

Exploring the Transformations of Interaction in Mobile Work Contexts

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Abstract—The usage of work related mobile services is often very complex, affected by a multitude of intertwined factors including the technological, environmental and human. Understanding how to model the complexity of mobile work and particularly its mobile interaction would be beneficial in ensuring the success of mobile services in user's long-term, goal-oriented usage. Previous attempts to evaluate success factors in mobile business services have concentrated on rigid analytical tools modeling users and tasks and mainly focusing on understanding routine work tasks and standard information exchange between different users. However, this covers only a narrow field of mobile work and it is argued here that existing analytical tools do not sufficiently consider factors arising from different levels of mobility and the temporariness and non-routine tasks of mobile work. In this paper we present a process oriented approach, 'MoBiS Map, derived from Actor-Network theory, to describe the complex network of interactions and the transformation of interactions. We argue that our approach is a useful analytical tool when the focus is on examining the transformation of interactions that takes place when mobile work services are implemented. This is a methodological paper aiming to better understand the transformation of mobile interactions, and therefore to support development of mobile business services.

Index Terms—Mobile computing, industrial applications, mobile measurement technologies, services for mobile networks

I. INTRODUCTION

Since our aim is to explore success factors of mobile work services we suggest that one of the key issues in finding successful services is to manage mobile interaction. Thus, as a starting point, we have to discuss what success factors we are interested in. On one hand, successful services at the individual worker level could focus on exploring and developing the usability of mobile services, while on the other success can be understood as maximum productivity and business performance at the organizational level and in business networks. We suggested that in mobile work, as distinct from non-mobile work, understanding the impacts of changing contexts and changing interactions is essential. Therefore, it is crucial to first discuss the characteristics of mobile work, and second, to discuss the characteristics of mobile interaction in the work context. In understanding these phenomena better, it is also clear that analyzing mobile interactions in the work context and developing better tools and methods for analyzing them would be advantageous in designing successful mobile services for mobile workers.

Mobile work is already a reality in several areas of business, e.g. [14], [36], therefore work with mobile technologies has become an emerging field of research, including aspects of mobile work itself, e.g., [24], [44], [49], mobile technology, and how these issues affect businesses and work practices [15], [16]. A variety of users in diverse contexts and environments are already working wholly or partly mobile. In order to understand, design, and develop successful services for mobile workers, first we need to better understand the nature of mobile work – the users, the context, and the work processes and tasks (see, e.g., [49]) so as to understand mobile interaction in the work context.

Analysis of the key issues of mobile work has tended to focus either on those mobile information workers who are quite familiar with using mobile information technology in their daily routines [34], or on static routine work tasks that involve standard information exchange. Furthermore, existing studies of mobile work also tend to consider the technology oriented issues more at the individual worker level when examining work tasks or contexts of usage. However, when exploring human-computer interaction (HCI) at the individual user level, for example, in the organizational context, by exploring *task, user type, system, organizational considerations* and *interface focus*, the impacts of HCI can be examined in more detail [39]. If nature of the task is routine and repetitive, organizational considerations can focus on technology acceptance, user productivity and user satisfaction; whereas if the nature of the task is non-routine and creative, organizational considerations will focus on issues of trust in, and motivation to use, the technology, in addition to acceptance (*ibid.*).

In examining mobile work, contextual complexity, i.e., dimensions of location, mobility, time, temporariness, diversity and modes of interaction should be taken into account. It is suggested here that understanding the contextual complexity of where mobile work is done, in particular seems to be one of major distinctions between non-mobile and mobile work.

We are taking an alternative approach to modeling mobile work by creating a better understanding of mobile interaction in mobile work contexts by modeling a network of technical and non-technical elements and their connection with or/and of mobile interaction. We aim to address two questions: firstly, to investigate the characteristics of mobile interaction at mobile work; secondly, to evaluate two tools for analyzing mobile interaction. The aim of our work is to first look at the method that models primarily a routine work process, and then second to compare the pros and cons of the process modeling method with a method that describes the network of significant

human and non-human actors by drawing the network of these actors and the relationships between them.

In this paper, we are interested in mobile workers and their mobile interaction not only in understanding the task-oriented side but also understanding the bigger picture in visualizing the transformation of interactions within a network of human and non-human elements or actors such as mobile services, administrative personnel or outcomes of the mobile work. In particular, it is interesting to approach these issues by studying mobile workers who do not have a dominant usage culture of mobile technology at work. We will explore mobile work and the special characteristics of mobile interaction in a work context when we focus on exploring mobile workers' ability to manage mobile interactions and to study interaction management. We present two methods to better understand the mobile interactions by modeling them with Unified Modeling Language (UML) and with the Actor network-theory approach (ANT).

