The Information System of Mobile Knowledge Workers: An Activity Theory perspective of information sources and interaction

By

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This thesis is submitted by Michael Er
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Certificate of Authorship / Originality

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Abstract

Mobile technology has the potential to connect the mobile knowledge worker (MKW) to information sources which will support their decision making. Many researchers in the fields of innovation adoption and human computer interaction advocate that the development of support technology (such as mobile technology) should be initiated with an understanding of the end user that is based on current work practices, in order to support acceptance and adoption.

The object of this research is to describe the existing information system used by mobile knowledge workers (MKWs).

The assessment of the existing information system of MKWs under examination in this research goes beyond the identification of data and the technical means of data supply. A holistic view of the information system is applied to take into consideration both the existing sources of information which assist in decision making and the interaction and/or access made by the user (MKW) with such systems.

An interpretive philosophical approach was taken via an empirical study of mobile workers in three different contexts. The empirical research resulted in the development of three case studies: Doctors working on ward rounds, Reporters working in the field and construction site workers operating on building sites. The case studies were executed in two rounds, the first round being focussed on the Doctors and Reporters, and the second being a main case study which examined the work practices of construction site workers. Consideration of these MKWs was developed using semi-structured interviews and interpreted through the lens of Activity Theory.

The resulting framework adapted from Activity Theory identifies technical, social and environmental factors which influence the way mobile knowledge workers interact with information sources. Of particular note is the identification of a previously overlooked information source which sits outside the organisation: that of the Contributor. Another significant finding is the preference for information provided by Collaborators over information supplied by information tools. The information provided by Collaborators was preferred as it was subject to the application of Collaborators' knowledge to the situational context.

Publications Supporting this Research

The following publications list peer reviewed papers which are directly related to my research:

Er, M., Lawrence, E., & Kay, R. 2010, 'Information Systems and Activity Theory: A Case Study of Doctors and Mobile Knowledge Work', ITNG New Generations, Las Vegas, USA, November 2007 in *Seventh International Conference on Information Technology*, ed Shahram Latifi, IEEE Computer Society, USA, pp.603-607.

Er, M. 2008, 'Technology Adoption and the Mobile Worker: The Case of the Field Journalist', CollaborateCom, White Plains, USA, November 2007 in *CollaborateCom 2007*, ed Dr. Jonathan Grudin, Dr. Wendy Kellogg, IEEE, Piscataway, USA, pp. 442-446.

Er, M. 2007, 'Developing Mobile Technology for Construction Sites', Australian Universities Building Education Association Annual Conference, Melbourne, Australia, July 2007 in *Australasian Universities Building Conference Association 2007*, ed Kenley, R., AUBEA, Hawthorn, Australia, pp. 140-149.

Er, M. & Underwood, J. 2006, 'Innovation for the mobile workforce: An active theory model', Transformational Tools for the 21st Century, Rockhampton, Australia, October 2006 in *Transformational Tools for the 21st Century*, ed Hasan, H; Wymark, G; Findlay, J, Knowledge Creation Press, Sydney, Australia, pp. 59-63.

Er, M. & Kay, R.J. 2005, 'Mobile technology adoption for mobile information systems: an activity theory perspective', International Conference on Mobile Business, Sydney, Aust, July 2005 in *Proceedings of International Conference on Mobile Business (ICMB'05)*, ed Brooks, W; Lawrence, E; Steele, R; Chan, E., IEEE, Piscataway, New Jersey USA, pp. 322-325.

Er, M. & Kay, R.J. 2005, 'Towards an activity theory perspective on mobile information systems', Australasian Conference on Information Systems, Sydney, Aust, November 2005 in *Proceedings of the 16th Australasian Conference on Information Systems (ACIS 2005)*, ed Campbell, B; Underwood, J; Bunker, D, FIT-UTS, Sydney, Aust, pp. 1-7.

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Chapter 1 Introduction

This thesis is concerned with developing an understanding of the information system used by mobile knowledge workers. This chapter provides a research overview and defines the scope of the study. The research question, objectives and methodology will be outlined, and the key contributions that will be provided as a result of this thesis will be discussed. To enable the reader to better understand the topic, key terms will be identified and the structure of the thesis illustrated.

1.1 Research Overview

Mobile technology, for the purpose of this thesis, is defined as any portable electronic device (preferably wireless-enabled) which offers support to the mobile worker. Examples include mobile phones, netbooks, laptops, personal digital assistants, GPS devices (such as Tom-Toms) and smart phones.

The mobile knowledge worker (MKW) for the purpose of this thesis is any worker who is required to work in a mobile sense (away from a traditional office) and who makes decisions using their knowledge.

Mobile technology potentially affords support for on the spot decision making by a MKW. That is, the mobile device potentially extends the information system, allowing access to data any time, anywhere. Portable technologies however, are not without their challenges. Much research has been undertaken in the area of technology development aimed at improving specific features of mobile Tools (see Chapter 2); however, adoption of such technologies continues to be relatively limited.

Barriers to mobile technology identified by previous research include both physical and social aspects. Researchers from a variety of contemporary technology adoption and development schools of thought have identified the need to understand the 'end user' and the way he or she currently carries out their work as an initial step in technology development. My research addresses the identification and description of the information system, specifically the information sources and phenomenon of interaction, which currently exist for a variety of MKWs.

1.2 Scope of Study

The following industry workers were identified and studied.

- Doctors (Doctors) undertaking ward rounds in both Singapore and Australia
- Newspaper Reporters (Reporters) in a major weekly Sydney newspaper publication.
- Construction Site Workers on two substantial construction projects, as well as a selection of consultants such as architects

This research is only concerned with developing a description of the existing information system of the MKW. The type of mobile device is not the concern of this study but will potentially be a prime consideration in further research.

1.3 Research Question

My research interest originally concerned the question, 'What are the barriers to the adoption of mobile technology by the MKW?' After considering the literature review, however, a matured view of innovation development (and mobile technology development) that accounts for acceptance led to revision of the research questions as outlined below.

The research questions subsequently chosen are, 'What are the major sources of information which comprise the information system for the MKW? How does the MKW's interaction with the information system affect his or her work?'

1.4 Research Objectives

The main objective of this study is to discover the sources of information for the MKW and develop a framework which describes both these sources and the forces governing interaction. It is hoped that through the identification of the information sources currently used by the MKW that mobile technology developers will be empowered to improve the integration of these useful devices into workers' everyday activities.

1.5 Methodology

The research methodology in this research is qualitative, and is determined by the research questions. The research is undertaken in two stages. The first stage consists of 2 interpretive case studies describing the MKW, their information system and their interaction with that system. These case studies are interpreted with the assistance of the Activity Theory framework. The second stage develops a third case study consisting of 2 major construction projects which are interpreted using an evolved framework based on Activity Theory, as applied in stage 1.

1.6 Research Impact and Significance

The study attempts to identify the existing information systems used by three groups of MKWs. The research resulted in the development of a framework which

describes the information sources as well as social and physical constraints which influence (encourage or discourage) interaction with these sources. This model can be applied by any organisation that is attempting to introduce mobile devices to their mobile knowledge workforce. The social impact of mobile devices in the work context is also considered.

It is hoped that the model will trigger further useful research on the adoption and development of mobile devices which will assist decision making by mobile knowledge workers.

1.7 Thesis Structure

This section provides an overview of the thesis structure and content.

Chapter 2

This chapter starts by defining the qualities of the research focus, the Mobile Knowledge Worker (MKW). An exploration of research previously undertaken research in this area is made through a literature review. A determination of the need to identify the existing information system by the MKW is made. Noting previous research, it is found that issues surrounding the adoption and development of technology potentially stem from physical as well as social concerns, which leads to the consideration of interpreting data from the perspective of Activity Theory.

Chapter 3

Chapter 3 considers Activity Theory as a lens through which the case studies can be interpreted. This chapter is a literature review of Activity Theory.

Chapter 4

This chapter outlines the qualitative research methodology used and starts with a discussion of the theoretical epistemology of interpretive research dealing with establishing trends in human behaviour. The research is conducted in two phases. Exploratory case studies based on interviews are developed and two categories of MKWs are examined. Following the initial analysis of the two case studies, a framework based on Activity Theory is introduced and employed to assist in the interpretation of the third case study. The use of exploratory interviews as a satisfactory data source tool is also considered.

Chapter 5

This chapter develops an understanding of MKWs and their information system through the interpretation of data from two case studies. The first case study considers the work of Doctors as they carry out their ward rounds and then applies this framework of description to the second, the Reporters case study. A comparison is made among the case studies and the Activity Theory Framework is adjusted to describe the information system of the MKW.

Chapter 6

Chapter 6 describes the final phase of the research: a major case study of two large scale construction sites. The decision making and the information system of the case study subjects is interpreted through the use of the developed Activity Theory model from the previous chapter. A model of the information system describing the decision making is then finalised.

Chapter 7

In the final chapter the findings of my research are summarised and the implications for both theory and practice are outlined. The developed Activity Theory model for

mobile workers is reviewed, showing the interactive effect on various components of the information systems. The limitations of the research are discussed, and the potential for future research is described.

The diagram below (Figure 1.1) outlines the structure of this thesis and provides a clear indication of the stages of research.

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│  │ Definition of the MKW and review of adoption   │  │ Overview of        │ │
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│ │ Doctors          │→ │ Reporters        │→ │ Discussion Pilot Case       ││
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        │ Chapter 6: Major Case Study                               │
        │ The Construction Site                                     │
        │ Enhancement of information system of the MKW and          │
        │ presentation of final framework                           │
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            │ Chapter 7: Summary of Research              │
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Figure 1.1: Summary of Research

A final note on presentation: direct quotes by interviewees will be presented in italics, to distinguish them from quotations from published research.

1.8 Conclusion

This chapter has presented the research questions and an outline of the thesis structure and chapter content. The next chapter considers the subject of this research, the MKW. A review of the literature in the area of adoption and use of innovations, including mobile technology, is considered. An examination of the requirements of the information system (and the decision support it offers) is made.

Chapter 2 – Literature Review: MKW and Mobile Technology Adoption

The value of any particular information technology can be determined only with reference to the social context in which it is used and, more precisely, with reference to those who use it...It is not just that people have difficulty accepting information technology in a social setting because their interactions are loosely structured. We know that people will treat computers and media as if they were people. Consequently, they superimpose social expectations on technological interactions. (Coiera, 2000, p.277)

2.1 Introduction

This chapter defines the parameters of my research and reviews previous research undertaken in this area through the appraisal of associated literature. I initiate the chapter by defining the Mobile Knowledge Worker (MKW). The information system of these workers affords support for decision making, and through the use of mobile devices the MWK's information system may be improved. (Lehman, Prasad & Scornavacca, 2008).

The adoption and integration of a new technology by a worker are subject to barriers in several forms. This is represented through the large quantity of research in the concept of innovation adoption. In reflecting on the topic of adoption, I consider existing theories of adoption such as the Technology Adoption Model (Davis, 1989) and Diffusion of Innovation Theory (Rogers, 2003).

With much of the research reviewed, the perspective on the introduction of an innovation is that it will bring benefit to the individual user or organisation. One issue with the adoption of an innovation (such as mobile technology) is that its

introduction may inadvertently produce a negative effect on the work of the MKW. That is, the introduction of a new technology will potentially change the way work is done and could interfere with 'invisible work' which makes the work process less productive, creating a challenge for adoption. The interference by new work processes upon an incumbent process prompted by the introduction of a new technology is noted by several researchers such as Suchman (1995), Star and Strauss (1999) and Nardi and Engestrom (1999). These researchers note that because 'invisible work' is not easily identifiable it is often overlooked in the development of innovations. An example of invisible work is informal work (Nardi and Engestrom, 1999) which is not part of the job description of any one individual's job but which substantially contributes to the collective work of an organization.

This chapter sets out to identify the need to map the existing Information System of the MKW in a much broader sense than just the data used. The way information is used (the work of MKWs) needs to be considered. The environment in which the MKW operates is dynamic, adding another level of complexity to the way these workers operate. Through the holistic representation of the MKWs' information system (including the way they work), developers of technology are better able to view how MKWs operate and better identify the information needs with which mobile technology can assist. Activity Theory offers a framework that can be used as a lens through which to examine and represent the work of the MKWs.

2.2 The Mobile Knowledge Worker

In the traditional office context, the work environment is configured by workers to optimise access to resources to assist in their decision making. Tools are reference books and paper documents, computer stored electronic files including local and Internet accessible server records, and even the orientation of team members' desks is geared to support the work process. (Perry et al., 2001)

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To varying degrees, however, many workers are currently required to operate in a mobile sense, away from their traditional office and information resources. That is, as a requirement of their normal work, the mobile worker operates away from an office. Physically, their work takes them to different spatial locations.

Luff and Heath (1998) examined the concept of mobility with regards to collaboration and established three categories of mobility. Micro-mobility describes the way in which an artefact is subject to movement and manipulation in collaborative work. Local mobility is the movement of workers around a local domain, such as moving between different offices in a building. The final classification that they describe is 'remote mobility', which is characterised by the movement of the worker around or between different physical locations in the course of their daily work.

Some remote mobile workers will only be required to pass on or collect information (for example, meter readers who record data at private premises). Another group of mobile workers consists of typical office workers operating from a home office. In this situation these workers will reproduce or have access to the resources of their office.

A subset of these mobile workers will be required to perform some decision making to produce their work outcomes. Examples of this group of mobile worker include Doctors who diagnose patient conditions or administer treatment to patients while on ward rounds; Foremen on construction sites directing tradesmen in their building work; and Reporters producing stories while in the field.

Such classes of mobile workers who are required to analyse and apply their knowledge correspond to the concept of knowledge workers as described by Drucker (1993). According to Drucker, a key feature of a knowledge worker is their ability to acquire and apply theoretical and analytical knowledge in their work.

Davis (2002) further noted that an important component of work by knowledge workers is the accessing of data in order to apply their knowledge work. 'In doing work, knowledge workers access data, use knowledge, employ mental models, and apply significant concentration and attention' (p.68). Knowledge workers operating in a remote mobile manner acquire data from the work environment in which they are working. While moving through their dynamic, ever-changing environment, they gather data and apply their knowledge.

Jaffer (1998) characterised the knowledge worker as a problem solver typically operating in a complex work environment. Knowledge workers possess specific knowledge which they apply in their work activities to get tasks done (Davis, 2002; Hammer, Leonard & Davenport, 2004).

The group of remote mobile workers who engage in analysing situations to gather data, apply their knowledge and make decisions in the course of their work are classified as Mobile Knowledge Workers (MKWs) and are the focus of this research.

2.3 Assisting Mobile Knowledge Work with Information Access

Although knowledge workers are characterised by their ability to apply their knowledge to work situations, the work environment for the MKW is characterised by the isolation from information resources which causes potential problems for accurate decision making and creates the possibility for costly mistakes Perry et al. (2001) notes the difference in terms of access to information (often described as decision support) between office based workers and mobile workers.

> When people work in an office, they have greater familiarity and certainty about the environment and resources (i.e., technologies, information, documents and people) available to them...they know how to find what they need to perform the job at hand...whereas mobile workers do not have access to colleagues or knowledge of

who to seek to get support...mobile workers have less control over their environment and therefore the way they manage their work. (Perry et al., 2001, p.324)

As noted, the complexity of the knowledge work of the MKW is further increased with the ever-changing physical environment (Sorensen & Al-Taitoon, 2008). The decision making of mobile workers can potentially be assisted by access to pertinent, up-to-date information. The development of innovations such as smart cell phones, personal digital assistants and laptops (Gebauer, 2008) hypothetically allows workers who are required to be mobile and away from their offices, access to information on demand while operating in the field. The use of mobile devices has the potential to provide improved communication support for mobile workers, anywhere, any time (Jarvenpaa, 2005). Davis (2002) highlights the potential usefulness of mobile technology for the MKW:

A dramatic increase in access to data and computing by knowledge workers can be achieved technically by mobile computing devices... The technologies release knowledge work from the constraints of a fixed office location and fixed office hours. Knowledge workers can work with full access to communication, data, and computing from any location at any time. (Davis, 2002, p.67)

Consider the Foreman working on a construction site as an illustration of this situation. Mobility is an essential component of a construction Foreman's work as he needs to move between the site office and the construction site itself. On larger projects there are also several points around the site at which work is being done and which also require the supervision of the Foreman. A model of the information system created by a construction site has been described by Er and Kay (2003) and illustrates that the central store of information is in the office (head or site offices) and not where the Foreman is working (the construction interface).
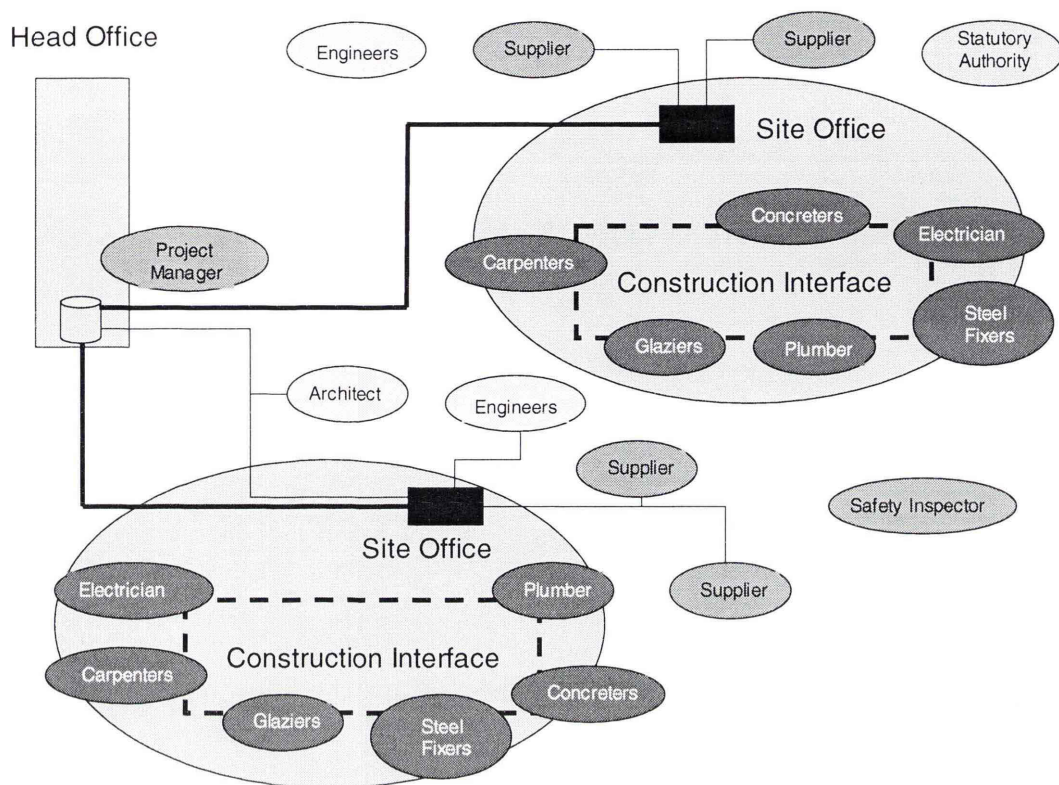
Figure 2.1: Illustration of information stores in the construction industry (Er and Kay, 2003)

Problems materialise as the Foreman moves around the site and through the various work areas. These problems often require the Foreman to make on the spot decisions – decisions which are usually made without access to information pertinent to the decision making process, as they do not have time to return to the office. The decisions they make, therefore, are potentially based upon inaccurate or inadequate information. A study by Bowden and Thorpe (2002) found that 65% (almost two thirds) of all re-work on construction projects was due to the lack of accurate information available to the Foreman on site.

The possibility of using mobile technology to allow Foremen real time access to information as they move around a construction job has been proposed by a number of other researchers (Arnold & Klugman, 2003; Brodie & Perry, 2001; Perry et al., 2001; Sun & Howard, 2004) as a possible solution to the information deficiency.

The development of mobile technologies such as the laptop, handheld computers (such as personal digital assistants, or PDAs) and communication devices like the Blackberry, with increased memory and wireless-Internet access, potentially provide the Foreman with many of the information resources that are available in the site office. As noted by Lehman, Prasad and Scornavacca (2008), mobile applications in business have the ability to provide better efficiency and performance, and generate an important source of competitive advantage.

2.4 Adoption Challenged

Mobile information technology offers workers 'boundary free interaction', the ability to engage in their dynamic work environments while at the same time providing mediation from their traditional office support (Sorensen & Al-Taitoon, 2008). Despite the potential value offered, the utilisation of mobile technologies to date has had surprisingly little impact on the way in which Foremen operate on site. Sun and Howard (2004) discuss the potential which mobile technology could afford knowledge workers on construction sites, however, they also acknowledge the resistance to change encountered.

Some researchers such as Cristensen and Raynor (2003) believe that the eventual success of an innovation is dependent upon the innovation itself and whether it is 'sustained' or 'disruptive' in nature. A sustained innovation is one which is based around improving the performance of a product to satisfy 'high-end' customers. In our case. this would be the improvement in access to information or the improvement of the information system for the MKW.

A disruptive innovation is one which is not aimed at improving performance and is often not as good as existing products. Disruptive innovations are nevertheless simpler, more convenient, and cheaper. A disruptive innovation is aimed at the large majority of users or 'low end' users who typically are happy with the abilities of the

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incumbent product and who make up the large majority of the user group. The disruptive technology is able to make an impression on the existing market of users through its cost, simple nature and convenience. Once a disruptive innovation has gained an audience, it goes into an improvement cycle and eventually replaces the incumbent product (information system) (Cristensen & Raynor, 2003).

According to Cristensen and Raynor (2003) the production of technology which is cheaper, simpler and more convenient should improve the acceptance of an innovation. Mobile technology offers the mobile knowledge worker improved convenience (offering access to information anywhere, any time) and the large investment in the development of mobile Tools should improve the cost and efficiency of these tools.

The incorporation of mobile technology is slow despite the substantial investment by many industries in developing mobile-capable applications. In research into mobile technology for nursing staff, Li, Chang, Hung and Fu (2005) noted that just because such technology exists and has the potential to assist work does not necessarily equate to adoption. Further, researchers such as Hoang et al. (2008), Carlsson et al. (2005), Ng-Kruelle (2003), Van Akkeren and Harker (2003), and Beulen and Strang (2002) noted the large investment that corporations allocate to purchasing and setting up infrastructure to support mobile technology to allow support for work anywhere, any time, but despite this investment, acceptance and use has not caught up with expectations.

2.4.1 Investment in Mobile Technology Development

There has been much research into the technical development, performance and limitations of mobile technology (Helal et al., 1999; Sengodan, Smith & Abou-Rizk, 2000; Kapoor et al., 2001; Bigioi, Susanu & Corcoran, 2001; Grundy, Wangand & Hosking, 2001; Lim et al., 2001; Dustdar & Gall, 2002; Kirda et al., 2002;

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Rodriguez et al., 2006; Sauter, 2006; Chao et al., 2007). Many technological considerations of mobile technology are aimed directly at improving or developing the functionality and capabilities of the technology.

Research investment includes the examination of such mobile technology developments as the evolution of different types of mobile devices and the features they offer the user. These include network architecture, software support requirements, such as web-based applications, interoperability, standards and wireless protocols such as Bluetooth, optimising mobile networks and so on.

Perry et al. writes that even in 2001 there was a large amount of research into the physical and technical attributes of mobile technology. These authors noted that 'much of the research on mobility has dealt with issues such as limited battery life, unreliable network connections, varying channel coding, volatile access points, risk of data loss, portability, and location discovery' (Perry et al., 2001, p.327).

Individual technology companies commit substantial resources to the research and development of mobile technology (Beulen & Strang, 2002). This input by industry to technology development is further emphasised by Nokia, a leader in the field of mobile phone technology, which reported:

> As of April 1, 2007, we had R&D centers in 11 countries and employed 14,500 people in research and development, representing approximately 32% of Nokia's total workforce. R&D expenses totaled EUR 3,9 billion in 2006, representing 9,5% of Nokia's net sales in 2006 (Nokia, 2008)

As noted above, much capital has been expended on developing mobile technology, yet these improvements are not a guarantee that they will be adopted by users. Davenport (1997) observed that:

We spend a great deal on systems solutions that don't provide the right information, or don't get used. We assume that an information management solution is finished when the technology has been implemented - if it ever gets implemented. The overemphasis on technology eventually even reflects poorly on technology itself, because non-technologists assume that their inability to get the information they want is due to inadequate equipment. (Davenport, 1997, p.24)

The performance limitations associated with currently existing mobile technology to assist the mobile worker influences the adoptability of a piece of technology, although these factors are not the only barriers to adoption. Beulen and Streng (2002) noted that technical difficulties associated with an introduced mobile technology are compensated for, and the innovation can be adapted by users to fit the environment in which it is implemented. In other words, the technical features of mobile devices are not the only limitation of the adoptability as these limitations are compensated for by users.

2.4.2 Mobile Phones and Success

Mobile phones have become ubiquitous in not just work but everyday life. Ling (2004) noted the successful adoption of mobile phones into work and everyday life, observing that such attributes as the low cost associated with owning and using a mobile have contributed to its widespread appeal. He also emphasised the significance of social influences in the success of mobile phone adoption. The mobile phone affords users flexibility in the coordination of social interaction, such as the ability to arrange and make plans on the run, even when en route to a meeting. In pre-mobile phone days, people would be incommunicado and therefore restricted in their ability to alter plans.

The mobile phone has evolved into a multifunction handset, integrating capabilities such as SMS, picture taking, radio, Internet access, navigational tools, email and

data capabilities usually associated with computers, as well as having conventional conversational features (DeVries, 2005; Sorensen & Al-Taitoon, 2008; Kellerman, 2006).

Despite this functionality, Sorensen and Al-Taitoon (2008) notes that it is still unclear whether the mobile phone will replace the diverged capabilities (non-conversational features) into useful work, like assisting with decision making.

2.5 Reflection on Limited Adoption of Mobile Technology

Despite the substantial investment in the development of mobile devices for the support of work (the potential to use mobile technology by mobile workers to interface with existing office based information systems), many researchers highlight the existence of ongoing barriers to the adoption of such technology.

Anderson (2007) noted several such barriers to the adoption of technology. These include such constraints as: costs associated with the introduction of the innovation; security and privacy associated with the storage and transfer of sensitive data; and interoperability issues such as standardisation of data. Pousttchi and Thurnher (2007) further found a barrier to the adoption of mobile technology in its integration with legacy systems which are designed for stationary IT.

While I agree that these issues may constrain the consideration or adoption of an innovation such as mobile technology, they are issues which are at the forefront of mobile technology investment in which much research and development is concentrated. This technology development already provides solutions to interoperability and security, therefore in theory, the functionality required to deliver support for the MKW already exists. The concerns associated with cost will always be an issue and are a function of production research (reducing the cost of

production). Technical areas such as functionality and issues associated with production costs are outside the concern of this thesis.

There has been substantial research in the area of innovation which has resulted in the production of several theories relating to adoption. The following section contains a review of the literature in the area of innovation and adoption.

Innovation and technology are frequently referred to in a similar manner in much of the literature. An 'innovation' can mean the introduction of a change which brings some advantage over an existing product or service, whether it is a new, more efficient way of doing things, the production of a new, more appealing or saleable product, or the introduction of a new technology. For the purpose of this thesis, I define an innovation as the introduction of a new technology which is the source of change and has the potential to afford a benefit over the existing system. This innovation may be the automation of a process, or it may replace an existing piece of technology.

Researchers such as van Biljon and Kotze (2007) and Beulen and Streng (2002) have noted that much research has previously been applied to the concept of technology adoption, resulting in the formation of well-tested theories such as Davis's (1989) Technology Adoption Model (TAM) and Rogers' (1983) Diffusion of Innovation Theory (DOI). Such theories 'could contribute towards anticipating future needs in a complex ever-evolving scenario' (Van Biljon and Kotze, p.152), thus making salient the barriers to adoption of mobile technology. These impediments are social in nature as opposed to technical.

There are several theories which address the issue of user acceptance of technology. Venkatesh et al. (2003) reviewed research in this area and identified eight prominent models of individual technology acceptance. These models are outlined in Table 2.1.

Theory	Core Constructs	Definitions
Theory of Reasoned Action (TRA)		
Drawn from social psychology, TRA is one of the most fundamental and influential theories of human behavior (see Shepard et al. 1988 for a review). Davis et al. (1989) applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behavior	Attitude toward behavior Subjective norm	"an individual's positive or negative feelings(evaluative affect) about performing the target behavior" (Fishbein and Ajzen 1975, p.216) "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein and Ajzen 1975, p.302)
Technology Adoption Model (TAM)		
TAM is tailored to IS contexts, and was designed to predict information technology acceptance and usage on the job. Unlike TRA, the final conceptualization of TAM excludes the attitude construct in order to better explain intentional parsimoniously. TAM2 extended TAM by including subjective norm as an additional predictor of intention in the case of mandatory settings (Venkatesh and Davis 2000). TAM has been widely applied to a diverse set of technologies and users.	Perceived usefulness Perceived ease of use Subjective norm	"the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989, p. 320) "the degree to which a person believes that using a particular system would be free of effort" (Davis 1989, p. 320) Adapted from TRA/TPB. Included in TAM2 only.
Motivational Model (MM)		
A significant body of research in psychology has supported general motivation theory as an explanation for behavior. Several studies have examined motivational theory and adapted it for specific contexts. Vallerand (1997) presents an excellent review of the fundamental tenets of this theoretical base. Within the information system domain, Davis et al. (1992) applied motivational	Extrinsic motivation Intrinsic	The perception that users will want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay or promotion (Davis et al. 1992, p. 112) The perception that users will want to

theory to understand new technology adoption and use (see also Venkatesh and Speier 1999)	motivation	perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al. 1992, p. 112)
Theory of Planned Behavior (TPB)		
TPB extended TRA by adding the construct of perceived behavior control. In TPB, perceived behavior control is theorized to be an additional determinant of intention and behavior. Ajzen (1991) presented a review of several studies that successfully used TPB to predict intention and behavior in a wide variety of settings. TPB has been successfully applied to the understanding of individual acceptance and usage of many different technologies (Harrison et al. 1997; Mathieson 1991; Taylor and Todd 1995b). A related model is the Decomposed Theory of Planned Behavior (DTPB). In terms of predicting intention, DTPB is identical to TPB. In contrast to TPB but similar to TAM, DTPB "decomposes" attitude, subjective norm, and perceived behavioral control into the underlying belief structure within technology adoption context.	Attitude towards behavior Subjective norm Perceived behavioral control	Adapted from TRA Adapted from TRA "the perceived ease or difficulty of performing the behavior" (Ajzen 1991, p.188). In the context of IS research, "perceptions of internal and external constraints on behavior" (Taylor and Todd 1995b, p.149)
Combined TAM and TPB (C-TAM-TPB)		
This model combines the predictors of TPB with perceived usefulness from TAM to provide a hybrid model (Taylor and Todd 1995a)	Attitude toward behavior Subjective norm Perceived behavioral control	Adapted from TRA/TPB Adapted from TRA/TPB Adapted from TRA/TPB

	Perceived usefulness	Adapted from TAM
Model of PC Utilization (MPCU)		
Derived largely from Triandis' (1977) theory of human behavior, this model presents a competing perspective to that proposed by TRA and TPB. Thompson et al. (1991) adapted and refined Triandis' model for IS contexts and used the model to predict PC utilization. However, the nature of the model makes it particularly suited to predict individual acceptance and use of a range of information technologies. Thompson et al. (1991) sought to predict usage behavior rather than intention; however, in keeping with the theories roots, the current research will examine the effect of these determinants on intention. Also, such an examination is important to ensure a fair comparison of the different models.	Job-fit	"the extent to which an individual believes that usage (a technology) can enhance the performance of his or her job" (Thompson et al. 1991, p.129)
	Complexity	Based on Rogers and Shoemaker (1971), "the degree to which an innovation is perceived as relatively difficult to understand and use" (Thompson et al. 1991, p.129)
	Long-term consequences	"Outcomes that have a pay-off in the future" (Thompson et al. 1991, p.129)
	Affect towards use	Based on Triadis, affect toward use is "feeling joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act" (Thompson et al. 1991, p.127)
	Social factors	Derived from Triadis, social factors are "the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations." (Thompson et al. 1991, p.126)
	Facilitating conditions	Objective factors in the environment that observers agree make an act easy to accomplish. For example, returning

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		items purchased online is facilitated when no fee is charged to return the item. In an IS context, "provision of support for users of PCs may be one type of facilitating condition that can influence system utilization" (Thompson et al. 1991, p.126)
Innovation Diffusion Theory (IDT)		
Grounded in sociology, IDT (Rogers 1995) has been used since the 1960s to study a variety of innovation, ranging from agricultural tools to organizational behavior (Tornatzky and Klein 1982). Within information systems, Moore and Benbasat (1991) adapted the characteristics of innovations presented in Rogers and refined a set of constructs that could be used to study individual technology acceptance. Moore and Benbasat (1996) found support for the predictive validity of these innovation characteristics (see also Agarwal and Prasad 1997, 1998; Karachanna et al. 1999; Plouffe et al. 2001).	Relative advantage	"the degree to which an innovation is perceived as being better than its precursor" (Moore and Benbasat 1991, p.195)
	Ease of use	"the degree to which an innovation is perceived as being difficult to use" (Moore and Benbasat 1991, p.195)
	Image	"the degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat 1991, p.195)
	Visibility	The degree to which one can see others using the system in the organization (adapted from Moore and Benbasat 1991)
	Compatibility	"the degree to which an innovation is perceived as being consistent with existing values, needs, and past experiences of potential adopters" (Moore and Benbasat 1991, p.195)
	Results demonstrability	"the tangibility of the results of using the innovation, including their

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		observability and communicability" (Moore and Benbasat 1991, p.203)
	Voluntariness of use	"the degree to which use of the innovation is perceived as being voluntary, or free of will" (Moore and Benbasat 1991, p.195)
Social Cognitive Theory (SCT)		
One of the most powerful theories of human behavior is social cognitive theory (see Bandura 1986). Compeau and Higgins (1995b) applied and extended SCT to the context of computer utilisation (see also Compeau et al. 1999); while Compeau and Higgins (1995a) also employed SCT, it was to study the performance and thus is outside the goal of the current research. Compeau and Higgins (1995b) model studied computer use but the nature of the model and the underlying theory allow it to be extended to acceptance and use of information technology in general. The original model of Compeau and Higgins (1995b) used usage as a dependent variable but in keeping with the spirit of predicting individual acceptance, we will examine the predictive validity of the model in the context of intention and usage to allow a fair comparison of the models.	Outcome expectations – performance	The performance-related consequences of the behavior. Specifically, performance expectations deals with job-related outcomes Compeau and Higgins (1995b)
	Outcome expectations – personal	The personal consequences of behavior. Specifically, person expectations deal with the individual esteem and sense of accomplishment Compeau and Higgins (1995b)
	Self-efficiency	Judgment of one's ability to use a technology (e.g. computer) to accomplish a particular job or task
	Affect	An individual's liking for a particular behavior (e.g. computer use)
	Anxiety	Evoking anxious or emotional reactions when it comes to performing a behavior (e.g. using a computer).

