When Users Move Faster Than IT:
a study of mobile technology in a work related setting

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abstract: this is a study of mobile information systems and services in a work related setting. In our view, much of the previous research in this area have been too narrow with an extensive focus on white collar workers who take their work away from the office. We are studying a group of workers who never had an office and always has been expected to do their job on the go, namely; field technicians in the Telecom business area of Eltel Networks in Norway. Our main objective is to study what happens when users move faster than IT, i.e. when workers take the initiative in using non-adaptable mobile systems in the field. In trying to solve the usability problems; we suggest that it's advantageous to make careful considerations with regards to 1) understanding the mobile context, 2) taking note of the janus-faced nature of the mobile phone and 3) being aware of the ubiquitous expectations that is associated with the smartphone. We also suggest that designs in this area can't be approached as usual greenfield designs. Legacy systems can't be replaced overnight, they must be designed under the awareness of sociotechnical complexities. As an alternative we offer heuristics garnered from information infrastructure theory.

Introduction

Introducing expectations of ubiquitous computing at work

In 1991 Mark Weizer prophesied the notion of ubiquitous computing. The notion was a future where computers were seamlessly integrated into the world at large. By being integrated into our everyday life, by running indistinguishable in the background, for the only purpose of serving us; machines were supposed to fit humans and not the other way around. Weizer argued that this would enable humankind to do everyday chores and work related tasks faster and easier, with less cognitive strain than before (Weizer, 1999).

Not everything about Weizer prophecy has panned out exactly like he imagined. But he got one thing right; information technology has gotten more mobile with the introduction of

smartphone technology, cloud computing tools and the gradual emergence of smart devices embedded within electronics, software, sensors, actuators. Today, smartphones has almost become a ubiquitous possession. Take a trip on some public transport or have a rest in some café, and almost everyone is entrenched in their mobile devices.

Making smartphones a part of our everyday lives creates expectations (Ling, 2013). There is now an all-round assumption that we should be able to perform tasks fairly easily while we are out and about. If you want to hail a cab, just request it via the Uber app; if you are lost, just turn on google maps; if you want to kill time, just turn on a podcast with some music and so forth. Obviously, this social behavior translates into all spheres of society, not at least when we're performing work-related tasks . Most of us will expect that there really should be no need to walk back to the desktop computer or drag a big laptop around if we want to do expedient and easy work tasks. But, despite innovations in mobile computing, to walk away from larger computer devices, isn't always as straightforward as we might think. There are still inherent problems with mobility and distributed collaboration, just like researchers in the pre-smartphone age uncovered long ago (Belloti & Bly, 1996).

Not all information systems are developed to run on small devices. They are not responsive as computer scientist will put it. Due to this fact a schism occurs in many instances. Workers expect to use mobile technology in all contexts, although employers ain't able to provide it . We are going to study an instance where workers don't sit around and wait for things to happen. In our situation workers have taken the initiative to take an unresponsive information system out in the field on their smartphones. In this situation the technology is the laggard. Users have moved faster than IT.

We want to study what happens *when users move faster than IT in a work related setting.* Our study is partly descriptive and partly normative. In the descriptive sense, we want to see how users handle an imperfect information system; what kinds of workarounds that has emerged due to system imperfection; how users handle goofy interfaces; how they tackle daily frustrations and so forth. In the normative sense, we want to come up with general guidelines for how these kinds of problems could be mitigated by employers.

The case: Eltel Networks

Eltel Networks is a sizeable corporation operating in 10 Northern European and several African countries. Eltel specializes in a field called “Infranet” and provide infrastructure construction and maintenance services within the business areas power, communication, transportation and security. The company employs around 10 000 people worldwide and have net sales of around €1.25B annually.

Our case study takes place in Norway. In a Norwegian context, Eltel is a fairly large employer, employing around 1 250 people. The majority of the workforce labor in the telecommunication infrastructure area. Their jobs are usually out in the field and consist of different kind of installation, maintenance or disconnection of various technologies, such as fiber, copper cable and mobile antennas. Accordingly, a large part of the workforce is on the go between different tasks in the field, working on demand from a company dispatcher. The work they do is socially critical, since it’s about making sure that much of Norway’s telecommunication infrastructure functions properly.