Our main research questions are

- 1) *how can mobile interaction be managed in any given context?*
- 2) *what should we evaluate when we are exploring issues affecting the success of mobile interaction in a work context?*

The given context is derived from mobile work. The challenge is to understand the range of variables that affect mobile work, which will be discussed below. As such, the paper gives an overview of: (i) definitions of mobile work (ii) definitions of the mobile interaction (iii) a task oriented method to model mobile interaction in a work context (iv) the actors' network method in analysing the dynamics of mobile interaction.

II. MOBILE WORK

Since we aim to better understand mobile interaction, in considering how to model and describe interaction, we therefore investigate it in the mobile work context by analysing the character of mobile work itself.

'Mobile work' refers to mobile spaces and places as working contexts, mobile subjects, mobile tools, and mobile object of work along with mobility in organizations and business models. Mobile work in general refers to a worker being able to move and complete tasks anywhere, anytime, using mobile technology. Extending that perspective of mobile work, *purposes of activities* for a mobile worker are explored in 1) *physical spaces*, 2) *virtual spaces* and 3) *mental and social spaces* (see table 1). Furthermore, the *mobility of a subject* (a worker) may be physical or virtual or both. Mobile workers use mobile technology, but it should be noted that *mobile technology* and *wireless technology* are not synonymous. Mobile technology refers to something that is portable, i.e. a laptop or mobile phone, while wireless technology refers to the ability to access networks [43]

In our study, we refer to the physical and virtual mobility of a subject who is utilizing wireless technology.

TABLE I.
OBJECTS FOR ANALYSING PURPOSES OF ACTIVITIES [43]

	Purposes of activities
Physical space	Describing distances, settings and physical environments
Virtual space	connections, devices, applications
Mental and social spaces	shared common experiences

In addition, Vartiainen [43] describes mobile work using *task and assignments*, *working context* and *outcomes*. According to Kristoffersen and Ljungberg [19], mobile work consists of three different modalities that give a clearer understanding of mobile workers: *visiting* means working in different places for a significant period of time, *travelling* means working while travelling in a vehicle, and *wandering* means working while being locally mobile. In addition to this physical and geographical movement, (i.e.; *locational mobility*), Kakiyama and Sørensen [18] argue that mobile work also includes *operational* and *interactional* mobility. Locational mobility refers to geographical movement, remoteness from a certain fixed point, transformation and motion, while operational mobility deals with issues around the capability for flexible operation as an independent unit of work. Interactional mobility is about the intense and fluid interaction with a range of people.

Yuan and Zheng [49] proposed a theoretical 'mobile work model' consisting of mobile workers, mobile tasks, mobile context, and mobile technology (see table 2). *Mobile workers* may work in sales, field work, or management [7], [35]. The characteristics of *mobile work tasks* include how structured the task is, its frequency, and the location where the employee typically performs the task [13]. Because mobile workers often have to perform actions other than information processing, the work also includes the handling of multiple tasks [49].

TABLE II.
MODEL OF MOBILE WORK [49]

	Characteristics
Mobile worker	different roles
Mobile work task	structured, non-structured, frequency, location
Mobile context	impacts of environment
Mobile technology	devices, connectivity

Mobile context refers to the circumstances in which mobile tasks are performed by mobile workers, such as workplace and temporal structure [49]. Examining work in a mobile context, recent studies concluded that there is a so-called "anytime, anywhere" paradox, that is, that time frames of mobile work are not always negotiable, nor are the places where mobile work takes place [47]. The variety of the mobile service context, the impact of the working environment (e.g. temperature, lighting, noise) on usage, and the limitations of mobile devices [19] are all challenges in the mobile context. Changes in the context may affect the performance of a mobile device, or interrupt the interaction between a user and a service. According to Dix et al.[10], mobile context includes the network infrastructure, the broader computational system, and the actual physical environment.

