title.

Please rate how you perceive the statement/question to fit your situation. For Parts A. through C. the scale ranges from 1 to 7, where 1 means that you strongly disagree; 4 means that you neither agree nor disagree; and 7 means that you strongly agree with the question or statement.

For Part D. of the questionnaire you will be asked how dependent you are of the applications of the system in your work-routines. The scale ranges from 0 to 3, where 0 means that you are not at all dependent; 1 that you are not very dependent; 2 that you are somewhat dependent and finally 3 means that you are very dependent of the application.

Part A. Task Technology Fit Measures

QUALITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
CURRENCY							
The data is current enough to meet my needs.	1	2	3	4	5	6	7
I have no doubts that the data I need for making prompt decisions is in real-time.	1	2	3	4	5	6	7
RIGHT DATA							
The data maintained by the Telecom network elements, through the operation support system, is basically what I need to carry out my tasks.	1	2	3	4	5	6	7
I do not feel that the operation support system available to me is missing critical data that would be very useful to me in my job.	1	2	3	4	5	6	7
RIGHT LEVEL OF DETAIL							
The operation support system maintains data at an appropriate level of detail for my tasks.	1	2	3	4	5	6	7
I feel that the data in the operation support system is in general very detailed.	1	2	3	4	5	6	7

LOCATABILITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
LOCATABILITY							
It is easy to find the data necessary for me to perform my tasks.	1	2	3	4	5	6	7
It is easy to determine what data is available in the operation support system.	1	2	3	4	5	6	7
MEANING							
The exact definition of data fields relating to my tasks is easy to find out.	1	2	3	4	5	6	7
In the operation support system or reports that I deal with, the exact meaning of the data elements is either obvious, or easy to find out.	1	2	3	4	5	6	7

AUTHORIZATION							
	Strongly disagree			Neither agree/ disagree			Strongly agree
AUTHORIZATION							
Due to the fact that I have the right authorization, I do not feel that data that would be useful to me is unavailable	1	2	3	4	5	6	7
Getting authorization to access data that would be useful in my job is easy.	1	2	3	4	5	6	7

COMPATIBILITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
COMPATIBILITY							
I feel that data from different sources in the network (elements of the same supplier) can be compared or consolidated without inconsistencies.	1	2	3	4	5	6	7
If data from different sources (operation support systems) were more compatible it would not affect the way I perform my tasks.	1	2	3	4	5	6	7

USABILITY / TRAINING							
	Strongly disagree			Neither agree/ disagree			Strongly agree
HARDWARE & SOFTWARE USABILITY							
It is easy to understand what the applications of the operation support system are intended for.	1	2	3	4	5	6	7
It is easy to learn how to use the applications of the operation support system.	1	2	3	4	5	6	7
The applications of the operation support system I use in my day-to-day operations are convenient and easy to use.	1	2	3	4	5	6	7
The applications of the operation support system are in general convenient and easy to use.	1	2	3	4	5	6	7
The applications of the operation support system are explicit enough for the needs derived from my tasks.	1	2	3	4	5	6	7
It is easy to customize the applications to fit my needs.	1	2	3	4	5	6	7
It is easy to locate the help-information the operation support system provides.	1	2	3	4	5	6	7
It is easy to understand the help-information provided by the operation support system.	1	2	3	4	5	6	7
The help-information that is provided by the operation support system is adequate for my needs.	1	2	3	4	5	6	7
TRAINING							
I feel that there is enough training for me on how to understand, access or use the applications of the operation support system.	1	2	3	4	5	6	7
I'm getting the training I need to be able to perform my tasks using the applications of the operation support system.	1	2	3	4	5	6	7

PRODUCTION TIMELINESS							
	Strongly disagree			Neither agree/ disagree			Strongly agree
TIMELINESS							
The operation support system, to my knowledge, meets the scheduled activities (such as software executions for instance).	1	2	3	4	5	6	7
Regular IS activities (report delivery and statistical data gathering etc.) are to my knowledge completed on time.	1	2	3	4	5	6	7

SYSTEMS RELIABILITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
SYSTEMS RELIABILITY							
I can count on the system to be "up" and available when I need it.	1	2	3	4	5	6	7
The operation support system I use is not subject to frequent problems and crashes.	1	2	3	4	5	6	7
To my knowledge, the operation support system has a high fault tolerance level (for errors caused by the user etc.).	1	2	3	4	5	6	7

RELATIONSHIP WITH USERS							
	Strongly disagree			Neither agree/ disagree			Strongly agree
UNDERSTANDING OF BUSINESS							
The operation support system has been developed in accordance with an understanding of the day-to-day objectives of my work group and its mission within our company.	1	2	3	4	5	6	7
I feel that the supplier of the operation support system has an understanding of our company's business missions.	1	2	3	4	5	6	7
INTEREST AND DEDICATION							
The supplier of the operation support system takes my company's business problems seriously.	1	2	3	4	5	6	7
The supplier of the operation support system takes a real interest in helping me solve my business problems.	1	2	3	4	5	6	7
RESPONSIVENESS							
The supplier of the operation support system is swift to communicate with me on my requests.	1	2	3	4	5	6	7
I generally know what happens to my request for IS services or assistance or whether it is being acted upon.	1	2	3	4	5	6	7
When I make a request for service or assistance, the supplier of the operation support system normally responds to my request in a timely manner.	1	2	3	4	5	6	7
CONSULTING							
I am satisfied with the level of technical consulting expertise I receive from the supplier of the operation support system.	1	2	3	4	5	6	7
IS PERFORMANCE							
The supplier of the operation support system delivers agreed-upon solutions to support my business needs.	1	2	3	4	5	6	7

Part B. Task/Job Characteristics Measures							
	Strongly disagree			Neither agree/ disagree			Strongly agree
TASK EQUIVOCALITY							
I frequently deal with well-defined, routine problems.	1	2	3	4	5	6	7
I frequently deal with ad-hoc, non-routine problems.	1	2	3	4	5	6	7
Frequently the problems that I work on involve new forms of decisions.	1	2	3	4	5	6	7
TASK INTERDEPENDENCE							
The problems I deal with frequently involve more than one business function.	1	2	3	4	5	6	7
The problems I deal with are not dependent of any other business function.	1	2	3	4	5	6	7
A major part of the problems I deal with are frequently escalated to another level of decision-makers.	1	2	3	4	5	6	7
A minor part of the problems I deal with are frequently escalated to another level of decision-makers.	1	2	3	4	5	6	7
TASK FUNCTION AREA							
The tasks I perform involve fault recognition, fault isolation, fault reporting and logging.	1	2	3	4	5	6	7
The tasks I perform involve installation of network equipment, setting of states and parameters and configuration of network capacity.	1	2	3	4	5	6	7
The tasks I perform involve collection, buffering and delivery of operating statistics; network optimization according to the operating statistics received.	1	2	3	4	5	6	7
The tasks I perform involve collection, buffering and delivery of charging and accounting information.	1	2	3	4	5	6	7
The tasks I perform involve administration of authorization functions, handling of simultaneous use of an OSS, protection against intrusion.	1	2	3	4	5	6	7