Table 2.1 Theories of technology adoption (from Venkatesh et al., 2003)

The above theories provide several different models identifying adoption barriers which could be applied to mobile technology. Other researchers build on these proposals, refining them to produce strategies which facilitate increased potential for

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a technology to be adopted. For example, Wakefield and Whitten (2006) build on Thompson, Higgins and Howell (1991), emphasising enjoyment as a facilitator for better adoption possibility:

> When individuals perceive that interaction with the mobile device is more playful, we find that subjects generally believe the device is more useful and enjoyable and subjects intend to use it more frequently (compared to those who do not perceive the interaction as playful). (Wakefield and Whitten, 2006, p.297)

Dickinger, Arami and Meyer (2006) researched the importance of social norms in social networks for mobile technology adoption. The importance of social norms is identified in several of the above theories of technology adoption.

My review of literature in the mobile technology adoption area found that much of the research is rooted in theories of general innovation and technology adoption, as described above. The two most popular theories to have been used or adapted by researchers of mobile technology are the Technical Adoption Model (Davis, 1989) and Diffusion of Innovation Theory (Rogers, 1983). See Table 2.2 below for a sample of researchers who have based their research on either the Technical Adoption Model or Diffusion of Innovation Theory.

Researcher	DOI	TAM
Kwon, H., and Chidambaram (2000)		X
Lu, J., Yu, C., Liu, C., and Yao, J. (2003)		X
Pagani, M. (2004)		X
Yang, K. (2005)		X
Park, Y., and Chen, J. (2007)		X
Parveen, F and Sulaiman, A (2008)		X
Lopez-Nicolas, C., Molina-Castillo, F., and Bouwman. (2008)	X	X
Kaasinen, E. (2005)	X	X

Ling, R. (2002)	X	
Han, S. (2002)	X	
Burley, L., and Scheepers, H. (2003)	X	
Van Akkeren, J., and Harker, D. (2003)	X	
Schwarz, A., Junglas, I., Krotov, V., and Chin, W. (2004)	X	
Burley, L., Scheepers, H., and Fisher, J. (2005)	X	
Mallet, N., Rossi, M., Tuunainen, V., and Oorni, A. (2006)	X	

Table 2.2: DOI and TAM in mobile technology research

I will now briefly outline the Technology Adoption Model and Diffusion of Innovation Theory.

2.5.1 Technology Adoption Model (TAM)

The Technology Adoption Model (TAM) was proposed by Davis (1991) and is based on the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975).

The basis of this theory is that an individual user's attitude towards a new technology or system is a major contributor towards its adoption and use. The key determinants of acceptance and use of a technology include the individual user's perception of (1) 'usefulness' - whether it is going to be something which is useful and (2) 'ease of use' - whether it will be easy to use. Davis clearly outlines these key determinants:

> A prospective user's overall attitude towards using a given system is hypothesised to be a major determinant of whether or not he or she actually uses it. Attitude toward using, in turn, is a function of two beliefs: perceived usefulness and perceived ease of use. Perceived ease of use has a casual effect on perceived usefulness. System design features have an indirect effect on attitude toward using and actual usage behaviour through their direct effect on perceived usefulness and perceived ease of use. (Davis, 1993, pp. 475-476)

Perceived Usefulness

System design features

Attitude towards using

Actual System Use

Perceived Ease of Use
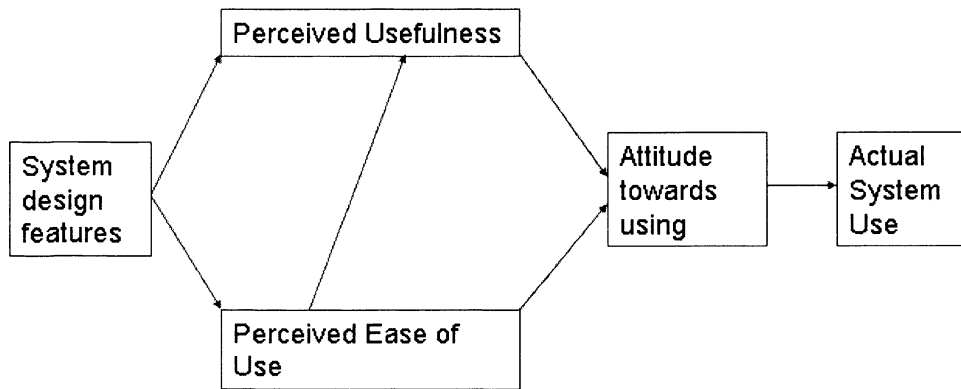
Figure 2.2: Technology Acceptance Model (*from* Davis, 1993)

The perceived ease of use refers to the intended user's perception of the degree to which the use of the introduced technology will be free of effort and will be seamlessly integrated into their everyday life. The perceived usefulness is the perception the intended user has of the potential improvement in performance in their job that the new technology offers.

Research by Venkatesh and Davis (2000) into TAM found that there is a social link in user acceptance of technology. Social influences on mobile workers, particularly those linked to existing work practices will influence how people perceive the usefulness and ease of use of a new technology.

> The present research develops and tests a theoretical extension of the Technology Acceptance Model (TAM) that explains perceived usefulness and usage intensions in terms of social influence and cognitive processes...Both social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) significantly influence user acceptance. (Venkatesh and Davis, 2000, p.186)

TAM fits in well with the developers of technology, as not only does it identify social influences as a central theme of acceptance but it also highlights the features of a technology that have a critical influence on adoptability.

TAM has previously been used to review mobile technology adoption, as in the study by Kwon and Chidambaram (2000). This research specifically examined the mobile worker and found that perceived ease of use was a major determinant of adoption and usage of the mobile technology. They concluded that efforts to make cellular telephones even easier to use would improve people's motivation to use them and thereby increase use.

2.5.2 Diffusion of Innovation Theory

Diffusion of Innovation Theory (DOI) was proposed by Rogers (1983). The underlying proposition of DOI is that an innovation and the adoption rate of that innovation is linked to the process of diffusion.

Diffusion is the process of communication among members of a social system about a subject innovation. Diffusion differentiates itself from other forms of communication in that it specifically carries messages concerned with a new idea. In the situation of the MKW, this innovation would be the introduction of mobile technology, or the improvement or change to the information system. The communication between two or more members of the social system would result in a mutual understanding and attitude towards the innovation which directly influences the rate at which it is adopted (see Figure 2.3 below).

Variables determining the rate of adoption

Perceived attributes of innovations

1. Relative advantage
2. Compatibility
3. Complexity
4. Trial ability
5. Observability

Type of innovation-decision

1. Optional
2. Collective
3. Authority

Communication channel (eg. Mass media or interpersonal)

Nature of Social System (eg. Its norms, degree of network interconnectedness, etc)

Extent of Change Agents promotional efforts

Rate of adoption of innovations

Figure 2.3: Variables determining the rate of adoption of an innovation (*from* Rogers, 2003, p.222)

Determinants of the adoption rate, such as the perceived attributes of an innovation, are not dissimilar from those ideas presented by TAM; however DOI is unmistakably different in its focus on the communication process. For example, when considering Perceived Attributes, Rogers (2003) noted that the degree of Relative Advantage is often measured in economic terms. In an examination of the diffusion of Palm Pilot technology in the early 1990s, it was found that the attributes of this technology presented users with computer power and a range of applications for a relatively small outlay. Rogers noted that 65% of users heard about it from someone else, and the diffused message was that the technology was relatively inexpensive.

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DOI is illustrated by a well documented case study by Rogers (2003) describing the failure of an innovation to be accepted. The case study examines attempts by the Peruvian Health Service to get local villagers to boil their water for consumption. The system of boiling drinking water was aimed at eliminating infectious diseases. In the process of diffusion, Rogers identifies an individual (or group of individuals) who initiate and promote an innovation as 'change agents'. In this case study, the change agent presented as both the change agent and diffuser of the boiling water innovation and was not trusted by the target audience. As a direct result, the innovation failed with only 5% of the villagers who were targeted adopting the boiling water system.

The issue was that the change agent charged with diffusing the innovation was perceived to be of a different socioeconomic and cultural background to the target group. Rogers noted that how potential adopters view a diffuser (and in this case change agent) affects their willingness to adopt a new idea:

> They distrusted the outsider, who they perceived as a social stranger. Nelida, who was middle class by Los Molinas standards, was able to secure more positive results from housewives whose socioeconomic status and cultural background were similar to hers. This tendency for more effective communication to occur with those who are more similar to a change agent occurs in most diffusion campaigns. (Rogers, 2003, p.5)

Rogers describes the degree to which interacting pairs of people are similar as homophily (and heterophily the degree to which they are different). The degree of commonality, homophily, means that communication is more likely to occur. Rogers noted that:

> When they share common meanings and a mutual sub cultural language, and are alike in personal and social characteristics, the communication of new ideas is likely to

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have greater effects in terms of knowledge gain, attitude formation and change, and overt behavior change. (Rogers, 2003, p.19)

Another factor determining the adoption of an innovation, according to Rogers, is the social structure of the social system in which the innovation is being defused. For example, in a bureaucratic organisation, managers will give orders which they expect lower level workers to obey.

In addition to the formal communication provided by the organisation structure, diffusion is provided through informal communications linking interpersonal networks in a social system. Homophilous communication includes this informal channel of communication which is conducted by groups of individuals in cliques. This diffusion is also disseminated through a social system using opinion leaders. The opinion leader is a measure of an individual's ability to influence the opinions of others. These individuals are not necessarily recognised in a formal position of leadership, however they are considered to be leaders due to their abilities or competencies and accessibility.

2.6 Reflection on the Role of Social Influence on Adoption

Both TAM and DOI show how non-technical, social factors can have an impact upon the adoption of technology. Kouroubali (2002) notes that in the area of healthcare, 80% of information systems failure is due to social and organisational factors. These theories could potentially be applied to MKWs and the adoption of mobile technology to explain the low uptake in these innovations.

In the case of both DOI and TAM, the assumption is also made that the innovation will mean a change to the existing system, and that it offers an improvement or advantage over the existing system. Jarvenpaa, Lang and Tuunainen (2005) noted

that mobile technology promises computing and communication support for the mobile worker.

Innovations also have the potential to bring unanticipated negative changes to an existing work system. Jarvenpaa and Lang (2005) in particular question the possible negative effects that mobile technology can have on work. Although it is anticipated that the change will be for the better, it may also bring negative changes to the work environment. The very ability to access computing and communication support creates the possibility of uncontrolled interaction in personal or 'out of work' time. The need to have the mobile device means that that device has to be carried at all times, and even carrying the device could physically hamper a mobile worker's ability to do their work.

Middleton and Cukier (2006) label the inadvertent negative effect of mobile technology as dysfunction usage. Davis (2002) notes the assumption that technology will bring improvement and the associated paradox of potential issues:

> A fundamental assumption in adopting new technologies is that organizations and individuals are willing to invest in new technology and new applications if it results in improved performance and productivity. However it is difficult to foresee the results of new technologies – there are many unintended consequences. Organizations and individuals make unanticipated responses as they adapt to new technology. They create new structures to promote or restrict its use. It is therefore useful to anticipate both desirable and undesirable responses and consequences. (Davis, 2002, p. 68)

Davenport (1997) considered the impact of the introduction of new technology to automate information systems on companies and found that in some cases the addition of the technology impacted negatively on the companies in his case study. Davenport concluded that better technology, such as computers and communication networks, do not inevitably lead to better information environments.

I came to the conclusion that before I could apply social theories such as TAM and DOI to mobile technology adoption by the MKW, further investigation was warranted into the possibility that the introduced technology could be ignored by workers. Worse, the innovation's introduction could even have an unanticipated or negative effect on mobile work.

A seminal case study on the use of mobile technology on construction sites was reported by Luff and Heath (1998). They observed the introduction of a laptop onto a construction site. The purpose of the laptop was to replace a paper-based form used to record the activities of workers. This information could then be used by the Foreman and other office based workers. In theory, by using the mobile system, information would be available faster and 'it was believed that a mobile system would enhance communication and collaboration, as well as making more bureaucratic activities more efficient' (Luff and Heath, 1998, pp.307-308).

Unfortunately the introduction of this mobile system transformed the work activity of the Foreman in a negative manner, impeding his work.

> Indeed in trying to use the system on the site, the Foreman would either not be able to deal with problems in a particular area or would remain tied to one location. Rather than becoming a resource for mobile collaboration, the technology actually appeared to hinder it...the introduction of the mobile system made the user less mobile, less able to monitor the ongoing work and less available to engage in activities with others on site. (Luff and Heath, 1998, p.308)

With such issues surrounding the use of the mobile laptop, the Foreman returned to the previous paper-based system to record information on site.

2.6.1 Management Driven Innovation

Within a group (such as an organisation), management could mandate the use of a new technology, such as the mobile phone, believing that it will bring a positive reward. Beulen and Streng noted that:

> Based on the business and IT strategy, companies may decide to invest in mobile office solutions to change work practices and business processes. Then usage becomes mandatory. The individual employees do not have the choice to use or not to use the mobile office. (Beulen and Streng, 2002, p.630)

The solution would therefore seem to be to engage the support of management, and in so doing, ensure the successful implementation of the technology. This view is noted by Gallivan who states that:

> Increasing evidence suggests that these traditional frameworks neglect the realities of implementing technology innovations within organizations, especially when adoption decisions are made at the organizational, division, or workgroup levels, rather than at the individual level...Under these conditions...authorities make the initial decision to adopt and targeted users have few alternatives but to adopt the innovation and make the necessary adjustments for using it to perform their jobs. (Gallivan, 2001, pp. 51-52)

Allen and Wilson (2005) examined two mobile information systems initiated by a police force. They found that despite the support from management, only one was well received and adopted while the other system was resisted. Allen, Wilson, Norman and Knight (2008) commented on this research noting that gaining acceptance is not simply a matter of top down implementation of systems.

Orlikowski (1996) developed a seminal case study in which a customer service department was examined. The customer service department implemented new

software called ITSS to track customer enquiries. ITSS was designed to allow support specialists to enter incidents directly onto the database while on the phone to customers.

> While this feature enabled direct entry, some aspects of its design were also constraining, sufficiently so that most of the specialists continued to use paper to record their phone interactions with customers, entering these calls into ITSS at a later time. (Orlikowski, 1996, p.73)

The reasons for the adapted use of the ITSS system were both technology based as well as social. The technology itself was limited in that the 'specialists were aware that the ITSS technology and underlying network might fail occasionally. As a result, many of them utilized paper as an improvised (manual) backup system' (Orlikowski, 1996, p.73). The ITSS system affected the specialists in a social way by publicly increasing the visibility of work. Previously, much of the work solving enquiries was done off-line by the specialist. The introduction of the new ITSS system meant that:

> ...the transparency of the electronic text ensured that specialist's work life was now more 'on display' or at least potentially so...Many specialists were acutely aware of their new visibility – some of them referred to it as 'big brother' – and responded by improvising some informal guidelines about what they would and would not articulate within the electronic text. (Orlikowski, 1996, p.77)

In this case, the targeted users adapted their use of the system. In another well-quoted case presented by Suchman (1995), the technology was completely ignored. The new piece of technology, which automated the scanning process for multi-page documents, was introduced to an 'expert user'. When a page was out of alignment, the user had the option to make use of the automatic realignment feature on the scanner; however, the user chose to do this process manually, starting the document scan again from the beginning:

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While use of the machine's page realignment feature would have obviated the need for rescanning of the entire set, it would have required more of the worker's time and attention. Dropping the entire document in for rescanning took more of the machine's time, but it left him free to attend other things. (Suchman, 1995, p.58)

Although it would appear that the new technology was supported by management and there were no ill-effects associated with the introduction of the realignment innovation, it was not used. It was a wasted resource, a waste of capital.

In the paper by Gallivan (2001), innovation adoption is identified as a two stage process. In the primary stage, the organisation (and in particular management) makes a decision to adopt the innovation. This is followed by a second stage in which the implementation of the technology takes place. However, as already noted in the above case studies by Orlikowski and Suchman, 'the primary adoption decision does not guarantee that the innovation will be implemented or used by the target users' (Gallivan, 2001, p.54).

2.7 Unanticipated Variations – Clues for Developing Useful Technology Through HCI

Human-Computer Interaction (HCI) is a very broad term used by researchers who examine aspects of interaction by human beings with technology. HCI is a well established area of research which attempts to address the above issues with technology and its use at the development stage of technology. That is, to ensure successful use of a new technology, its design is examined at the development stage.

Dix et al. (2004) describes HCI as the design, implementation and evaluation of interactive systems in the context of user's task and work taking into account:

- The user refers to an individual user, a group of users working together, or a sequence of users in an organization.
- The computer refers to any technology ranging from the general desktop computer to a large scale computer system, a process control system or an embedded system.
- The system may include non-computerized parts, including other people.
- Interaction refers to communication between a user and a computer. The important thing is that the user is interacting with the computer in order to get something done.

Interaction design is a well established and frequently used form of HCI development. Researchers such as Preece, Rogers and Sharp (2002) are well-cited interaction designers in the HCI field. Interaction Design takes a user centred approach to development by investigating the use of an artefact (such as the mobile technology in my research) using ethnographic research methods. According to Preece, Rogers and Sharp (2002, p.12) interaction design consists of four core activities. These are:

1. Identify needs and establish requirement
2. Develop alternate designs that meet those requirements
3. Build interactive versions of the design so that they can be communicated and assessed
4. Evaluate what is being built throughout the process

A comparison which assists the concept of interaction designers is made by Winograd (1997) in comparing the difference between an architect and engineer:

> Architects are concerned with people and their interactions with each other and within the house being built. For example, is there the right mix of family and private spaces? Are the spaces for cooking and eating in close proximity? Will people live in the space being designed in the way it was intended to be used? In contrast, engineers are interested in issues to do with realizing the project. These

include practical concerns like cost, durability, structural aspects, environmental aspects, fire regulations, and construction methods. (Winograd, 1997, p.158)

2.7.1 Understanding Users

> Your attention should be on your goal, not the technology you are using to accomplish it...the goal is to enable you to do a better job. (Shneiderman, 2002, pp.12-13)

HCI researchers such as Shneiderman (2002) emphasised the need to develop technology that the user wants. He differentiated between the technical developers of technology – those that worked on faster processors, larger databases, and more reliable networks (p.11) – and those concerned with getting users to use the technology.

Technologies produced by technical developers

> produce confusion and frustration. Too often they have incomprehensible terminology, poor online assistance, and nasty failures... These experiences generate anxiety about computers, resistance to using technology, and fear of losing control... The challenge of new computing developers is to understand what you, the user, want and to help you get it. (Shneiderman, 2002, p.12)

Norman (1988, p.155) believed that the problem for technologists is that they project their own 'rationalizations and beliefs onto the actions and beliefs of others'. He further notes that technologists such as programmers have never thought of the problems faced by the user and are surprised to discover that 'their creations tyrannize the user' (Norman, 1988, p.155).

The underlying philosophy of HCI requires that technologists consider the way work is done by people and account for the existing system of operation. This means a

shift of the design and development focus away from the technologist and onto the user.

An example of this inability to understand the mobile user and the resultant negative outcome (non-adoption of technology) is illustrated by Sellen and Harper (2002). In their case study, they describe a telecommunications company that wished to improve efficiency by connecting and sharing information about clients. The account managers on the road were digitally connected to office based bid and sales teams using a new electronic document database combined with portable hardware.

The new system replaced the traditional paper-based system and in theory should have improved two-way communications between team members. It was found that the implementation of this new system had few technical difficulties, but there was strong resistance from the account managers.

The information supplied by the account managers was found to provide much less information than expected, due to the fact that they 'believed the information (often kept in their notebooks) was unsuitable for sharing...Hence they continued to use their paper notebooks to store such information, not the newly created customer database.' (Sellen and Harper, 2002, pp.44-45)

The approach of understanding the user and the way they work is a practice advocated by many researchers in technology design. For example, Shneiderman (2002, p.12) writes: 'The challenge for new computing developers is to understand what you, the user, want and to help you get it'.

Understanding the user and supporting their work is not a simple task. Success requires more than just the digitalisation of paper documents. Luff and Heath (1998) found that consideration must be given to the user and their work practices. The success of the system requires:

more than just transforming a paper document into an electronic one. Serious attention has to be paid to the ways in which personnel interact with colleagues whilst out on site and use various objects and artefacts to accomplish their work with others. (Luff & Heath, 1998, p.309)

Another case study which highlights the difficulties of understanding the user and their existing system of work is presented by Er and Kay (2005) in which a laptop was to be used by Doctors on ward rounds. The underlying purpose of this mobile system was aimed at allowing Doctors to gain access to patient information on demand. Prior to the introduction of this system, Doctors would download onto paper all the required case notes and then proceed on their ward rounds. Typically, the ward round would last four hours and vital information about the patient could potentially be missed if test results were updated while the doctor was on their round. Moving from a paper-based system to one which was digital would afford 'just in time' access to information and theoretically improve patient care. Nevertheless, the system was rejected by the Doctors even though it was perceived to be a useful tool.

We note that in the original mobile ward case study, the users were involved in its development. The Chief Information Officer of the case study hospital indicated that she consulted with registrars and the Doctors to see what they needed and we customised the application so they were satisfied. (Er & Kay, 2005) This raises the question of why, if the users were involved in the design process, the introduced system failed.

Suchman (1995, p.56) makes the point that 'too often assumptions are made as to how tasks are performed rather than unearthing underlying work practices'. In the mobile ward case study, the user participation was limited to gathering the existing hard data needs of the Doctors (for example, patient records). Issacs and Walendowski (2002) state that in developing a technology you should begin with an activity that needs supporting and allow that to determine the technology to build.

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2.8 Reflection on Mobile Knowledge Work – What Do They Want?

The integration of technology into work should first and foremost focus on the worker and their work – what will help the MKW and how they can be supported.

Drucker (1993) makes an important observation about knowledge workers with regards to the use of technology:

> Machine operators in the factory did as they were told. The machine decided not only what to do but how to do it. The knowledge employee may need a machine, whether it is a computer, an ultra sound analyser, or a radio telescope. But neither the computer nor the ultrasound analyser nor the telescope tells the knowledge employee what to do, let alone how to do it. Without the knowledge which is the property of the employee, the machine is unproductive.

> The worker under capitalism was totally dependent on the machine. In the employee society, the employee and the tools of production are interdependent. One cannot function without the other. And while the tools of production, such as the ultrasound analyser, are fixed in place, the technician who knows how to run them and how to interpret their readings has mobility. The machine is dependent on the employee, not the other way around. (Drucker, 1993, pp.64-67)

Drucker's observation notes that the development of mobile technology designed to assist the MKW will encounter difficulties as the technology cannot determine the way these workers operate; rather, it is the knowledge worker who will determine when or even if the tool will be used. The MKW is the 'master' and the Tools used to assist in decision making are the 'slaves'. For developers or champions of a technology being introduced into work, this adds further complexity to integration and adoption.

From the HCI perspective, the main consideration is the end user and fulfilling their needs. In order to assist MKWs, a view of how these people currently do their work is required in order to find out where there is potential for assistance from mobile technology. In considering how to support the work of the MKW it is important to investigate what will help them make a decision.

The information system is, according to Morgan (1997), a communication and decision making system. What really needs to be considered then is: what is the existing Information System, the supporting structure behind the knowledge management of a mobile worker?

2.8.1 Components of the Information System

An information system is defined by Avison and Wood-Harper (1990, p.3) as 'a system to collect, process, store, transmit and display information'. This information is used so that an organisation can function and achieve its goals (Lee, 2004). Further, Gupta (2000) notes that information systems generate information which assists individuals to make meaningful decisions.

The focus in the development of information systems has traditionally concentrated on the delivery of the information through technology which, as already observed, is subject to failure. Gobbin (1998) commented on the shortfall of traditional information systems analysis:

> Traditional systems analysis methodologies used in information systems development follow historically derived methods for the interpretation and description of human sequential activities. They address a particular task or data path following a humanly determined work sequence. As with all human activity, computer-supported work is bound to suffer the effects of tool mediation. In particular, the introduction of new computer systems can generate cultural rejection because whole areas of cultural, social

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and cognitive issues are omitted from current systems analysis and design methodologies. (Gobbin, 1998, p.109)

Wiredu and Sorensen (2006) reported on the trial use of mobile technology to assist in the learning process for health professionals who assist with the pre- and post-surgical care of patients. These health professionals are required to be mobile, moving around the different wards in a hospital. As part of their training, they were required to work in an operational setting and used a PDA to record their descriptions and reflections while they worked in the hospitals to which they were allocated.

Unfortunately, of the three PDA information applications trialled, all failed.

> On the surface, it appears the technology failure was caused by human-computer interaction factors such as design flaws in the system, slow running applications, and the systemic deficiencies of the PDAs that reflect their low processing power, low storage capacity and low memory. However, the accounts of the PSPs (health workers) also point to considerable interpersonal problems in their hospitals that were directly confrontational as far as interaction with the PDAs was concerned. (Wiredu and Sorensen, 2006, p.313).

The introduction of the trainee health worker was seen as a threat to the existing teams and created an unwillingness to cooperate. Conflict also arose between the training manager and the heads of the surgical teams. The instructor was concerned with gaining the best training for the health professionals but the surgical team leader was concerned with getting the most out of the trainee. The PDA was rendered useless.

The failure to introduce the mobile technology into the learning system was due to a conflict between user groups on a social level rather than a failure on a technical level. They concluded that 'we must look beyond the physical and systemic designs

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of technology for problems of effective use of mobile technology' (Wiredu and Sorensen p.317)

The information system should not be confused with mere information technology. Lee (2004) notes that often an information system is equated to the technical system (i.e., information technology) associated with the needs of an organisation. This

> view of information systems focuses on information requirements – which describe the information that an organization requires from an information technology so that it can function and achieve its goals – as well as how to design, implement, install, or otherwise procure information technology so that it can deliver the information required…This view is incomplete because it is blind to systems other than the technical system…" (Lee, 2004, pp.10-11)

Lehaney et al. (2002) also differentiate between an information system which is concerned with human activity (and is a social system) as opposed to the information technology of that information system which is concerned with technical support, such as automation and the telecommunication medium. An information system may or may not have a technical component. Lehaney et al. (2002) conclude in their research that the failure of an information system is a result of focusing on the technical aspects of a project while neglecting the human-centred issues. Further, when studying an information system, the spotlight should be orientated to the examination of human activity and the social system.

Engestrom and Nardi (1999) noted the importance of understanding the information system from a social system view highlighting the concept of 'visible' and 'invisible' work, both of which must be accounted for when developing new information systems.

> What is work? Efforts to design and introduce new technologies and to restructure workplace (which often involve new technology) will be most successful when built

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on a firm foundation of knowledge about how work actually gets accomplished. Much work is visible. It yields to being mapped, flowcharted, quantified, measured. When planning for restructuring or new technology, visible work is the focus of attention. It is the only work to be seen, so efforts to restructure center on how visible work can be manipulated, redrawn, reorganised, automated or supported with new technologies. But a growing body of empirical evidence demonstrates that there is more to work than is captured in flow charts and conventional metrics...

Sometimes new work processes are introduced that undermine good but invisible work being done by employees. For example, the work of telephone operators is often defined by telephone companies as rote and routine, amenable to being tightly scripted on a second by second basis (saving the phone company money). Upon closer scrutiny, it is found that telephone operators frequently solve problems for customers in a resourceful, proactive manner (e.g. "My heat has been turned off. Who do I call?"). Attempts to constrain and reduce interactions with customers result in poorer customer service and less satisfaction with the phone company service, leaving companies vulnerable, over the long run, to competition. (Engestrom & Nardi, 1999, pp.1-2)

Taking into account the social nature of an information system, Benson and Standing (2002) and Gordon and Gordon (2004) incorporate people into the definition of an information system. The information system encompasses not only the technical infrastructure which facilitates the provision of information but also the users, their work and social interactions.

It is important to consider the existing information system of the MKW to make sure that a broader view of existing work practices (not only that which can be digitised) is captured and included in the developed information system.

Isaacs and Walendowski (2002, p.94) note that 'Even though people may have many problems doing the task today, it's important to notice the advantages of their current methods so you don't forget to address those in your solution'. This point is

important to remember, as even though there could be an issue with the existing information system, the work is still completed. Research by Gebauer and Ginsburg (2009, p.130), however, noted that 'the requirements for the development and use of mobile information systems to support mobile professionals are not fully understood'.