For mobile work, information technology can be seen as a mobility-booster, sustaining multiple on-going interactions, and emphasising the importance of personal networks and places as a material foundation [18]. Technology supporting mobile work includes mobile devices and communications infrastructure [49] as well as mobile business services. Mobile business services are those used in a work context through mobile devices. These services enable, for example, mobile access to corporate information systems and the Internet, or real-time data collection in the field, e.g., [37], [35]. Benefits derived from using mobile business services include improved productivity and operational efficiency [13], [35]; improved working processes, internal communication and knowledge sharing, and employee satisfaction [37]; as well as greater effectiveness, flexibility, visibility and customer satisfaction [15]. However Van der Heijden et al. [42] argues that the benefits of mobile technology are usually overestimated and the drawbacks underestimated. One reason for this could be that working cultures using mobile business services are still quite immature.

The adoption of new mobile services at work means that we have to rethink how our mental furniture is arranged. Mobile and wireless technology shift the concepts of where and when we can travel, how we organize our different everyday activities, and how for instance we 'micro-coordinate' work related tasks. Being 'mobile' in general helps in being accessible to and keeping in touch with important contacts at work, which in turn contributes to a better flow of information and effectiveness - *fluid interaction*; but also means that professionals need to cope with an overwhelming flood of interaction from others [16]. People are faced with an ever more intense flow of information, both professionally and as individuals, and are facing ever more complex decisions [24].

III. MOBILE INTERACTION IN A WORK CONTEXT

The key part of this study is to better understand mobile interaction in a work context, since it would contribute to the design of successful mobile services. As mobile technology enables on-going multiple interaction, understanding the characteristics and dynamics of mobile interaction is essential in addressing such issues as how to manage interaction better, the effects mobile interaction has on the success of mobile work services, and the overall design of mobile services.

According to Sorensen and Pica [38] there are rhythms of interaction to be found among mobile workers. In their study of policemen in the UK, Sorensen and Pica [38] argued that policemen make rhythms of interaction in their daily routines as they interact with each other and the general public. Within these rhythms there are elements of coupling and decoupling, and elements of regular change in the intensity of being busy and in continuous contact. [38]. In addition, interruptions while working and completing tasks may affect task performance [33].

Mol and Law [28] propose that mobile interaction may be understood as a means of social topology. In social topology, mobile interaction is explained as a construction of regions, networks and fluid. Regions are objects that are clustered together and delineated by boundaries, e.g., traditional HCI as networks describes relative distances

that are a function of the relationships between the components, e.g. modern life-style. In addition, in fluids, boundaries or relationships do not mark differences, boundaries come and go, show leakage and disappear, while relationships also transform themselves, e.g. the relational disposition of HCI is ambiguous and transitory, "a world of mixtures", "variation without boundaries and transformation without discontinuity" [28].

The mobile interaction enables "remarkably uneven and fragmented flows of people, information, objects, money, images and risks across regions in strikingly faster and unpredictable shapes" [48] as well as causing interaction overload, [28], [25].

The vital part of the mobile interaction displays asymmetric elements of interaction [31]: the mobile user may be interactive or interpassive [17] with their interaction activities.

According to Kakihara and Sorensen [16], managing an interaction involves management of the 1) relevance of the interaction, 2) interaction modalities, and 3) offering the receiver of the request for interaction the chance to postpone or prioritize the interaction. Furthermore, one of the key issues seems to be managing multiple ongoing conversations. Mäenpää [30] stated that mutual awareness of location is relevant in any interaction, in addition to awareness of activity [46] session management and floor control.

Taking all the above points into consideration, it appears that mobile work and mobile interaction are complex and changing processes affected by a variety of different factors. For this reason, in order to understand and manage work related mobile interaction better; we will next discuss and suggest some methods for modeling it.

A. Modelling the Mobile Interaction

The success of mobile interaction depends on many variables, for example, the device via the service used, and the functionality of the telecommunications network. In their study Markova et al. [27] introduced some success factors of mobile business services and how to measure the success. Their study suggests that new operating systems in mobile devices can cause problems for service providers because their service may not work with the new versions. In that situation, the critical actor for the success of mobile business service is the software provider. It is essential for developers of mobile business services to identify the critical actors that make mobile interaction possible or even impossible. In addition, analyzing the strength of the actors' influence on the success of the mobile business services helps to identify which are the most critical actors. The critical actors are part of the network that affects the success of a mobile business service. The network may be an organization or a part of it, people as well as devices in the organization, so it can be quite small. Moreover, from the mobile business service point of view the network usually consists of several organizations. Tilson and Lyytinen [40] present major organizational actors in the wireless industry for example: network operators, device manufacturers, infrastructure manufacturers, and customers, as well as content and service providers. This network is naturally quite large and therefore even complex.