The laptop PC has been the strategic platform of choice for Eltel since the start of the company 15 years ago, and is still the official IT strategy. The field technicians have specialized applications and equipment for working and reporting in the field. This system, and way of operating, has been developed over a long time, and builds on a web based interface. Accordingly, it’s designed for PC and has limited support for mobile use. Due to this fact, the system isn’t easy to use and interact with from mobile handsets. Despite usability problems inherent in the system, it’s the users who have taken the initiative to transport it directly into a mobile setting. In this case; we particularly want to find out:

- Why is there user-initiated adaption from laptop PCs to mobile devices even though the web based interface isn’t responsive?
- Do the users use smartphones and laptops in combination, and do they use other media in addition?
- What is cumbersome or ineffective in this scenario?
- How could the work process be more efficient with better mobile system support?

This is an in depth qualitative case study into exactly one work setting. We look at the Eltel case as an *intrinsic and instrumental case* (Stake 2005). This is not a *critical case* suited for falsifying and verifying hypotheses (Flyvbjerg 2006). We want to understand how the expectation of doing ubiquitous computing is shaping practices in Eltel, and learning from

that, provide insight into similar cases where non adaptable mobile systems has been implemented in the workplace. Our primary goal is to contribute to *rich insight* about the particular case. Specifically, we want “to capture insights from [the case] that are not easily categorized as concepts, theories, or specific implications” (Walsham 2002). Furthermore, based on the *rich insight* and by studying the system from the perception of the users themselves, we hope to uncover some findings that can be used to generate general theories about the particular subject and what happens when users move faster than IT.

Researching field technicians

Our research group has been expected to be working with a variety of technologies for a long time. Despite this fact, researchers have only recently started to investigate the use of technology in relation to multi-location work. Several studies have been concentrated upon what happens when white-collar workers start working from outside the office (Peters and Heusinkveld, 2010; Bosch-Sijtsema et al., 2010; Hislop and Axtell, 2009). Further, much effort has been expended on answering whether mobile work is good or bad (Sarker et al., 2012; Gregg, 2011; Kanellopoulos, 2011; Pyöriä, 2011). In our view, much of the previous research have been too narrow, many knowledge workers, like our field technicians, have never had an office, so what we really need is a redefinition of the workplace. In our case, making judgements between good or bad is totally irrelevant, field technicians have no choice; they have to be out in the field. Hence, we will discard value-laden judgements and carry out our research under the same prism as Sebastian et al. (2016), which focuses exclusively on “particular work activities, their contexts and the ways work activities are undertaken as part of a telework regime”.

Primarily, we want to find out whether the smartphone has introduced new usability problems for our research group. Our investigation is going to be contrasted with background theory about ubiquitous expectations (Ling, 2013), the “janus-faces” of the mobile telephone, especially the dichotomy of fixed – mobile (Arnold, 2003) and paradigms about understanding mobile contexts (Pascoe et. al., 2000).

In regards to our normative perspective, we’re going to build on theories about how we best go about doing design on an installed base, i.e. how we can do brownfield design on a legacy system? This is theories developed by a group of researcher who we by shorthand call for the information infrastructure community (Hanseth et al. 1996; Benkler 2006; Hanseth & Lyytinen 2010; Tilson et al. 2010).

Methods

This study is conducted with qualitative research methods. Basically, we have six sources to gather information from, when conducting a case study: documents, archival records, interviews, direct observation, participant observation, and physical artefacts. We have used three strategies to gather data: interviews; observation; and document analysis.

In the first round, we studied field technicians at work through passive observation. In the second round, we interacted more with the users, asked them why they choose to do things in certain ways and so on, i.e. using participatory observation. After having done sufficient observation, we garnered enough insight into what kind of issues field technicians encountered when using legacy systems on mobile devices. This insight led to formulations of concrete questions that could be embellished upon through interviews with participants in the research group. Through interviews, we acquired a rich description of the user context, potential user problems and user behavior. In the last round, we came up with simple suggestions for how the system can be improved to better suit the user's need. In order to make improvements, we had to take a look into technical aspects of the system, i.e. making an analysis of whether our improvements were doable.

Special Considerations

One of the researchers currently work in Eltel and has first hand knowledge of what goes on there. Since we are dealing with qualitative data, it is of outmost importance to be aware of any biases which close proximity to the research objects can lead to. We have solved this by doing analysis of the data material independently before we compared our findings.