2.8.2 Mapping the Mobile Information System

[The] Hawthorne studies...conducted in the 1920s and 1930s under the leadership of Elton Mayo...The studies are now famous for identifying the importance of social needs in the workplace and the way that work groups can satisfy these needs by restricting output and engaging in all manner of unplanned activities. In identifying that an "informal organization" based on friendship groups and unplanned interactions can exist alongside the formal organization document in the "blueprints" designed by management, the study dealt an important blow to classical management theory. They showed quite clearly that work activities are influenced as much by the nature of human beings as by formal design and that organizational theorists must pay close attention to this human side of organization. (Morgan, 1997, p. 35)

This quote by Morgan (1997) again highlights the multiple forces influencing the use and usefulness of the different components of the information system. Research is required into identifying how people do work and interact with their information system. From this research, technology developers and innovation implementers will be able to anticipate potential conflicts and improve the usefulness delivered by the adoption of the innovation (mobile technology).

Kaufmann (2002) emphasised the need to examine the social side of mobility. The technology offers the user the infrastructure to be mobile; however, successful integration of the technology needs to take into consideration the underlying reasons for the worker being mobile. A study of the information system must therefore take

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into account the social aspects which influence the use or rejection of the system components.

In order to develop a useful tool which will be integrated seamlessly, there is a need to not simply model the information. As noted by researchers such as Jarvenpaa, Lang and Tuunainen (2005), Jarvenpaa and Lang (2005) and Middleton and Cukier (2006), mobile technology can bring advantages but also negative effects. It is important to encapsulate the existing tools and historical traits (social norms) associated with the tools and system of work in a model of the adoption of invisible work. Activity theory has been suggested by researchers such as Nardi (2008), Engstrom (2000) and Bannon (1997) as a means of holistically modelling work (what people do). Activity Theory offers a lens through which work can be modelled, and its potential is considered in the next chapter.

2.9 Conclusion

This chapter has defined the concept of the Mobile Knowledge Worker (MKW). I noted the existing literature which indicates that the use of mobile technology could be useful in assisting MKWs to carry out their work; however there have been relatively low levels of adoption.

Different theories of adoption were considered to explain the low rate of adoption, and most of these assumed that the new technology would bring beneficial change. Some of the literature showed that unanticipated consequences of the introduction of technology often result in the technology not being used, or being used in unanticipated ways, which could result in a net negative return.

Researchers in the HCI field are concerned with the development of technology, and in particular in developing systems which the user wants. Knowledge workers make use of information systems to support their decision making. The information system is difficult to analyse, with many traditional researchers only accounting for 'formal

work' in systems development (e.g. digitising documents). 'Informal' work also needs to be accounted for in the analysis of work.

Davis (1993) noted that the use of an information system by an organisation is aimed at providing an improved information system and therefore better performance on the job. If users reject the use of an innovation (such as mobile technology) however, then the performance impacts are lost along with the resources expended to introduce it. That is, a system which has the ability to deliver information to a user will be rendered useless if the user is unwilling to use it. It should also be noted that a system which does not deliver useful or pertinent information is also unacceptable.

The information system of workers is not easily mapped. It was clear to me in the early stages of my research that a broader approach to analysing the mobile workers' information system was required. As noted, researchers such as Gobbin (1998), Suchman (1995) and Engestrom and Nardi (1999) have emphasised that traditional methods of systems analysis are limited, only taking into account 'visible work'.

> Traditional tool analysis and design still use the systemic adaptive model where humans and computers are treated as objects quite divorced from the cultural environment. This paradigm does not take into account the social and cultural context in which humans use tools to achieve determined goals. It also does not take into account intentional motives behind the use of some information systems and the individual level of user cultural adaptation to particular software tool functionality. (Gobbin, 1998, p.116-117)

Activity Theory appeared to be a lens through which I could examine my case studies and information systems, as it manages to encapsulate a broader view of work. Randall, Harper and Rouncefield notes that:

> activity theory moves us towards real-world contexts of use, a context that is social through and through (or cultural-historic)...rather than the information-process

models of humans and computers, an approach to the behaviour of both in a wider environment is required. (Randall, Harper & Rouncefield, 2007, p.91)

Although Activity Theory is essentially a theory of learning (Engestrom, 2001) many researchers such as Nardi (2008), Engestrom (2000) and Bannon (1997) have previously applied Activity Theory to their research, with Bannon noting that Activity Theory provides 'a general conceptual framework for understanding and analysing human activity' (Bannon, 1997). Further, Kuutti (2001) advocates Activity Theory as a potential framework for research in the area of Human-Computer Interaction. 'Activity Theory is a philosophical and cross-disciplinary framework for studying different forms of human practices as developed processes, with both individual and social levels interlinked at the same time. (Kuutti, 2001, p.25)

The next section provides an overview of Activity Theory and illustrates the potential assistance which it lends to holistically modelling the work of mobile workers. My research will make use of Activity Theory to develop a framework which describes the work and interaction with the information system by mobile knowledge workers.

Chapter 3 - Literature Review: Activity Theory

3.1 Introduction

Activity Theory is used in my research as a lens to view the information system of the case studies. The following chapter will first outline in detail the main concepts of Activity Theory. I will then outline my application of Activity Theory as a framework for analysis which will be employed to the findings of the mobile workers.

3.2. What is Activity Theory?

Activity Theory was initiated by a group of revolutionary Russian psychologists in the 1920s and 1930s, and the theory is specifically credited to Lev Vygotsky, A. N. Leont'ev and A. R. Luria. The underpinning philosophy of this theory aimed to explain human consciousness and behaviour. Verenikina and Gould (1998, p.8) have noted that 'Vygotsky's life goal was to create a psychology adequate for the investigation of consciousness'.

Activity Theory is the study of what humans 'do'. The Russian word 'dyeyatelnost' which translates to 'activity' has been suggested to be better represented by humans 'doing' or 'performing or operating both physically and mentally' (Hasan, 1998, p.25). Further, Activity Theorists believe that what we do (an individual's activity) defines our consciousness and mediates the way we 'do' things. Nardi noted that:

> Activity Theory says you are what you do. If you spend your days digging ditches, your consciousness will be thusly shaped. If you find yourself writing computer programs as your life's work, that is quite another consciousness. Activity Theory asserts that the consciousness created by your everyday activities spills over into

other seemingly unrelated activities, so that activities like formal education and reading have tremendously powerful effects on consciousness. (Nardi, 1998, p.34)

Within the theory, therefore, the analysis of human practice is done on the basis of 'doing' or activity. Human activity is described broadly by Nardi as including:

> things like speaking, mediating, remembering, as well as activities more centred on the body and its movements...Saying you are what you do includes the way you physically move through the world, and the tools you pick up and put in your hands and use, and the hugs and kisses you give and get and everything that makes you human. (Nardi, 1998, p.34)

3.3 Subject – Object and Activity

A 'Subject' is an individual or group of individuals involved in a common Activity. The Subject undertakes some activity in order to achieve an 'Object' (see Figure 3.1 below). The arrow in Figure 1 below represents the Activity, i.e. the element symbolising work. The Activity is the point of interest for my context as it is the 'black box' detailing how the MKW gets work done.
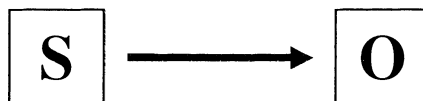
Figure 3.1: Subject, Object and Activity (*from* **Kaptelinin and Nardi, 2006, p.30**)

The concept of Object-Orientation should not be confused with the same term used in the field of computer programming. In Activity Theory, reference to the Object alludes to the desire (theoretical result) that the Subject is trying to fulfill, or the underlying motive for the activity. The Object is what drives an activity.

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Objects of activities are prospective outcomes that motivate and direct activities, around which activities are coordinated, and in which activities are crystallized in a final form when the activities are complete...Objects can be physical things (such as the bull's eye on a target) or ideal objects ("I want to be a brain surgeon."). (Kaptelinin and Nardi, 2006, p.66-67)

The concept of the Object is a source of ongoing misunderstanding, as noted by Rogers (2007). Kaptelinin and Nardi (2006) also noted the confusion originating from the Object and the two different models offered, one by Leont'ev and the other by Engstrom. The main point of difference is that Leont'ev suggested that an Activity is viewed from the individual's perspective, while for Engstrom the analysis of an Activity is 'defined as a collective activity system...The object of activity is defined by the community, and it is the community that carries out the collective activity as a whole (Engestrom, 1999, p.142). That is, the Object is viewed as an Individual or a Collective Group level.

The Object is dynamic and can change or develop over the lifetime of an activity. 'It is possible that the object and motive themselves will undergo changes during the process of an activity' (Kuutti, 2001, p.27). Therefore, in undertaking the activity, the anticipated Object and the actual Outcome may differ. An example used by Kaptelinin and Nardi (2006) describes how a house being built by a family may change over time and, when complete, may be substantially different to that initially envisaged.

One other consideration with relation to the Object is that at any one time an individual may have more than one motive. The decision about which motive to act on is, according to Kaptelinin and Nardi (2006, p.149) a function of the social context and the conditions and means available to the individual. These two motivating forces will constitute part of the investigations of the main case study.

3.4 Tools and Mediation

My initial premise for using Activity Theory derived from one of the main constructs of this theory, namely, that the way a worker will approach or carry out their work is mediated by their tools (means available – see above paragraph). According to Activity Theory, the development and use of existing tools must be viewed from a cultural-historic point of view, as such tools and associated processes were developed by earlier participating workers. The intimate knowledge that these workers possessed served to influence and shape existing tools and their use. The tools therefore have embodied knowledge which mediates work.

The concept of Tool Mediation is considered by Activity Theorists as a fundamental component to understanding consciousness and the way Activities are approached. Further, according to Kuutti (2001), all Activity contains or involves interaction with tools. Tools, often referred to as artifacts, are created by humans and offer signs to the Subject which assists in directing them towards a particular action.

> Mediation by tools and signs is not merely a psychological idea. It is an idea that breaks down the Cartesian walls that isolate the individual mind from the culture and the society...The idea is that humans can control their own behaviour – not "from the inside," on the basis of biological urges, but "from the outside" using and creating artifacts. (Engstrom, 1999, p.29)

Tools

Subject   Object ——▶ Outcomes
Activity
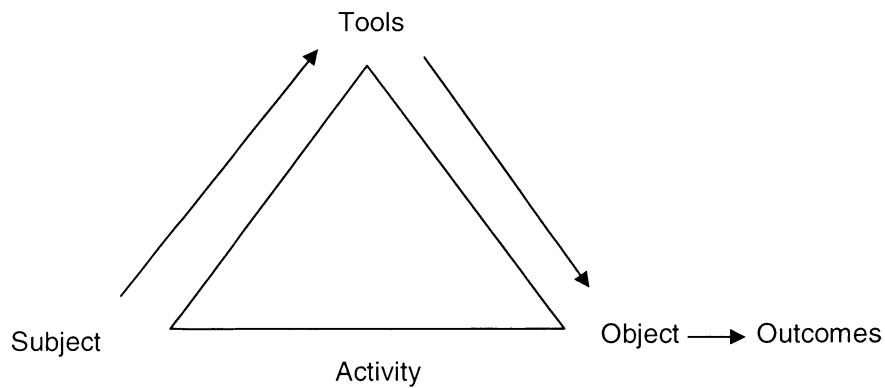
Figure 3.2. Basic model of activity

As can be seen in Figure 3.2 above, the way in which the Subject approaches the activity in order to achieve the Object is mediated through Tools (also described as artifacts). That is, the tools humans use influences the way they approach an Activity and assists with their decision making or prompts the Subject to take a course of action. Vygotsky wrote that

> when a human being ties a knot in her handkerchief as a reminder, she is, in essence, constructing the process of memorising by forcing an external object to remind her of something; she transforms remembering into an external activity. (Vygotsky, 1978, p.51)

Tools can take various forms depending upon the context of the study; they may range from instruments, signs, procedures, or machines, to language, methods, laws, and forms of work organisation. Hasan (1998, p.27) further elaborates on three categories of tools.

- *Primary Tools: artifacts, instruments, machines, computers etc.*
- *Secondary Tools: language, signs, ideas, models etc.*
- *Tertiary Tools: cultural systems, scientific fiction, virtual realities*

Irrespective of whether a Tool is physical or mental in nature, the key feature of a Tool is that it provides signs (prompts or clues) which mediate the way an activity is undertaken by the Subject. These Tools are historic in nature, having been developed by earlier participants.

3.5 Community of Practice and Divisions of Labour

As noted above, Tools have been developed in the context in which they are to be used by Actors who have an intimate knowledge of the work (Activity). These Tools carry Cultural-Historic significance, providing some assistance to the Subject in what they do. It is vital, therefore, to acknowledge and account for the viewpoint of the experts in the different fields of mobile work. Another mediating factor which is Cultural-Historic in nature are the Rules which mediate an Activity and the interaction between subjects within the Group.

As described above, Activity Theory centres around mediation and the concept that the way humans undertake an activity is influenced by the environment around them and their ability to develop an understanding based upon previous experiences in order to make logical actions. This mediation is man-made in that the tools which influence a Subject have been developed by the Subject or other people who have previously worked in the same context.

Ryder (2004) writes that in most human contexts our activities are mediated by using culturally established standards, such as language, artifacts, and established procedures. A second influence which mediates an Activity is the Community. Kuutti notes that the mediating Tool model is insufficient:

> This structure is too simple to fulfill the needs of a consideration of the systemic relations between an individual and his or her environment in an activity, however,

and thus a third main component, community (those who share the same Object), has been added. (Kuutti, 2001, p.27)

Activity Theorists believe that the human mind, our consciousness, is one which is social in nature. Kaptelinin and Nardi (2006) note that:

> human beings are shaped by cultures, their minds are deeply influenced by language, and they are not alone when interacting with the world. Typically they act with, or through, other people, for instance, as members of groups, organizations, communities, or cultures. (Kaptelinin and Nardi, 2006, p.37)

The influence that the Community of Practice has upon an Activity is applied through Rules to which the Subject adheres. These Rules are implicit and explicit governance which direct the Subject. Explicit Rules are easily identified as documented codes of practice or standards which govern the requirements of workers. Implicit Rules are the norms which the Subject accepts as requirements (informal procedures as well as the social relationship between the Subject and the Community), often derived from other more experienced workers.

> Some of these rules may be explicit – set by law, the parent organization, or the team manager – but many of them are most certainly implicit, either as a part of the general working culture or developed as the team works together. (Kuutti, 2001, p.29)

A model proposed by Engstrom (1987) incorporates the concept of the Community and its influence. The model has the three main elements in an Activity as the Subject, Object and Community with a relationship which is mediated between each of these elements. The relationship between a Subject and Object is mediated by Tools; the Subject and Community are mediated by Rules; and the Community and Object are mediated by Divisions of Labour.

The Community has previously been described as the organisation in which the Subject operates (Barab et. al., 2001 and Engestrom, 2008) with the Divisions of Labour representing the collaboration with other stakeholders (both within the organisation and as external workers) who collaborate in an Outcome. Engestrom's model of Activity is pictured below.

TOOLS

SUBJECT   OBJECT ⟶ OUTCOME

RULES   COMMUNITY   DIVISION OF
                                  LABOUR
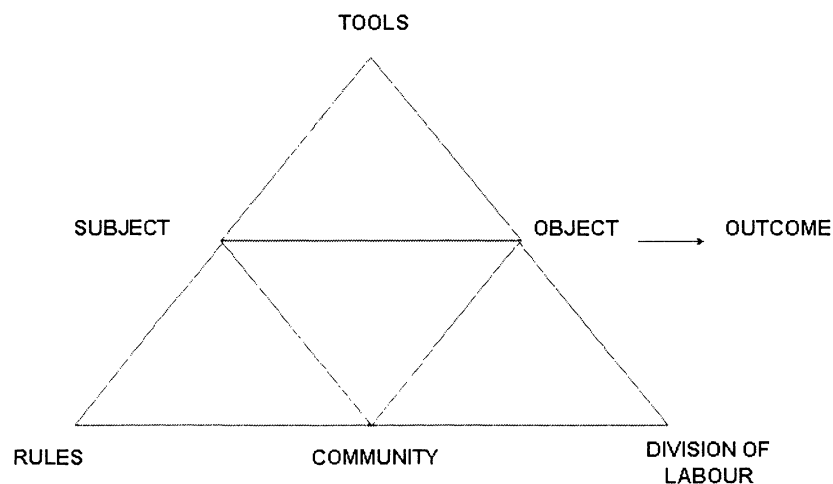
Figure 3.3: Engestrom's Model of Activity

The line of division between the Subject, Community of Practice and the Division of Labour is determined by the analyst or researcher. Engestrom and Miettinen (1999) noted that the analyst constructs a holistic view of an Activity by initially selecting a Subject and then interpreting the system from that Subject's point of view.

3.6 Contradictions

It is evident that a potential mobile technology used to support mobile workers in the field could be substituted as the Tool that is mediating the Activity. That is, an

introduced piece of mobile technology will mediate the way in which the work Activity is undertaken.

The introduced technology could, however, have negative effects upon the Activity and cause an undesirable Outcome, such as those described by Luff and Heath (1998). Bodker (2001) described this situation as Breakdowns in an Activity.

> Breakdowns related to the use process occur when work is interrupted by something; perhaps the tool behaves differently than was anticipated, thus causing the triggering of inappropriate operations or not triggering any at all.. (Bodker, 1999, p.150)

Breakdowns or disturbances are a result of what Activity Theorists identify as contradictions. Contradictions occur when there is tension between different elements in an Activity. Engestrom (2008, p.27) notes that 'contradictions emerge when one component changes or develops beyond the operational logic of the other components'.

Contradictions play an important role for researchers such as Kaptelinin and Nardi (2006) as they incorporate interaction design with Activity Theory. This works well as Engestrom notes that:

> when an activity system adopts a new element from outside (for example, a new technology or new object), it often leads to an aggravated secondary contradiction where the some old element (for example, the rules or division of labour) collides with the new one. Such contradictions generate disturbances and conflicts. Engestrom, 2001, p..137)

In my research, I examine and identify the existing information system and interaction of the MKW. Although my research does not involve any action research or the introduction of a specific tool, it is important to take into account the potential that contradiction has to disrupt a system in equilibrium. That is, it is important to

note the existing system components and how they interact in order to anticipate and avoid contradictions and disruptions.

Further Kuutti believes that contradictions are a source of potential improvement:

> External influences change some elements of activities causing imbalances between them. Activity Theory uses the term contradiction indicating an unfit within elements, between them, between different activities, or different developmental phases of a single activity. Contradictions manifest themselves as problems, ruptures, breakdowns, clashes etc. Activity Theory sees contradictions as sources of development; real activities are practically always in the process of working through some such contradictions. (Kuutti, 2001, p. 34)

3.7 Internalisation and Externalisation

According to Kaptelinin, Nardi and Mcaulay (1997), there are five key principles which form the basis of Activity Theory. The concepts of internalisation and externalisation are key concepts.

Human activity is categorised as external – what you do in the world – and internal – what is stored in the mind and generated by the individual. The process of internalisation involves the individual learning from their experience and being trained by others. The internalisation allows humans to envisage possible future actions and their outcomes.

> It is through activity that we learn and internalize concepts that then become a psychological tool that is manipulated in the 'internal plane of action'. The internal plane of action is a concept developed within activity theory that refers to the human ability to perform manipulation with an internal representation of external objects before starting actions with these objects in reality. (Hasan, 1998, p.25)

Externalisation reflects the actions the Subject takes in the real world based upon their internal construction of the Activity and 'the better the model the more successful the action' (Kuutti, 2001, p.31).

The concepts of internalisation and externalisation, although important in the application of learning, are limited in my use of Activity Theory.

3.8 Using Activity Theory

Engestrom (2008) used Activity Theory as an analytical tool to examine existing systems of works. In using Activity Theory, Engestrom noted that it offered a framework which targeted the social aspects often overlooked in systems development.

> To analyse a reasonably complete process of work, one typically needs to cover a lengthy chain of actions, a trajectory from the initial 'raw material' to the finished product (Strauss, Fagerhaugh, Suczek & Wiener, 1985). This is attempted by various methods of business reengineering (Hammer & Champy, 1993). The weakness of such attempts is that they typically miss much of the 'invisible work' (Nardi & Engestrom, 1999; Star, 1991) of small everyday contingencies, trouble, innovations, and sideways interactions, often giving an idealistically streamlined picture of what is going on (Engestrom, 1999b).

> To capture in detail the rich texture of communicative events and interactions, on the other hand, one typically needs to focus on small chunks of the process and to look at them as if through a magnifying glass...A common weakness of these attempts is that they tend to focus on relatively arbitrary segments of work and communication, with no interest or ability to connect the analysis of local interactions to broader institutional, cultural, and historic forces...A conceptual model of the activity system is particularly useful when one wants to make sense of systemic factors behind seemingly individual and accidental disturbances,

deviations, and innovations occurring in the daily practice of workplaces. (Engestrom, 2008, pp.23-27)

I will apply a similar methodology to that of Engestrom, using Activity Theory as an analytical framework to review the existing information systems of mobile knowledge workers. The key components – Tools – as well as the influences of the Community (Social Rules and underlying motives) affect the work practices of an Activity and assist in interpreting the information system. An explanation of how Tools are used and the social factors influencing their use will create a holistic view of the information system for the Activity of a MKW.

Mwanza (2001) suggests eight steps to using Activity Theory as an investigative tool. Mwanza noted that

> using the Eight-Step-Model whilst answering questions in relation to the situation being examined enables the investigator to acquire basic knowledge about that situation. This is necessary for the purpose of mapping Engestrom's model onto the situation in order to produce an activity system of that situation. This approach helps to identify areas to be focused on during the investigation and also in deciding on what resources would be necessary during the analysis. (Mwanza, 2001, p.4)

The eight steps set out by Mwanza are:

Identify:-
1. Activity of interest
    - What sort of activity am I interested in?
2. Object or Objective of activity
    - Why is this activity taking place?
3. Subject of this activity
    - Who is involved in carrying out this activity?
4. Tools mediating the activity

- By what means are the subjects carrying out this activity?

5. Rules and regulations mediating the activity
   - Are there any cultural norms, rules or regulations governing the performance of this activity?

6. Divisions of labour mediating the activity
   - Who is responsible for what, when carrying out this activity and how are the roles organised?

7. Community in which the activity is conducted
   - What is the environment in which this activity is carried out?

8. What is the desired Outcome from carrying out this activity? (Mwanza, 2001, p.4)

In the next chapter, Activity Theory will be used as a lens to examine in detail the Information System of one of the MKW Case Studies. The above methodology for the application of Activity Theory will also be customised to fit the MKW Information System context.

The issue I have with the use of Activity Theory as outlined by Mwanza is the independent examination and breakdown of the components of an Activity. Hasan and Gould (2001) rather view the unit of analysis (the Activity of concern) as having two main mediating influences. These are the Cultural Historic Tools and the compelling explicit and implicit Rules of the Community of Practice (organisation). As an analytical tool Engestrom (1993 and 2008) takes a similar view to Hasan and Gould (2001).

Taking this into account, the method of analysis used for my research, integrating Activity Theory, is as follows:

1. Identify the Subject, Object and Activity that are to be the focus of research
2. Interpret data from the point of view of mediating influences, these being the tools and the influence of the Community of Practice.

3. Determine whether there are any other emergent themes which provide an influence upon the Activity

Chapter 4 - Methodology

4.1 Introduction

The research in this PhD aims to develop a view of the MKW's information system which incorporates not only the information used by these workers but also the when, how and why it is accessed - in other words, the way their work is done. This work contributes to the study of information systems by providing a 'theory of explaining' (Gregor, 2006). That is, in studying the information system in the context of the MKW, an explanation of how and why things happen is provided, for example, how, when and why information is accessed and used. In the following chapter I outline the methodology selected as the best fit for achieving my research goals.

The research methodology applied to this thesis is qualitative in nature. In this chapter, I outline the selection and application of the methodology used and the interpretive epistemology underpinning my qualitative research. This chapter will address the design logic behind the research and outline the interpretive case studies cultivated. I also explain the processes of data collection through interviews and thematic analysis using the computer program N-Vivo.

4.2 Methodology Options

The research methodology was selected based on the requirements of my research. The rationale for the selection of interpretive case studies is based on the development of a theory to assist in the understanding of MKWs in relation to interaction with their information system.

Research in general can be categorised as either qualitative or quantitative. The research philosophy or epistemology refers to the underlying assumptions that validate a piece of research and guides the selection of an appropriate research method.

4.2.1 Quantitative Research

Quantitative research takes the representation of the data and interpretation of these numbers to provide scientific evidence of the phenomena being studied. Straub et al. (2005) notes that quantitative research is motivated by numerical outputs and methods to derive meaning. According to Myers and Avison (2002), examples of quantitative research methods include surveys, laboratory experiments, formal methods such as econometrics, and numerical methods such as mathematical modelling.

Quantitative research has an epistemology that is positivist in nature and therefore the data gathered is collected, ordered and represented as numbers. The production of evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population are all examples of positivist epistemology.

4.2.2 Qualitative Research

Some phenomena are not easily quantifiable or categorised as black or white. According to Myers and Avison (2002), quantitative research was developed to study natural sciences and natural phenomena, whereas qualitative research was developed to assist researchers to understand people and the social and cultural contexts within which they exist.

A feature which differentiates qualitative research is the emphasis placed on context. Kaplan and Maxwell (1994) highlight the importance that is placed by qualitative research on context (socially as well as institutionally) from the point of view of the subject or participant. This is lost when textual data is quantified in quantitative research.

Avison and Myers (2002) give examples of qualitative methods such as action research, case studies and ethnography and methods of data collection as observations and participant observations (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impressions and reactions.

Qualitative research has three possible underlying epistemologies (again, the assumptions about knowledge and how it can be obtained). These are Positivist, Interpretive and Critical. See Figure 4.1 below.
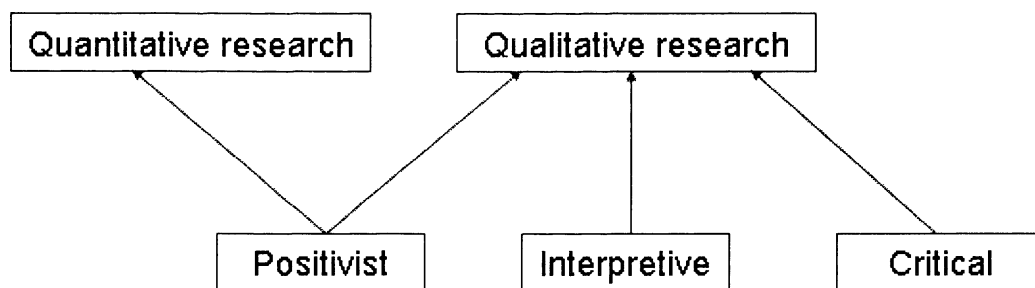
Figure 4.1: Epistemological assumptions for qualitative and quantitative research (*from* Straub et al. 2005, p. 226)

Just as with quantitative research, qualitative research can have an epistemology which is positivist. Qualitative research is positivist if the underlying reason for the research is to increase the predictability of a phenomenon by testing a theory for predictability.

Critical research is aimed at emancipating people and improving their social and economic circumstances. Myers and Avison (2002, p.7) notes that 'critical research focuses on the oppositions, conflicts and contradictions in contemporary society, and seeks to be emancipatory i.e. it should help to eliminate the causes of alienation and domination'.

The interpretive epistemology attempts to understand a phenomenon through the meaning that people assign to a context. According to Myers (1997) the interpretive approach begins by assuming that access to given or socially constructed reality is determined via social constructs such as language, consciousness and shared meaning.

4.2.1 Selection of the Qualitative Interpretive Approach

My research aims to gain an insight into the perceived operations and interactions of MKWs with their information system and therefore a qualitative research approach is better suited to provide an understanding of this phenomenon. The exploratory nature and 'real life context' of this research required a qualitative case study approach (Yin, 2002; Preece, 2002;, Benbasat, Goldstein & Mead, 2002).

In considering the proposed outcomes of my research, the quantitative approach and positivist epistemology would be less suitable, as what I am studying concerns people and the choices they make (how, what and when they access information). Since the subjects of my research are human beings, I was conscious of the contextual influence on decision making and the findings therefore need to offer a guide to what will happen, as opposed to the 'black or white' or prescriptive finding which is proposed by positivist researchers.

Strauss and Corbin (1990, p.19) note that 'qualitative methods can be used to uncover and understand what lies behind a phenomenon about which little is yet

known'. This adds further justification that qualitative research is a good match with my research.

I identified my research as being interpretive, particularly noting the contextual nature and social interactions which are encountered in understanding MKWs and their information system. Supporting the interpretivist epistemology, Walsham (1993) notes that, in terms of information systems research, the interpretive methods are attempts to understand the information system context and the processes where systems influence or are influenced by the contexts.

4.3 Research Design – Interpretive Case Studies

The research methodologies available to qualitative research include action research, case studies and ethnography (Avison and Myers, 2005). Of these, a case study methodology as described by Yin (2002, p.13) 'allows for investigation of a contemporary phenomenon within a real life context, especially when the boundaries between phenomenon and context are not clearly evident'. This suggested to me that it is most suitable for investigating the workings of the MKW and in particular, for understanding the Information System from the point of view of the user, the technology and the organisation.

The interpretive case study methodology, according to Walsham (2002, p.104), uses theory as an 'initial guide to design and data collection; use of theory as part of an iterative process of data collection and analysis; and as a final product of the research'. Activity Theory provides a theoretical perspective through which the case studies will be examined.

The methodology used by researchers such as Kaptelinin and Nardi (2006) and Barab et al. (2002) uses Activity Theory as a basic set of concepts in the application of interaction design. Activity Theory in these cases supports researchers by:

- Providing a structured approach to the object of study;
- dividing problems into easily managed sub-problems;
- Prioritising and establishing the importance of research issues.

The use of Activity Theory in this case did not suit my research as its application is aimed specifically at the action research of interaction design.

Kaptelinin and Nardi (2006) also identified two further uses of Activity Theory in research and interaction design, firstly as a descriptive theory that identifies a number of fundamentally important concepts and secondly as an exploratory theory that suggests mechanisms explaining why and how certain phenomena take place.

Engestrom (2008) undertook research which considered disturbances in the form of deviations from the planned course of events in the work process from the point of view of the production team (Producer, Director, Senior Audio Technician and others). To assist in the interpretation of this case study, Engestrom used a conceptual model of Activity Theory as a lens through which data was translated. Consistent with this research, I selected Activity Theory as a platform through which I investigated my case studies, assisting in the interpretation of the MKW and their identification of, and interaction with, their information system.

The case study developed through the lens of Activity Theory encapsulates into a model of the decision making process as a component of the work Activity of a MKW while in the field, and the Subject is the mobile worker, operating away from a formal office situation (see Figure 4.2 below). The information system that the MKW interacts with is viewed as the Tools, while the interaction with this information system is mediated by Rules – the social norms and standards that are the influences exerted by the Community of Practice.

In utilising Activity Theory as an interpretive tool to provide a holistic view of the interaction by the MKW with their information system, the role of Collaborators cannot be ignored (Divisions of Labour). Collaborators will be considered as a potential source of information and mediating force on an Activity.