Understanding the complexity of the network and the interaction between humans, or humans and systems

within it, can be aided more clearly by diagrams, figures or models. Contextual Design (CD) developed by Beyer and Holtzblatt [3] is one user-centred design method. It helps designers to understand how people perform their work and to design interactive systems that support it. CD includes, among other things, different models to describe how work is done, one of which (the flow model) is intended to describe communication and coordination within a specific group or organization. The flow model presents the people, who interact each other and the artefacts they send each other.

Studying people's work environment and analyzing in detail how they perform their work is emphasized when developing mobile services for work use. Task analysis provides the tools for this [9]. Different models and diagrams have been used or developed for modeling work tasks, for example operational sequence diagrams, and Concur Task Trees Environment (CTTE) [29], and Tamot [26].

Business process re-engineering (BPR) and modeling (BPM) are methods that can be used when improving business processes through information technology. BPR includes three major stages; "the analysis of existing processes, establishment of the redesign objective, and design of new and improved processes" [23]. BPM can be seen as a BPR tool – it aims at structuring the activities of an enterprise in either an as-is model (current situation) or a to-be process (proposed situation). Business processes can be visualized using different diagrams, graphs, and interactive tools. In modeling business processes for example, activity diagrams [2], P-graphs [41]; [15] and flow charts, e.g. [45], may be used. A very popular method for modeling business processes is Unified Modeling Language (UML), see, e.g., [12], and this is next introduced in more detail along with an applied modeling method called Mobile Business Service - UML.

B. Unified Modelling Language and Mobile Business Services – UML

Modeling is a central part of any software project and it should occur before the programming. It helps to communicate the desired structure and behaviour of the system and in visualizing and controlling the system's architecture. Moreover, modeling helps to better understand the system [4]. Modeling also ensures that the user requirements have been taken into account, and that the design of the software supports these requirements, for example in the expandability, security and accuracy of the software. Unified Modeling Language, UML, is a widely used modeling method in software development processes. It is also a well defined standard supported by many tools and vendors. UML modeling offers several diagrams to support modeling of the structure, functionality and architecture of an applications using, for example class diagrams, object diagrams, use case diagrams, sequence diagrams, or activity diagrams [4]). Although UML is traditionally used in software engineering, it provides a "common grammar" for service developers and business users (e.g., marketing, management, decision-makers in the client company) and is very suitable for modeling business processes. According to Dobing and Parsons [11], class, sequence, and use case diagrams are the most commonly used UML diagrams in software projects whereas activity diagrams are basically used to model business processes [12]. They argue that to be effective the models should be described

in an understandable way [12]. That statement can be assumed to be valid when describing anything by using models.

If the network needs a broad description, the flow model of the Contextual Design method, existing task analysis methods or business process modeling methods are not suitable. The shortcomings of the task analysis models for the current purposes is that they focus on modeling the users' tasks, but they do not take into account the whole business process and different stakeholders. Analyzing potential benefits requires a consideration of the business process context in which the mobile service is to be deployed [8]. In addition, identifying all critical actors connected to a work process becomes more important.

Understanding the need for a new modeling method to analyze the success of mobile business services we have developed a modeling method called MoBiS-UML (Mobile Business Services – Unified modeling Language). It is based on the sequence model of the UML. MoBiS-UML combines business process modeling with mobility and usability requirements. It is a method not only for developers, but also for marketers and decision-makers. Because MoBiS-UML presents the usability problems in a process, it aids in the marketing of a new mobile service by making possible comparisons between the customer's current process (as-is) and the potential process when using the mobile service (to-be); and in developing mobile services that better support the user's mobile tasks and work processes. It therefore helps developers understand the causes and effects of usability problems. The benefits for business managers are that MoBiS-UML highlights the time savings a new mobile service can produce. However, since MoBiS-UML is intended to model work processes, it does not take into account the affects of the actors in a wider network, such as network operators.

When modeling interaction with UML or BPM, the underlying assumption is that work involves routine work tasks and information exchange is standard. Thus, understanding the construct of mobile interaction in this way seems to cover only single cases and tasks. We argued that any analysis should go beyond that and that there is an urgent need to pay more attention to analyzing mechanisms of interaction.