Part C. Individual Performance Measures							
	Strongly disagree			Neither agree/ disagree			Strongly agree
PERFORMANCE IMPACT OF COMPUTER SYSTEMS & SERVICES							
The operation support system has a large, positive impact on my effectiveness and productivity in my job.	1	2	3	4	5	6	7
The operation support system and the services surrounding it are an important and valuable aid to me in the performance of my job.	1	2	3	4	5	6	7
I feel that the knowledge I have on the operation support system is sufficient to have a positive impact on my job performance.	1	2	3	4	5	6	7

Part D. Utilization of the Computer System				
Perceived Dependence: How dependent are you of the following XMATE/NSM-applications in your work-routines? (If there you use applications that are not in the list, please add them.)				
XMATE	Not at all dependant	Not very dependant	Somewhat dependant	Very dependant
Graphical Alarm presentation	0	1	2	3
Transaction Log Manager	0	1	2	3
Command Handling Tool (WIOZ)	0	1	2	3
Macro Command Tool (MCT)	0	1	2	3
Enhanced Command Handler (ECH)	0	1	2	3
Winfiol	0	1	2	3
Remote Load Tool (XRL)	0	1	2	3
OMS converter	0	1	2	3
STS Measurements support	0	1	2	3
CCS7 Statistics converter	0	1	2	3
PA Database Administration tools	0	1	2	3
	0	1	2	3
	0	1	2	3
	0	1	2	3
	0	1	2	3
	0	1	2	3
NSM	Not at all dependant	Not very dependant	Somewhat dependant	Very dependant
ISM Alarm	0	1	2	3
ISM Monitor	0	1	2	3
	0	1	2	3
	0	1	2	3
	0	1	2	3
	0	1	2	3

General questions	
What is your position within your company? (Employment, Title, Responsibility etc.)	
Number of years on current job:	
Number of years in the Telecom field:	
What would you consider a reasonable price for a service from the system supplier?	
Anything that you would like add?	

Definitions of the elements of TTF

Task Technology Fit captures how well technology functionality matches or fits the needs of the task being performed. To be able to measure the fit, questions are constructed around eight factors and within them sixteen dimensions. The first five factors focus on meeting task needs for using data in decision making. The fifth also focuses on meeting the operational day-to-day needs, as does the next two factors. The last factor focus on responding to changed business needs. Table 1 displays a list of the definitions of the different dimensions of the factors of task/technology fit measures.

Table 1 The dimensions of the Task Technology Fit measures of TTF

QUALITY

Currency	Data that I use or would like to use is current enough to meet my needs.
Right data	Maintaining the necessary fields or elements of data.
Right level of detail	Maintaining the data at the right level or levels of detail.

LOCATABILITY

Locatability	Ease of determining what data is available and where.
Meaning	Ease of determining what a data element on a report or file means, or what is excluded or included in calculating it.

AUTHORIZATION

Authorization	Obtaining authorization to access data necessary to do my job.

COMPATIBILITY

Compatibility	Data from different sources can be consolidated or compared without inconsistencies.

USABILITY / TRAINING

Hardware & software usability	Ease of doing what I want to do using the system hardware and software for submitting, accessing, analyzing data.
Training	Can I get the kind of quality computer-related training when I need it?

PRODUCTION TIMELINESS

Timeliness	IS meeting scheduled operations.

SYSTEMS RELIABILITY

Systems reliability	Dependability and consistency of access and uptime of systems.

RELATIONSHIP WITH USERS

Understanding of business	How well does IS and the IS-supplier understand my unit's business mission and its relation to corporate objectives?
Interest and dedication	IS-supplier's interest and dedication to supporting customer business needs.
Responsiveness	Turnaround time for a request submitted for IS-service.
Consulting	Availability and quality of technical assistance for systems.
IS performance	How well does the IS-supplier keep its agreements?

In Part B. of the TTF-questionnaire involves questions of task characteristics. The definition of the task/job characteristic measures can be found in table 2 below.

Table 2 Definition of the task/job characteristics measures of TTF

TASK/JOB CHARACTERISTICS	
Task equivocality	How vague the task performed is. It is a matter of non-routineness.
Task interdependence	How dependent is the task to other business functions?
Task function area	To what function area do the task performed belong?

In Part C. of the TTF-questionnaire individuals will be asked what impact computer systems and services have on their effectiveness, productivity, and performance of their job. The definition of the performance of computer systems can be found in table 3 below.

Table 3 Definition of the individual performance impact measures of TTF

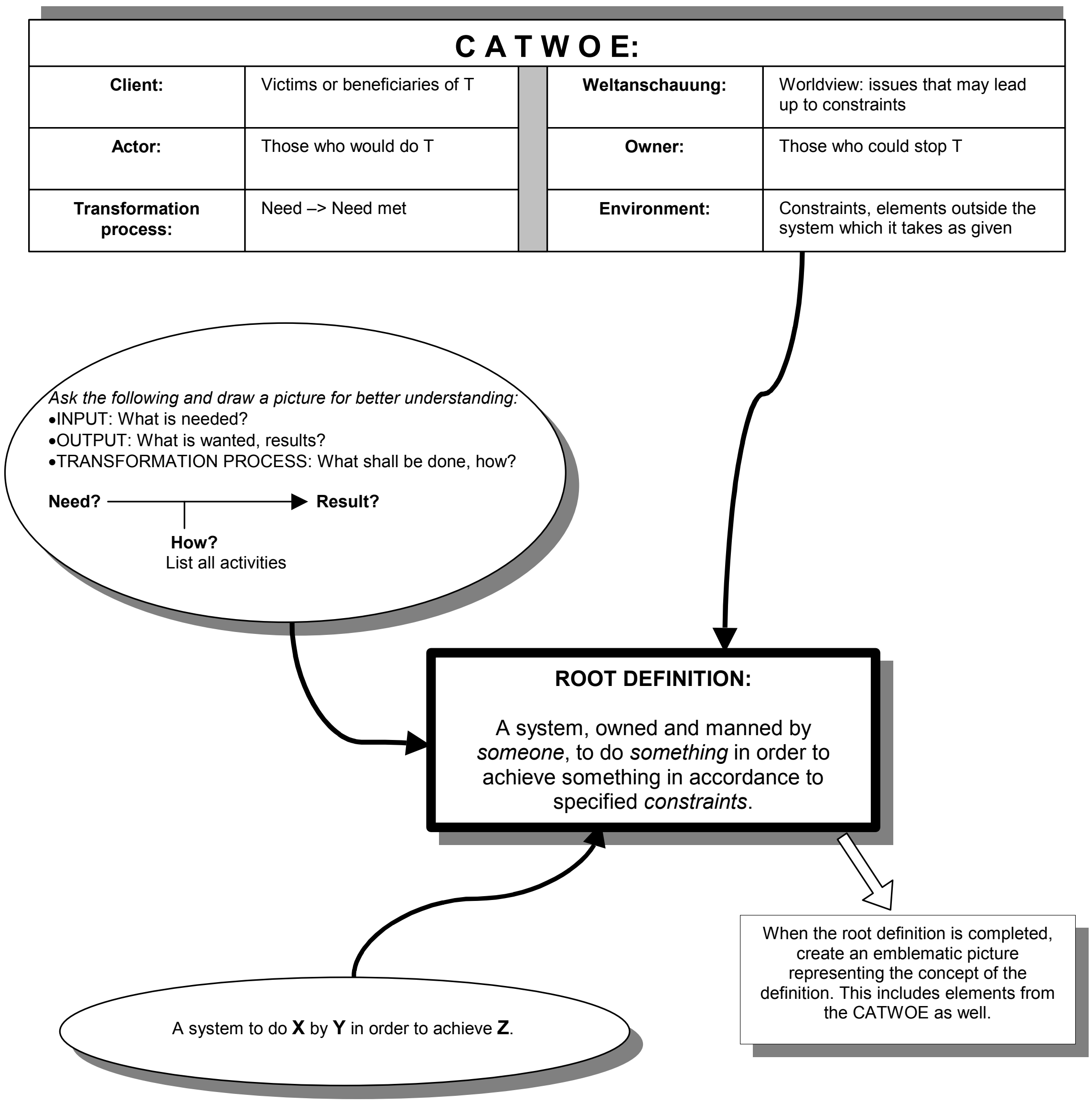
INDIVIDUAL PERFORMANCE MEASURES	
Performance impact of computer systems	How well does the computer systems aid the performance of the individual?