INFORMATION SYSTEM
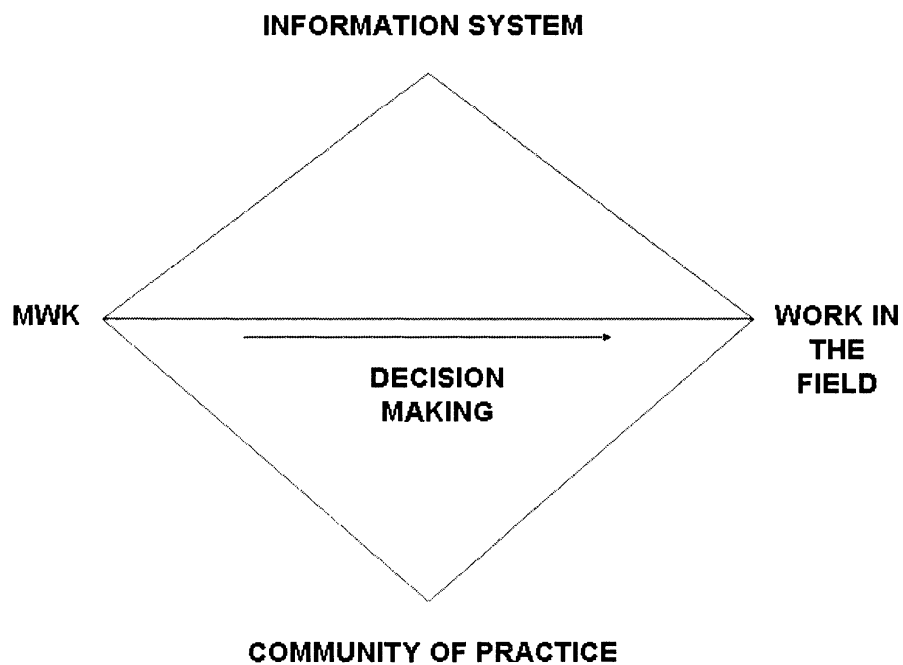
Figure 4.2: Activity Theory and the MKW

To allow for a broad view of this system, the model was created through studies of different MKWs, specifically, Reporters in the field, Doctors on ward rounds, and Construction Site Workers operating over different areas of a construction site or across a number of building sites. A detailed list of these workers and the logic behind their selection is listed in the introduction to each of the respective case study sections.

The interpretive case study method is iterative in nature and requires at least two rounds of data collection, in which the theories that emerge from the first round are

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tested in the second. An example of this approach is that taken by Orlikowski (1996) where data collection was conducted in two phases.

Iteration in qualitative research is supported by Gorman and Clayton (2005) and allows for refinement of my research through informed modification to the model being developed. Gorman and Clayton (2005) suggest a three-phase research process which I will follow. These are as follows:

1. The initial phase is 'Preliminary Preparation'

This stage, as described by Gorman and Clayton (2005), considers the focus and selection of a topic, a literature review and formulation of the research question. Chapters 1-3 demonstrate these processes, which were undertaken prior to the start of my research.

2. The second phase is described as 'Broad Explanation'

Typically, this phase includes such processes as conducting pilot case studies, and includes the search and selection of suitable subjects. The pilot case studies selected in my research consider the mobile knowledge work that is conducted by Doctors examining patients on ward rounds and newspaper Reporters as they develop and deliver stories from the field.

3. The final phase of this iterative research is the 'Focused Activity'

This phase of the research is an iteration of the previous phase once the research has been amended and refined, taking into account the findings of the pilot studies. In my research, this constitutes the main case study, which is the examination of Construction Site Workers. Following the analysis of the pilot studies of Doctors and Reporters, a comparison of the identified themes was made against the evidence provided by the second case study, refining the mobile information system model

(Pare and Elam, 1997). The details of the two iterations of the case studies in phases 2 and 3 can be found in Section 4.5.

4.3.1 Data Collection – Semi-structured Interviews

When considering the data collection method, I initially considered interviews to be the most suitable technique. Walsham (2002) asserts that, particularly for case study research, interviews are a primary data source because the researchers can access various interpretations of the participants towards actions and events and views of themselves and other participants.

The main form of data collection in constructing the case studies was through semi-structured interviews.

Silverman (1993) suggests that the use of interviews is advantageous as it allows for interviewees to freely respond and therefore define their unique understanding of situations. Particularly given my limited understanding of the work involved in the pilot case studies of the Doctors on ward rounds and the field Reporter, the interviews allow for issues that may not have been previously defined to materialise from the respondents.

Interviews have the potential to generate data which is non-productive (Hove and Anda, 2005). Other concerns with interviews are raised by Walsham (2002), noting that if the interviews are too tightly controlled, much of the richness of data gained from the expressions of the subjects interviewed could be lost. Conversely, if the interviewer is too passive then adverse effects may occur, such as missing the opportunity for exploration of new directions. Additionally, interviewees could conclude that the researcher is not interested hearing negative responses with ongoing collaborations. This was a particular concern for my research as I intended,

and indeed, conducted follow-up interviews with many of the subjects. To address the above concerns, I decided to conduct all interviews myself ensuring a consistency in the interviews as well as maintaining a level of quality control over the interviews.

Similar to research undertaken by Wood (1997), to further assist in efficiency with the data collection, I decided to use semi-structured interviews as a means of keeping interviews focused on the relevant topic of examination. As Wood (1997, p.53) notes. 'guided questions help keep the user focused on relevant aspects of the work domain without narrowing the focus too early'. (The guiding interview questions for the semi-structured interviews are available for review in Appendix B.)

Preece, Rogers and Sharp (2002) and Wood (1997) note that data collection using interviews can be enhanced if undertaken in the subject's place of work. Through this method Preece, Rogers and Sharp (2002, p.211) state that 'if interviewed in their own work or home setting, people may find it easier to talk about their activities by showing the interviewer what they do and what systems and other artefacts that they use'. I decided, therefore, that the large majority of my interviews would be undertaken face to face in the workplace to assist with the integrity of the data collected. Some interviews were conducted via phone calls due to issues such as time constraints and availability, or as a preference of the interviewee.

It is imperative for the collection of data in interpretive case studies to be as effective as possible (Walsham, 2005). To ensure this, all interviews were digitally recorded and transcriptions were made of the recordings. These transcriptions were used to facilitate a thematic analysis as noted in Section 4.4.

Confidentiality was applied to data through the desensitising of names (Veal, 2005) which was also a requirement for Ethics Approval by the UTS Research Office. Because all interviewees were informed about the desensitising of data (all signed a

consent authority – see Appendix A), this also assisted with freedom of expression in interviews, resulting in a rich source of data.

The case studies aim to describe the existing information system available to the examined MKW. Since the information system supports decision making, exploring how the MKW makes decisions would provide a snapshot of scenarios in which these workers interact with information sources.

The overall focus of the interviews was aimed at extracting the following:

- Describing how the interviewees operate in mobile scenarios and in particular the different sources of information
- Identifying information sources
- Identifying potentially useful information sources for decision making available to office based workers but unavailable to the interviewed MKWs when operating in a mobile mode (gaps in the mobile information system of the interviewed MKWs)
- Identifying how the workers fill in the gaps in their information system

To ensure that I was able to focus the data collection on the above areas of interest and also allow freedom for the respondents to contribute, I used semi-structured interviews. A key feature of the semi-structured interview technique according to Gibson and Brown (2009) is that it permits the researcher to consider the predefined themes of the interview while allowing flexibility to give participants the freedom to explore emergent topics.

I found that an advantage of using semi-structured interviews as the data collection medium is that it allows for the changes in direction, opening up unanticipated areas for consideration while still offering a guide to the underlying themes to be examined. For example, it did not occur to me that the different MKWs would have

a central information store, such as an office, from which they regularly operated. A comparison between the way in which some MKWs operated in the office and in the field was then considered as part of the pilot case studies, leading to some interesting outcomes.

Interviews started with participants providing a brief description of their role, the general work they do and the number of years they have been involved in this type of work. The interviewees were asked to describe situations in which they worked in a mobile sense and how, if at all, they made decisions while mobile. The tools for decision making (information and its sources) were explored (see Appendix B for sample questions).

Hypothetical questions about 'decision making' allowed for the construction of vignettes (Sleed, et al. 2002; Finch, 1987). Using scenario-based short stories assisted in the production and interpretation of data concerning decision making from the interviewed MKWs.

The interviewees were also asked to consider any issues with information sources that were used in their mobile work. An explanation of how these workers overcame these issues highlights the non-explicit ways in which decisions were made and information was gathered and used. A final consideration proposed to interviewees was the possibility that mobile technology could assist in their mobile work.

A concern identified by Gibson and Brown (2009) with the use of semi-structured interviews is that the researcher conducting the interviews will have to make judgments 'in the heat of the moment' about what is relevant and which flow of conversation to follow. To overcome this, several of the participants were re-interviewed after some analysis of their initial interview. This allowed for emergent topics which were initially overlooked to be represented.

4.3.2 Sampling

In the development of the pilot case studies, snowball sampling was used as a means of assembling subjects for interview. Patton (1990) describes snowballing or chain sampling as the discovery of a wide sample of persons via people who know other people within the area under examination. Such people can provide information rich cases that are particularly good for case studies.

The reasoning for using this sampling technique is that I have relatively little experience or understanding of either Doctors working on ward rounds or Reporters working in the field. This means that the initial contact has the ability to assist by establishing appropriate subjects for examination. Penrod et al. (2003) note that snowball sampling is of particular use when examining sociological endeavours, as it allows for the sampling of natural interaction units. Lopes, Rodrigues and Sichieri (1996) highlight an advantage that snowball sampling provides within a field of interest as referrals. Through referrals made by those already selected for matching the target research criteria and based on their interpersonal knowledge of other professionals in the same field, there is increased potential for matching subjects of interest, both in the relevance of interviewees and the data collected.

In my experience of the snowball sampling method ,I found that there appeared to be a level of comfort between myself and the interviewee. The subjects were very open in their responses to questions and their descriptions of topics were candid and detailed. This could have been a direct result of having been introduced to the interviewee by a common personal contact. Unfortunately, I also encountered limited availability of potential subjects, as several of the recommended contacts were unavailable for interview.

I found that using the 'interview – snowball' approach to gathering data also assisted in the selection of subjects of the case study. The instance of examination was the

application of knowledge supported by information in decision making by mobile workers; however, some of the interviewees were not mobile workers. For example, the Editor was interviewed for his views on how Reporters operated in the field which revealed a misconception about the usefulness of laptops, allowing for a broader organisation view of the subject MKW. Further information is contained within future chapters.

The main case study examined various Construction Site Workers on two different building sites. My personal experiences, having worked for over ten years in this industry, allowed me to exercise some judgment to undertake purposeful sampling. Marshall (1996) describes this sampling technique as the researcher choosing the most productive sample to answer the research question. Further justification can be found in Boyatzis (1998) who stated:

> Knowledge relevant to the arena being examined is crucial as a foundation, often referred to as tacit knowledge. For example, it is difficult to perceive and make sense of patterns in Shakespeare without understanding Greek and Roman mythology. Strauss and Corbin (1990) claimed that theoretically sensitivity is the ability of the researcher to recognize what is important, give it meaning and conceptualize the observations. In this sense, a researcher needs to have the patience to perceive themes or patterns and the 'lens' through which to view them. Cleaning your glasses helps, but conducting qualitative research involves emotional, value-laden, and theoretical preconceptions, preferences and worldviews. (Boyatzis, 1998, pp.7-8)

Case studies and the data collection, in the form of interviews with subjects, were continued until a consistent theme was identifiable theoretical saturation, (Eisenhardt, 1989) or until that source was exhausted as a result of repetitious responses.

4.4 Analysis

Gibson and Brown (2009) described two well-used analytical approaches towards qualitative research as 'top-down' or 'bottom-up'. Top-down makes use of a theory to interpret data, as opposed to bottom-up, which is a grounded approach in which the data informs the themes of research.

Initiating my analysis, a top-down hermeneutic analysis (Avison and Myers. 2002) was applied. Themes associated with Activity Theory were used as an interpretive tool to assist the understanding of ideas associated with my investigation of MKWs and their information system. According to Avison and Myers (2002, p.11), this approach to analysis of data is validated through overcoming the potential 'confusion, cloudy and contradictory views on issues' of the interview group. The analysis of the text of conversation using the hermeneutic approach tries to 'make sense of the whole, and the relationship between people, the organization, and the information technology' (Avison & Myers, 2002, p.11), in my research this being the MKW, their information system and the associated interaction.

Walsham (2002) notes that a potential danger to the interpretive case study is that the researcher only sees what the guiding theory suggests and overlooks potential new avenues of exploration. With this in mind I applied a combination of both the top-down and bottom-up approach to my data analysis.

Following the preliminary analysis based on Activity Theory, open coding, that is breaking down and examining the data, (Strauss and Corbin, 1990) based on a thematic analysis was applied to allow for the assessment of emergent themes outside the scope of Activity Theory.

To facilitate an interpretive analysis of the data, all interviews were digitally recorded and transcribed. The transcribed data was analysed with the assistance of

NVivo. NVivo was developed by QSR (Qualitative Solutions and Research Pty Ltd) and is a computer aided qualitative data analysis software package (Veal, 2005) which facilitates the efficient storage of primary textual data as well as providing assistance in coding, sorting and organising the text.

Using the NVivo package, I loaded individual interview documents (initially stored as MS Word documents) into a project file. For example, I created a project file called Large Construction Site and uploaded all the interview transcriptions into that project (see Figure 4.3 below).
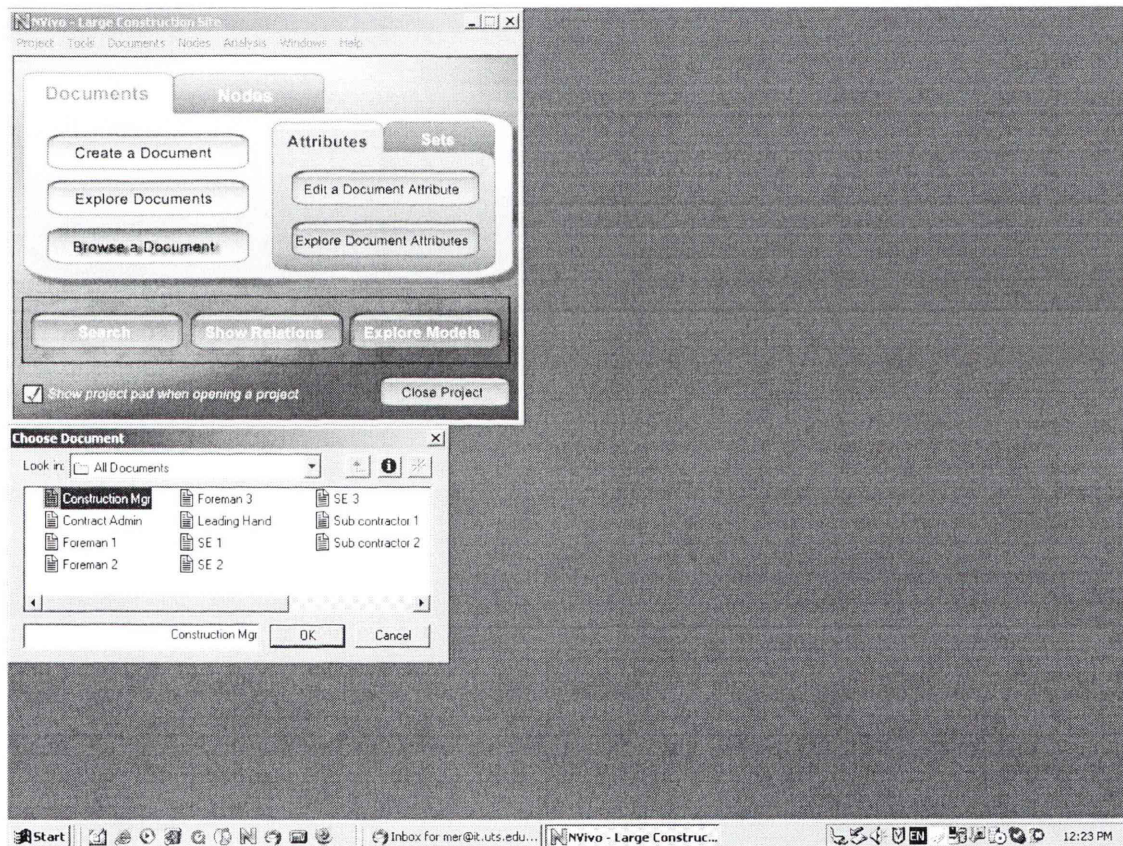
Figure 4.3: N-Vivo file holding project – large construction site

Interviews were then subjected to a thematic analysis as described above. The interpretive themes, as well as those identified through an open coding process, were sorted and labelled in the text as nodes in the N-Vivo program. Following Bazeley

and Richards (2000), text in the uploaded documents was categorised by highlighting pertinent phrases and assigning them to a node or common theme. Additional themes were added as required. Following this process, nodes can be collated and displayed in reports. (See Appendix C for a sample report.)

In analysing and sorting the data using Activity Theory as an interpretive platform, I found that the themes such as Tools and Community could be further individualised. For example, the overarching theme of Tools had categories such as Prepared Material and Opportunistic Interaction. This 'drilling down' into the data is consistent with a coding tree or 'dimensions', categorising data as sub- and super-code as described by Corbin and Strauss (1998) and Gibson and Brown (2009).

4.5 Research Process - Case Studies

The following section outlines the sample group selection.

4.5.1 Selection of Case Study Subjects

The initial selection of MKWs was based on the following criteria:

1. Workers are mobile operating in a remote sense. They work away from their usual work office and as such operate in unfamiliar locations, isolated from information.

2. The work of the sample group is complex, requiring the application of knowledge and information to make decisions while in the field. The questioning and data collection was aimed at revealing the information system of the MKWs through the decision making process, as 'decisions are based on information' (Hutchinson & Warren, 2002, p. 287).

3. Another selection limitation concerns the availability of participants. For example, one of the Foremen working on the second construction project case study was not interviewed due to a busy work schedule and social life. Availability or limitation due to access is noted by several qualitative researchers such as Patten (1990), Strauss and Corbin (1998) and Meho (2006).

4. Having sufficient diversity in the data capture group to represent the range of MKWs is important. Love (2005) researched mobile workers and HCI and noted that characteristics such as age or personal attributes, such as individual cultural backgrounds, can be impediments to interaction with technology and thus with their information system. For example, as an individual gets older they may face impairments such as a decrease in hearing or vision which affects the ability to communicate. Noting the above, I attempted to ensure that a range of interviewees was considered. For example, the Doctors interviewed had a variety of specialty or general work experience.

Several other subject groups, such as Real Estate Agents and Fire Service Engineers, were initially interviewed; however, these subjects were eliminated from this research as they did not meet the level of mobile work, complexity and application of knowledge to information for the decision making attribute of the MKW.

As mentioned earlier, a hermeneutic approach to the analysis and interpretation of data was used and an initial pilot case study was therefore developed, followed by a major case study. Prejudice or other bias is an important consideration with respect to research. As noted by Myers (2004), prejudice in positivist social research is considered to be a hindrance to 'true knowledge'; however, from a contrasting position, hermeneutics requires interpretation as a medium to understanding and as such there is no knowledge without foreknowledge. The issue with prejudice is to be aware of our own biases.

The pilot case studies used to develop a view of the MKWs were iterative processes, initially composed by Doctors working on ward rounds and secondly by Reporters working in the field. The major case study examined Construction Site Workers operating on large construction sites. The pilot case studies are in areas of which the author is relatively unfamiliar, as opposed to that of the construction sites. This measure is aimed at limiting prejudice in the initial analysis and development of the mobile worker framework.

4.6 Conclusion

This chapter reviews both quantitative and qualitative research and outlines the logical selection of the interpretive case study methodology to use in my research. Qualitative case studies interpreted through the use of Activity Theory is a suitable approach for research to model MKWs and their interaction with the information system. The data collection process, including the selection of subjects, has been considered.

Following the research design outlined in this chapter, the future chapters will firstly report on the findings and analysis of the pilot case studies. The pilot case studies involved Doctors on ward rounds and Reporters operating in the field. Once these have been completed, the refined major case study focusing on Construction Site Workers is considered.

Chapter 5 – Results: Pilot Case Studies

5.1 Introduction

This chapter reports on the existing information system for the two pilot case studies of knowledge workers operating in a mobile manner. The first case study is an examination of Doctors on ward rounds and the second considers the newspaper Reporter's production of stories while in the field. Specific consideration is given to the mobile worker's ability to make on the spot decisions, the identification of and accessibility to their sources of information, and how the process of decision making is assisted, if at all, by the existing information system when the worker is functioning in a mobile environment.

In keeping with the thematic case study approach outlined in Chapter 4, I start each case study with a description of the work and establish the mobile work or the context of the Activity which is being investigated. The case study portrayal of the two MKWs illustrates their Activity, what constitutes their information system and the idiosyncratic rules associated with their work. Attention to the Community of Practice and the mediating role it has is another important focus of the research.

Activity Theory provides a holistic view of the subject MKW and opens up a broad view of the information system, taking into account information sources as well as the role which information plays in decision making. Allowing for the mediating influences in the analysis of decision making (the interaction between a MKW and their information sources) provides a description of the information system in use. New themes associated with the work Activity of the MKW such as the influence of the conditions or environment in which they work are examined.

This chapter is presented in three parts. Part 1 describes the Doctors on ward rounds and includes the findings of research followed by an analysis and discussion. Part 2 is a description of the findings of the second case study: the mobile work of Reporters operating in the field. The Reporters case study is an iterative study of the MKW and builds on the insights developed in the first case study. Part 3 is an analysis and discussion of the MKW from the perspective of both case studies. A generic framework which describes the Activity of both MKWs and the interaction of Subjects with their information sources in decision making is presented.

5.2 PART 1: Doctors Ward Round System

5.2.1 Background to the Work of Doctors

My first MKW case study scenario examines Doctors and the way they operate on ward rounds. Wards are designated areas within a hospital where patients are housed during their stay. The wards usually have clusters of patients and are often categorised by the needs of the patient; for example, the Intensive Care Unit (ICU) will house patients with severe illness with high dependency on medical equipment and staff.

Hospitalisation of a patient results in the immobilisation of the patient, restricting him or her to the ward in which they are temporarily housed. The ward round requires the Doctor to physically move to where their patients are hospitalised, working in a mobile manner between hospital wards and away from their consulting rooms. Each patient, even if suffering the same classification of illness, is an individual having different characteristics which may result in different complications, creating the need for individual diagnosis and treatment.

The mobility of Doctors is essential as their rounds often consist of visiting more than one patient in a single ward, and indeed sometimes involves several patients spread over several different wards. It is not unusual for specialists to work across several patients across several different hospitals, further emphasising the need to be mobile.

The work of medical professionals is information intensive, requiring storage and timely access. Burley, Scheepers and Owen (2006) note that efficient interaction with the information system is vital to the work of medical staff and inaccessibility to information can potentially have fatal consequences.

The development of this case study was based upon interviews conducted with three Doctors. All the participating Doctors were required to make ward rounds as a regular part of their working week. The interviews lasted an hour on average. Doctor 1 and Doctor 3 were initially interviewed and then interviewed a second time to extract and clarify data.

To ensure that data collected from the interviews was consistent with practice (and ensure an added element of rigour), Doctor 1 was subject to observations. Doctor 1 was followed while doing ward rounds, and duties included attending several wards in two different hospitals.

Due to the complex nature of the human body, most Doctors working in a hospital specialise in a specific area of medicine. To work as a specialist, Doctors require post-graduate qualifications which often involve several years of training and experience in their chosen area of expertise.

The three Doctors interviewed were all specialists: two renal physicians, or nephrologists, and a cardiac surgeon. All had worked in the industry for a considerable length of time (see Table 5.1 below).

Participant	Experience with ward rounds (Years)	Specialty	Number of interviews
Doctor 1	32	Nephrologists	2
Doctor 2	25	Nephrologists	1
Doctor 3	25	Cardiac Surgeon	2

Total number of interviews: 5

Table 5.1: Doctors interviewed

Doctors are concerned with the health of their patients and pivotal to their diagnosis is the face-to-face contact facilitated by ward rounds, enabling the ongoing examination and care of patients.

All the Doctors interviewed usually started their working day with ward rounds, examining their patients. In each instance the interviewee followed their ward round with consultations in their private rooms or clinic.

> *As a physician I am involved in seeing both in-patients and out-patients in both my consultation room as well as in a hospital setting. The typical day would start off at about 8 o'clock and involve going to the wards in the various hospitals; that would take about an hour and a half and then start the* [private] *clinics and this will take up most of our time. In between, we will be seeing the patients that are on dialysis which are also our patients and then after that at the end of the day there will be a second visit to the hospital.* (Doctor 2)

5.2.2 Findings

5.2.2.1 Mediating Influences

During the ward round, several Tools are used by the Doctors to make a diagnosis of the patient's condition. There are also several Rules which influence the behaviour of the Doctor and the way in which decisions are made concerning the health of their patients.

5.2.2.2 Case Notes

The focus of my research is to examine knowledge workers while they are operating in a mobile sense; however it became obvious during the study that Doctors operate from a traditional office in their consulting rooms as well as in a mobile manner on their ward rounds.

Patients are admitted to a hospital or examined in a consulting office to be treated. The location determines the central point of information storage and retrieval, and on admission a patient is classified as an 'in-patient' or 'out-patient'. An out-patient is one who is attended to by a doctor in their consulting room, and an in-patient is admitted to the public ward of a hospital. The difference between these two classes of patient is paramount to the information system. The out-patient information is collected, stored and controlled by the specialist doctor whereas the in-patients' records are all kept by the hospital.

Where possible, Doctors will diagnose and treat a patient in their consulting room; however, hospitals provide greater support and infrastructure, such as other departments as well as operating theatres and recovery wards which the consulting

rooms usually do not possess. Where the Doctor deems necessary, patients will, after the initial diagnosis, be admitted to the hospital.

In their office domain, the Doctors are able to access information in a variety of ways. Patient records, such as case notes and correspondence with other specialist Doctors, are stored in paper-based files as well as in digital format on their computers. When talking about his consultation office, Doctor 3 noted:

> *Our patient records are kept on a manual card system. I take notes by writing on these cards but we also have some electronic medical practice software which stores all my letters. Letters which I dictate regarding patients for storage on that, as well as all incoming correspondence, so any letters sent to me from other Doctors or other hospitals, medical reports are all stored electronically. They are taken as hard copy and scanned into a PDF file. Each patient has their own electronic record. (Doctor 3)*

During their ward rounds, Doctors often make on the spot, critical decisions using a disconnected information system as they are required to examine patients to assess their health away from the primary data store in their consulting room.

Doctor 1 pointed out that their consultation office is often not in the hospital. The fact that specialist Doctors consult to more than one hospital means that their office space may be physically far from the wards which they service. This means that while the doctor is working on their ward round they are disconnected from their primary information store.

The issue with the out-patient information, which is essential for accurate decision making, is that it is therefore not always on hand while the doctor is on their ward round.

In-patients (admitted to the ward through the hospital) have case notes kept on the ward which include information such as laboratory results and hand written notes entered by various attending Doctors after each visit in hard copy format. Doctor 1 noted:

> *We use a fairly archaic system, still writing down notes – case notes and we don't have direct online access to information such as laboratory data.*

Doctor 1 pointed out that these case notes kept on the ward were not, as a matter of privacy policy, to be physically removed from the ward. In a similar vein to the out-patient and access to information while on a ward round, the reverse is applicable to in-patients and the doctor's consultation office. Doctor 1 noted that in-patient information *is kept on the ward. We do not have access to it* unless on the ward.

Doctor 3 notes that if a patient has been previously treated for an illness at another hospital or by another specialist then he would not know or have access to relevant case notes. Further, patient history kept by one Doctor may not be available either to other specialists or on a ward as an in-patient.

> *Currently none of the hospitals give electronic copy...All records are hard copy ...The only way I can access the medical record of a patient is to ring up medical records of that particular hospital and they have to photocopy them...It is a big problem. There is currently no standardised electronic, even summary sheet of people's information. So we do run into trouble. If an acute or emergency patient comes in, he may have had all their treatment at Monash hospital in Melbourne* [note: doctor is based in Brisbane] *and their medical records have to be photocopied over there. It comes down to the person photocopying the information; he might photocopy the right stuff but there is still a large delay, we probably can't get it so you make an analysis on what you can find at the time, observations and history that you can get*

from relative or friends at the time...They might be allergic to something and we wouldn't know. (Doctor 3)

Case notes are difficult to share or view in locations other than the point at which they are kept. i.e. lack of scalability. Once a patient has left the ward, their case note files are put into storage, further complicating access to patient case notes. They are not kept electronically, so if they need to be recovered for review by a doctor at a later date then someone has to physically go to the storage area and collect them.

Doctor 2 emphasised that the information system deficiency created by the paper-based system which is not shared between the two points of decision making (on the ward and in the consulting office) can cause a critical loss of time for diagnosis and decision making, particularly in emergencies, endangering the care of the patient.

5.2.2.3 Patients

The diagnosis of patients requires Doctors to undertake ward rounds. Patients provide information to the Doctors which assists in their diagnosis and the dispensation of care. There are two main ways in which patients provide Doctors with information. Firstly, the Doctor will examine the condition of the patient. The physical examination, although undertaken by the Doctor, directly provides information from the patient assisting the Doctor with the diagnosis about his or her condition.

The second source of information is provided by a conversation between the patient and the Doctor. On entering each of the patients' rooms, Doctor 1 would immediately ask the patient how they were feeling. In all cases (except in the ICU where the patient was unconscious), patients were able to provide feedback describing how they were feeling. Doctor 3 noted that patients *often give clues to their condition that you might not expect...They are the only ones that tell you how*

they are. They can tell you what's bothering them. Doctor 3 noted that the information provided was invaluable to assist in the diagnosis of a patient.

5.2.2.4 Ancillary Hospital and Ward Support

On the ward itself, depending on the severity of the patient's illness, monitoring equipment provides information to the Doctor about the patient's condition. An electrocardiograph (ECG), for instance, monitors and records a patient's heart activity.

Tests on patients can also be carried out with the support and collaboration of the different departments of the hospital. X-rays and magnetic resonance imaging (MRI) can be provided by the Radiography Department and blood tests can be processed by the hospital's pathology laboratory.

Information contribution from other departments within the hospital is vital in assisting a Doctor's diagnostic process through direct conversations with experts in other departments. Doctor 2 noted that *we have to look through MIMS* [Monthly Index of Medical Specialties] *and sometimes the MIMS is not geared to specific questions, so in these cases we will call the pharmacist.*

5.2.2.5 Collaboration with Other Doctors

Doctors work in areas of speciality. A patient will often have more than one doctor looking after their health. For example, a nephrologist specialises in the renal tract, which includes the kidneys, whereas a cardiologist's area of interest is the heart. Often patients are admitted with complications, and in these cases multiple Doctors will be involved. A high level of coordination and collaboration is required between the different Doctors as well as with other medical staff.

Sometimes we need to consult. Collaboration is a very big part. Because sometimes searching by yourself, you will not be able to find it, and the specialist...the person will be able to give you an answer much faster. You can get the answer straight away...Only when you meet the specialist in the right field will they be able to tell you what is wrong. (Doctor 2)

Each specialist will also keep their own records of a specific patient. With the potential for several different specialists to be involved with one patient, an issue arises concerning the sharing of their individual information.

They've [other consulting specialists] *got to get information from us and again if they want information they've got to ring during office hours when the secretary is available who will print out a copy of my previous letters and fax it to them so it's pretty inefficient in that way.* (Doctor 3)

Further illustrating the flaw in the information system with respect to the collaboration of specialist Doctors are the inefficient communication practices. When asked 'in these situations how do you (the different Doctors) collaborate?' Doctor 1 responded:

We communicate badly. Of course by phone, in more complicated cases we have meetings together...otherwise we rely on case notes...If there are major issues with a patient then the doctor will ring the other Doctors involved.

Doctor 2 confirmed this practice and went on to say: *We communicate through the phone or we leave notes...If we meet a doctor in the corridors then we may have a discussion.*

This method of communication is opportunistic and is dependent upon chance meetings between colleagues while conducting their ward rounds.

Although it is essential for specialist Doctors to work together to ensure the quality care of a patient, Doctor 1 noted that Doctors do not carry out ward rounds together.

> *Doctors are busy so how can we get together, we work at different hospitals...I start at 7am; most of my colleagues might not come in till 8-9 o'clock.* (Doctor 1)

An interesting source of information is afforded Doctors in informal settings around the hospital. Doctors will often elicit and pass on information informally in settings such as the lunch room. The passing of information is opportunistic when a specialist with specific skills and knowledge happens to be in the same vicinity as another doctor. They may ask general questions with regards to assessing symptoms and what the other might do or think. They may also ask very specific questions about an individual case which may lead to the other doctor becoming formally involved in a case, as they may ask to see the patient.