C. The Actor Network-theory Approach to the Ecology of Mobile Services

Process methods such as UML provide valuable information of the usage problems in certain design cases, and especially in describing details of single processes on a concrete level. However, because mobile services are used in various working contexts, this poses challenges in finding approaches which describe mobile interaction on a broader and contextual level. The 'disposable' nature of the process tools often makes them inadequate for explaining interactions beyond single specific cases. Thus, in order to explain the interaction and ecology of mobile service use in more contextual depth, we need to take a broader view. Mobile communications are still relatively new technologies and are quite open to reinterpretation, while their newness means that we are making up the rules as we go along and are still in the process of making sense of them.

Quite often, either technical or social determinism are used as explanations. It is taken for granted that either

technology or humans are the determinators: that the one is driven by the other. [21]

There is also a tendency though, to avoid this kind of technological determinism and reductionism in interpretations; and seek more varied and context sensitive analysis (see for instance [32]). In order to understand the interaction systems between human and mobile technology we need to better understand how the interaction is constructed. For instance, what kinds of preferences do humans or machines have? What kinds of interactions are successful in reproducing themselves?

Actor network theory (ANT) is a relational and process-oriented approach, which analyses interactions and the mechanics of power and organization. According to this theory it is a good idea not to take for granted that there is a macrosocial system on the one hand, and pieces of microsocial on the other. Instead we should start with a clean state: for instance assuming that interaction is all that there is. We might ask why how some kinds of interactions more or less succeed in stabilizing and re-producing themselves: how is that they overcome resistance and seem to become macrosocial; and seem to generate effects such as power, fame, scope or organization which we all know [21],[22]

ANT suggests that society, organizations, agents and machines are all effects generated in patterned networks of diverse (and not only human) materials. According to the theory, network is better seen as a verb rather than a noun. ANT relates to the sociology of science and technology which argues that knowledge is a social product, rather than something generated through the operation of privileged scientific methods. 'Knowledge' may be seen as a product or an effect of a network of heterogeneous materials, it is material (for instance in papers, preprints and patents) but is also a matter of organizing that material. Networks are composed not only of people but machines, animals, texts, money, and architecture too. Not all the things that form a social network are human. In this concept the task of research/sociology is to characterize these networks in their heterogeneity.

Many of our interactions with other people are mediated through some kind of object (a writer, thoughts, text, a keyboard, paper) while our communication is mediated by a network of objects, such as computers, media, and books. It is also mediated by networks of objects-and-people, such as the postal system. Various networks participate in the social realm. If human beings form a network they interact not only with other human beings but other material things too. Human beings also have preferences: they prefer to interact in certain ways instead of others, and materials and different technological artefacts too may have preferences.

ANT theory does not celebrate the idea that there is a difference between people on the one hand, and objects on the other. It actually denies that people are anything special when looked at from the aspect of the network. The dividing line between people and machines is subject to negotiation and change. Thus it is easily shown that machines may gain and lose attributes (such as independence or intelligence), while conversely people may take on and lose attributes of machines and animals.

IV. MOBILE WORK AND NETWORKS

According to critics, one of the shortcomings of ANT is its inadequacy in respect of the actor. It is no stable theory of the actor, but instead suggests radical indeterminacy. For instance, psychological factors and motivations behind actions can't be predetermined. This of course, may be problematic, as it may result in complete relativism, where anything can be defined as action. [5], [6]

For instance, ANT has been applied in analyzing the economic market, where it has been used to follow the birth of an organized market [6]. The market is an instrument which mixes the human and non-human, and controls their relations. Economic theory describes the circulation of goods and the allocation of resources between human agents. According to Callon [5], there it is a challenge to apply ANT to the market, as the market suggests a strict separation between human agents who are able to make decisions, and the goods in circulation which are passive and non-human by nature. However, ANT can for instance help to map the entirety of a network of relations: all the work that has to be done, and all the investments that have to be made in order to make relations calculable in the network. [6]

We have applied ANT in order to understand more clearly the interactions between contexts, environments, actors, institutions and technological artifacts in work related mobile service use. This, in turn, helps us to identify obstacles and success factors in the process of work related mobile service use and contribute further to the development of useful metrics for mobile business services.