Background theory

Although it's too pompous to say that we want to stand on Merton's (1965) "shoulders of giants", we do want to build our research on previous findings with regards to our research questions. Previous research gives us a scene to stage our case on as well as guidelines to how we can interpret our own findings. When it comes to interpreting user behaviour in multi-local work, it's all about user expectations, user contexts and the physical artifact itself - the mobile phone. And when it comes to doing brownfield design, it's never all about the technology itself, but also about socio-technical complexities.

Ubiquitous expectations

As smartphones becomes everyone's possession, they facilitate an accumulation of reciprocal expectations among their owners. The smartphone doesn't only become instrumental in how we organize our daily affairs, it also become instrumental in how we relate to others in our social circle. In reality, it's impossible to opt out of this process, when technologies gains such a critical mass, we're compelled to follow the crowd, in order to function as ordinary members of society. "As a technology becomes more ubiquitous and taken for granted it moves from being an oddity to becoming expected" (Ling, 2014). We have internalized it as a natural part of our everyday activities.

Mobile user contexts

We believe that in order to fully understand mobile usage, we have to analyze the environment where use happens. It's the amount of mobility the users are undertaking while simultaneously interacting with mobile devices which decides system requirements. Just like Pascoe et. al. (2000), we differentiate between four types of mobile contexts. The first context, refers to *dynamic user configuration*, i.e. that users will need to use handheld devices under all circumstances whether "they are standing, crawling or walking". The second context, refers to *limited attention capacity,* i.e. that users need to pay attention both to what he observe and the device used for note-taking. The larger the movement in the objects being observed, the more stress becomes associated with using the smartphone. The third context, refers to the *speed of interaction*, i.e.how much data that needs to be

recorded both quickly and accurately in a limited time-span. The last context, refers to *context dependency*, i.e.that “fieldworkers activities are intimately associated with their context or, if different, the subject’s context”.

The janus-faced mobile phone

The mobile phone is cursed and blessed with having two faces facing in different directions (Arnold, 2003). Arnold points for instance to the fact that the technology is both liberating and incarcerating. The mobile phone enables us to stay in constant touch with each other regardless of distance, but at the same time it keeps us reachable at all times. There is no opting out. Further, the performance of the smartphone means that it’s not necessary for employers to facilitate a good working environment. In theory, the technology entails that everyone can work from anywhere. This blurs the line between a work-place and a place that is distinct from work. Alas, in our case, field technicians aren’t the only ones who expect to do their work while being on the go, it’s also something the employer suppose. The janus-faced mobile phone makes necessary tuning of technological solutions in work-related circumstances harder to achieve. Expectations about ubiquitous computing has become pervasive. The norm is that work tasks can be performed easily everywhere, so putting resources into paving the way for good mobile working tools, gets more or less put on the mental shelf. The technology like it appears today is the answer, nothing else.

Information infrastructures

The information infrastructure community theorizes a digital infrastructure as an open, shared, evolving, standardized, and heterogeneous installed base (Hanseth & Lyytinen, 2010). Their view of installed base goes beyond users to include socio-technical systems, i.e. human, organizational, social, political and technical factors (Sommerville, 2012). A key point for the information infrastructure community is to work out contradictions between the *bootstrap* problem and the *adaptability* problem (Hanseth & Lyytinen, 2010). The bootstrap problem describes how an information system must recruit early adopters in order to establish itself. The adaptability problem describes how digital infrastructures must readjust in order to maintain its existing users and acquire new. In general, solutions to the bootstrap problem causes lock-in and path dependency, matter of contentions which limit options for

the adaptability problem to be addressed later on. The solution to the adaptability problem is referred to as cultivation strategy. Cultivation implies that changes to the information system must happen in a gradual and an incremental manner (Grisot et.al., 2014). The point of the strategy is to keep users motivated and on board with technical changes, although the process might lead to far-reaching organizational changes.

Data Collection

Understanding the domain

Obviously we can't study everyone in a workforce consisting of over 1 000 people. We were naturally mostly interested in studying field technicians who we through various sources had heard were using their smartphones in their work assignments. But, how could we find them in a haystack of employees? Therefore, before we could do anything else, we had to acquire an overview of the workforce; getting a simple sketch of who were doing what and so forth? Fortunately, we received help from various members of the management to carry out the mapping.

Through consultation with managers in the main office we gained knowledge about the nature of working in the field and the diversity between different tasks. We got especially good assistance from the line management and the internal IT department, which we interpreted as the entities in the company with the most knowledge about the domain .