In Part D. of the TTF-questionnaire individuals will be asked to rate how dependent they are on a list of applications of the operation support system available to them. Utilization is to what extent to which IS have been integrated into each individual's work-routines, whether it is voluntary or mandatory. This reflects the individual or organizational choice to accept the systems, or the institutionalization of those systems. The definition of perceived dependence can be found in table 4 below.

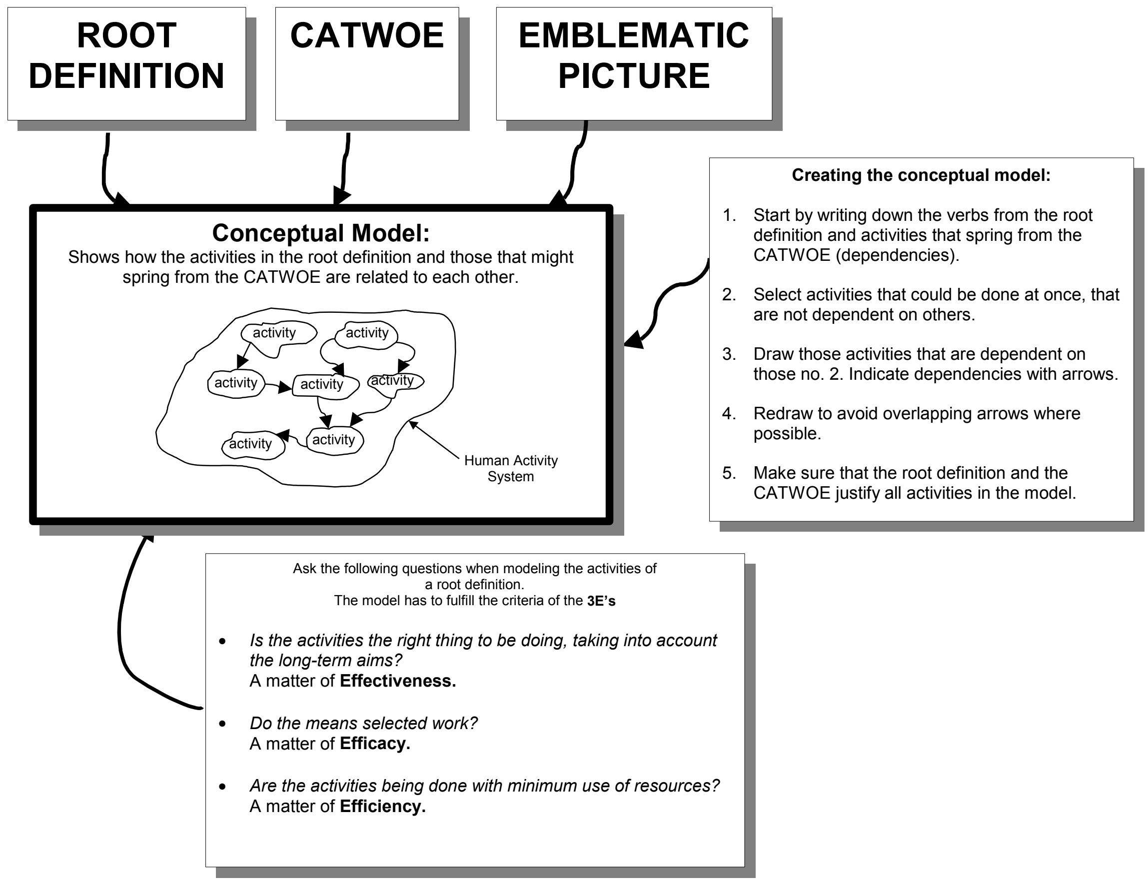
Table 4 Definition of the perceived dependence measures of TTF

UTILIZATION	
Perceived Dependence	How dependent is the user of the computer system applications in his/her work-routines.