We used the safety measurement process as an example to model work process and to describe the interaction between humans and systems. The safety measurement is based on a method called TR-measurement [20] which improves work site safety by checking that various safety issues (e.g., the use of helmets) have been taken care of according to requirements. In Finland, the law requires safety measurement and it is done weekly in all construction sites. During the TR-measurement process, a work site is checked by walking around the site and making observations. The assessment is made according to a predetermined list. Two people participate in each measurement: an industrial safety officer and an industrial safety delegate.

To model safety measurement process (see figure 1) we collected data by contacting the customer services department of a mobile service provider currently using the above-mentioned service in their work. We collected data from the service users through a group discussion and an interview at the construction company. In addition, data was gathered by observing three users of the mobile service in their work at two different construction sites. Two researchers who followed the safety measurement process, done by an industrial safety delegate and a site supervisor, conducted the observations. After gaining a comprehensive view of the business processes affected by, and the usability issues related to, the use of the mobile service, we modeled the process with MoBiS-UML.

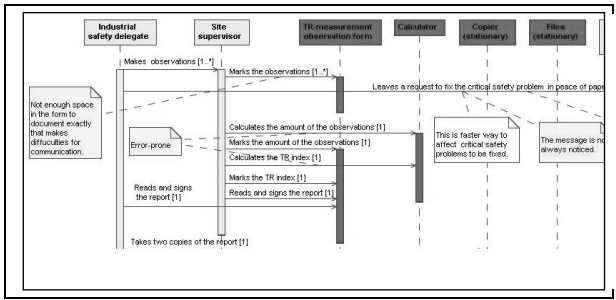


Figure 1. Modeling the model safety measurement process

By modeling the safety measurement process, we are able to understand the tasks and their dependency and relationships better. However, when modeling tasks in this way, only a cross section of mobile work processes and related challenges is attained. The impacts of instantaneous conditions are emphasized, but as some of the key impacts of mobile work are only perceivable by long-term analysis, goal-oriented usage or when understanding the social structure and dynamics of mobile interaction are essential, we propose the MoBiS-Map be considered as an analytical tool.

Thus, we developed two networks, MoBiS-Map maps, (see figures 2 and 3) to describe the network of actors that a mobile worker completing the safety measurement process has. First, we describe a mobile worker without the mobile service (figure 2) and second, with the mobile service (figure3). The main goal is to study the transformation that occurs in a working context after applying a mobile service.

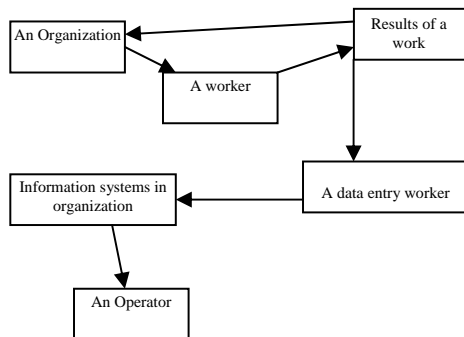


Figure 2. The mapping of 'work' as network

The starting point in with modeling the transformation of interaction by the method of an actor's network is modeling interaction without the mobile service. Figure 2 presents the network that a construction worker conducting the safety measurement process has. The worker is connected directly to their organization and supervisors and the results of their own work, and indirectly with a data entry operator. When using a mobile service for the safety measurement process, the network changes, and so too does the interaction between different actors (see figure 3).

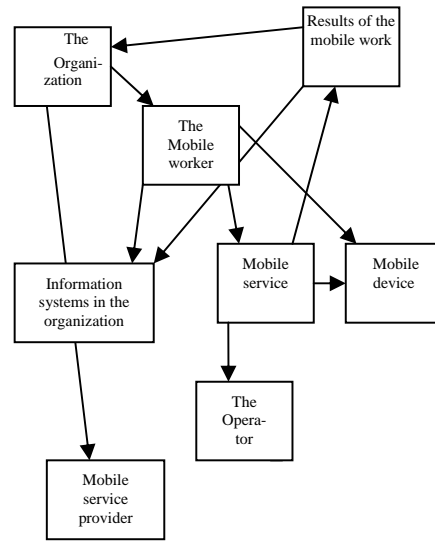


Figure 3. The mapping of 'mobile work' with wireless technology as the network

In this example using a mobile service to complete the safety measurement, the construction worker is directly connected not only to their organization and supervisors, but also to information systems, mobile service, a mobile device and mobile operator.