The Telecom business is split into 2 Area Business Units - Mobile and Fixed, which in turn are divided into regions and teams. On team level there are in general two types of specialization; Care & Connect (C&C) teams with many small work-orders, and Build teams handling larger projects. All use the same systems, which are communicating with the customer Telenor via B2B integrations. It would seem that the C&C teams in Fixed Telecom are the most mobile users, since they are expected to be in contact with their team manager, Telenor and service users throughout the day.

We decided to look further into the C&C field force user group as they appeared to have tasks that involved a lot of movement and smartphone usage. Through a conversation with

one of their managers we also got the impression that many technicians might be required to work, test and report through a number of technologies at various places. Conversations with other Eltel personnel confirmed the impression we got from the manager.

How the system works today?

The company's policy is that the workers should use laptops out in the field. Despite this, many in the workforce choose not to comply, and uses the mobile phone as the technology of choice.

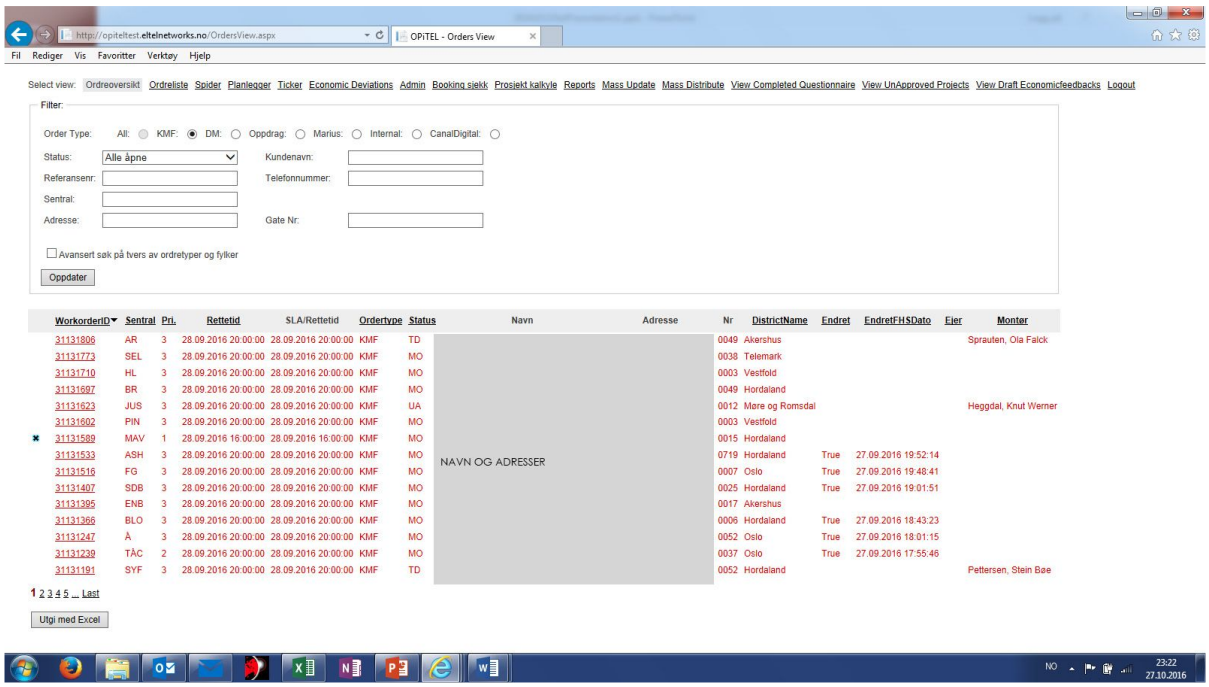

Fig 1. Opitel PC browser orderlist view

During the initial phases of our study, we learned that this practice was something the main office already were aware of. It also became clear that the system developers had worked to make the most relevant features of the Workforce System mobile friendly. Although not officially a strategic choice, there was and continues to be a common understanding within the company that using smartphones in the field is beneficial, and due to this accepted fact; service-minded people in the IT-department have been allowed to address the most evident shortcomings in the system as a result of mobile use.

Despite this ad-hoc tinkering from the IT-department, Eltel is by no means within an immediate reach of being able to provide their workers with a fully functional system that is responsive to smaller screens. As proof of this, users have reported functionality not compatible with the smart mobile internet browser as bugs directly to the system developers, or through the helpdesk, as if it's expected to work everywhere, because it's web based. Corporate standardisation on browser support for the MSIE family above version 6 does not appear to have any bearing outside of the IT organisation as users expect the system to work with whatever browser they prefer.