> *It's a critical exchange of information. I probably learn more in the lunch room than any other places. You get consultations, discuss problems etc...Usually informally sitting around having lunch and people ask you questions about problems or about somebody. Some people may informally be talking about a patient but they might at the end up asking you to see the patient.* (Doctor 3)

Other examples of this informal exchange of information include passing in the hallways and at the nursing station. The opportunistic exchange occurs because Doctors respect the opinion of other medical staff, such as specialists who can provide an educated opinion about their patients.

5.2.2.6 Trust and Collaboration

Patient care and allocation to particular Doctors is based on referrals. This system can be seen to be used by Doctors to assist in successful collaboration. The admitting doctor will have experience working with the various Doctors in associated specialist fields. They will refer a patient to specialist with whom they have a good working relationship.

> *Most Doctors will know where their boundaries are; I'm the specialist of this, I can't say to the cardiologist that you cannot use that. I would never do that* [tell the cardiologist what to do]. *I stay within my boundaries, but there are some that cause problems. Imagine giving a conflicting statement to the patient's relatives, 'hey that doctor said this, how come you are doing that'…Usually I will work with a doctor who I know, that I have developed a relationship with. I work with a few Doctors, we work very comfortably together. There's never any trouble, never. Some are domineering and I say forget it, I won't work* [with them]. *If don't want to work with them then I won't work with them…Sometimes there's no communication, how do you work with them?* (Doctor 1)

5.2.2.7 Nursing Staff

Case notes were kept on the ward, usually at the nursing station, although sometimes they were kept at the patient's bed-side. Doctor 3 noted that *all attending Doctors write on the one set of notes kept on the ward at the nursing unit.*

A hub of activity on the hospital ward is the nursing station. When the doctor first arrives on the ward, the nursing staff will greet the doctor. The nurses will know which patient each doctor is there to examine and will brief them on what has

happened in the previous 24 hours, or since their last visit. The nurses maintain the case notes for all patients on the ward, handing over the necessary documents while conducting the briefing. Doctor 2 noted:

> *Nurses coordinate a lot of the things that the Doctors do. Basically there are many Doctors and the nurses make sure the tests are done, apart from the normal nursing duties such as serving medication, meeting the needs of the patients. Helping to coordinate, they make sure the tests are done and the results are returned to the Doctors, the relevant or correct Doctors that are interested in those tests. Sometimes they contact the new Doctors that have been asked to consult to come and consult the patient. They have to transmit messages that some Doctors, tell so and so...They actually fill in a lot of the gaps. (Doctor 2)*

Nurses carry out verbal orders from the doctor. Doctors will give instructions in documentation and the nurses will carry out the orders. *When we give verbal orders the nurse will write it down on the medical chart and the doctor must sign it within 24 hours. (Doctor 3).* If there is information which one doctor wants to pass to another in an immediate manner, for instance, if there is something critical taking place, then the doctor will convey the message to the nurses and they will contact the other doctor, often paging them. It was noted that during each of the patient examinations, the doctor would verbalise his diagnosis and the nurse would repeat and to some extent verify his analysis.

At night, the nurse is pivotal in coordinating and communicating with the Doctors. If there is a problem or change in the health of a patient, they will ring the doctor for instructions or attendance.

At each of the nursing stations there are computers which connect to the hospital intranet. These provide medical staff with up to date information; however, the

Doctors do not interact with these tools. If the doctor wants to find something out then the nurses will look up the details. Doctor 1 noted,

> *We have to rely on nurses to retrieve data online and then show it to us in print form. I cannot access this information on line.*

All the participant Doctors carried a pager and mobile phone while undertaking their ward rounds. The mobile phone has the potential to deliver information, allowing a collaborating doctor instant communication with colleagues. It is mainly used in an asynchronous manner. It was used when a message was received on the pager and the doctor would respond using the phone. The main source of the pager message would come from the nurses on the ward. They would send a message to report on the patient, particularly any change in their condition.

In the case of an out-patient, the role fulfilled by the nurse is mimicked by the secretary. Verbal communication is also made use of, however the protocol is that the communication is between secretarial staff unless the matter is of an urgent nature.

The use of letters (including written paper letters, faxes and electronic emails) is the main method of communication used by the specialists.

> *I often ask the patient which specialists are looking after you... I tell the secretary to CC, carbon copy, so every time I send a letter regarding a patient to the GP or client doctor, a copy is sent to all the other specialists so they can keep up to date about what I'm thinking about and most of the time they will do the same.* (Doctor 3)

The main store of out-patient information is typically located in the private clinic of the doctor. The secretarial staff working in the Doctor's consulting office play a crucial role in this communication. The doctor will often ask the secretary to contact

a contributing doctor for information. This role of disseminating information mimics that of the ward nurse.

> *Most specialists, because they are so mobile, are usually in hospitals, they're often not in their rooms. I usually get my secretary to ring their rooms to get information.* (Doctor 3)

5.2.3 Analysis and Discussion

5.2.3.1 An Activity-based View of the Mobile Work of Doctors

The work of Doctors is complex to the point that it requires the division of patient care into specialty areas. Fig 5.1 below summarises the complex information system as described by this case study.

Tools

Case Notes; Monitoring Equipment; Patient Feedback

Rules

Case notes stored in hard copy in either consulting room or ward; Office is primary point of information access and storage, Doctors return to office for reference assistance; Anticipation required to have access to case notes on ward; Availability of Monitoring Equipment is dependent on the ward and severity of patient illness; Level of caution in verbal Patient feedback

Doctor / s

Patient Care

Rules

Several Specialists may be involved with care of single Patient; Specialist collaboration often informal / opportunistic; Doctors tend to work with other Doctors they trust - use of referrals; Reliance on Nursing Staff to carry out work, provide 24 hour care for patients and as a conduit for communication between Doctors; Secretary role similar to Nursing Staff but in consulting room communication

Community of Practice (Division of Labour)

Collaboration with Nurses, Secretarial Staff, Ancillary Departments and Other Doctors

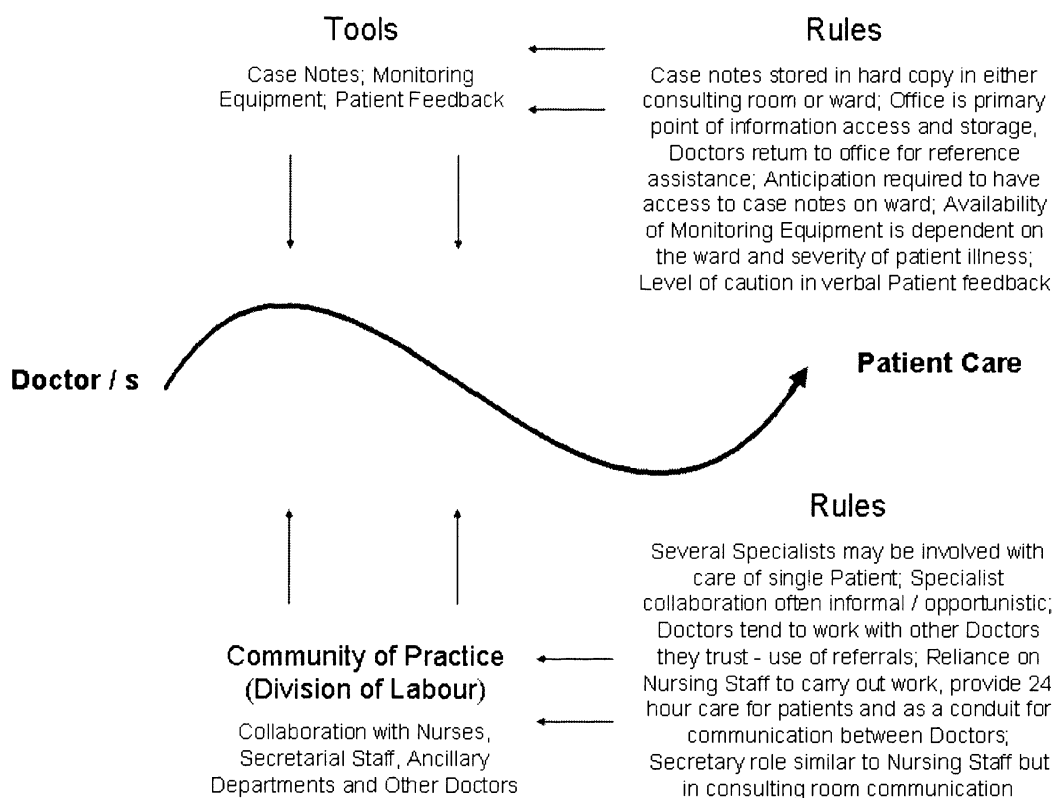Figure 5.1: The information system of Doctors on ward rounds

Assisting with patient care are such Tools as the history of individual patient care in the form of case notes. This Tool usually exists in hard copy format, is not also digitised. and is stored either in a Doctor's consulting room, on the ward where the patient is being cared for, or in the hospital's storage rooms. Accessibility poses a

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problem, as the case notes are physically limited to either the consulting room, ward or storage room. To overcome this issue, the Doctors apply informal protocols (Rules) to gain access, such as:

1. Doctor 1 maintained a good rapport with nursing staff on the ward and would often ask them informally to photocopy and post or fax copies of the case notes on the ward to his consulting room.

2. Although all Doctors maintain that the first thing they do on a typical work day is their ward round, Doctor 3 noted that prior to the ward round he would go to his office to review case notes, and would take them with him. This premeditated action gives him access to the case notes cards for patients he intends to visit on his round.

The development of Rules to which the subject Doctors adhere is a result of the interaction between the Subjects and the Community of Practice. The required training required by doctors and the years of professional experience are noted at this point as formative factors in the definition of Rules upon the interviewed Doctors. The detailed process of reviewing the development of Rules, however, is beyond the scope of my research.

Following their ward rounds, the Doctors will often return to their consulting office prior to passing on instructions or varying the instructions issued on the ward to the nursing staff for patient care. In their office domain, the Doctors are able to refer to paper-based reference material, such as medical journals, as well as those digital material. An example of reference material is the Monthly Index of Medical Specialties (MIMS). MIMS is a pharmaceutical database, incorporating information from both MIMS Bi-Monthly and MIMS Annual Online. It offers access to essential information on over 2,300 prescription and non-prescription drugs. The ability to refer to their office-based information system assists with their decision making with regard to the care of patients.

If I'm at my desk there are no problems because I have the computer beside
me, but when you are moving around in the wards then you of course need to
have information about particular illness or the treatment, then we need to
get computer access. Of course some times you don't have the NET [Internet]
or access at that point in time, so it's kind of difficult. You have to come back
to base, to the office, to get the information that you want. (Doctor 2)

A formal Tool specifically designed and co-located on the ward which is used to
help make decisions for the care of patients is the monitoring equipment on the ward.
The nature and severity of the patient's illness will determine the extent of
monitoring required.

Another formal Tool which assists the Doctors' decisions are the reports assessing
the patient's condition. These reports are expeditiously produced by various
departments within the hospital.

The explicit data-producing sources of information noted above are all Tools which
are easily identified components of a Doctor's information system.

Another component of the information system is provided by Collaborators, or
Divisions of Labour within the Doctor's organisation or Community of Practice.
Data is provided through both formal communications (e.g., case notes on the ward)
as well as through informally passing information via networks of people who are
also involved in patient care. The main groups populating this collaborative system
are other Doctors, nursing staff and the consulting room secretary. Much of the
information sharing is conducted between other specialist Doctors and nursing staff
who are directly involved with a common patient. Sometimes Doctors will also hold
informal discussions with other Doctors about a case of interest to gain another
'educated' evaluation.

Although communication with other qualified health professionals is clearly an essential component of a Doctor's decision making process, the selective nature of collaboration is salient. The referral system ensures that Doctors control their network of collaboration, working mainly with people for whom they have high regard and whom they trust.

5.2.3.2 Representing Activity

Previous models of Activity have all represented the progression of an Activity by the Subject as an arrowed straight line (for example, see Figures 3.1, 3.2 , 3.3 and 5.2 below).
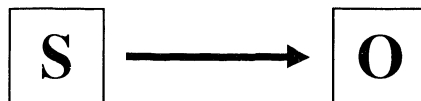
Figure 5.2: Original representation of Activity (replication of Figure 3.1)

In Figure 5.3, I have adjusted the representation of the work Activity to be a variable and wavering line. The Activity of the MKW Subject in the case of the Doctors is one which is flexible and adjustable to accommodate the mediating forces provided by Tools and Collaborators as well as their respective Rules.

Rules

↓

Tools

↓   ↓   ↓   ↓

S   O

↑   ↑   ↑   ↑

Community of Practice
(Divisions of Labour)

↑
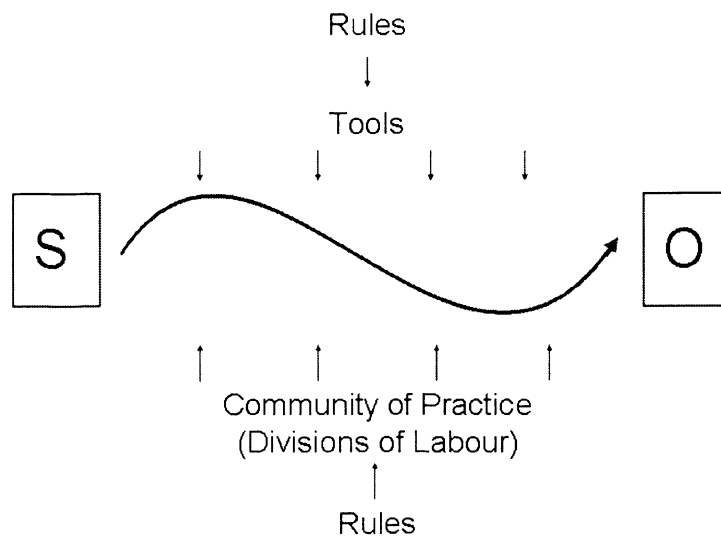
Rules

Figure 5.3: Adaptive representation of the MKW's Activity

The dynamic nature of a MKW's Activity is a result of a variety of mediating information sources, each with respective Rules of interaction, which will be considered in each of the following case studies.

5.2.3.3 Emergent Theme - Urgency

An interesting point to note is that if there is an urgent case that needs attention, then the usual mode of communication (the Activity of patient care) seems to change. In such cases, a Doctor will directly contact the other attending Doctors for consultation in order to make a rapid decision.

> *If I think that it's urgent enough then I will get the nurse to ring up, or I'll ring up myself, if there are problems, major decisions [or] major changes. Then we will talk.* (Doctor 1)

Doctor 2 also noted that in an emergency, the normal mode of communication between different departments changes. Tests are processed and instead of being loaded onto a computer and printed out by nursing staff on the ward, the results are faxed directly to the Doctor.

In situations of urgency, the mode of communication – the Activity undertaken by the Subject Doctor – appears to change. Doctors are not afforded the luxury of returning to their consulting rooms to engage with information sources; they are required to make on the spot decisions. The Activity of the Doctors seems to be mediated by the urgency of the case before them. In cases of less urgency, as already noted in 5.2.2.7, Doctors will return to their consulting rooms to review information which is stored or accessible at that point.

Doctor 2 noted that on an emergency ward there is usually a team of Doctors and support staff such as nurses in attendance. Although these workers operate in the one ward (they do not do ward rounds) the emergency ward scenario emphasises the theme that in an urgent situation Doctors tend to work in a close collaborative manner where there is a need for direct communication and information sharing.

At this point I hypothesise that the context of urgency is an additional mediating force which influences the way in which an Activity is done. See Figure 5.4 below. This emergent mediator will be considered in the analysis of the following case study, Reporters in the field.

Rules

Rules

Tools

Community of Practice (Division of Labour)

Case Notes; Monitoring
Equipment; Patient Feedback

Collaboration with Nurses, Secretarial Staff, Ancillary
Departments and Other Doctors

Doctor / s

Patient Care

Rules

In urgent cases Doctors will contact other
Specialists directly, Ancillary Departments
fax results directly to Doctor and Doctors
work directly with other Doctors. In non-
urgent cases decisions are often deferred
and the Doctor returns to their consulting
office for reference material

Urgency

Patient cases can be either urgent in nature requiring
immediate attention or not urgent requiring ongoing
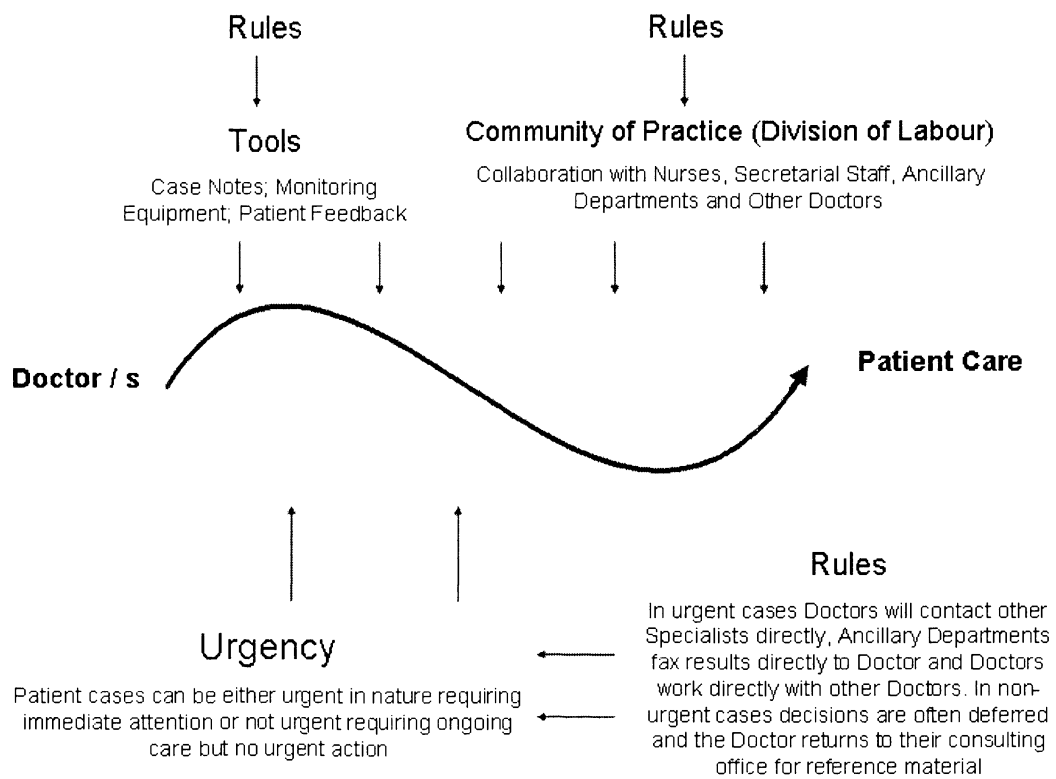care but no urgent action

Figure 5.4: Urgency mediates the Activity of a Doctor

5.3 PART 2: Reporters and Fieldwork

5.3.1 Introduction and Background to the Work of Reporters

The second case study focuses on Reporters operating in the field. The interviews consist of six interviews which, on average, lasted approximately one hour. The interviews were conducted in two rounds with an analysis of the initial findings being conducted prior to the second round.

The main subjects of this case study were Reporters who were required to go to various locations to cover a story. An Editor was incorporated into the second round. The interviewees all worked for the same publication (a major weekly newspaper publications and part of the largest publishing group in Australia), and had varying degrees of experience. Table 5.2 details the interviewees, their experience and the round in which they were interviewed.

Participant	Experience in Publishing Industry	Interview Round
Reporter 1	11 years	1
Reporter 2	6 years	1
Reporter 3	30+ years	1
Reporter 4	5 years	2
Reporter 5	10 years	2
Editor	13 years	2

Table 5.2: Reporters

The work associated with newspaper production includes four main processes (Hirschheim and Klein, 1989) which comprise writing, editing, typesetting (laying out the presentation of the publication) and printing. The writing component is the process associated with the work of Reporters, while other staff such as editorial and

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print staff complete the job of getting the newspaper to press. In the process of my research, I found that there are two main tasks associated with the work of Reporters in the field. The first is to research a given subject in preparation for the production of a story. The second is to gain new information which extends their office research and provides writing material for their stories. The final task is to construct and submit their article or story for publication.

Journalists working in the subject newspaper are required to write several articles each week with the major publication being produced on a weekly basis (specifically a weekly on Sunday newspaper). Initially, journalists are given a lead to a potential story by an Editor. During their working week, the journalist researches the area of interest by a variety of methods. These include reviewing other sources of published material stored in the company's library, on-line searches using the Internet, consulting colleagues and friends on the topic, and conducting interviews. Once they have completed their data gathering, they will formulate an article which is then submitted and reviewed by the editor for approval, and sub-edited if necessary for publication in the newspaper.

Within the newspaper, the journalists work in news or special interest areas, such as sports or finance. Each news area consists of journalists, sub-editors and an editor. The journalists submit their written articles to the editorial staff who review the work, check spelling and facts, adjust the length, add titles or captions, and format the article to fit the page design.

Although much of the work which the case study Reporters described was office based, they are sometimes required to work in a mobile sense. Just as with the doctor attending their ward round, Reporters are sometimes required to be on location to capture information for a story, formulating the article and then submitting it from the field in order to make the publishing deadline. This means that the field reporter is often subject to physical isolation from their office based information system.

In this case study the majority of the working week for the Reporter is spent in the office and only one or two days a week are spent in the field (acting in a mobile sense).

4 days a week I'm pretty much in the office and I basically work using the phone, go out occasionally but it's much easier over the phone. Then on Saturday the paper becomes a daily paper so we're all out all over the place…mainly one day a week I'm out of the office. (Reporter 4)

Although the focus of my research is concerned with the knowledge worker operating in a mobile sense, the work of the Reporter in the office is an important consideration for two reasons. Much of the work in the office done by the Reporter is in preparation for their field work; for example, researching a topic of interest. Secondly, in considering the Tools afforded the Reporter in the office, a comparison can be made with the way in which the Reporter operates on assignment in the field.

A generic view of the Activity of the Reporter (and in particular work in the office) is now provided, followed by a description of their mobile field work.

5.3.2 Findings

5.3.2.1 Operating in the Office

The work of the case study Reporters is aimed at the production of newspaper articles, the majority of which are produced in the office. Reporter 1 noted: *By Friday I would have four or five stories* [produced in the office] *and on Saturday* [their day in the field] *one or two extra*. Although the newspaper is only published once a week on Sunday, the Reporters work on stories throughout the week as *A lot of stories fall through* according to Reporter 1, who further said that the actual amount of time dedicated to an individual story varies and is a factor of desirability (see below).

> *It depends if you're after something desirable like an exclusive interview with someone, you might have to put in a lot time into finding where they are, they might not return your phone calls so you may have to seek them out, knock on their door. It's very variable. I think most weeks I write between two and three thousand words.* (Reporter 1)

The production of individual stories is the result of several processes. At the beginning of the working week, Reporters meet with the Editor to consider potential stories of interest. The Reporters are allocated several stories, or 'leads', which the paper is interested in pursuing by the editorial staff . Once the Reporter has been assigned a story, they research the topic area before conducting an interview. They then formulate and write the article which is submitted to the editorial staff for review. New stories are continually breaking throughout the week and are assigned by the editor on this ongoing basis.

5.3.2.2 Research and Preparation

The large majority of research and preparation is conducted by the Reporters from their office base which is central to their ability to interview subjects both in the office as well as in the field. The Reporters prepare for work (such as conducting interviews and writing stories) by first undertaking background research which assists with understanding topics of interest. One Reporter noted:

> *research is so important as well as preparation. That gives you the best chance of getting your facts right at the time.* (Reporter 2)

The research and preparation is facilitated through the use of various office based Tools or characteristics of the office.

Typical of research, the use of a library is used to gather information about topics of interest. The publication has a private library which houses hard copies of paper publications. The Reporters will review the material and take copies of relevant material for use at their desk. The Reporter will often carry these articles, which are referred to as 'tear sheets', with them when on assignment out of the office and in the field .

> *We got magazines, like for example in rugby league we got* [magazine 1] *and* [magazine 2]. *We'll look there or in newspapers, things that have been written about the team or players in the lead up to the game* (Reporter 2)

A major source of information available to the Reporters interviewed, while working in the office, is the use of digitally stored information. The Reporters have access to a proprietary system which, as one Reporter noted, *has all the past articles published by* [parent publishing company] *and* [publishing company] *and a lot of regional papers.* (Reporter 1)

This resource is relied upon heavily for information and is easy to access from the computers at their work desk. The online database is used both to obtain background information about the topics of interest as well as being a Tool to check up on information which they have elicited from other sources, such as from an interview. The ongoing use of this system in the production of stories assists to ensure the integrity of facts published by the paper.

> *We have a database of previous stories from 1988 onwards, so they may look up keywords, check previous stories... check that the facts are right from that.* (Reporter 2)

Another resource which is also used to gather background details is the information available on the Internet. Again, the Reporters make use of the office computers to access pages on the Internet. Reporter 5 liked to use the Internet as it provided a large information source covering a vast number of topics which goes beyond the information available using the proprietary database system and library.

> *The Internet is huge these days for research. If you're going to the boxing and there are two guys you don't know, it's so easy to put them into Google and you can have their life story in five minutes.* (Reporter 5)

The in-house database publication system is able to access articles published by several well-established publications and is considered a reliable source of information. The reliability of information is important to the Reporters and when accessing information sources through the Internet, only reliable sources are trusted.

> *Technology is very useful. The Internet is a tremendously useful tool to find out what newspapers around the world have said and it is a tremendously useful thing to get the latest from reliable web sites like ABC News... and it's a good gauge to find out things that I don't know anything about. But when*

you go outside those respected web sites like ABC News or 'company web site' then I'm a little suspicious about where the information is coming from. (Reporter 3)

5.3.2.3 Eliciting Information - Interviews

Once the journalists have completed their background research and data gathering, they conduct interviews with persons of interest which forms the basis of the stories published in the paper. Y*our job there is to elicit information from the person.* (Reporter 3) The information gathered from the interviews is unpublished and is used to produce news stories.

The journalists described two main methods by which they conduct interviews. These are either face to face or over the telephone with interviewees. Speaking of the interviews, Reporter 2 said:

> *Either I'll do them over the phone for time reasons or I'll go out and see someone. If I do it over the phone I'll call the person up and take note, shorthand notes and then transcribe that back later.* (Reporter 2)

The telephone interviews formed the majority of the interviews and again were conducted from the newspaper's office. This method was used as it was considered to be more time efficient. The efficiency of interviewing people over the phone in the office is highlighted by Reporter 1 who noted:

> *Say you're interviewing someone out at Penrith, it would be nice to go out with the photographer, the photographer always has to go out. It will take you an hour to go out there, an hour doing the interview and an hour to come back versus say 20 minutes or half an hour on the phone...So if I want to do two or three interviews then it's more efficient to do it over the phone.*

The telephone is also used as a source of information and allows the Reporters to gain background information about the subject of their story. The telephone facilitates the interviewing or discussion with persons who have a relevant background. Again, this method of interviewing allows the Reporter access to many different experts across a field of interest and facilitates efficiency in their research.

> *If I were going out to interview someone I might speak to someone else, or a couple of people beforehand. I'm not actually interviewing them for the story but I'm getting background from them...Like the Australian Medical Association and I'm interviewing a doctor, they might give me background on the doctor's previous work.* (Reporter 2)

5.3.2.4 Writing and Editing Stories

Once the interviews are complete the journalists will formulate an article which is then submitted and reviewed by the editor. Not all the submitted articles will be published; several stories will be disregarded.

The editing process is subject to several stages of review. Typically, the senior editor will review a submitted story to determine whether it fits in with the theme of the paper. Each week, the editorial staff will determine the news which they think will be interesting and establish which articles fit the information flow, editing or eliminating the submitted stories. The accepted stories are then assigned an appropriate heading and examined by several sub-editors to check the facts of the story as well as spelling and grammar.

> *Quite often the journos'* [journalists] *their idea of what they think the story is* [about]*, is not quite what it is. We'll think it's something slightly different, the emphasis should be somewhere else, so you might rework it, you may cut*

it in half. They may think it's fascinating and needs to be 1000 words but we might think completely differently...I would think about 8 or 9 times out of 10 need some kind of work. (Editor)

The editorial staff develops the layout of the paper, the size and placement of headings, written articles and associated photographs or pictures. The pre-determined layout will also affect the editing of a story.

> *At various times you're going to carve things up because it's just not what you wanted. You might be doing a double page spread on something and they may have filed a story but to fit it in with the spread, the bigger picture, you may have to 'remeld / retop' it as we say, which is to give it a slightly different angle, which is not changing the facts, just moving them around. The emphasis has changed.* (Editor)

The editing of a story may be for reasons other than the quality of the article; for example, the story may need to conform to the publication's layout. Irrespective of this, the Reporters don't like having their articles adjusted by the editorial staff. As Reporter 5 observed:

> *It can be that for whatever reason a story's been hacked to pieces, unrecognisable, there's nothing that upsets a journo more than that happening... I thought that if this person thinks that they can write better than me then fine let them write it and you do get pissed off, especially if you've put a bit of effort into it and you think it's half decent otherwise you wouldn't put it through in the first place... I probably feel a bit insulted that someone thinks they can do it better.* (Reporter 5)

5.3.2.5 Collaboration in the Office

The office described by Reporter 1 is open plan with groups of Reporters clustered together according to their area of interest. For example, the sports journalists are in one area and the general news in another. The configuration of the office and close proximity of staff allows collaboration between the Reporters. Reporters are able to ask each other for assistance in researching a story. For example, Reporter 4 described a situation in which she was writing a story about a new product and wanted some background information. Instead of using Tools such as the Internet or library facilities, the Reporter just called out for assistance to the other Reporters in her area. Another Reporter replied with the name of an expert and their contact number.

The collaborative nature of the Reporters goes further, with the fellow journalists assisting with the checking of facts as well as aiding each other in writing and editing of stories.

> *There's always people* [in the office] *who know something about those minor sports...Sure. Journos are good with help when you type it* [the story] *out.* (Reporter 5)

The editorial staff, such as the sub-editors, are also in close proximity to the Reporters. The co-location of the Reporters and editorial staff allows for assistance in the production of the story. Reporter 4 noted the assistance she gained from her Editor.

> *Yea, say if you can't think of a word to describe something or my immediate boss I may pass her my first few lines and say how do you like that? And she might say 'I would bring that up earlier' or something.*

The collaboration in the office extends the information available to the Reporter. Much of this collaboration (e.g. getting information and the editing of stories) comes in the form of informal discussions and takes place prior to the submission of the story for review by the editorial staff.

Reporter 5 noted that most Reporters take offence at interference by the editorial staff in changing a submitted story. This is avoided to a certain extent by the close proximity of the editorial staff and Reporters, because the informal flow of information, such as the appropriateness of a story, creates a harmony between the Reporters and editorial staff. If there is an issue with a submission, the sub-editor will often discuss any problems with the Reporter prior to editing the story. The co-location of staff, however can be a double-edged sword. There is potential for tension between a Reporter and the editorial staff if one chooses to ignore the other. As highlighted by Reporter 5:

> *If you put something through on Wednesday and the paper's not out till Sunday, and they're all sitting around reading it so if there is something they want to check or run by you, it should all be done together.* (Reporter 5)

5.3.3 Mobile Work of Reporters

5.3.3.1 Introduction and Background

Where possible the Reporter will return from the field to the office in order to write their articles; however, this is subject to meeting the print deadlines of the publication. It is common for Reporters on assignment in the field to produce their stories and submit them remotely from the field. The construction and submission of stories directly from the field further supports the proposition that the context of Urgency is an additional mediator of an Activity.