To carry out the MoBiS-Map method when analyzing the transformation of a mobile interaction, we suggest conducting the following phases:

- define the key actor as a starting point (in our case a construction worker)
- define and specify the most important human and non-human actors in the current situation
- define the critical actors
- define and specify the most important human and non-human actors in new situation with the mobile service
- define the critical actors
- determine whether the actor's network changed
- determine whether there are new critical actors in the network
- analyze the transformation of the interaction
- define the influences of the transformation on mobile work

Obviously, the MoBiS- Map method shows the complex interdependency between the different actors, both human and technological. For instance, there is as deep an interconnection between the service provider and the tele-operator, as there is an interconnection between the individual worker and the different actors. An ANT map helps to further analyze these actors, which usually may be only usually weakly recognized.

A deeper comprehension of mobile interaction and particularly the transformation of interaction are emphasized here. This transformation of interaction and the impacts of transformation may vary in different work contexts. According to Vartiainen and Andriessen [1] the types of mobile work (see figure 4) depend on the level of mobility and the level of routinisation of the work. In this paper, it

is suggested that if the type of mobile work is highly routine, modeling tasks and processes may describe the transformation well, but could still be better. When exploring less routine work, the shortcomings in understanding the actors' network become perceivable.

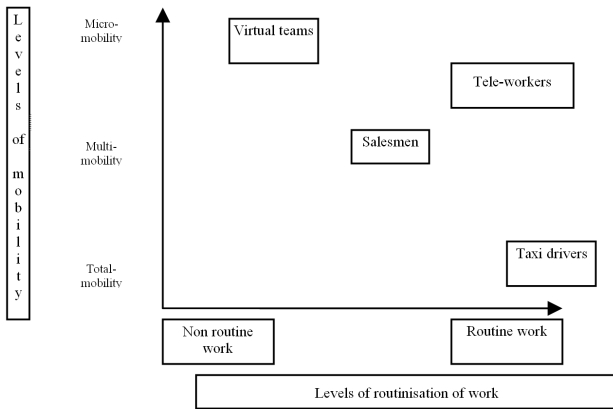


Figure 4. Types of mobile work [1]

V. CONCLUSIONS AND DISCUSSION

In addition to existing mobile work, there has been a rapid change from traditional office work towards mobile work in different fields and therefore designing successful mobile services for mobile work contexts is crucial. To design successful mobile services, the focus should be upon the special characteristics of mobile work and the mobile interaction that takes place. Furthermore, we need new tools to analyse the key issues of mobile interaction in a work context and particularly tools for better understanding the dynamics of interaction.

This paper presents two methods to analyse mobile interaction in a work context (see table 3). The first method, MoBiS-UML, is introduced to model single work tasks alone. However, it is suggested here that the process tools are often inadequate for explaining interactions beyond single specific cases. Thus, in order to explain interaction in a more contextual level, we present a more social network oriented method, MoBiS-Map.

TABLE III. TWO APPROACHES TO MODEL TRANSFORMATIONS OF MOBILE INTERACTION IN A WORK CONTEXT

	MoBiS UML	MoBiS Map
How	modelling work tasks (current, optional, observed)	modelling networks (current non -mobile and with mobile service)
Why	determine transformation of interaction between current, optional and observed work tasks	determine transformation of interaction between work without mobile service and with mobile service
Prospective strengths	understanding interaction in routine work and in standard information exchange	understanding interaction in non-routine work and in non-standard information exchange

Although the MoBiS-Map method is still in its developing stage, we suggests that it is justified by aim of understanding the interaction systems between human and mobile technology and in particular of understanding better

how the interaction is constructed and transformed. For instance, what kinds of preferences do humans or non-human actors such as mobile devices and networks have? What kinds of interactions are finally successful in reproducing themselves?

Examination into supporting mobile work has started to emerge and the challenges that it faces requires considerable further research. To mobile workers, it might seem that what is related to mobile service and what is related to a mobile device or networks are not quite distinct. However, when exploring a mobile interaction in the work context, mobile workers experience all these three elements as an undivided experience, which has an influence on the work performance.

In summary, we have investigated success factors of mobile business services by developing a better understanding of how to analyze success factors of mobile work. In order to analyze these success factors, we analyzed management of mobile interaction in a work context. We argued that for exploring mobile interaction, several approaches are required. First, an analytical tool for exploring work process and interaction is needed so that a cross section of mobile work is achieved. There are several elements in mobile work that are dynamic in nature, i.e. changing context, and therefore an analytical tool for long-term investigation of mobile work is important. We present the MoBiS- Map as such a tool.

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