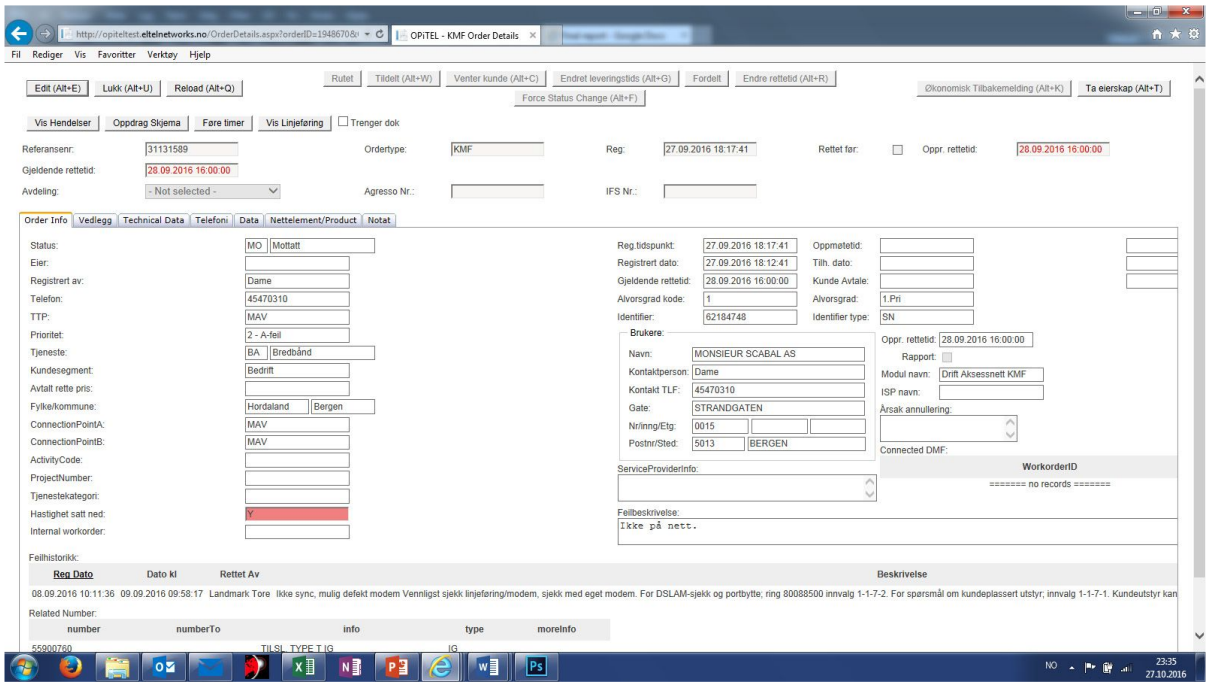

Fig 2. Opitel Workorder PC view

Based on theories about ubiquitous expectations given to us by Ling (2013), this behavior didn't come as any surprise to us. People who are not schooled in computer science do not realize that smartphones need another type of software than computers with larger screens. We also expected the management of the company to be somewhat in a limbo confronted with the issue. Above all they would like to see a fully functional generic system adaptable to all kinds of devices, but when this hasn't been achievable, they have fallen back on doing a balancing act. Trying to stretch the lifespan of the old legacy system without incurring excessive development cost to modernise the system.

Observation

Observing field technicians in their natural habitat from a distance is interesting enough, although we learned that it didn't give us too much insight into mobile IT usability issues. Therefore, we quickly realized that we had to engage our research objects while they were doing their job, i.e. being inquisitive about the work process; asking the workers to be explanatory about what they were doing; try to make them reflect on what kind of the work processes they were pleased and frustrated about.

Through participative observation we learned that much of the work is apparently planned ahead and HMS considerations are important. Working up in telephone poles or in roadside telecom cabinets the user context is such that concentration needs to be on the job. When technicians work in pairs the phone is used for traditional voice communication.

According to the workers documentation of damages and work done by using the phone camera is an obvious improvement over the larger digital cameras that needs to be put back into the service vehicle between use. Only the simplest reporting of status changes seems to be done outdoors on the phone. SMS messaging is done towards automated testing systems provided by the line operator. We learn that these processes are old and not integrated with other systems.