Appendix 5 – The process of creating the Root Definition



Appendix 6 – The process of creating the Conceptual Model



Appendix 7 – The Rich Picture of the ETL NOC

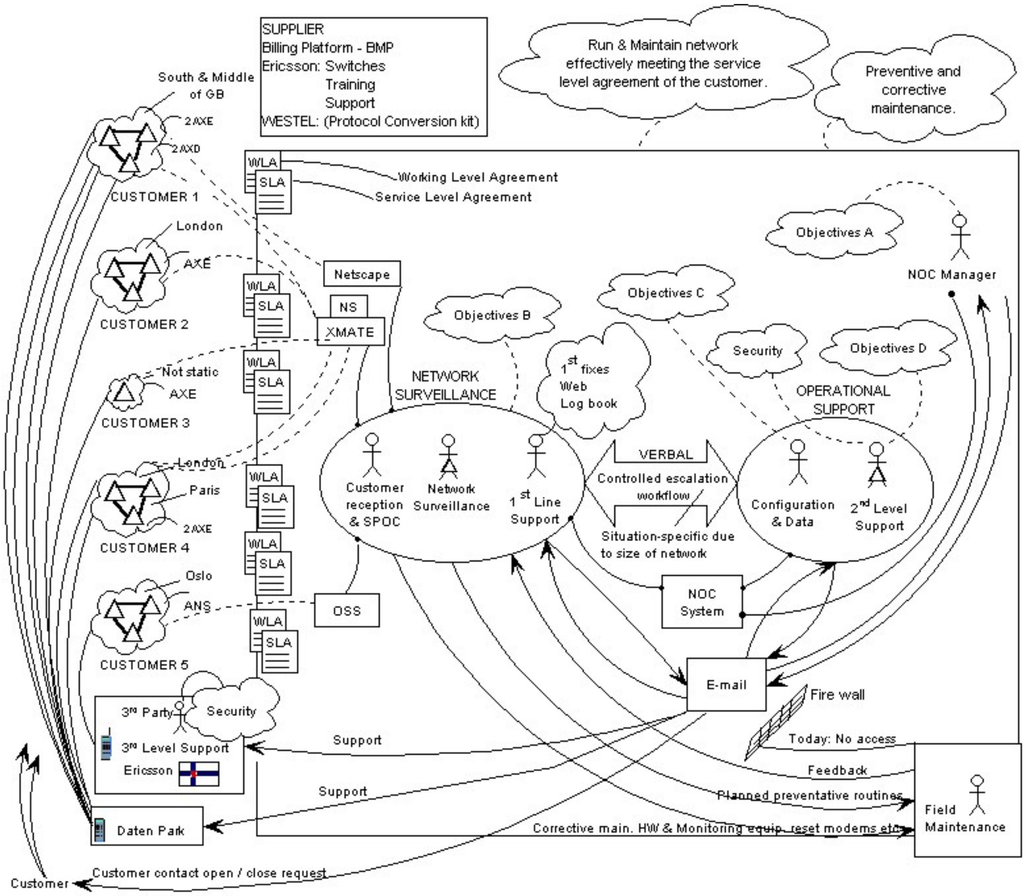


Figure 3 *The Rich Picture of the ETL NOC, 11 of June 2001.*

Objectives A - NOC Manager

- Ensure all Operations and Maintenance Activities are carried out in a professional manner.
- Supervise all NOC Personnel and ensure they are correctly provided with the training, information and tools necessary to perform their work.
- Contribute to the optimal efficiency of the NOC and the Network.

Objectives B - Network surveillance

- Act as the single point of entry for all contact and enquiries into the NOC.
- Ensure all active alarms are dealt with in a professional manner.
- Deal with all inquiries, Trouble Tickets, Works Orders and requests for assistance in a professional manner.
- Contribute to the optimum efficiency of the NOC and the Network.

Objectives C - Network surveillance

- Ensure all activities involving Data Build are carried out in a professional manner.
- Ensure that the people escalating problems are kept fully informed of progress and advised when the problems are resolved.
- Contribute to the optimum efficiency of the NOC and the Network.

Objectives D - 2nd Level Support

- Ensure all activities associated with Network Operations are carried out in a professional manner.
- Deal with all complex AXE switching problems in a professional manner and ensure they are resolved.
- Deal with all complex Transport network problems in a professional manner and ensure they are resolved.
- Ensure that the people escalating problems are kept fully informed of progress and advised when the problems are kept fully informed of progress and advised when the problems are resolved.
- Contribute to the optimum efficiency of the NOC and the Network.

Appendix 8 – The emblematic representation of the root definition for ETL NOC

The emblematic picture of the root definition is created after the actual formulation of the root definition and its main purpose is to bridge the gap between definition and building of the conceptual model. The picture is based on the root definition that was created by Peter M, Network Surveillance, 12th of June 2001. The root definition is defined as follows:

> **Root Definition a) for the ETL NOC:**
> A system, owned and manned by ETL NOC, to operate and maintain the customers network keeping with the service level agreement (& working level agreement) of the customer. The operation, maintenance and management of the network is done by the means of Network Surveillance, Configuration & Data, 2nd Level Support and Field Maintenance.

Figure 1 is an attempt to demonstrate how a system to operate and maintain the customers network will make all parties happy.

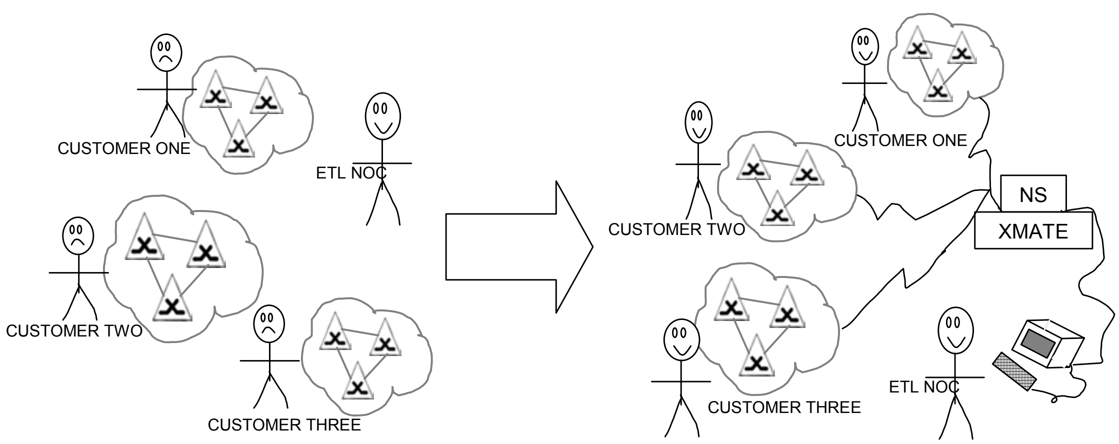


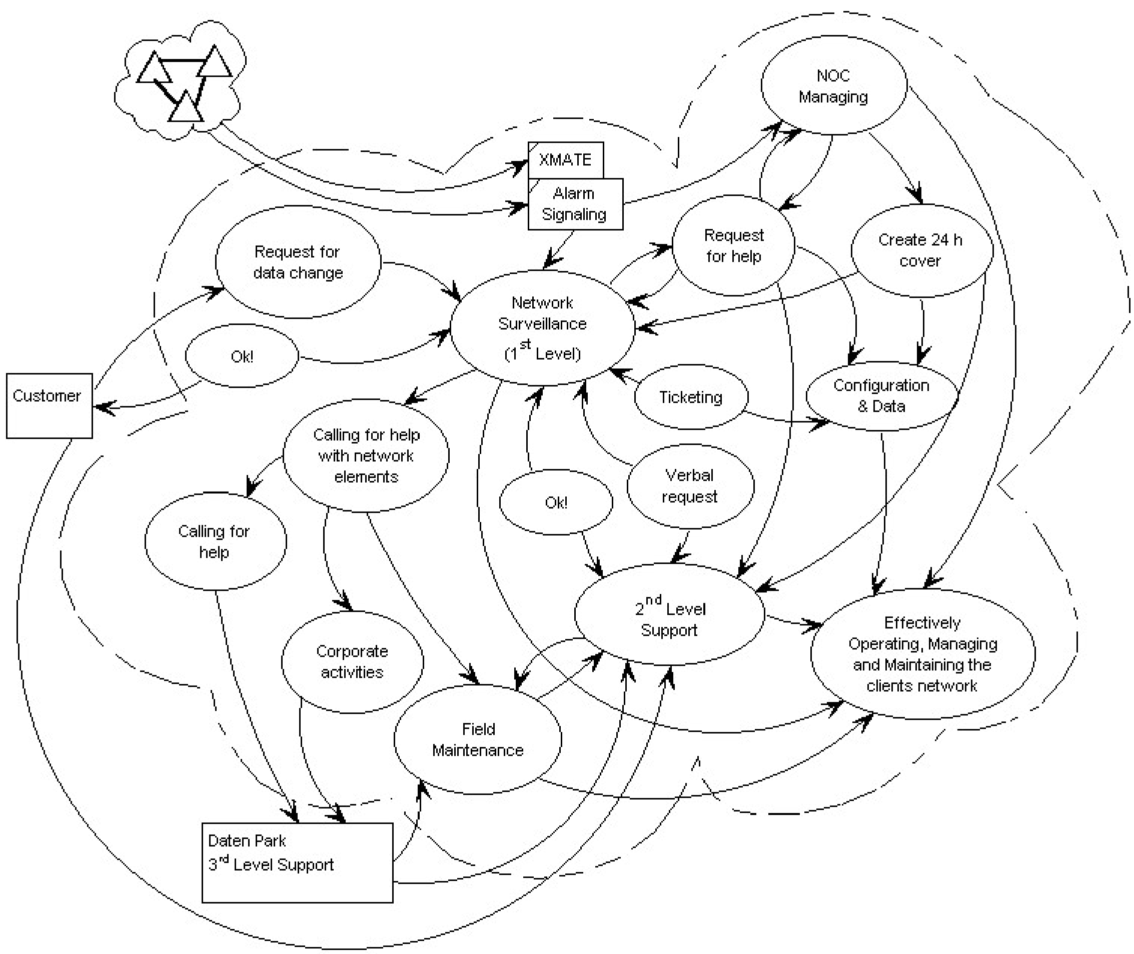
Figure 1 *The emblematic representation of the root definition of the ETL NOC, 010612.*