The work which is undertaken by the Reporter on assignment in the field has an additional layer of complexity because the environment in which they are immersed is dynamic and continually changing, added to which , the assignments are often in different, sometimes widespread locations. One day they may be covering a horse race in Melbourne and the next they may be in a court-house in Sydney, or covering a catastrophe like the tsunami in Thailand and Indonesia. With a changing work environment comes a variation to the access to information.

The difficulty produced by the dynamic work environment comes on top of the complication produced by the broad range of topics which they are required to write about, particularly for those Reporters in the general news section.

In some instances, a familiarity is developed with the work environment and associated access to information. In these cases, the same Reporter is repeatedly sent to the one location or to a similar situation. The two main situations in which this were noted to occur were in covering a Rugby League match and being sent to an organised press conference, such as a government-organised press release. In both these instances, information support for the Reporter was provided by the event

organisers. This support often comes in the form of a media liaison officer who assists with the passing of information.

The reliability of the information system in which the Reporter operates, in most situations, differs from that of the Doctor in that although the condition of the patient may change, the availability to the Doctor of Tools such as the monitoring equipment and attendance of the nursing staff remains relatively consistent for the Doctor. Where control is possible, the MKW will manipulate their environment to afford a consistent information environment. In considering the mobile work case studies of the Reporter and the Doctor, the environment appears to be a fourth mediating force Activity. This theme is highlighted in this case study on reporting from the field.

5.3.3.2 Eliciting Information in the Field

There are two main sources of information cultivated by Reporters working in the field. The first is through face to face interviews with persons of interest. Although these interviews are considered time inefficient, as noted above, they do have several advantages over phone interviews conducted from the office.

Some situations do not allow for a Reporter to interview from their office. News which is 'breaking' is difficult to cover from the office; someone needs to be on location where the situation is unfolding. For example, Reporter 1 noted that he might be sent to cover an event such as the Melbourne Cup horse race. At such an event, different perspectives can be gained from a variety of people or groups, and potential interviewees include celebrities, horse owners or members of the general public. This increases the amount of information available to the journalist to form a story, which may improve the story's appeal to readers.

There's just so many people on the ground that you need to speak to that you can't do it over the phone. You have to actually be there. (Reporter 1)

The face to face interview also allows for better engagement between the Reporter and interviewee, creating the possibility of extracting more information. Reporter 3 noted the following:

The person has got to feel relaxed with you. You're bringing all your skills you've learnt to elicit information and sometimes that requires being very sympathetic to the person. Say like a person from the Bali 9, you wouldn't want to be aggressive to them because you're not going to get any more information from them...You try and get something going between you and the person you're interviewing. (Reporter 3)

The second source of information in the field is the Reporter's own observations, which may affect the content or change the emphasis of a story.

Being on the ground you can see what it's like, you can see interesting situations as they come up. You may get a different angle on the story which you didn't expect to get, like you may notice that all the hotels are overflowing, or you may notice that there's a lot of women involved or something like that which you wouldn't get over the phone. (Reporter 1)

Reporters' stories were often opportunistic in nature. The Reporter may have been sent to an event to cover breaking news or conduct an interview; however, the observations made by the Reporter on location could lead to a totally different story.

Seeing what people are wearing, being on hand just in case something does happen, like a bomb goes off or a horse breaks its leg. None of those things are you going to be able to do over the phone. When it's a happening news event you need to be there. (Reporter 1)

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5.3.3.3 Information Tools

Conducting interviews and observations are the primary motive of Reporters to carry out field work; however, support in the form of information on the topics of interest may assist them with their work. For example, having relevant background information allows the Reporter to pose both ad-hoc and in-depth questions to interviewees.

The reliability of information contained in a story is vital for the reputation of the Reporter as well as that of the publication. There are Tools in an office setting to assist the Reporter in composing their stories, but accessing information while conducting an interview in the field requires variation in the information system to allow for the mobile circumstances. The information system of the mobile Reporter consists of the following:

A. Preparation and Research

Research as a preparation tool is one of the main components of the work of Reporters, not only in the office scenario but also for field reports. As with the office, the Reporter will initially undertake a thorough investigation into the background of a possible story. In the quote below, Reporter 3 points out that the background research needs to be detailed and thorough, to capitalise on the potential of an interview. When the Reporter travels to the field, he or she will take a 'tear sheet' of the notes they have made, or photocopies of important articles.

> *Whenever you're going into an interview, you research well beforehand, you don't do it five minutes beforehand, unless it has come up as a bit of a surprise. Say for example you're trying to*

interview one of the people in the Bali 9 or a foreign minister of a country like Indonesia. You would, when you're in that situation, your job as a journalist is to know all the background, all the things that have lead up to that point. So you're asking questions that would elicit new information. You would have researched all that well beforehand; you would keep in touch with the office to find out if anything new has broken in the last few hours. You can, if you've got a laptop or can plug into the Internet somehow, you can catch it up on websites like the ABC or [the company] has its own news web site. They carry AAP Copy which is the agency copy and that would be the latest known. I would read that and then go into an interview. (Reporter 3)

Being accurate in their stories is important to maintaining reputation as a reporter. Reporter 2 believed that good preparation and research was the key to *getting the facts right at the time* in the field, thus maintaining their credibility.

B. Mobile Phones and Office Contact

The above quote from Reporter 3 also reveals that the office remains central to the Reporter in the field. To check or update facts post- as well as pre-interview, journalists will often make use of phones. Like Reporter 3, Reporter 2 would also use the phone to check last minute facts before going to an interview, and Reporter 1 would ring to confirm facts after an interview.

If there's information that I particularly need that I don't have with me, say there's something I need to know that I hadn't found out before hand I might call someone back in the office or text 'can you find this out for me' and they'll call me with the answer (Reporter 2)

If someone says 'it reminds me of Memphis' and I didn't know what Memphis was, I could have rung up the office and said 'could you just look on the Internet or on Fairfax Digital what Memphis is. (Reporter 1)

C. Information and the Environment

One of the advantages of conducting field interviews is that it allows for the gathering of information from surroundings. Reporters are able to confirm information that they have already elicited at interviews from a variety of sources, including the environment in which the interview was conducted as well as from a variety of people other than the subject of the interview. For example, Reporter 2 describes how, at a rugby league match she was covering, she was able to pick up information from the live commentary of the TV Reporters who were covering the same match.

Listening to radio reports and TV reports (during the game)... listening to commentary of the same game... You get another insight opposed to just watching the game and just seeing what's in front of you, you also get the commentary. You get the commentary on the refereeing that you might not pick up yourself. (Reporter 2)

Assistance with information is sometimes provided by the interviewees (or their representatives) who purposely provide public relations assistants. These media liaison officers often assist Reporters with information.

Say you went to a political meeting, you would generally find the public relations officers (PR) or press officers and say 'what's going on here', 'what's that person's name, who's that person'...With some

of the parties that I've covered for the paper you would go out and the job is to find out what celebrities were there. So with your PR officer who has organised the party and you hook up with her straight away and say 'who's here?' or 'who are you expecting tonight' and get the information from her... You can't expect to know every single person. (Reporter 1)

D. Collaborating with Other Reporters

Other Reporters are able to access information to verify facts as well as using their knowledge to elicit new information. Sometimes the Reporter will allow another journalist to conduct an interview if they feel they have less background on the area of interest. For example, Reporter 2 noted:

If you didn't know much about the topic then you would definitely do that, let the other journalists ask the questions, which often happens when you're in general news. For example, if you're going into a story that you might not have time to research...You might have to go out to a press conference, go out into public and you don't have time to sit on the Net and find out about it before hand. (Reporter 2)

An interesting method of information verification is that Reporters often consult with journalists from rival publications. This collaboration would seem illogical as they are in competition with these other Reporters in their field of expertise; however, it is perceived to be normal practice.

If it's a journo at your paper or a journo at another paper who's an expert in boxing or whatever...with the boxing I've got friends at the [opposition paper] who know about boxing and I've got no trouble

ringing them up and saying I've got to cover this bloke – what's the story and what to watch out for, etc. (Reporter 5)

A commonality with the Doctors' case study is that the collaboration with other journalists was based upon having a certain level of rapport and trust between Collaborators.

E. Individual Experience and Knowledge

The general knowledge and experience of individual Reporters contribute to the establishment of Rules and are the foundation for the development of Tools. General knowledge and tacit knowledge are other sources of information which the Reporter uses when operating in the field. Previous life experiences allow for insight and general knowledge, which provide Reporters with a certain perspective in the production of a story. Reporter 1 highlighted the importance of familiarity and background as a journalist:

These Reporters come over from England and they're hot [sic] *Reporters from Fleet Street but I think that there's a bit of a cultural problem with them because they don't have the cultural background that we have. This knowledge is what you carry around having grown up in Sydney. When someone says something happened at Maroubra or something happened at Kensington or Avalon, to someone who has grown up in Sydney we know straight away what that is. So that's part of the equipment which you carry around in your head all the time, whereas someone who's come over from England, they wouldn't understand the cultural differences, even the geography...They wouldn't know what certain areas are known for or famous for.* (Reporter 1)

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5.3.3.4 Reporting from the Field – Urgency and Information

A feature of reporting, particularly from the field, is that journalists have deadlines by which time they must submit various articles for publication, which means they are often under pressure to get the article written and submitted.

You got 45 minutes to do three or four interviews, choose what you want, get it down on paper and ring it in. You just got to go... (Reporter 1)

The time constraints means that Reporters are often required to submit a story directly from the field as they do not have time to return to the office. Stories by the case study Reporters are filed mainly in one of two ways, either using Copytakers or introduced mobile technology in the form of a laptop computer.

The implication of being away from the office means that the journalist is away from information sources which would ordinarily be in close proximity to their work area such as a personal computer (PC) and Internet access. Having these sources of information on hand in the office allows the journalist to quickly check facts provided by or about interviewees. This assists in the production of a story by ensuring that details are correct and, during a telephone interview, allows the reporter to check information 'on the run' and to improve their interview questions. Conducting face to face interviews does not allow reference to supporting information.

> *You would never break off in the middle of an interview to check something on a Palm Pilot or something like that, no...It would be very rude, it would break with the interview contact...* (Reporter 3)

The inability to reference support material in the field can result in misreporting of the news. Reporter 1 noted:

If you have a look at page 2 of the Sydney Morning Herald every morning you see retractions...I wouldn't have had a correction in the last year or two but I certainly would have had one a couple of years ago. Because, for example you might have to write 500 words in about 45 minutes to an hour and there's enormous time pressures because you don't know who is going to win and you've got to get the winner's name, the horse's name the owner's name, the trainer's name. You may have referred to other people and you've only got a certain background knowledge... at the end of the day you've got to get that story in. (Reporter 1)

Misreporting information is a big issue with field Reporters, who say it is *very embarrassing* as you *pride yourself on your accuracy* and *don't want to give them* [the paper] *a bad reputation for getting things wrong.* (Reporter 1) Further, as noted by the Editor, continual erroneous reporting could become an issue and lead to the termination of employment.

Someone [one of the senior editors] *will have a word to them along some point in the process. Often someone will speak to them and say 'look this is why we've changed your work, you need to work on a couple of things. Don't do so much of this, do less of that, do more of that.' There's plenty of feedback...I've had to get rid of a few of them because they were too difficult to get them to the point...when they start filing copies every day and you have got to work on every single story, you know, every one poorly written or they take a bad angle or line on everything they do. You can counsel them, go through all the processes, but you can often reach the point where you realise that no matter what you do they're just not going to get there.* (Editor)

A common theme which emerged from the Reporters was the importance of time. Reporter 2, for example, stated that *'If you couldn't find out the facts in time to file the story then I'd just leave it out* (Reporter 2). Reporter 2 went on to say that once

the story is filed, the responsibility for checking facts and grammar, and writing the headline for the story, lies with the editorial staff in the office. Inaccuracy is obviously an issue, but it only becomes an issue with the editorial staff if the reporter gets it wrong on a regular basis. Indeed the Editor indicated that getting the story, getting the interview with the subject, is of greater importance.

> *I've worked with great journos who are terrible writers but are great journos or Reporters because they get great stories. At the same time, they work the phones well. Writing out the story is only half the job. Getting the stories is probably the most difficult part of the whole thing. I've worked with journos that are so well connected that they get so many great stories but they couldn't write if their life depended on it. They're supplying the goods all the time.* (Editor)

5.3.4 Filing Stories from the Field

After a Reporter has gathered new information from an interview or through observing a situation, he or she is required to compose and submit a story. The process of composing a story is dependent upon the submission method.

Laptops are made available to Reporters when they go into the field which allows them to write and submit articles directly from the field. The alternative to using the laptop is the Copytaker system. The Copytaker system could be thought of as an incumbent system as it is the traditional method of filing a story from the field.

Despite several advantages identified by the Reporters with regard to the laptop system, and several disadvantages associated with the incumbent system, using Copytakers is largely the preferred system of information transfer by Reporters. *There is a prejudice towards the old Copytaker way of doing things.* (Reporter 1)

and

> *The way you file stories for me hasn't really changed all that much. I still prefer to ring up and talk to a Copytaker when I'm out in the field...I would prefer to ring up and talk to the Copytaker because quite often you get a response.* (Reporter 3)

On the surface the use of Copytakers seems illogical; however the reasons for using Copytakers becomes clear through an examination of the two systems through the lens of Activity Theory and, in particular, their associated implicit Rules.

5.3.4.1 The Copytakers

The incumbent system requires the reporter to phone a call centre and relate the story to a Copytaker, who transcribes it and forwards it to the editing staff.

I'll hand write it in my notebook and then ring up the Copytakers, there's a whole department...and then you just read it very slowly , they're very fast typers. (Reporter 4)

The majority of the Reporters interviewed outline the story roughly on a notepad in point form prior to reading it out to the Copytaker. In the case of Reporter 3, the composition is done totally in his mind. *...often it's off the top of my head. You may have a few notes that you refer to for quotes but the framing of the story is all done in my head and goes straight in as I talk.* (Reporter 3) The ability to frame the story 'off the top of his head' was identified as a skill which this Reporter had developed over years of experience and of which he was quite proud.

Several issues associated with using Copytakers cause concern (see Table 5.3 below). The Reporters noted that using Copytakers is relatively slow and not as fast as typing out a story themselves; the final articles will often contain errors as a result of misunderstandings by the Copytakers who are not always available and not always reliable.

Issues	Comment by Reporter
Slow	*It's quite slow with a Copytaker because you have to spell every name to them and make sure that's right. A 500 work story could take half an hour. But if you're sitting there with your laptop as the game is going on then its all being written at the same time. Right on full time you can hit a button and it's in the office.* (Reporter 5)

Mistakes	*But the thing with Copytakers is that there's word mistakes. It's like 'Chinese whispers' sometimes, like you're saying a word and they're hearing it in a different way...They don't have the same vocabulary maybe and they come across a word that they haven't experienced before they may write it down wrong...You try to be as clear as possible with them and that could take a bit of extra time. You've got to spell out every name which is unusual; you just got to take it slow.* (Reporter 1) *I'd much rather have it and be able to write the story myself as opposed to calling it through and the danger with Copytakers, it's not their fault but things can go a bit wrong...* (Reporter 5)
Reliability	*I used Copytakers on the weekend and there's so many frustrations too, like getting through various switchboards to get them or they've gone to the toilet...you can't file your story...you got to go through the switch and I've had occasions when for 20 minutes no-one has answered the phone because they've gone to the bathroom or they've snuck in a coffee...* (Reporter 1)

Table 5.3: Issues with the Copytaker system

The issues associated with the Copytaker system were also noted by the editorial staff. *The other side of that is that you tend to get a massive number of names spelt wrong that comes through Copytakers because they're doing it on the run. They* [the Reporter] *might not spell the name out thinking everyone knows how to spell it. Sometimes it makes less work for us, sometimes it makes more.* (Editor)

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5.3.4.2 The Laptop

Using laptops involves the reporter typing out their stories, logging into the paper's network and transmitting the digital written document. This eliminates the Copytakers from the submission process.

Several advantages were identified by the interviewed publishing staff.

1. Ongoing access to stories while in the field

Reporters working in the field are often required to submit their stories remotely from the field in order to meet publication deadlines. Although the case study publication is a weekly one, several different editions are produced, because the publication office and printing plant are based in Sydney but the publication is distributed across a large area,–all of NSW and interstate. In order to deliver the paper to the furthest areas from Sydney, an early edition is produced.

The paper continues to be worked on, and material is updated until the second deadline is reached and another edition is printed. For each edition there is a deadline by which stories must be submitted in order for them to be published. The ongoing revision of the paper is continued until the final deadline is reached, and the final edition is printed and delivered. Using a laptop allows the Reporter to review and rewrite their story on an ongoing basis. Using Copytakers does not. Reporters using Copytakers are restricted because they are not able to access a story for reviewing once an article has been submitted verbally. As the Editor noted, *If you use Copytakers you can't really rehash that. You've got to do the whole thing from scratch.*

An example of this scenario was described by Reporter 2. The Reporter was covering a game of rugby league during which time she submitted one story just

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after the end of the game and then submitted a second after gathering more information from post-match interviews.

I watch the game, taking a laptop out with me. I'd watch the game and take notes in my notepad and write up the story as I go on the laptop. Once the game finishes I'd have to file the story about four or five minutes after the game finishes...There's a press conference after each game with the coach and the captain from each side and I'll take my tape recorder to that and record those interviews. Then I'll go to the dressing rooms and record interviews, I'll record interviews with a couple of players who had a significant impact on the game. Once I've done those interviews then I'll go back up to where my laptop is and listen to the interviews on the tape recorder and then write another report using those quotes for the match report. (Reporter 2)

2. Elimination of misinterpretations through double handling of work

As mentioned above, Copytakers often make mistakes. Reporter 1 highlighted the regularity of mistakes saying, *If you look at page 2 of [rival newspaper] every morning there are about 2 or 3 retractions.* (Reporter 1)

Misreporting information is a big issue with field Reporters as it is *very embarrassing* as you *pride yourself on your accuracy* and don't *want to give them (the paper) a bad reputation for getting things wrong.* (Reporter 1)

Reporter 5 noted that eliminating the Copytakers from the production of a story also eliminated the potential for mistakes, noting *They could misunderstand something that you've told them or a no might be left out of a massively important part... There's been times, occasions in the past, I can't think of something specifically, where a not in the opening paragraph has been left out, someone is a rapist, someone is not a rapist, you know what I mean, not saying that specific thing but that can make a big difference. If it's all on your laptop you know yourself and you*

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can see it and everything else, but if it's over the phone and you're typing in what someone says and you're in a hurry... (Reporter 5)

3. Ability to visualise and structure a story

The Editor observed that he was better able to write stories when he had the text in front of him, as opposed to composing it and telling someone to write it.

> *Best thing about a laptop is that you can word it exactly the way you want to word it and there's a bit more flexibility too at the last minute to put that up and the whole cut and paste thing. The stories tend to flow better, naturally, if you can see the whole thing in front of you. If you're going through a Copytaker, if you've got time you try to write it out longhand and read it out that way...I try to write it out beforehand. It's a bit hard to call cold and read them out a story, and then you start repeating yourself.* (Reporter 5)

and

> *for me personally, it's so much easier writing it out. If I had to do one (story) over the phone I'd be lost* (Editor)

4. Creation of an audit trail

Having an accessible copy of what has been written also creates an audit trail of what each Reporter has produced.

> *The other thing is that you've got a copy of it... In general I would think that you'd want a copy of what you filed because you might want to take a look at it afterwards, you might want to rewrite it* (Editor)

5. Allowance for opportunistic work

Using a laptop facilitated opportunistic work to be done in time which would normally be considered dead time. Reporters were able to undertake work, formulating parts of their story, while gathering information in the field as well as during "dead times" such as when travelling between locations.

Reporter 5 and 2 both reported on rugby league matches. Reporter 5 noted that he was able to write his story on an on-going basis while the game unfolded. By the time the game finished he was able to produce a completed article ready for submission. *If you're sitting there with your laptop as the game is going on then It's all being written at the same time. Right on full time you can hit a button and it's in the office.* (Reporter 5)

The concept of 'dead time' for mobile workers is described by Perry et al. as:

> Large amounts of time are spent outside the trip's scheduled activities (this is characteristic of much business travel). This time was described by participants as 'dead' time, 'travel' time, 'spare' time, or 'wasted' time. The common factor was that this time occurred between tasks and between meetings, in which the participants usually had little control over the resources available to them. (Perry et al, 2001, p.337)

In another scenario described by Reporter 5, he noted that he was able to make use of his travel time to get work done on the laptop, which would not be the case if he did not have access to one.

> *I live up at Avalon, so I got an hour on the bus every day. If I'm getting caught up, late in the day and I'm just going to sit there and write up a story then I just jump on a bus and do it on the laptop on the way home...And there are days when you just work from home and just do it all on the laptop at home.* (Reporter 5)

5.3.4.3 Preference for Copytaker System

The Editor interviewed believed that the use of laptops was more effective than using Copytakers, stating *I would have thought that the vast majority of Reporters would be using laptops.* Despite the potential advantages of a laptop, the negative points associated with the Copytaker system and the support from editorial management, all field Reporters preferred to file stories using the Copytaker system except Reporter 5.

The suggestion was made that perhaps the laptop was cumbersome for the Reporter and inhibited their mobility, but when this possibility was suggested to a Reporter, no such complaint was registered. Reporter 5, who regularly used a laptop in his work, said that it was not an inconvenience. *No not really, it's like a sports-bag. They're real tiny.* (Reporter 5)

Consider the two scenarios from the holistic point of view of Activity Theory. In considering an Activity, not only must you take notice of the Tools and explicit Rules, you also need to take into account the sub-Actions, Rules and cultural-historical nature of Tools; because Tools have been developed by their 'users' they have built in mediating properties. The purpose of the mediation may be an important Action; however it is often implicit and therefore hidden from the Subject.

The primary purpose of the Copytaker system and the laptop system (Tools) is to assist the Reporter with the submission of a story. To this extent, a secondary Action could easily be overlooked. An Action and major advantage of the Copytaker system is that the formulation of stories is assisted by the Copytakers during the transcription. In essence, the article is subject to an edit or proof-reading prior to reaching the editorial staff.

One of the good, semi-benefits is that the Copytakers will not rewrite, but take out bits and pieces as they go. So if they [the Reporter] uses the wrong word or something, they'll clean it up as they are going. There's a semi-editing process that goes with that. (Editor)

Although this editing process was acknowledged by both the Reporters and the Editor, it is not an explicit or formal process. I noted earlier that the Copytaker system is also subject to misinterpretations and misspelling by the transcriber. It is the role of the editorial staff to edit the story; the role of the transcriber is to transfer the verbal material into text, and the transcriber is not necessarily trained or qualified as an editorial journalist.

Consider the case of Reporter 3. This reporter had a definite bias towards using the Copytaker system. While filing his stories from the field, he described the requirement of Copytakers to read back what they had transcribed. They were also asked if what they had written down made sense. This informal quality assurance practice ensured that the article made sense not only to the reporter but also to the 'lay person'.

They [Copytakers] *were invaluable because often you would get feedback from them about what you were writing, like they would say 'are you sure about that' or 'you've mentioned that further up the story do you want to say it twice and you'd say no, ok, thank-you. So you've got a human, instant response to what you're dictating is very important, a machine can't do that. And sometimes when if they laugh at a joke or something funny you put in then you think great I've hit the spot, if they're shocked at what I say then great, I've hit the spot, I've captured it. If they cry, fantastic, you really got the story. A machine can't do that.* (Reporter 3)

Copytakers assist by providing immediate feedback to the Reporter, which assists with the content and structure of their submission.

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The assistance of Copytakers provides a positive contribution to the Reporters and the submitted work. Using a laptop isolates the Reporter from the Copytaker and their assistance, their editing and feedback. This implicit Rule is a fundamental attraction of the Reporter to the Copytaker system.

Two vignettes or short stories (Finch, 1987; Sleed et al., 2002) provided by Reporter 3 and Reporter 5 describe specific instances in which a laptop was used instead of the Copytaker system. In both instances, the Reporter finds a replacement to support the editing process for their stories.

5.3.4.4 Vignette 1 – The Luddite

Reporter 3 has been working as a reporter for over 30 years and claims to have an aversion to using technology.

> *I do feel a total Luddite compared to these young Reporters now; as I said I still don't know how to do a SMS text message, I don't have a laptop when I go on jobs.* (Reporter 3)

This claim is made despite the fact that he uses a computer in the office for such tasks as searching the Internet for information.

> *Technology is very useful. The Internet is a tremendously useful tool to find out what newspapers around the world have said and it is tremendously thing useful to get the latest from reliable web sites like ABC News...and it's a good gauge to find out things that I don't know anything about.* (Reporter 3)

Reporter 3 prefers to use the Copytaker system; however, he did describe how he made use of a laptop on one occasion while in the field. In this instance the Reporter

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was covering the destruction caused by a tsunami in Indonesia, and he filed his stories using a laptop. This laptop belonged to the photographer who accompanied him, and it was the photographer who assisted the Reporter in a similar manner to the Copytaker.

> *Quite often when we go out on jobs like the tsunami the photographer has a laptop...The photographer is much more technically competent than I am. They file pictures through the laptop and so on...If I'm on a story I would be discussing it with the photographer.* (Reporter 3)

With the support of the photographer, the Reporter is able to maintain the informal edit of his story before submission to the editorial staff.

5.3.4.5 Vignette 2 – Sports Reporter

Reporter 5 tended to exclusively file stories using a laptop while in the field and mainly covered sports stories. Reporter 2 had worked temporarily in the sport section of the publication and had a similar experience, filing stories via the laptop rather than by the Copytaker.

The sport reporter superficially seems to operate in an isolated manner, not having the assistance of the Copytaker to edit his work; however, the need to collaborate in the production of his work continues to pervade his work practice. To fulfil the collaboration needs with the information gathering and editing process prior to lodging a story, the sport reporter falls back on the only available personnel, that is, the opposition journalist. This behaviour seems strange considering each publication would want the 'best story'.

Reporter 5 justified this conduct by saying:

Journos are good with help when you type it [the story] *out.* [whether] *it's a journo at your paper or a journo at another paper who's an expert in boxing or whatever...It's a cut-throat business in a way in that everyone wants to get a better story, but especially in sport there's a bit more camaraderie, because we're basically all sports fans, at the risk of sounding a bit daggy, but everyone is keen on sport, we've all got the same interest...with the boxing I've got friends at the* [opposition paper] *who know about boxing and I've got no trouble ringing them up and saying I've got to cover this bloke – what's the story and what to watch out for etc...Don't get me wrong,* [collaboration] *it's more in-house. If there's people in your own paper who can help you out, that's where the vast majority comes from. But especially when journos go on the road, on cricket tours and things like that, it's a very tight little group.* [Reporter 5]

In a similar way to Reporter 3 (the Luddite) using the photographer, the sports journalist's collaboration with opposition journalists supports the Rule of pre-editing stories and substantially highlights the importance of this process in mediating the Activity. Even though there were physical constraints (such as no access to the Copytakers in tsunami-devastated Indonesia), the Rule associated with pre-editing a story is maintained through other mediatory elements which are available in the contextual environment. A change in the environment requires a change in the way an Activity is carried out.

5.4 PART 3: Discussion of Combined Pilot Case Studies

The focus of much innovation research has concerned the features of the technology and what that technology is identifiably replacing. This point is noted by Barber (2009) who writes"

> The design team focuses its attention on the device, but the concept of usability used in this chapter implies that the device is only part of the equation and that other factors relating to the user and environment can play significant roles. The problem with this, of course, is that these factors lie outside the remit of the design team. One irony of this is that a well-designed device can 'fail' as the result of unanticipated activity, user characteristics and environmental features. (Barber, 2009. p.90)

An information source is redundant if it is not used, and sometimes the reasons for this are outside the focus of the design team.

Barber's (2009) description of a redundant technology is consistent with the MKW work environment and is illustrated by the laptop versus Copytaker scenario. The laptop system of story submission in theory offers several advantages, such as greater reliability and accuracy, over the Copytaker system; however, its user requires a change to the information system and Activity. Using the laptop results in by-passing the opportunity to interact and collaborate with the Copytakers, or to receive the supportive feedback they provide in the production of a story. The demise of the laptop is further accentuated by Reporter 1 noting in a follow-up interview that the number of Copytakers within the publishing company was to be increased, whereas the number of available laptops remained consistent.

The shortcomings of the concentration on such a narrow field as the technology (Tools) for development is overcome by using Activity Theory. As illustrated previously, according to the model by Hasan and Gould (2001) (Figure 5.5), the two

principal mediators of an Activity are the Tools and/or the Community. The addition of Rules, which are user developed and produced by the Community of Practice, are socially defined work practices and have a major influence on how an Activity is undertaken. This mediation of an Activity provides an explanation of unexpected poor innovation adoption despite technological developments in both functionality and technical usability (i.e., whether the technology is easy to use and affordable).
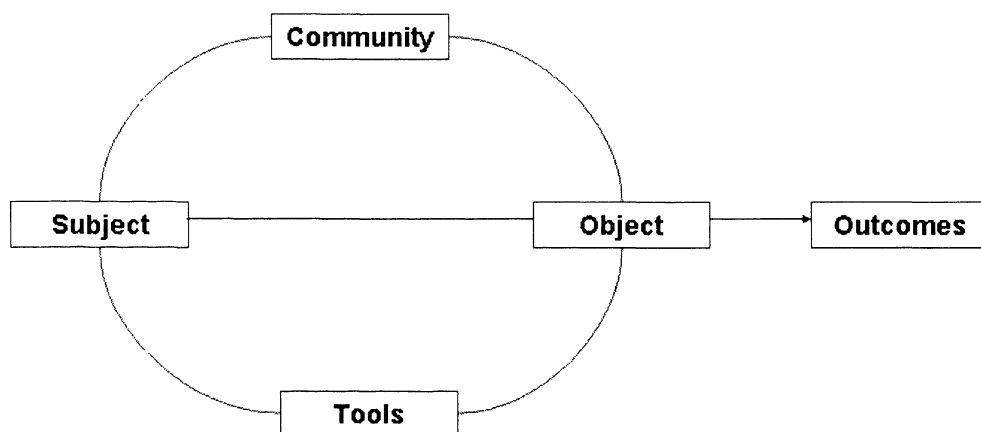

Figure 5.5: Mediators of an Activity (*from* Hasan and Gould, 2001)

The examination of the Pilot Case Studies through the lens of Activity Theory reveals the complex nature of work facing the MKW. These workers have to deal with ad-hoc situations in which they are required to make crucial decisions based on limited formal information.

5.4.1 Differences Between Case Studies

The focus of the research in the case studies was applied to a knowledge worker while they were operating in a mobile mode. I note that clearly the work of the Reporter and the Doctor are different (producing a story and looking after the health of patients respectively). Fundamentally, both of these mobile workers apply their knowledge to make decisions, and their ability to make decisions is supported through their information systems.

A second difference between the case studies is the environment in which on the spot decisions are made. The environment in which the Doctor operates is controlled (on the ward) allowing for Doctors to place support systems such as nurses and monitoring devices to provide 24 hour observation of the patient condition. On the other hand, the mobile work environment of a Reporter can be totally open and unfamiliar. This places a high level of importance upon the planned support of their pre-mobile, office research and allows the Reporter to take with them appropriate printed material.

The Reporter operates in a mobile sense in order to gather information by assessing the situation and context in order to make a decision). Information support for Reporters is additionally realised from their open environment in the form of Contributors. Contributors are outside the organisational structure of the worker; they are not classified as Collaborators, nor are they within the Community of Practice. Contributors are 'bystanders' or other people who happen opportunely to be in the same vicinity as the Reporter and can provide information to assist the story.

The Contributor information system developed by the Reporter MKW includes both formal and informal components.

1. Formal or targeted information sources are one of the major reasons for Reporters to be mobile. This is afforded to the MKW through formalised meetings or through interaction with official personnel such as experts in the story's area of interest, or a media liaison officer at the point of interest to assist with the dissemination of information.