We observed that opening the laptop in the car took some time, and a few users prefered the easy availability of the phone, although the required data input was harder to complete. We remembered that the team leader had informed us in an earlier conversation that the data quality varied considerably between technicians. As researchers normally do; we had a discussion between ourselves about whether this could be a result of difficult smartphone reporting, but agreed that this couldn't be confirmed without some

performance tests. And this was outside our research scope. Similar situations should however be investigated by other researchers in different studies, because we do think this is an issue that are rather central to the problem of legacy systems not entirely suited for telework.

To sum up, through observations we learned that it was a variety of practices involved. In total the workers used three types of media: smartphone, laptop and paper. Usually two of them were used in combination.

- Laptop and Smartphone
- Laptop and Paper

When it comes to understanding the field technicians mobile context in relations to Pascoe et al. (2000), we believe that the perspectives *speed of interaction* and *limited time span* is the most relevant. It's not that the workers need to carry out their registration with so much speed as such, they can do it in their comfort of their car and so forth, but they should carry it out before they leave the scene and they have to carry out a number of separate tasks at different locations during the day. So, having a responsive interface working on a smartphone, would be useful for those workers who not necessarily want to bother with pulling up their laptop. Based on observations though, impressions would lead one to conclude that a better system could lead to usage where less concentration goes into working around system deficiencies. The workers would most likely be more flexible if they didn't have to put so much care into making sure that they were in a total serene environment (e.g. in the car or sitting) when working with their phone. And that a more responsive system could lead to a more seamless existence between workers and technology, but in this case; "the technologies [has yet to] weave themselves into fabric of everyday [work]", as Weiser (1999) would put it.

User Interviews

The users that triggered our interest to do this case study was the ones that had stretched the boundaries of the mobile technology and the workforce system by working as much as possible from their smartphones. Initial inquiries indicated that this was a matter of personal preference and initiative, and not so much a matter of what kind of work was done.

We interviewed several field technicians and realised that they have the possibility to work with or around the system in many different ways. All users had laptop computers with integrated WIFI and mobile 3G networking capacity. Most of the employees also had some sort of ruggerized Android 4+ based smartphone with 4G capacity and 4-5” touchscreen.

The official procedure guideline is to bring the Laptop in the service vehicle and report online through the Mobile Workforce application before starting each job, and after completing each work-order. In some cases documentation is required before and/or after work.

Some users have adapted their working style to their preferences within what is allowed in the customer agreement, and possible within the limits of the technology available to them. This worker group was flexible in their approach to work tools, and prone to use the smartphone instead of other devices. Others though, selected another approach by printing all the work-orders for the day to paper and set the status to “Work Started” before leaving home in the morning. They worked regularly on paper throughout the day, unless they received notice of an urgent work-order that needed to be addressed and completed using the PC in the normal way. Others again, were mostly playing by the rules, following policy as prescribed.

In result, user interviews made us draw comparisons to the ubiquitous expectations and the janus-faced mobile phone we already theorized about in the previous subsection of this paper. Since the work was supposed to be reported in realtime, the notion about ubi-expectation seem to have been strengthened. And although the smartphone in this instance was easy and tempting to use due to the laborious work processes and constant change of work-environments, the janus faced aspects of the mobile phone insured that some of the reporting from the field was associated with usability frustrations. Furthermore, we confirmed that the device which was most unsuited for mobility was in fact the laptop, because it could only be used in the car, in contrast to paper and mobile phone that could be brought outside.

Analysis

Why hasn’t Eltel implemented a better system?

As a matter of fact, the system has been marked for termination for the last 9 years. The dream has been to do a total rework of much of most of the company’s information system. Eltels directors are well aware that there are several challenges with maintaining an inflexible legacy systems, the problems doesn’t only reside in the area of field work. In the last years the company have arrived at the belief that the most effective would be to implement software packages, These packages are developed by software vendors, but are not specifically designed for Eltel or any other company for that matter. The software packages are meant to be generic, designed to serve a range of different organisations and contexts. At implementation it has gotten obvious that these packages hasn’t been so flexible as Eltel might have hoped. In addition, there has been external problems related to vendors and clients, which has proved to be obstacles to a generification process. To this day 3 generification projects has stranded in this specific area.

We also learnt that the corporate IT strategy has had a mobile App planned since 2012, but non delivery has left the fieldworkers to find workarounds to use available technology efficiently. Based on these initial observations; we got confidence in the information infrastructure theory as a toolbox for how we should go about making suggestions for improving the system.