Appendix 9 – The Conceptual Models of ETL NOC

All the conceptual models were created during the Case Study at ETL NOC, Burgess Hill in England.

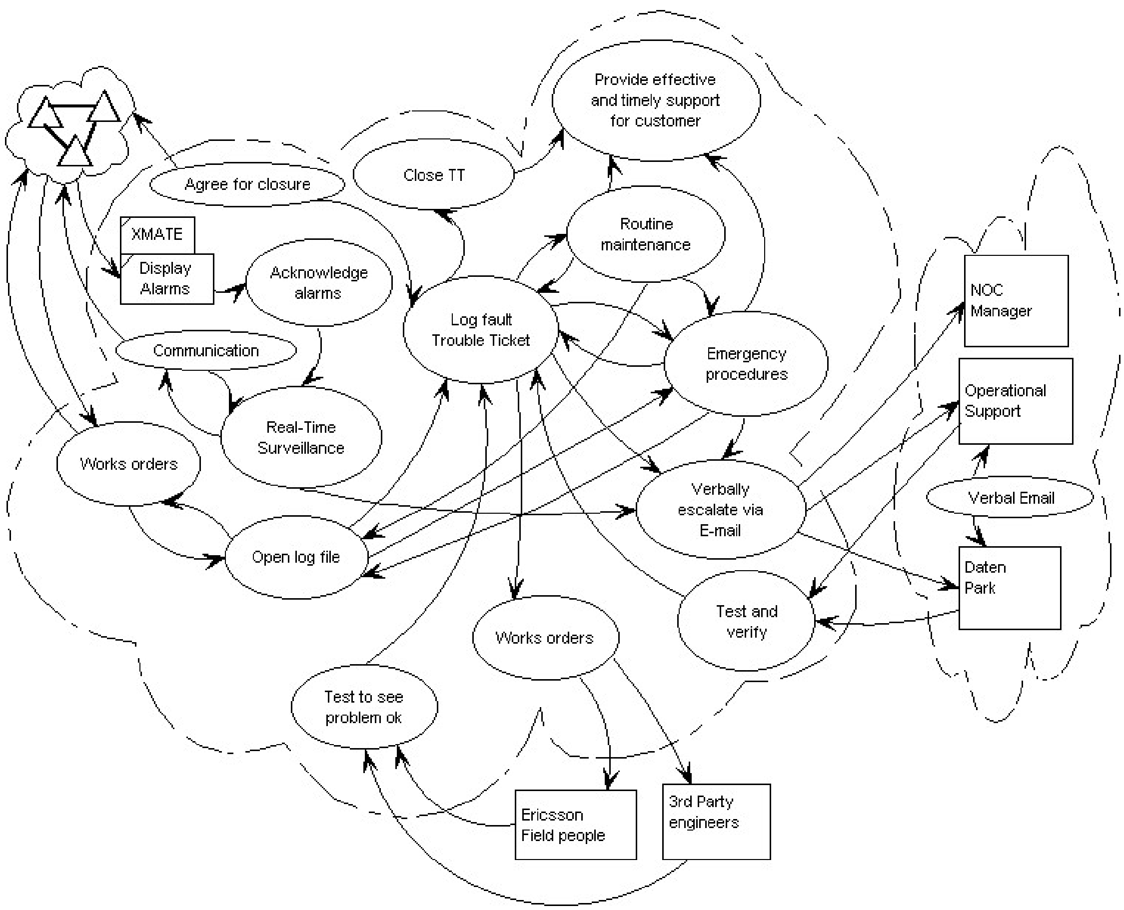
The conceptual Model of ETL NOC

Peter M, Network Surveillance
12 of June, 2001



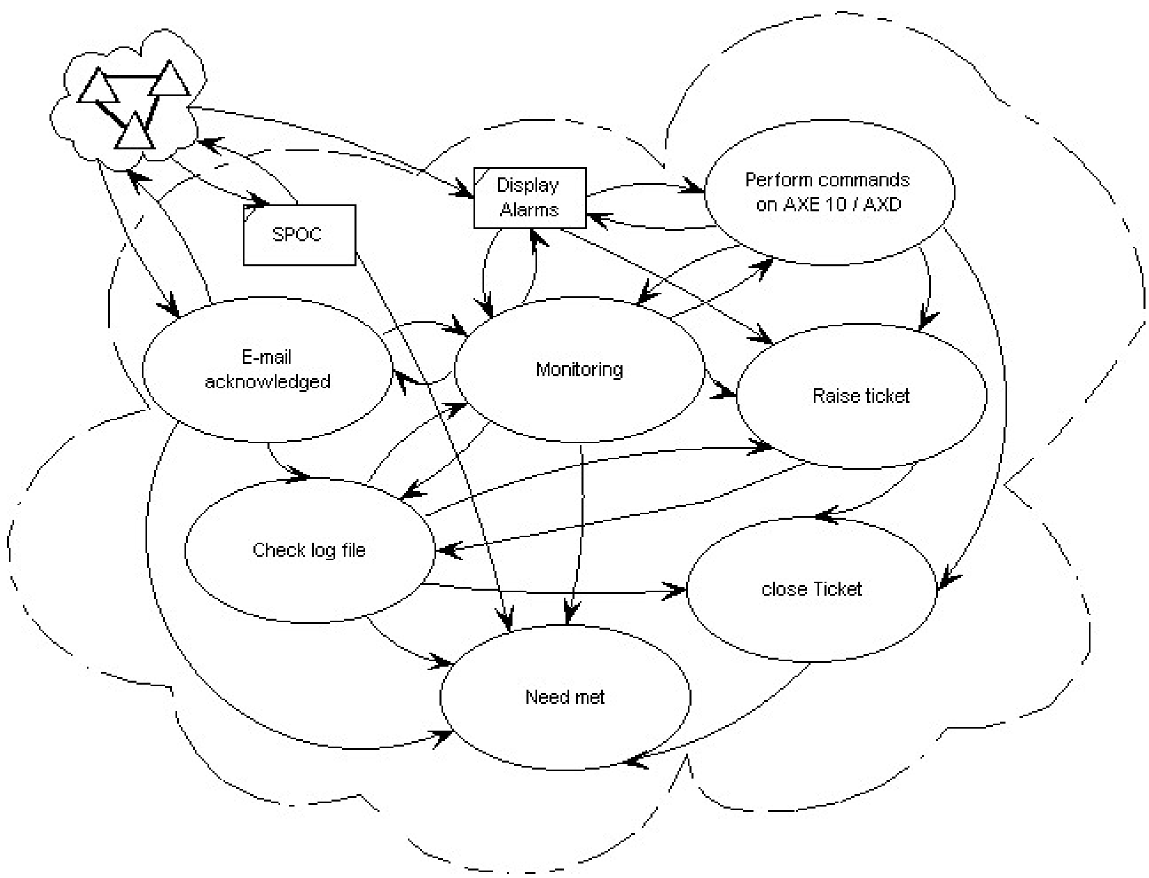
The conceptual Model of Network Surveillance