2. Dynamic information sources. These include interaction with people in the field who are consulted in an ad-hoc or opportunistic manner. This collaboration with the Reporter often provides a third party perspective on the situation.

Information support for the Doctor MKW is one in which they are able to manipulate the environment by placing systems on the ward in a controlled manner. The Reporter is able to design information support for decision making by arranging interviews; however they are also able to make use of the open environment by using Contributors in an ad-hoc manner. The Doctor MKW does not make use of Contributors, which appear to be a unique property of working in an open, dynamic environment.

5.4.2 Common Themes

In both cases the MKW operated from an office which acted as a central information store. The office acted as an information hub where information was stored as well as a place from which access to external sources via formal systems was well established. The importance of the office to remote work has been discussed by researchers such as Fulton (2002). In Fulton's research, remote workers, operating from home, reconstructed the organisational office in their home work space, even duplicating printed resources.

This formal information system is not always available to the MKW when they are away from the office, although it may be available in a limited form using Tools such as mobile phones. When there was no urgency for immediate decisions to be made, both the Reporter MKW and the Doctor MKW would return to their office to access decision support Tools before completing their work tasks.

Mobile workers such as Doctors and Reporters do not carry all their information with them in the field. Instead, planning, research and preparation are used to facilitate the premeditated production of pertinent information which the MKW anticipates he or she will require while mobile.

The main Tool or source of information support in both case studies came in the form of paper-based documentation. For example, Doctor 3 carried the appropriate patient's case note cards on ward rounds and Reporter 2 took relevant reference magazines or papers when covering a sporting event. The information support afforded to these MKW in the form of paper-based documents is static and limited to what they can carry in the field.

The limitations associated with paper information are well documented. Sellen and Harper (2002, p.31) note the mediative attribute associated with paper files: 'we can view paper as an artefact that shapes interaction that allows certain actions and not others'. They go on to list some of the limiting features associated with the nature of paper, these being:

- Paper must be used locally and cannot be remotely accessed without supporting technology
- Paper occupies physical space and thus requires space for its use and storage. Vast amounts of paper require vast amounts of storage space.
- Paper requires physical delivery

- A single paper document can be used by only one person at a time; if shared, this significantly changes the way it is used

- Paper documents cannot be easily revised, reformatted, and incorporated into other documents

- Paper documents cannot be easily replicated without the help of photocopier, scanner, or similar

- Paper documents, on their own, can be used only for the display of static, visual markings. They cannot display moving visual images or play sound without technological assistance.

Often the MKW is faced with unforeseen situations; the dynamic and volatile nature of mobile work means that anticipating information requirements is therefore difficult.

In order to deal with complications arising in the field, the MKW has developed a system which improves information reliability through the pre-mobile preparation of work and by extending their information system to include other sources of information such as informal conversations and collaboration with trusted sources.

As previously noted, planning and anticipating information needs contribute significantly to the MKWs ability to adapt in the field. It is also clear that the experience and individual skills of the different MKWs enable them to envisage their field needs. That is, the material which is prepared and taken with the MKW is done so in a premeditated manner which requires the ability to envisage the information needs of their mobile work.

Another human source of information, or Tool, is the Collaborators who work with the Subject MKW. As observed, a clear distinction between Collaborators and Contributors is that Collaborators are part of the organisational fabric of the MKW, whereas Contributors are not. Collaborators may be remotely accessed, but may also

be present in the field and appear to be an important information source (Tool in their information system).

The remotely accessed Collaborators were mainly contacted using Tools such as mobile phones. Collaboration occurred both within the particular MKWs office as well as in other collaborating organisations. For example, in the case of their respective offices, Reporter 3 would contact the librarian for information, and Doctor 3 would call his secretary for case note information left in his consulting room. In examples of external collaboration, Reporter 5 would often contact Reporters in other organisations for background information in areas he was unsure of, and Doctor 2 would contact other specialists for their insight on a particular patient issue.

Informal communication with both Collaborators and Contributors is an important component to the MKWs communication system. Kraut et al. noted that:

> formal coordination mechanisms often fail in the face of novel or unplanned events. Novelty, unexpectedness and uncertainty are frequent in organisations and are often components of what appears to be routine procedures (e.g., Suchman & Wynn, 1984). Under these circumstances, informal communication seems needed for coordination in the face of uncertainty and equivocality. (Kraut et al., 1990, p.6)

Noting the dynamic conditions in which the MKW operates, it is no surprise that informal communication plays a prominent role in their work.

A clear concern with all information sources was reliability. MKWs scrutinise sources of information such as Collaborators to determine whether they deem them a reliable source of information. Trust is a another prominent attribute which has to be established between the MKW and a Collaborator. The Reporters pointed out that they only used reliable, document based information sources, in particular other reliable publications or web sites.

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Research by Fagrell, Ljungberg and Kristofferson (1999) found that knowledge work by mobile workers was assisted by collaboration in several forms. Their research differs from mine in that the mobile workers in their case study worked in pairs. Each knowledge worker entered the field with a Collaborator, thus, the premise of the research was of a scenario in which collaboration is inevitable. The MKWs in both the Doctor and Reporter scenarios operate, on the surface at least, individually. The Doctors' independence while working on their ward round is for the most part maintained. Only in urgent matters, when collaboration is essential, does the Doctor initiate collaboration. The Reporter also maintains independence until they have to submit their story with the assistance of a Copytaker to meet their print deadline.

5.4.3 Emergent Themes: Environments and Activity

Following an analysis of the Doctors Ward Round case study, I proposed a third mediating influence which affects the way an Activity is done: Urgency. I have also mapped a similar influence which materialised in the Reporter case study. The Urgency mediator could, however, be a subset of another, broader force which takes into account the context in which the Activity is being undertaken, the Environment.

I have divided the Environment mediator into two very distinct groups. First, there is the physical Environment. The Physical Environment mediator became evident in the Reporter Case study (see 5.3.3.3 C). The Environment in which a mobile worker operates is dynamic which means the Tools which are available to the MKW are subject to variations in availability. Love (2005, p.106) comments on the environment in which mobile workers operate, noting that 'mobile workers inhabit dynamic environments, they have different demands in terms of the resources that are needed for mobile communication and the constraints that impede mobile communication'.

In reviewing the Pilot Case Studies, the influence that the Environment can potentially have upon an Activity can be observed.

While working in a mobile sense, the MKW is subject to a changing Environment. The physical and social landscape are subject to change in the mobile Environment which can result in variation of the sources of information and potentially a change in the Activity that is the Subject's focus. For example, a patient developing unforeseen complications may change the Activity of a Doctor on a ward round. The Object of the Activity may not necessarily change, however, the Environment may change requiring an appropriate response. As already noted in the Reporter case study, dramatic changes such as a bomb going off will change the topic of the story. In this case, obtaining the earliest, or possibly exclusive, report becomes the priority in the social context and Reporters will use whatever is at hand to do their work.

Physical Environment

The influence of the Environment on an Activity can be illustrated by considering that, although several tools may be available to the Subject to assist with their decision making, the particular context may prejudice the selection of one over another.

In the case studies, for example, Reporter 3 was unable to use the assistance of a Copytaker due to telecommunications restrictions. The Copytaker is used by the field Reporter as an editing Tool (a Tacit Rule), however when this option was not available the Reporter looked for another option. As a result of the availability in the Environment of the Photographer, the Reporter made use of him as a source of criticism.

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In another example, a Reporter makes use of the available information sources in the field, in this case, other people in the vicinity of the story, such as the ground announcer or even other Reporters. These sources of information are used opportunistically by the Reporter:

> *When I first started as a reporter I got sent out to cover a rugby game and I didn't understand all the rules about rugby at that stage. When I first started I would go to the announcer's booth and just ask the announcer 'what's happened here' or 'who was that player' so you would use the expertise of other people like trustworthy sources. You're always gathering information from people...With some of the parties that I've covered for the paper you would go out and the job is to find out what celebrities were there. So with your PR officer who's organised the party and you hook up with her straight away, usually it's a her, and say 'who's here' or 'who are you expecting tonight' and get the information from them...You can't expect to know every single person.* (Reporter 1)

In the case of the Reporter, even the focus of the story can change. The Reporter may go into the field with a certain topic in mind for a story, but after being immersed in the field, another story of more interest may evolve. Reporter 1 noted that most of the time he conducts interviews over the phone in the office, however:

> *Seeing what people are wearing, being on hand just in case something does happen, like a bomb goes off or a horse breaks its leg. None of those things are you going to be able to do over the phone. When it's a happening news event you need to be there...being on the ground you can see what it's like, you can see interesting situations as they come up. You may get a different angle on the story which you didn't expect to get.* [Reporter 1]

Social Environment

The Social Environment is the second contextual grouping which mediates an Activity. This groups includes the level of Urgency, which has been identified in both case studies; however, it also includes the overall 'social setting' in which the work of the MKW is being performed. A good illustration of the social setting is the comment by Reporter 3 who said:

> *During an interview I would never ring up and ask for information because it breaks the thread of an interview. You couldn't do that. Your job there is to elicit information from the person.*

In a similar manner, Doctor 1 mentioned that he would never discuss the condition of a patient with another Doctor in the same room as the patient, because their conversation could be overheard by others in the room such as the patient themselves, friends or relatives.

Another observable difference in the social environment context of Doctors and Reporters is in the level of 'forgiveness'. The social environment afforded the Reporter allows for mistakes to be made in the reporting of a story. The health of patients, however, means that mistakes in decision making could be fatal. The social environment reflected this point with Doctors giving no indication of errors, whereas mistakes were acknowledged by the Reporters. A mistake by the Doctors could result in the death of their patient, whereas an error in a story written by a Reporter can be accounted for by a published retraction . Reporter 1 noted that retractions by the publication was a common occurrence.

Clearly MKWs are able to make use of the tools and Collaborators that are available to make decisions. The Environment in which they are operating at any given time

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also has a significant effect and as such I suggest that a more descriptive model of Activity should include the environment, as illustrated in Figure 5.6.

Rules   Rules

Tools   Community of Practice (Divisions of Labour)

Doctor / Reporter

Patient Care / Produce Story

Social and Physical Conditions of Environment

Rules
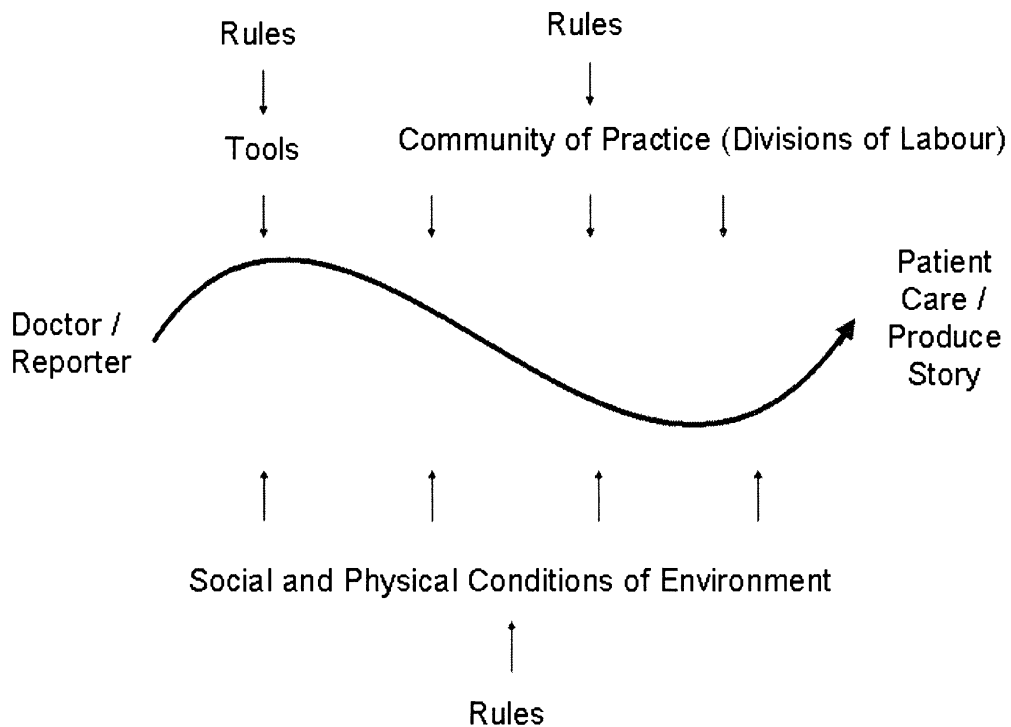
Figure 5.6 Inclusion of the environment into Activity of mobile workers

The effect of the environment is not as prominent in the case of more stable work spaces such as the worker in an office location. Reporter 4 noted that *4 days a week I'm pretty much in the office and I basically work using the phone, go out occasionally but it's much easier over the phone*. The Reporter in the office has easy access to more stable, reliable information sources such as their library, dependable Internet connections on site, and knowledgeable colleagues. In the case of the mobile worker, however, the dynamic, changing nature of the mobile context has an effect on their work.

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The model of mediators of Activity in Figure 5.5 will be further evaluated in the next chapter, which considers another set of MKWs, Construction Site Workers.

5.5 Summary

In this chapter I have described two case studies which focus on the work (Activity) of mobile knowledge workers (MKW). These case studies examined Doctors conducting ward rounds and Reporters operating in the field. I identified their sources of information with respect to decision making. To assist in the understanding of the case studies, Activity Theory was used as a lens of interpretation. The key findings from the case studies are as follows:

1. Non-explicit Rules have an influence over interaction with information, via the use of Tools and interaction with Collaborators. The emergent theme of the Environmental Condition is also subject to Rules.

2. The introduction of a Tool such as mobile technology has the potential to change the Activity of the MKW (change the way work is done) and potentially result in the demise of the implemented Tool. This case is underscored by the example of the laptop versus Copytaker systems. Despite the considerable advantages afforded by the laptop system it was overlooked by the majority of interviewed Reporters as it indirectly eliminated collaboration with Copytakers.

3. The office is a key information hub for the MKW and is used to prepare for mobile work as well as for decision making on their return from the field. Contact with office resources is conducted over the phone. This communication can, however, be limited, such as when a Reporter is conducting an interview. In this case, communication with the office is considered inappropriate and is severed by the MKW. There is also a reliance on the availability and competency of others.

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4. Where possible the MKW will use their mobile work to gather information which is used on their return to the office.

5. Interaction and information support from other people comes in the form of Collaborators and Contributors. Collaborators exist within the MKWs organisational structure, whereas Contributors are outside. Examples of Contributors are patients being examined by Doctors and bystanders at an event being covered by the Reporter; both potentially serve as opportunistic information sources.

6. The Doctor has control over the hospital ward environment in which he places patients and does work, and is able to make use of 24 hour information support Tools such as monitoring devices and Collaborators such as Nurses.

7. I suspect that although Contributors and Collaborators exist in the mobile work environment for both Reporters and Doctors, the open Environment of the Reporter is more likely to yield Contributors and the controlled environment of the ward is sympathetic to the participation of Collaborators. This suggests that there is a link between the level of openness or control in the mobile environment and the level of collaboration or contribution.

8. Collaboration is an important component of the information system for both types of MKW. Both formal and informal communication is used. The communication between Collaborators is used as a means of primary information or discovery as well as a source of affirmation of the decisions made. Examples of the reassurance provided by Collaborators can be seen in the interaction between Reporters and the Copytakers who assist in the transcription of a story, and the informal discussions that take place between Doctors in the lunch room.

9. The work of support staff is another important form of collaboration for the MKW. For example, nurses provide 24 hour monitoring of patients for Doctors, carry out the Doctors' instructions and act as a conduit for information sharing between collaborating Doctors.

10. The physical and social setting for work – the Environmental conditions – provide a source of information as well as a mediator of the Activity. For example, if a matter is urgent, the Activity of the MKW will require additional, on the spot work or decision making.

11. Despite the limiting attributes of paper-based information, it remains a highly utilised form of information storage and transfer.

12. The MKW's personal knowledge and experience is significant and adds to their ability to do work.

13. The reliability of information sources is important to both types of MKW, whether the source of information is another person or an article from the Internet. The reliability of another person as an information source resulted in the development of such work practices as Doctors using a referral system to ensure that they worked with other Doctors they trusted.

Chapter 6 will refine these findings through consideration of a third type of MKW, Construction Site Workers. This case study will capture a detailed view of the MKW through interviews with several associated participants in two different construction projects as well as inter-organisational Collaborators such as consultants and subcontractors.

Chapter 6 - Main Case Study: Mobile Knowledge Workers on Construction Projects

6.1 Introduction to Chapter

In previous chapters, I examined two different categories of mobile knowledge workers (MKWs), Doctors and Reporters, and found that the concepts associated with Activity Theory provided a logical framework for the holistic examination and description of their information system. By using an Activity as the unit of analysis, I provided a broad view of these information systems which incorporates the identification and interaction of information sources by the MKW.

The Activity of the Doctor and the Reporter working in a mobile manner provided a context in which I considered decision making. This investigation allowed for the identification of supporting information sources, interaction behaviour of these MKWs and the construction of a description of their individual and combined information systems. The description includes not only the Tools, or explicitly developed information sources, and the data or functionality they provide in support of decision making, but also the Rules which explicitly and implicitly dictate how interaction with the information sources takes place. The case studies highlight the formal and informal interaction between the Subject MKW and Collaborators, with the Collaborators constituting a substantial source of information.

An addition to the model of decision making by knowledge workers (based on Cultural Historic Activity Theory - CHAT) as described by Hasan and Gould (2001) is the influence of the Condition of Environment, both in physical as well as social contexts. The Environment, or context in which an Activity is being observed, is a further determining factor which mediates how things are done, particularly in the

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case of the MKW operating in a dynamic Environment. The Environmental conditions influence interaction between the Subject and the information sources, which in turn mediates the Activity.

In this chapter, I examine the MKW operating on a construction site, identifying the information system and its use in decision making. The information system of this MKW is examined from the perspective of an Activity and the decisions which shape the Subject's work. The mediating forces identified in the previous chapter form the framework upon which the Activity is viewed and analysed, namely Tools, Collaborators, Rules (explicit as well as informal) and the Environment.

6.2 Introduction to the Construction Case Study

The development of this case study was undertaken in three phases. The first phase identified the sources of information used by the head contractor's site workers on a building site. Following a review of the Activity of these workers, a second construction site was examined, extending the subject group to include Subcontractors. In the final phase of development, a third group of interviewees was considered: the Consultants, including a client side Project Manager and three Architects.

An important selection criterion for the case study sites was physical size. To guarantee that there was a significant distance between the site office and the work face, only larger sites with multiple work faces were selected. The logic behind this parameter is that, due to the distance, it is relatively inconvenient and inefficient for the construction site MKW to continually move between the site work face(s) and the site office. This creates a disconnected information system.

Two construction sites were selected, and personnel from those sites were interviewed. The sites were managed by different contracting companies.

The first construction site which met the mobile workers' isolation criteria was identified as a new AUD $13.5 million sports complex. The case study data was developed through interviews with the construction company's site staff. Four staff members were interviewed and included the Project Manager, two Foremen and a sub-Foreman, or Leading Hand. All the interviewees had substantial experience in the construction industry. See Table 6.1 below

Participant	Experience (years)	Position
Site Worker 1	15	Project / Site Manager
Site Worker 2	15	Foreman 1
Site Worker 3	21	Foreman 2
Site Worker 4	7	Leading Hand

Table 6.1: Construction site workers interviewed on Construction Site 1 and their experience

To differentiate between the first and second sites, the first construction site will be referred to as 'Site 1' and the second construction site will be referred to as 'Site 2' .

Site 2 was an AUD $82 million 22 storey office and retail building. The scale of this project had additional complexity in technical aspects as well as in organisation and management. The additional complexity of this project meant that substantially more construction site personnel were involved in the project than on Site 1.

To ensure a significant data capture, several more site staff members were interviewed. (See Table 6.2.) In addition to the head contractor's site staff, two Subcontractors were also interviewed. This was a direct result of the snowball approach to data collection (Patton, 1990; Penrod et al., 2003); subsequent to the analysis of data from Site 1, it became apparent that the Subcontractors were intimately involved in the construction site context.

Participant	Experience (years)	Position
Site Engineer 1	16	Site Engineer
Site Engineer 2	4.5	Site Engineer
Site Engineer 3	3+	Site Engineer
Construction Manager	13	Construction / Site Manager
Contracts Administrator	17.5	Contract Administrator
Leading Hand	5	Leading Hand
Foreman 1	34	Foreman
Foreman 2	34	Foreman
Foreman 3	19	Head Foreman
Subcontractor 1	33	Subcontractor (Masonry)
Subcontractor 2	23	Subcontractor (Formwork)

Table 6.2: Interviewees and work experience of construction workers on Construction Site 2

Following a review of the initial data collection from Site 2, four additional interviews were conducted. A group of interviewees which I classified as construction site Consultants was initially overlooked as they did not have a physical presence on the construction sites visited. However, again due to snowball sampling, I determined that their inclusion was necessary. This group includes a Client Side Project Manager and three Architects (see Table 6.3 below). These workers both collaborate in decision making as well as make critical design decisions which directly affect the work of site personnel. The data from these interviews were incorporated as part of the second construction case study site.

Participant	Approximate Years in the Industry	Consultant Profession
Project Manager	10	Client Side Project Manager
Architect 1	5	Architect
Architect 2	5	Architect
Architect 3	26	Architect

Table 6.3: Construction site consultants on Construction Site 2

A brief background to the construction industry follows, with particular reference to information dissemination and use. This will allow the reader to gain a perspective on the industry and the interviewees. The results of the three phases are then reported, followed by analysis and discussion.

6.3 Background to Construction Sites and Information

Typically, construction projects are initiated by a client (a person or corporation wanting to build something) who engages a design team comprised of Consultants such as architects and engineers. Once the design has been formulated, the construction of the project will be attended to by a construction firm, which is designated the 'Head Contractor'.

On both construction sites that make up this case study, the Head Contractor operated from a head office with satellite site offices for each construction project the company managed. The procurement and planning of this construction project took place at the head office of the contracting company, and once the contract to build the projects was awarded, the respective Head Contractors set up the site offices. Information concerning the planning and ongoing management of the project was replicated and kept in both the head office and the site office.

The Head Contractor manages the construction process, contracting and overseeing the Subcontractors, who are specialist tradespeople such as electricians, carpenters and plumbers, ensuring that the work is completed within the agreed specified time, cost and quality parameters.

The complexity of the information system varies from project to project and is affected by many variables. In most cases, each construction project has individual attributes which distinguish it from other jobs. The construction of a high-rise building or dam is not mechanistic as, for example, producing a widget in a factory where most variables can be easily controlled. Some construction work such as building project homes attempt to mechanise the work and information system; however, even in these situations, no two projects are exactly the same. Variables such as the location of the site and differences in the construction site workers can create complications in the construction process and the information system that is

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used to assist decision making. For example, as the scale and difficulty of a building project increases, so does the complexity. This increase in complexity often equates to a larger organisation, which will have a greater number of participants with whom to negotiate, more site workers to supervise, and specialist Consultants, all of whom require direction from or negotiation with the Head Contractor.

The physical location of the construction site workers can have an effect on the complexity of a project. Some are off-site, some are on-site, and some have offices. Sometimes the worker may be on-site but he requires head office approval for particular activities. A verbal order such as a site instruction to a Subcontractor might need to be put in written form and sent to a workers' head office for the order to be formalised and the on-site worker to comply.

Adding to the complexity are the lines of contracted responsibilities and authority. For example, the Subcontractors are contracted by the Head Contractor, so the Project Manager, despite being the client's representative, cannot issue a direct order to the Subcontractor. An order can be made in writing to the Head Contractor who then passes on the order to the Subcontractor.

It is worth noting that the title and role of different participants in the construction process can cause confusion. A Project Manager or Project Superintendent may be employed to represent the client's interest during the process, supervising the Head Contractor during the construction phase. Specialist project management firms, or often one of the designers, such as the architect, fulfil this role because a proficient level of understanding and competence in construction is required.

The Head Contractor sometimes employs a Project Manager. This Project Manager may oversee or manage several different construction sites, and has a similar role to the client side Project Manager, except they negotiate with the client and their Consultants on behalf of the Head Contractor. The Project Manager in Construction

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Site Case Study 1 is a Head Contractor's Project Manager, whereas the Project Manager interviewed as part of the Consultant review is a representative of the client.

A construction site information system is used to support project personnel in the construction of such structures as houses, factories, commercial high-rise buildings, roads, dams, bridges and so on. As in the Doctor and Reporter case studies, the timely use of information, its storage and access, on a construction site project is vital for success. Deibert, Hemmer and Heinzl (2009) noted the importance of information to a construction project:

> For the success of a project it is very important what information is available and who can access this information. Moreover, the communication, i.e. the distribution of information to other project participants, depends on the quality, quantity and timing of information. (Deibert, Hemmer and Heinzl, 2009, p.1)

Construction Site Workers such as the Foreman and Site Engineers or supervisors spend much of their time working in a mobile mode, moving around the construction site to supervise work. A similarity with the Doctor and Reporter case studies is that these workers also make use of an office, and typically, information on the construction site is stored in the site office.

The size and scale of many construction projects also demands that participants are mobile in order to view work first-hand. There could be several on site locations where work is being carried out, and the optimisation of work requires supervision of site workers such as Subcontractors. The physical construction is not undertaken in the site sheds, but at the multiple work faces around a building site. The various points of work are, therefore, isolated from many components of the information system.

As far as possible, complications that may arise with the building work are accounted for in the planning phase; however, many issues may not become evident

until the work has started. This creates the need for 'on the spot' decisions (Ashan et al., 2007). The issue can be escalated if pertinent information for decision making is not at hand, resulting in mistakes which have cost implications. The construction context is plagued by inefficiencies associated with information, which is highlighted by Bowden and Thorpe (2002) who suggest that 65% of a construction contractors' work is generated by insufficient, inappropriate or conflicting information. Further, Jones (2010) reports that, in Australia, the cost of rework in 2009 was estimated to be AUD $5.8 billion.

Researchers such as Bowden and Thorpe (2002), Chen and Kamara (2005), Ashan et al. (2007) and Deibert, Hemmer and Heinzl (2009), note that despite the availability of technology to supply information to Construction Site Workers working in a mobile manner, there is still little information support for Construction Site Workers outside the established site office.

6.4 Findings - Construction Site 1 (Site 1)

The construction of a new sports complex was the site on which the first case construction site case study (Site 1) was based. The complex consisted of an indoor swimming pool, 'water play' area, two indoor basketball courts, a caretaker's residence and landscaping works. The substantial footprint of the development meant that there was considerable distance between the work areas and the site sheds where information such as plans and documents were kept.

6.4.1 Construction Site Workers and Mobile Work – Site 1

The Leading Hand spent the majority of his time on site at the points of work. He noted:

> *I'm paid to be on site* [all the time] *but come back to the office if I need tools or to ask the Foreman something.* (Leading Hand)

The Leading Hand supervised other site workers such as Subcontractors and labour. On this site the Leading Hand answered directly to the Foreman, describing himself as the 'eyes and ears' of the Foreman. The Foreman would issue him with instructions for work to be carried out and it was the job of the Leading Hand to supervise the various workers on site to get it done.

The Foreman also spent the majority of his day moving around and supervising work, although substantial amounts of time were also dedicated to work based in the site office. This time in the site office was dedicated to managing the project and involved such processes as planning and programming work, costing and documenting work, and formal communication with the various Subcontractors, Consultants, and head office managers.

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The Project Manager divided his time between the head office and the various projects he was managing, managing this project from the site office as well as inspecting work progress and addressing concerns noted by either of the two Foremen.

6.4.2 Tools - Site 1

Plans

Plans are a particularly important Tool used by site staff such as the Foreman and Subcontractors. Plans are drawings or 'blueprints' produced by design Consultants, such as the Architect and Engineer, and depict critical specifications such as the appearance, dimensions and elements of what is to be built. The interviewees, however identify several issues in relation to this information source.

The working plans used on a daily basis are located in the site office and are generally hard copy, i.e., printed out on paper. A central repository of documentation is necessary because the site workers are required to be mobile in their work. The large amount of documentation makes it unfeasible to carry that information with them; the architectural and engineering plans alone may number hundreds of A1 size sheets.

A consequence of this form of hard copy storage is that the Foreman needs to leave the work face whenever he wants to view the full set of plans or documentation.

An informal work practice noted by Foreman 1 is that he would print two copies of the architectural and engineering plans. One set of plans always remained in the site office and are never taken outside, ensuring that details of the project works were always available in the office. The second set was used opportunistically and taken

on site when necessary; for example, when he was setting out work for Subcontractors.

Taking plans to the work area is a premeditated exercise by the Foreman. For example, if the Foreman knows there is a certain tradesperson, such as an electrician or plumber, working in a particular area, he might carry with him a copy of the drawings pertinent to that work. Nevertheless, the ad-hoc nature of on-site work means that different problems may manifest as site staff move around the various work areas on the site, which makes it difficult to determine which plans are needed from day to day. The size and number of plans makes carrying all the plans impossible.

During the lifetime of a construction project, the plans are amended by the Consultant designers to reflect approved changes or added details which were neglected in the original documents. An issue associated with these changes to plans is that different versions of a plan may be used by different stakeholders. When changes are made, the plans and documents need to be revised to reflect the changes and then reissued. Unfortunately, there is frequently a breakdown in the dissemination and use of these revised plans, often resulting in inaccuracies in the finished product.

Another manifestation of this issue which is associated with the paper plan form is that the plan on site is often 'marked up'. For example, notes about minor changes are made by the Foreman on the paper plan. This information needs to be transferred to the main copy kept in the site office as well as the copy held in head office, which is not always done.

This problem, often referred to as 'versioning', is compounded when other details of changes are not made to the main drawings. Instead, sketched details are made and ensuring that all the workers affected by the change are informed is a difficult task.

A lot of architects issue file notes but between them and the revised drawings there is a whole lot of confusion. (Project Manager)

The Leading Hand noted that misdirecting Subcontractors has happened as a direct result of versioning. He often felt embarrassed and frustrated after the Foreman changed the work order to directly contradict him.

A Subbie may ask me a question out on site and I might have gone over the plans and told them to go ahead but little do I know a variation has come through, and it happens all the time where things get changed. But they [Foremen] obviously can't keep me up to date every single time they have a meeting on what's going on. Sometimes it's frustrating and embarrassing like when I tell the Subbie to do something and then the Foreman comes out and tells them something else because it has changed and that makes me look stupid. (Leading Hand)

Preparation and good planning is used as a tool to assist in making decisive evaluations and avoiding misinformation on a construction site. As noted, plans are continually adjusted and decisions made on the spot as issues arise. To deal with the dynamic nature of construction and maximise the communication of information, such as changes to the plans, the Leading Hand and Foreman start each day with a walk around the work site. The Foreman in an opportunistic manner will pass on information to the Leading Hand, such as things that need to be done, what is being delivered and when, and who is working on site.

Other Paper-based Documentation

Paper forms are an integral part of a project's information system and are used by on-site staff for planning, issuing instructions, record keeping and information

transfer. On most construction sites, all the documentation for a particular project is situated in the site office with the plans.

The paper-based documents record essential information which informs the Foreman about the works. They include the following:

1. Contracts and specifications. Contracts are legally binding agreements between the client and the Head Contractor, or Subcontractor agreements between the Head Contractor and the Subcontractors. Included in these contracts is the description of works, known as the 'scope of work', which the various parties have agreed to perform, and details of the payment to be made in consideration of that work.

2. Program. This is the timing of the works and shows when the different Subcontractors should start, be on site and finish their work. It is often in the form of a *Gantt chart*.

3. Site diary. The site diary is generally kept by the Foreman and Leading Hand. It records the day to day operations of the construction, such as who was working on site and the work they were doing.