General discussion of key findings

Its perhaps natural that a large technology services company has a tech savvy set of employees that will push the envelope. We suggest that the success of the world wide web and the expectation of platform independence of web based applications have led the general public to not consider compatibility issues anymore. The work done by the W3C and WaSP on creating web standards (Zeldman, 2003) has given browser developers and website developers a defined and evolving framework that ended the browser wars of the ‘90s.

Mobile browsers don’t have the same level of backwards compatibility as WIMP based browsers, but this is not known to most users. The vast number of free apps available on iPhone and Android based phones strengthen the impression that system development is a trivial matter. As the smartphones all have web browser functionality and the Opitel workforce system is web based and accessible from the Internet users have just started used it the way they would any other site. Appearance might be different from normal, but people have been accustomed to the variations of approaches to web design in the mobile age. Some create separate sites for mobile devices, some use responsive design that tries to reformat the content for the current screen resolution while others rely on the smartphone users ability to zoom and focus on what is relevant to them.

Functionality that did not work as expected has been reported as bugs to the Opitel DevOps team. As it has been reported as bugs rather than change requests strengthen our thesis that users expect platform independence, and ubiquitous computing is a part of the business fabric for field workers.

It would appear that the context and preferences of the worker is related to the choice of technology or media to a greater extent than what the system is best supported on. This ties in with Pascoe et al. (2000) findings when studying field researchers need for mobile devices to support their primary work. Our users don’t have the same need for GUI simplicity as they can single handle their work process and shift focus more than field studies observing something constantly.

That said it is clear that better support for mobile devices in the system design and code would improve the user experience for the fieldworkers and quite possibly increase the rate of adoption of mobile system use. Some users and managers wish for an app to replace the current solution, as this is expected to be better suited to the device for the purpose. The legacy system has been developed over some 15 years and reimplementing as a proprietary app seems costly. Replacing it with a commercially available system with a combination of wimp and mobile apps has been tried 3 times, so far without success for different reasons.

Suggested improvements

Our recommendation to Eltel Networks would be to incrementally evolve the system for better mobile support by updating code and GUI in a user centric design process. Starting with the C&C workflows and better support the process of primary and secondary work (Gasser, 1996) would be a good start.

From our observations, we noticed the possibilities for using the phone's interfaces in combination with the workforce system in such a way that navigation, photographic documentation and automated SMS-ing became an integrated part of the work process. In this respect, it's reason to believe that a system with better mobile support, and a higher range of mobile adaptable services within the workforce system, could lead to increasing efficiency out in the field, i.e. freeing up both time and effort for the worker.

Going forward we suggest that Eltel take note of sociotechnical complexities and implement cultivation as a strategy of IT evolution, rather than revolution. In general it is sensible to make sure business critical systems are well maintained and functional until they have been decommissioned.

Performance issues should be addressed, and we suggest that the GUI is reworked for a responsive web design. A combination of usability testing and user centric design for further improving the system can be done incrementally after the basics for mobile use are covered.

Conclusion

Users adopt ways to work around technology that they feel is not well suited for the purpose. In this case it would seem that the WIMP laptop is less portable and flexible than newer technology like tablets and smartphones, or slower and less durable in the field than older technology like paper and pencil.

The convergence of technology in the smartphone, and the support for web based applications and information, has made it a very useful tool for mobile working. There appears to be little patience on the user side for systems that are not usable on smartphones. Management and customers have high expectations of constant status and progress reports due to the ubiquity of mobile technology.

We can hereby sum up our main findings:

- Yes, there are ubiquitous expectations as work is supposed to be reported realtime.
- Smartphones are easily at hand, but the amount of information related to the job is extensive and not so usable on the phone
- Laborious work process and change of work environment is suited for smartphones
- Laptop stays in car while phones and paper can be brought outside
- The system can be improved by incremental implementations and doing continuous usability tests

Like we stated in the introduction, we view this as an intrinsic and instrumental case study. Its likely that workers in similar fields both abroad and nationally might struggle with similar systems. We suggest that companies who are experiencing much of the same problems takes note of both social and technical complexities in trying to improve their systems. As an heuristic rule we therefore strongly suggest that the theory about information infrastructure design is adhered to. To think that huge reworks of legacy systems is going to save the day, is likely to be a panacea; something that never is going to be fulfilled.

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