Peter M, Network Surveillance
12 of June, 2001



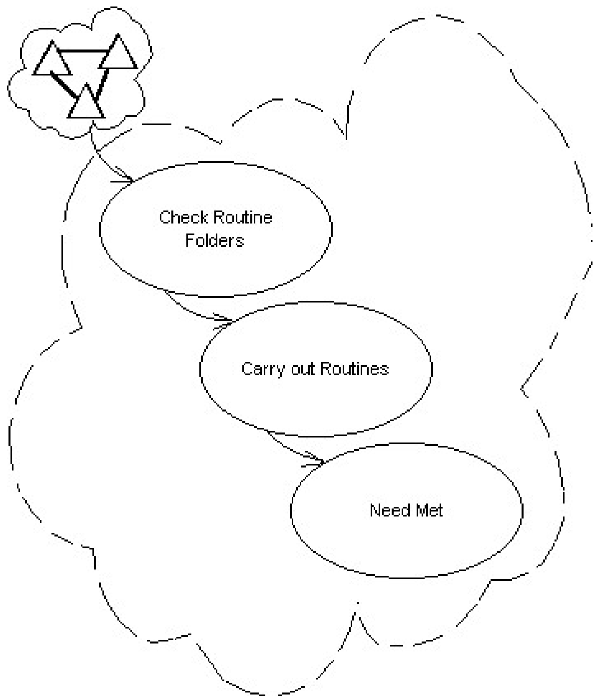
The conceptual Model of Real-Time Surveillance

Peter M, Network Surveillance
12 of June, 2001



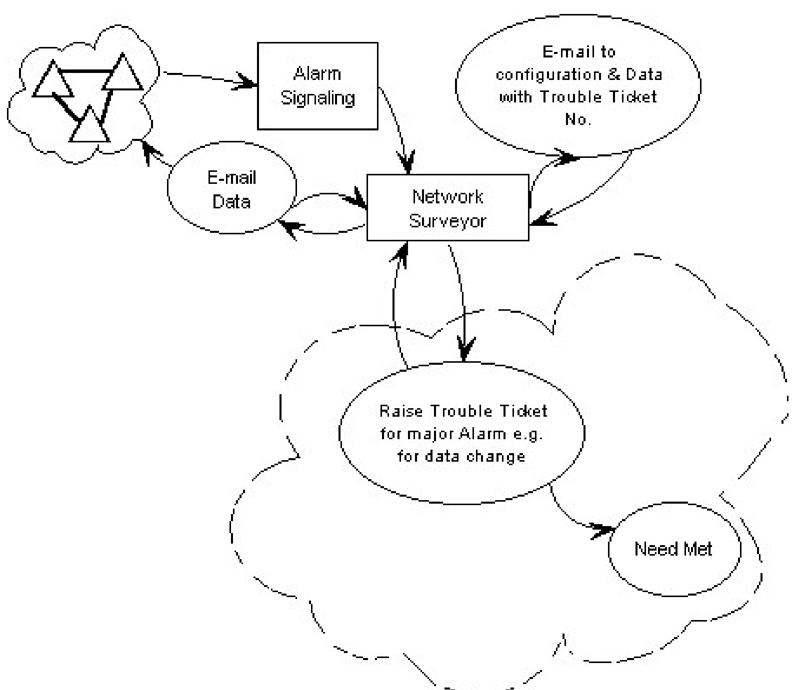
The conceptual Model of Routine Maintenance

Peter M, Network Surveillance
12 of June, 2001



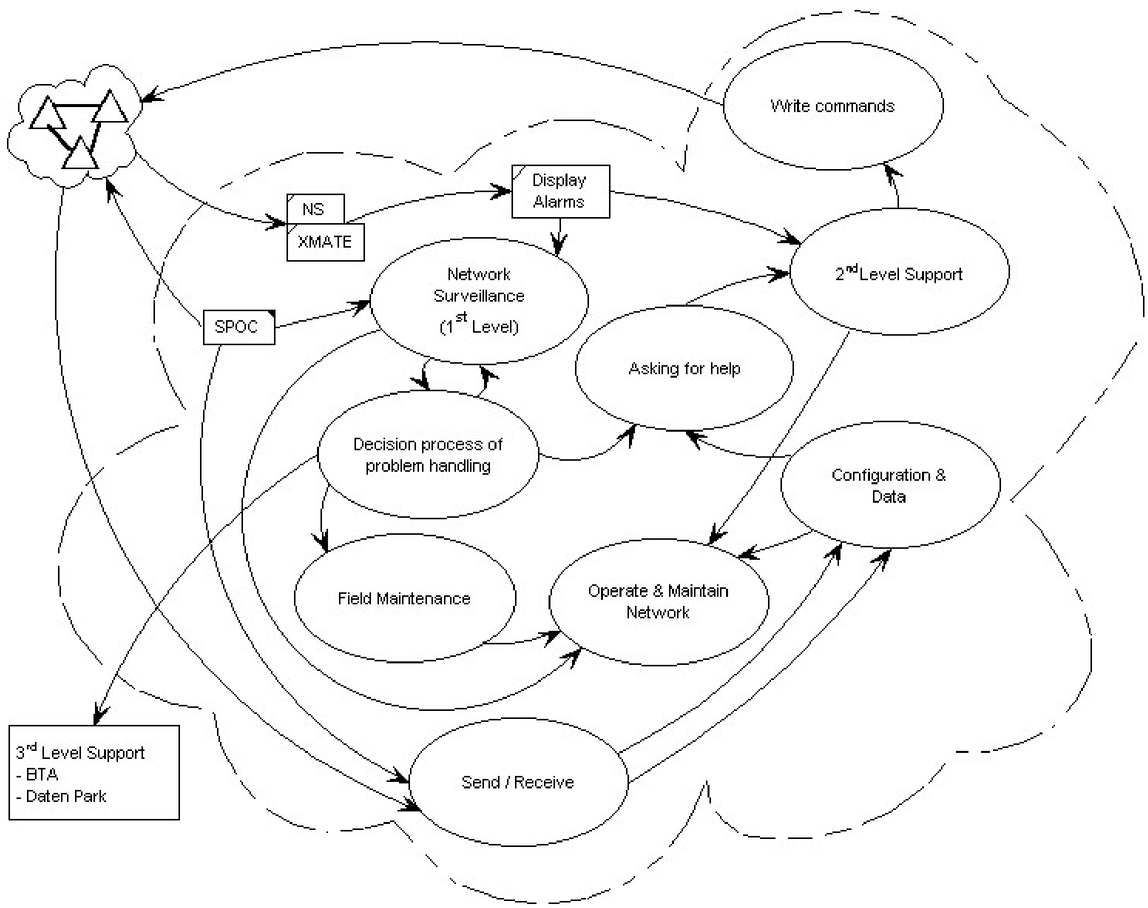
The conceptual Model of Trouble Ticket

Peter M, Network Surveillance
12 of June, 2001



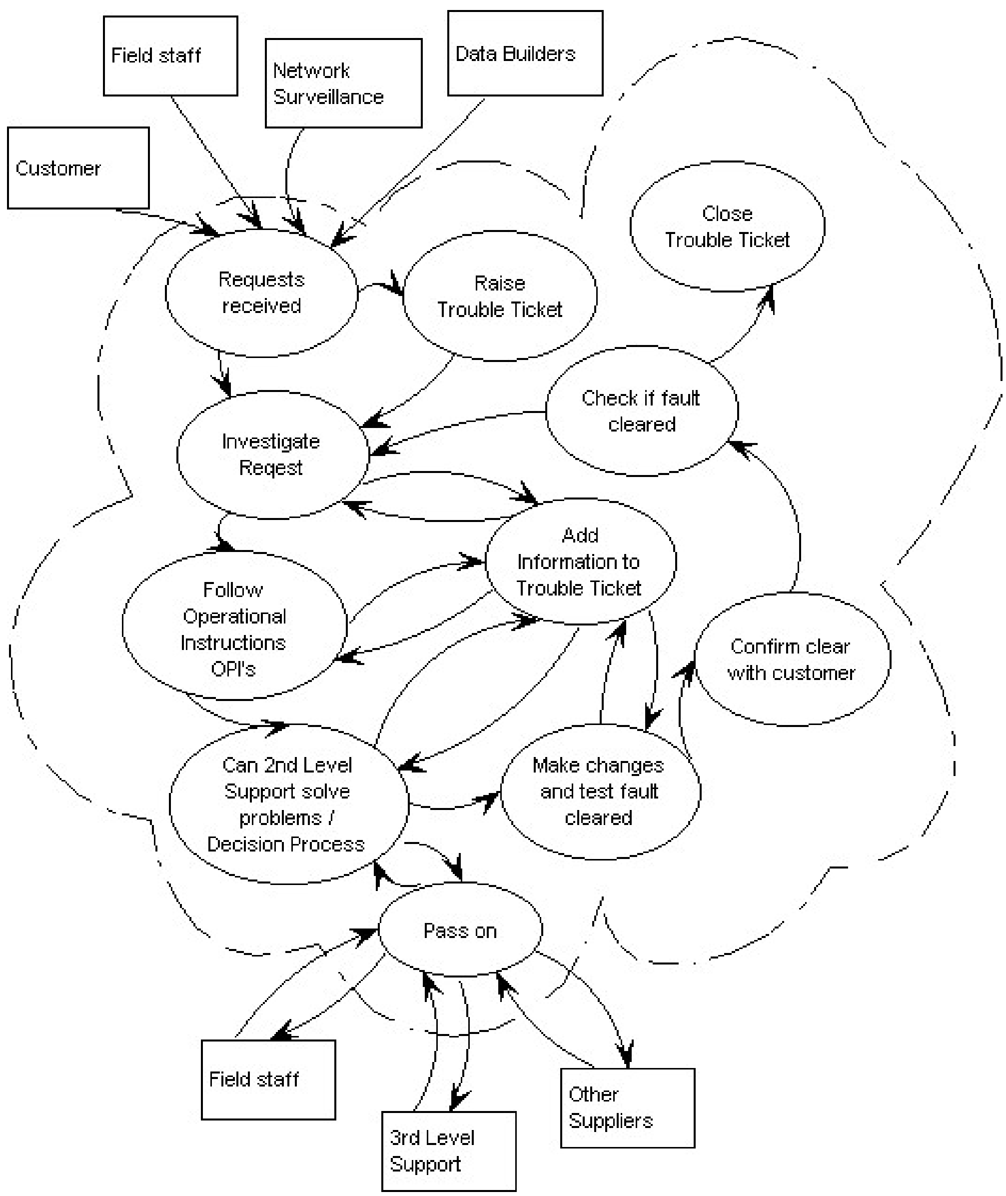
The conceptual Model of ETL NOC

Andy O, 2nd Level Support - Switching
13 of June, 2001



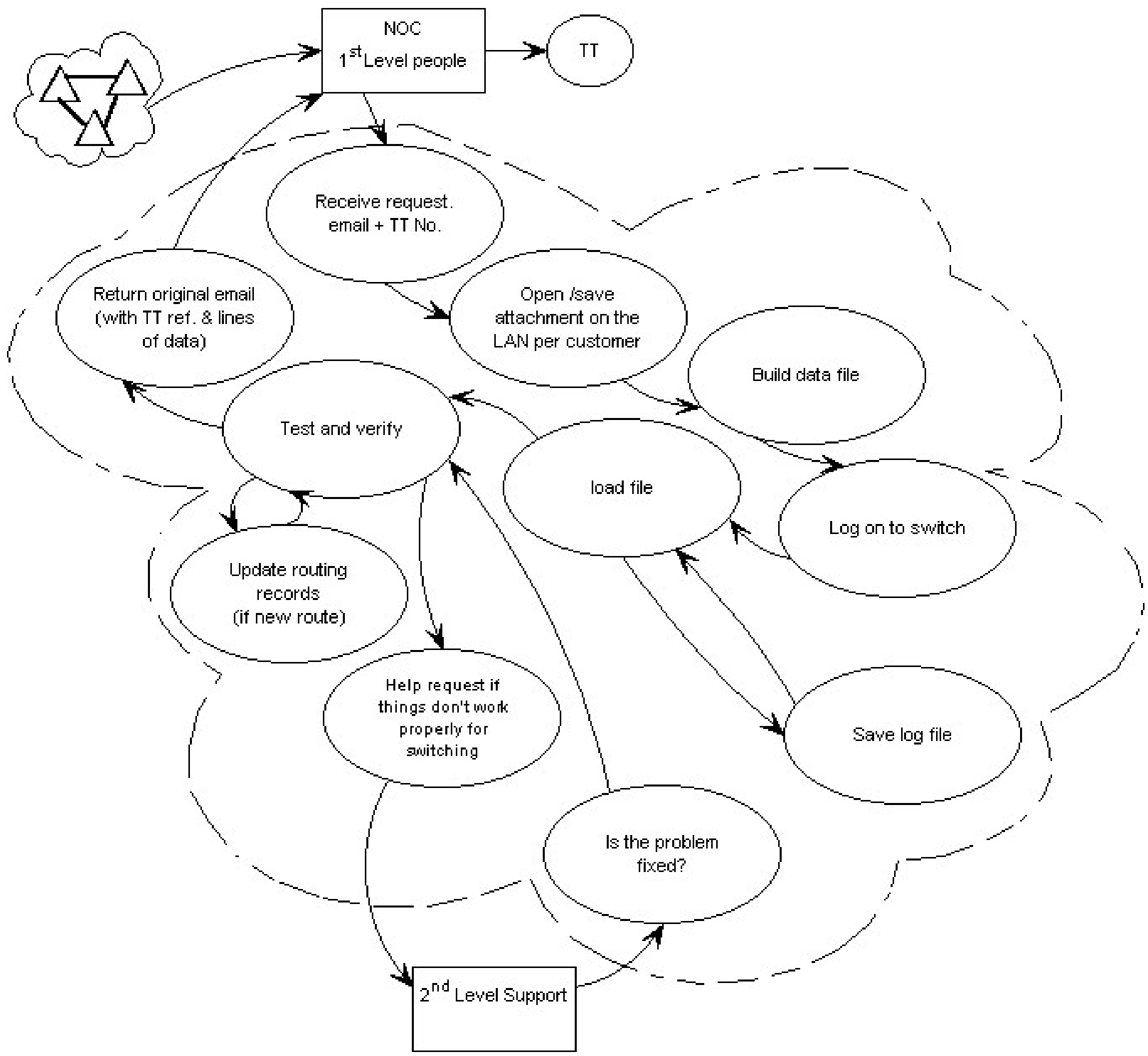
The conceptual Model of 2nd Level Support, Switching

Andy O, 2nd Level Support - Switching
13 of June, 2001



The conceptual Model of 2nd Level Support, Configuration & Data

Andy H, 2nd Level Support – Configuration & Data
13 of June, 2001



Appendix 10 – The responses for Part A. of the TTF-questionnaire in its tabular form

Part A. Task Technology Fit Measures							
QUALITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
CURRENCY	1	2	3	4	5	6	7
The data is current enough to meet my needs.			1	1	3	1	
I have no doubts that the data I need for making prompt decisions is in real-time.			1	2	3		
RIGHT DATA	1	2	3	4	5	6	7
The data maintained by the Telecom network elements, through the operation support system, is basically what I need to carry out my tasks.			3	1	1	1	
I do not feel that the operation support system available to me is missing critical data that would be very useful to me in my job.			5		1		
RIGHT LEVEL OF DETAIL	1	2	3	4	5	6	7
The operation support system maintains data at an appropriate level of detail for my tasks.			5	1			
I feel that the data in the operation support system is in general very detailed.		1	4	1			
LOCATABILITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
LOCATABILITY	1	2	3	4	5	6	7
It is easy to find the data necessary for me to perform my tasks.			1	1	2	2	
It is easy to determine what data is available in the operation support system.			2	1	2	1	
MEANING	1	2	3	4	5	6	7
The exact definition of data fields relating to my tasks is easy to find out.		1	1	1	2	1	
In the operation support system or reports that I deal with, the exact meaning of the data elements is either obvious, or easy to find out.		2		1	2	1	
AUTHORIZATION							
	Strongly disagree			Neither agree/ disagree			Strongly agree
AUTHORIZATION	1	2	3	4	5	6	7
Due to the fact that I have the right authorization, I do not feel that data that would be useful to me is unavailable		1		4	1		
Getting authorization to access data that would be useful in my job is easy.		1	1	2	2		
COMPATIBILITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
COMPATIBILITY	1	2	3	4	5	6	7
I feel that data from different sources in the network (elements of the same supplier) can be compared or consolidated without inconsistencies.				4	2		
If data from different sources (operation support systems) were more compatible it would not affect the way I perform my tasks.		1	2	3			

USABILITY / TRAINING							
	Strongly disagree			Neither agree/ disagree			Strongly agree
HARDWARE & SOFTWARE USABILITY	1	2	3	4	5	6	7
It is easy to understand what the applications of the operation support system are intended for.				1	2	3	
It is easy to learn how to use the applications of the operation support system.				2	2	2	
The applications of the operation support system I use in my day-to-day operations are convenient and easy to use.				2	2	2	
The applications of the operation support system are in general convenient and easy to use.				1	2	3	
The applications of the operation support system are explicit enough for the needs derived from my tasks.				1	3	2	
It is easy to customize the applications to fit my needs.			1	1	3	1	
It is easy to locate the help-information the operation support system provides.				3	1	2	
It is easy to understand the help-information provided by the operation support system.			1	1	2	2	
The help-information that is provided by the operation support system is adequate for my needs.				2	2	2	
TRAINING	1	2	3	4	5	6	7
I feel that there is enough training for me on how to understand, access or use the applications of the operation support system.			2	2	1	1	
I'm getting the training I need to be able to perform my tasks using the applications of the operation support system.		2		4			

PRODUCTION TIMELINESS							
	Strongly disagree			Neither agree/ disagree			Strongly agree
TIMELINESS	1	2	3	4	5	6	7
The operation support system, to my knowledge, meets the scheduled activities (such as software executions for instance).			3	2	1		
Regular IS activities (report delivery and statistical data gathering etc.) are to my knowledge completed on time.			1	2	2	1	

SYSTEMS RELIABILITY							
	Strongly disagree			Neither agree/ disagree			Strongly agree
SYSTEMS RELIABILITY	1	2	3	4	5	6	7
I can count on the system to be "up" and available when I need it.		3	1	1	1		
The operation support system I use is not subject to frequent problems and crashes.	2	1	1	1		1	
To my knowledge, the operation support system has a high fault tolerance level (for errors caused by the user etc.).		1		3	2		

RELATIONSHIP WITH USERS							
	Strongly disagree			Neither agree/ disagree			Strongly agree
UNDERSTANDING OF BUSINESS	1	2	3	4	5	6	7
The operation support system has been developed in accordance with an understanding of the day-to-day objectives of my work group and its mission within our company.			1	3	2		
I feel that the supplier of the operation support system has an understanding of our company's business missions.			2	1	3		
INTEREST AND DEDICATION	1	2	3	4	5	6	7
The supplier of the operation support system takes my company's business problems seriously.		1		1	3	1	
The supplier of the operation support system takes a real interest in helping me solve my business problems.			1	1	3	1	
RESPONSIVENESS	1	2	3	4	5	6	7
The supplier of the operation support system is swift to communicate with me on my requests.			1	1	2	2	
I generally know what happens to my request for IS services or assistance or whether it is being acted upon.			1	2	2	1	
When I make a request for service or assistance, the supplier of the operation support system normally responds to my request in a timely manner.				2	3	1	
CONSULTING	1	2	3	4	5	6	7
I am satisfied with the level of technical consulting expertise I receive from the supplier of the operation support system.			1	1	3	1	
IS PERFORMANCE	1	2	3	4	5	6	7
The supplier of the operation support system delivers agreed-upon solutions to support my business needs.				3	2	1	