4. Site instructions. This is a copy of the instructions issued to Subcontractors if the detail in the plans, specification, or contract is unclear. The Leading Hand noted that he did sometimes issue site instructions, but generally the Foreman would make a decision and issue an instruction to do work.

   The site instruction is an important record to maintain, as it has the potential to create variations in time or cost due to additional work outside the original scope of work. It is required to be made in writing. Foreman 1 noted that when issuing a site instruction he would generally issue a verbal instruction to get the work started and would then return to the office to submit it

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formally in written form. The Foreman noted that in many instances the Subcontractors will not undertake work on a verbal order and will wait until they are handed a written instruction.

5. Request for information (RFI). During construction, the Head Contractor may require details of the design from the client or the client's designers, and a RFI is made. The request is usually made in writing and a response is required within a specified time limit. If a Project Manager is assigned to the project, all RFI are made by the Head Contractor to the Project Manager, who passes on the request to the appropriate Consultant or the client.

An issue identified by the Project Manager and both Foremen is the communication process and the time delays which are a result of the official approval procedure. For example, the work by Consultants may need to be redesigned or adapted to address an unforeseen condition and represents a slow turnaround time even though the site workers know what has to be adjusted. The Project Manager noted that it is:

> *very frustrating when they propose a detail and everyone is waiting on the architect's approval and to issue the new plans. Everyone knows which way to go but they can't do it until they receive the plans and it could take a couple of days for someone to drive out and issue the plans so potentially we could lose half a week.* (Project Manager)

These paper forms are central to guiding the construction process and assisting the Head Contractor's site staff in making decisions. Paper-based documents face the same inaccessibility issue as the plans, as they are also stored in the site office. To officially issue a site instruction, the Foreman has to leave the work area to retrieve the forms as he does not generally carry them with him.

A facsimile machine is also located in the office. The fax is used to transfer paper-based details between the site office and participants (such as Consultants and the head office staff of both the Head Contractor and the Sub-contractor). Access to a fax at the point of work around the construction site was only possible if premeditated prior to leaving the office.

Digital Information

Another component of the construction site office information system is the use of digitally stored information. This electronic form of information allows for documents such as plans to be stored and accessed in the head office as well as the site office. Further, the use of digital information permits communication to be conducted expeditiously using email.

> *For instance if you got plans, before you used to use hard copies but now basically everything is being emailed from one place to another.* (Project Manager)

Marked up changes are required to also be made to the digital copy. Attempting to make the changes and read off the digital copy itself presents problems, as identified by the Project Manager.

> *You can't get ten blokes into a small office all looking at a 10 inch screen and try and coordinate the project. It's not going to work. You can't mark up a screen... Everyone likes to see a big drawing and how the detail works and looks say on an elevation.* (Project Manager)

The digital information is stored on individual computers and the company server, and is accessed on work stations set up in the site office, or on a laptop. At the time of interview, Foreman 1 made use of a company laptop and the Leading Hand had

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previously used the laptop for work; however, access to digital information was not available at the points of construction work around the site. Even though the laptop is a piece of technology which allows for mobility, it was only ever used in the site office by the Foreman and Leading Hand. It was never taken out of the site office, despite the acknowledgement by all the site staff that using mobile technology such as the laptop to access up to date information would be very useful.

The Leading Hand presented two reasons for leaving the laptop in the office. Firstly, while on-site the workers need to be free to carry out manual labour, and having a laptop on-site is a hindrance. Secondly, a laptop would be subject to damage. The Leading Hand noted:

> *It would be a hassle to carry that sort of thing around...sometimes I get dirt splashed on me or I smash into different things. For me to actually have one on site would be a pain. I'd most probably break a couple of them for sure.* (Leading Hand)

6.4.3 Collaboration and Communication

Collaboration plays a major role in the completion of work on this construction site and the dissemination of information amongst the Collaborators is vital for decision making. The Head Contractor's staff interacted with Subcontractors, Consultants and the client's representative to ensure the work was completed to the specifications of the client.

Foreman 2 emphasised the importance of communication with the Subcontractors on site and noted the difficulty of getting work done correctly due to communication issues. Many of the Subcontractor's workers were from non-English speaking backgrounds, and as such, the language barrier became a reality of day-to-day work for the Foremen.

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It was noted that the Foremen attempted to establish relationships with those they collaborated with, allowing them to develop unofficial forms of communication to overcome issues with formal information. The Foremen would make informal commitments with the Subcontractors as part of their decision making. The relationship with the Subcontractors is emphasised in the resolve held by one Foreman: *My word is my bond* (Foreman 2). The familiarity which the Foreman has built with the various Subcontractors allows him to give a verbal order on which the Subcontractor will act. Instead of having to immediately hand over a written site instruction, the Foreman will return to the site office to write out the instruction at an opportune time such as lunchtime or the end of the working day.

Another indication of the importance of information communication through informal or casual conversation is illustrated by the activity of Foreman 2 selling cheap drinks from the site office. The Subcontractors would come from the work areas during the day to buy a drink. The interaction was then used by this Foreman to strike up an informal conversation from which he could both assess how work was proceeding and pass on information about the project. He notes:

> *I sell cans of drink for a dollar, I don't make money...they have to come to me...every person who wants a drink, which is 90% of the people on site, has to walk past me to get it. At that point I'm not talking to them about what they're going to get with that can of drink, I'm asking them how you going, getting an update on what they're doing and at that point and have you got the latest drawings.* (Foreman 2)

Issues associated with decision making centre on the ability to access appropriate and up to date information. To overcome issues of information isolation at the point of work, the site workers make use of face to face meetings. The Project Manager noted that formal meetings were organised with site workers, including Subcontractors and Consultants such as the Architect.

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A major formal site coordination meeting enables the transfer of information. These meetings are usually held in the site office, although they often incorporate a walk around the construction site. The site coordination meetings are usually held on a weekly basis and involve all the stakeholders (client representatives, Head Contractor staff, Consultants and Subcontractor representatives) allowing information to be shared by all. By means of the site meeting, the workers on site are kept up to date with information.

If an urgent or substantial issue arises, another site meeting is arranged which all concerned participants attend. Minutes of the meeting are kept, noting the points needing action by various participants; these are followed up at the next meeting. With respect to the site coordination meetings, the Project Manager noted that:

> *A lot of the architects don't like updating their drawings; they issue file notes and it's up to the builder to coordinate. In most cases if there is a file note we try to issue it through the coordination meeting so that everyone gets a chance have a look at it and give their feedback. That's our main way of coordinating. A lot of the subcontractors on site are here to do their work; they're not here to think. It's their bosses in the office that try to coordinate and think and they come to the coordination meeting and then go out and organise their guys and hopefully give them the up-to-date information.*

'Toolbox talks' are organised meetings concerned with specific aspects of a project which are discussed by the participants in a specific work area. These discussions are usually held around the site work areas and involve the Foreman, Leading Hand and Subcontractors working in a particular area.

The use of mobile phones and 'walkie talkies' facilitate collaboration between site workers and are a major element in the information system of the mobile Construction Site Worker, as noted by all the site staff interviewed (see Table 6.4

below). The use of the mobile phone allowed indirect access to information stored in the office by calling the office from the point of work to ask for details from site staff in the office, as well as enabling contact with off-site Collaborators such as Consultants.

Site Staff	Comment on information and mobile phones
Leading Hand	*Mobile phones make a big difference as you can get an answer straight away*
Foreman 1	*Things to move a lot faster. Using a mobile you get things done then rather than years ago you would write things down and come back into the office to call them from there, possibly an hour or two hour later.*
Foreman 2	*Normally I just take myself and my mobile [phone] out to site...* [Mobile phones are useful] *if you need to find something out or if you need a second opinion.*
Project Manager	*Mobile phones are great for emergency situations where valuable time is saved; instead of running out to the shed you've got a phone handy, and it's critical you get the response.*

Table 6.4: Mobile phones on construction sites

6.4.4 The Environmental Context

Construction Site 1 is a controlled environment in that the work area and site office are enclosed by a security fence and only personnel directly involved in work are allowed on to the site.

As mentioned, the site office is the physical 'hub' of information on a construction site, and where possible, the Project Manager and Foremen return to the site office before making a decision. Foreman 1 noted:

Plans and documentation are kept in the site office. In the site office, you got your plan bench and mostly I keep my architectural and structural on the bench all the time and on the plan rack to the side there, you got all the other plans there...I come back in and check things. (Foreman 1)

The site coordination meetings and the formal notification of site instructions both take place at the site office.

The decision making on this construction project was subject to a dynamic environment. The construction work was also subject to a tight program and changes caused delays. Foreman 1 noted:

If we're half way through the structural steel and they want to make a change to something then obviously there's going to be delays for those guys to make the change and then subsequently delays for everyone that follows. (Foreman 1)

Both Foremen noted that decisions had to be made on the spot. Foreman 2 said:

Unfortunately you've got to have good reactive skills because no matter how much planning you can do you still have the weather, people don't turn up and it's a deck of cards, it dominos and it can have an effect on other aspects of the building. (Foreman 2)

The condition under which site workers operate means that many decisions are made on the job without returning to the office. Experience was acknowledged as an important Tool used to make decisions when there is a lack of information, such as

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when plans are not available at the work site. The ability to foresee and resolve issues on site is dependent on the abilities and experience of the Foreman. Foreman 1 noted that he relies on *memory of details while walking around site* in his decision making. Foreman 2 noted that much of his work, and his approach to work, is based on his experience, explaining the construction company hired him for this experience.

6.5 Findings - Construction Site 2 (Site 2)

The focus of the second construction site (Site 2) case study was a project that includes a 22 storey office tower, an underground car park and retail podium levels in Sydney, Australia. At the time of the case study interviews, the estimated cost of construction was approximately AUD $82 million and the estimated construction time frame was approximately 18 months.

The footprint area of the construction work occupied an entire city block, which resulted in the site office being located several storeys up in an office block adjacent to the site. To access the site from the site office, personnel had to take a lift to the lower-ground floor and walk through a loading dock, crossing a road before entering the site. A traffic controller was required to ensure the safe movement of personnel across the street because of traffic. To access the construction work areas, a hoist was provided for personnel and materials. At the time of the interviews, the work was being carried out on several floors, from the basement to the 14th level.

The movement of site staff to and from the site office and the work areas was time consuming. Although two hoists were used on this project, they were often busy moving materials which further impeded access to the work areas.

The site personnel on this project differ substantially to those on the smaller construction site case study. The difference is not only in the number of staff but also in the delegation of responsibility.

On this project, the work is broken up into activities which are assigned to particular Foreman and Site Engineers to supervise. Some of these construction activities are the structure, the services, the facade and the finishes. Within each of these groupings are many work areas to which several workers are assigned. Throughout the day these workers are generally required to work in a mobile sense, moving

around the expansive work area and often between different work areas. These workers include:

- Site engineers
- Site manager
- Foreman
- Leading hands
- Day labour
- Subcontractors
- Consultants

Some of these workers are based on the construction site, spending the large majority of their time there. Others are based in the site office and spend part of their typical working day there and part on site, although the time on site is proportionally less than those that are site based. The final group is made up of those who spend very little time on site and only come onto the project for specific meetings. This group mainly consists of Consultants, such as architects and engineers, but also includes the client and Subcontractors' head office works supervisors or project managers. See Figure 6.1 for a model of where work is conducted on Site 2.

Site Engineers spend the majority of their work
time in the site office.

Foreman spend the majority of their work day
on site

Site Office Work

Site Manager

Site Engineer

Foreman

Off Site Office Work

Client   Engineers

Architect   Project Manager

On Site Work

Leading Hand   Labourers

On Site Subcontractors – Plumber, Form-worker, Concreter etc

Consultants
operate from
their consulting
offices and
come to site
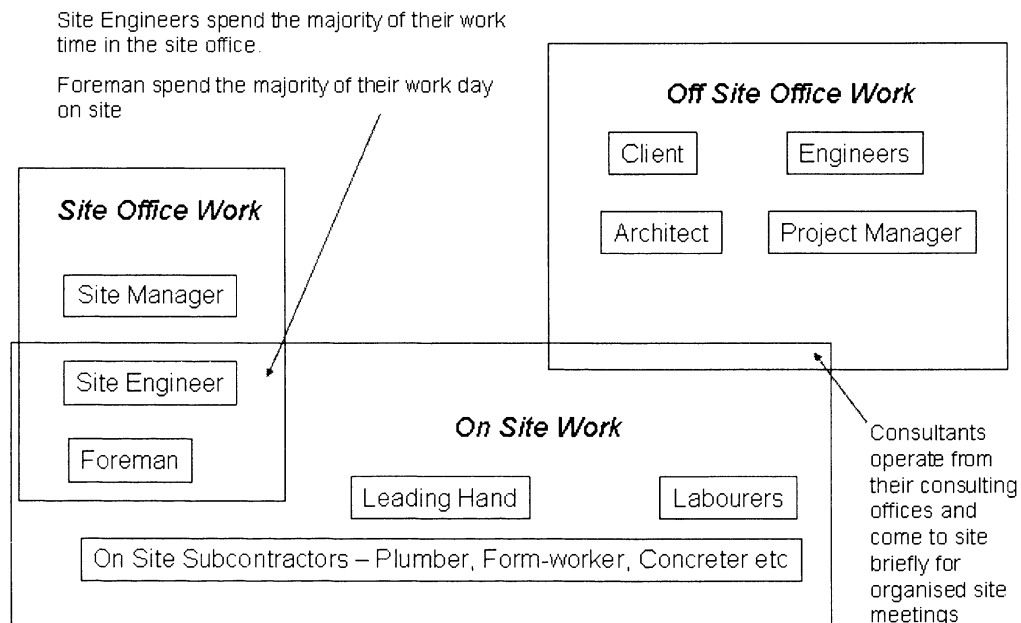briefly for
organised site
meetings

Figure 6.1: Model of where work is conducted by mobile workers on Site 2.

At the time of interviewing site staff, the construction of the basement structure was complete. Typical of most high-rise construction projects using a reinforced concrete frame and post-tensioned beams and floors, the lift core is constructed before the floors of the building are formed up and the concrete poured. Safety standards do not allow the height of the construction work on the structural lift core to be more than four storeys above the completed floors. Once the structure concrete has cured and the post tensioning is complete, the cladding is attached to the structure and the fit-out of floors can proceed. At the time of this research, work was being carried out in several different locations of the project.

In the case study, a Foreman was appointed to an activity with a corresponding Site Engineer. Each activity had work areas supervised by the various Foremen, who

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were often assisted by a Leading Hand. In the case study, several Foreman and Site Engineers were working on the project concurrently.

6.5.1 Construction Site Workers and Mobile Work – Site 2

The role of the Leading Hand on this site was primarily to supervise the on-site Subcontractors, and he rarely left the work area. The Leading Hand indicated that he also participated as a decision maker on site.

> *Typically my job entails overlooking the Subcontractors. They know what they've got to do but if they have any problems with whatever they come to me... So I resolve the issue for them.* (Leading Hand)

Although the Leading Hand does make small decisions, it is rare for one to make a decision without taking directions from a Foreman.

> *If I can't solve it then I go to my superior, whether that being the Foreman or Head Foreman or an engineer and get clarification on the matter...* [if it's a major decision] *I'm not sure enough yet to go and make the decision in case it might be the wrong one sort of thing.* (Leading Hand)

The role of the Leading Hand is as a conduit to the Foreman, bringing to his attention issues which need to be resolved and only making a decision themselves when the matter is relatively trivial.

The role of the Foreman on this project was to oversee the work, ensuring that the work was carried out by site workers (both those employed by the Head Contractor as well as those employed as Subcontractors) in accordance with the plans, in a safe, efficient manner, as shown in Table 6.5 below.

Foreman	Description of work role
Foreman 1	*I mainly coordinate the Subcontractors and get them to the work areas I need program-wise*
Foreman 2	*My job as the finishes Foreman is to ensure the Subcontractor does the job right from the start to finish*
Foreman 3 - Head Foreman	*On a day-to-day basis, I start off early in the morning. Get to the office and get some paperwork done, fill out some diaries, try to plan the day's activities depending on the weather. Depending what day it is I might have a meeting. Like Wednesdays we have the safety walk, project reviews, subcontractors' meetings...While I am on site, I generally look at safety. Safety is my main responsibility as well as quality, program etc. But I lean more towards safety.*
Construction Manager	*A Foreman's role is to just manage the on-site works and manage the people on site and how the work is completed on site.*

Table 6.5: Work of Foremen on Site 2

In order to carry out their duties effectively, it is important that the Foreman remains at the point of work to provide guidance to workers (both day labour and Subcontractors), to give instructions and deal with any queries. The Head Foreman noted that by walking around the site, he will hear about problems or things that are not going well through the Subcontractors. Foremen spent the majority of their day at the site work areas and only moved back to the site office as the need arose to get information. Foreman 2 noted:

> *Foremen need to be on site, what are they doing in the office? Alright, sometimes you come up for a drink or coffee, but you come in the office for a reason. The Foreman should only be in the office to look at the drawings, check up on drawings and clarify issues then discuss with the subcontractor – hydraulic, fire or whatever.* (Foreman 2)

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Foremen work directly with an allocated Site Engineer, forming a team responsible for the delivery of a specified component of the construction.

> *Each work area, such as the structure has an Engineer and a Foreman working on it.* (Foreman 3)

Site Engineers described their role on this construction project as the manager of a specific area of allocated works, ensuring the completion of works within time and budget. For example, Site Engineer 1 managed the construction of the structure and Site Engineer 3 managed the services.

> *Each Site Engineer is given a particular area that they are responsible to complete within cost and time.* (Site Engineer 1)

Foreman 1 noted that the Site Engineer provided them with vital information as they required it, *steering them in the right direction* (Foreman 1).

The Site Engineers agreed that they spend approximately 40 % of their time at the construction work area (monitoring work) and the rest (60%) of the time in the site office.
The Site Engineer provides support to the Foreman. For example, if the Foreman identifies an issue which could result in a cost variation, then the Foreman will contact their counterpart Site Engineer. The job of the Site Engineer is to liaise with the client's representatives, such as the Project Manager or Architect, for a resolution. Foreman 3 noted:

> *The engineers are in the office and have the facilities to get information quicker. We tend to find the Engineer will chase up information whether it is a change in the drawings or a site instruction.* (Foreman 3)

The Foreman is required to make on the spot decisions while on-site, reacting to ever-changing work conditions. Foreman 3 noted:

It's hard to plan my day...I try to follow a bit of a plan but it gets a bit all over the place and that's like most Foremen. (Foreman 3)

Some of the issues presented by the Foreman included:

- Incorrect or inaccurate details in the plan drawings;
- Slow approval of work from the client or client's representative, leading to delays in obtaining details from Consultants;
- Weather conditions. Weather is a limiting factor in construction project work; for example, the pouring of concrete can be delayed due to rain, and if there are high winds then the crane which is used to transport materials to the work area cannot be used;
- Delay in the delivery of materials;
- Clashes between different Subcontractors for the use of resources such as the crane;
- Inadequate Subcontractor staff on site to do the work.

6.5.2 Tools – Site 2

On this construction project, several tools were used by the Foremen to aid their decision making. The explicit formal Tools identified by the construction site personnel interviewed included:

- Plans, sketches and other project specific paper-based documents such as specifications. Plans are the main information Tool identified by the Foreman at the work site area.

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- Digital information from computers in the site office such as emails; information from the client's representative such as work specifications; and RFI's from design Consultants. This support was not directly available at the work site area, when the MKW was working in a mobile manner.
- Site diary: this is a record what has happened throughout each day. Site diaries are reviewed by senior staff such as the Head Foreman and Construction Manager in the review of work, such as in the case of a dispute. Site diaries are kept by all the interviewed Foremen although, as with the digital information, this information source was accessed in the site office and not directly available at the site work area.

Plans are the main information source (Tool) identified by the Foreman to assist them in decision making at the site work area.

Plans

As noted above, plans are the main Tool used by Foremen, Subcontractors and Site Engineers to assist in the making of a decision while working on-site in a mobile manner. The plans are associated with a particular project and will illustrate the specific details of what is to be constructed. Aesthetic and technical information regarding a building is maintained on plans and provides workers with a concept of the requirements of the client. Foreman noted the importance of Plans, and in particular the information that is available (see Table 6.6 below).

Site Staff	Commentary on Plans
Foreman 1	*To find information I go back to the drawings...they give you the specifications and you'll take the important bits of information that you need related to that workplace.*
Foreman 2	*I always go by the drawings. Because if the drawing's wrong then I'm wrong and in this case no one can blame me because it's all on paper. I carry my drawings in my hands, in my folder with me. So if you ask me a question then I can open my folder, check and say, this bulkhead is in the wrong position, this pipe is in the wrong position, this wall is in the wrong position – check up and measure*
Foreman 3	*It's the drawings* [plans] *that you need to have on site* [to make decisions] *Every Foreman is different and some are better at making decisions than others, but I think that the Foreman should have drawings on site and decisions should be made with the drawings, working through the relevant drawings.*

Table 6.6: Foremen and decision making – the importance of plans

On this construction project, plans were distributed and stored in an electronic format; they were sent via email and in-house management systems and stored on the company server which was accessed by personnel from their computers. Each of the Site Engineers and Foremen had a computer terminal at their site office desk. Although they are disseminated to all project stakeholders in digital format, the Foreman mostly use the plans in paper form.

As noted, plans are referred to by Foremen when making a decision. The A1 size plans were kept in hard copy on the plan bench in the site office. On this project, a full set of A3 size plans, which were reduced copies of relevant drawings for a particular work area, were issued and kept in storage boxes for use by the Foremen.

The Foremen started their working day in the site office, going over plans and noting details, before going on site.

Despite the access to the A3 size plans on the site, relying on these plans can be problematic. Site Engineer 1 noted that plans get misplaced or damaged. Paper-based Tools such as the plans and site diaries kept in the construction work area are subject to *grubby conditions* (Leading Hand) which reduces their functionality.

The Foremen were not able to carry all the plans with them as they moved around the construction site because of the large number of drawings associated with the project. Foreman 2 noted that he would need a filing cabinet on his back to carry all the plans; however, he took copies with him of the relevant plans for the work area he was to visit during the day. The plans were copied according to the anticipated work in his supervision areas.

> *I carry all the plans for the floors that I am doing. At the moment I am doing the basement, 1, 2, and 3, the lower ground. In this case, I carry all those drawings for those areas, so if someone asks me a question about services or whatever I can answer them.* (Foreman 2)

Foreman 2 carried the relevant plan copies to ensure that work being undertaken by the Subcontractors was being done to specifications; however, this involves pre-determination by the Foreman of which plans he will need. Foreman 2 admitted that in the past he has had to return to the office when he did not correctly anticipate what work was being done and thus did not have the required plans.

As noted in Construction Case Study 1, 'versioning' is a term related to the update of plans during a construction project to reflect changes and add information. In many instances, not all the detail is available when the plans are first produced. It is also often the case that problems arise during the construction of the project.

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Plans are distributed using an online system. All the latest plans are posted on the server and made available to the Subcontractors and site staff. When a plan is updated, an email is sent to Subcontractors, which ensures that they have the latest plans to work with. However Foreman 2 noted:

> *Whenever a new version is updated, it is issued to everyone the same day. The Subcontractor had this Foreman and he never checked his drawings. We gave him the first drawing and he was always using that first drawing.* (Foreman 2)

To overcome versioning issues, a process of handing printed drawings to the Subcontractors' site staff was implemented by the Site Foremen. They would print the plans and take them directly to the work area, where they would review the changes face-to-face. The Head Contractor undertook audits of plans held by Subcontractors every few weeks to ensure they had the correct version.

In a similar manner, consulting Architects noted that they will follow up significant changes with the Head Contractor. Although the responsibility for keeping the drawings up to date, and conveying this information to site workers, does not fall upon the Consultants, they tend to follow up with a phone call or at weekly meetings.

Plans often have mistakes or do not have all the detail necessary to carry out the work. Foreman 2 noted the deficiencies of plans:

> *There's a lot of frustration in it because when we get the information from the engineers to us, we decipher the best way to attack it. Nine times out of ten you will go there to attack it you'll get 85% of the work started and then there'll be a mistake in the design or whatever and you'll have to go back or stop.* (Foreman 2)

Subcontractors were also issued updated versions of plans using email; however, they did not like the electronic issuing of plans as they described a tendency for the Head Contractor to issue all plans to all Subcontractors, even the irrelevant ones, such as giving the bricklaying contractors the landscape plans. This creates more work for the Subcontractor and transfers responsibility for the detail of the trade work onto the Subcontractor.

> *From personal experience, it's supposed to be a better system but the problem is that it has created more work for us because the builder has found a new medium where he can pass on to the Subcontractor and make him more responsible to check any drawings that come straight from the consultants rather than the builder physically coordinating all this prior to issuing a marked copy.* (Subcontractor 2)

6.5.3 Collaborators and Decision Making

The Foremen's Collaborators on this construction site included the Leading Hand and Site Engineer and although they worked for another organisation, the Subcontractors formed an important part of this group. These Collaborators provided support for decision making by the Foreman, with the Leading Hand acting as a monitor of work and bringing issues to the attention of the Foreman. The Site Engineer acted as a medium between the Consultants, such as Architects and Engineers, the client and the Foreman.

The Foreman will take advantage of Subcontractors' specialist knowledge to assist in their decisions. Because these workers are in the work locality being scrutinised, they are able to contribute in a 'just in time' manner, having assessed the situation first hand (see Table 6.7 below).

Foreman	Commentary of Collaboration with Subcontractors
Foreman 1	*We couldn't do the job without them...*
Foreman 2	*It's important to have a good Subcontractor on the job. If he does a good job, then you've done a good job... A good Subcontractor is the best. If the Subcontractor is good, you are good. If the Subcontractor has good supervising people you only have to come in and look; there is nothing to do. You have to check up on the work and check if things are correct or not, but if they are not there then I have to do everything...Sometimes they've got good ideas, easy way to fix something.* (Foreman 2)
Foreman 3	*If a bond is formed with the Subcontractors that are working directly for you, you can get a lot more out of them when you need to. Such as if you had to ask a steel fixer to work back because you got to do a pour, but if you have no relationship or you hate each other, then they'll say why should I help you out.* (Foreman 3)

Table 6.7: Foremen and collaboration

The Foremen also interacted on occasion with the design Consultants, such as the Architect. The Architects noted that, as part of their work, they would come to the site to carry out an inspection of the works. In relation to issues that affect the design, such as buildability, they would always take the advice of the Foreman into account, considering them to be the 'experts' in the field.

Developing a level of trust plays an important part in the facilitation of the relationship between the Foreman and the Subcontractors or Consultants. Trust allows the Foremen and Subcontractors to make informal agreements with respect to work. Foreman 3 noted that instead of having to issue a written site instruction to a Subcontractor to do work, as legally required, the Subcontractor will do the work knowing that the Foreman will organise the instruction with the Site Engineer at the

end of the working day. Foreman 2 commented on the importance of a good, trusting relationship with both Subcontractors and Consultants, as shown in Table 6.8.

Subcontractor relationship	*That's all involved in relationships. If you have a good relationship with the people that you work with, nine times out of ten they'll do what you ask them to do.*
Consultant relationship	*You normally form a relationship with these people early in the piece. So they know who you are and you can ring them and get information out of them pretty easily.*

Table 6.8: Foreman 2 and collaboration

Trust is also developed over time. Foreman 2 noted that he had previously worked with some Subcontractors and this familiarity meant that he knew the level of quality that they would produce. When working with less well-known Subcontractors, he would be forced to continually check their work.

Foreman 3 informally used the site induction process to get to know the Subcontractor and his workers. During the induction, the Foreman tries to develop a rapport with the Subcontractor and his workers, observing:

Over the years I've worked out how to get the best out of people. People are different and some might need to be yelled at to be dealt with firmly and yet others you need to take the soft approach. You learn how people react and learn to get the best out of them. (Foreman 3)

Note on Occupational Health and Safety legislation
All workers in the State of NSW, Australia, must attend a site induction when coming onto a site. The site induction is a legal Occupational Health and Safety requirement at which the Head Contractor's staff (usually the

Leading Hand or Foreman) convey instructions on the conduct of 'safe work' practices, such as the safety procedures on site and location of amenities such as toilets and the first aid box. Prior to arriving on site, all workers must obtain a construction 'green card' as part of the general induction course for Occupational Health and Safety. During the site induction, the Foreman gauges the attitude of the Subcontractor and his workers.

The dissemination of information and collaboration is facilitated through formal meetings and the informal discussions that take place at the site work area. The site meeting is one of the main ways of disseminating information. The Construction Manager stated:

> *We have team meetings once a week, every week, and they can raise issues in that...we have a weekly Subcontractor coordination meeting and all the Foreman are together trying to work out their week's worth of work and coordinate with the trades. All the main Subbies go along to the meeting and all the Site Engineers as well. They all attend.* (Construction Manager)

Hard copy forms of communication such as site instructions are a requirement; however Foreman 3 noted that 90% of his communication with Construction Site Workers is done verbally.

Mobile phones and handheld transceivers, or 'walkie-talkies', are important Tools in facilitating collaboration through verbal communication. Foreman and Site Engineers carry walkie-talkies, which provide better, more consistent coverage around the construction site than mobile phones which are subject to poor coverage areas, such as the basement of buildings. This ensures ongoing contact with the site office for the Forement.

Collaboration which assists with work not only involved interaction between other groups, other than contact with the Foremen. For example, the Leading Hand noted:

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I always got help. I got the Leading Hand for the Subcontractor, he's a smart bloke. Like this is only the first one that I've done and he's been doing it for a long time, so between me, him and the Foreman we can always figure out a solution and I'm never at a complete loss on how to do something. I can always ask...It can get frustrating, the Foreman may be busy doing something and you want them to come up and give you a hand but sometimes you just have to wait...It's always resolved in a day and you can always find some other work to do in the mean time. (Leading Hand)

6.5.4 Environmental Conditions on Construction Site 2

This construction site (2) has a controlled environment. Both the site office and the construction work area are isolated from the general public. The construction work site is separated by hoarding with access gates manned by security officers. The office has a reception, and visitors are required to sign in and out.

The mobile workers' environment has two clear influences upon their Activity: the work that is done and the way it is carried out.

Firstly, the dynamic nature of the environment impacts directly on site personnel and the decisions that are made. Control of work by the Head Contractor's site staff is compromised through the use of Subcontractors and material suppliers who are all independent entities. Such things as the directing Subcontractor staff or the production timing off site of prefabricated building elements, such as the curtain wall cladding, are beyond the control of the Head Contractor. On-the-run decisions to adapt to unanticipated change is common on construction sites, and some changes will have 'knock on' effects, which can equate to an escalation of problems.

An example of the changing environment and its effect on the decision making activity can be observed through the allocated use of the tower crane for materials handling. The ability of the Subcontractors to get their work done quickly and efficiently is partly dependent on the steady flow of materials. Due to storage limitations on-site, the materials for the various trades are delivered and moved directly to the work face at which it is required. Two main transportation systems are used on Site 2: the crane, and two man-material hoists. Lifting heavy or large material loads is handled by the crane, and issues arise when the various Subcontractors, who are independent of the Head Contractor, clash for the use of the crane. Site Engineer 1 noted this problem.

> *The others think, they coordinate the trades, for example, crane lifts, if there's a block layer who wants to lift this, the formworker wants to lift their timber, the reinforcing guys want to lift their steel, so who goes first? So he* [the Foreman] *will look at the program, looking at the area, I need the reinforcing now, I'll lift the reinforcing first, whoever come first* [in the program] *they will prioritise. They can make decisions, sometimes they don't even have to look at the drawings. If the blocklayer comes and says 'mate I got ten blokes, I need these blocks now, you promised me, I booked it in, and now you're not going to let me crane it?' Things like that, it's pretty easy to make a decision on the spot. OK you booked it, you got ten blokes sitting there. The formworker will jump up and down on the spot because he needs timber to form and they say 'hang on you said we could lift at 12 o'clock' but sometimes the truck comes a little bit early, what can you do?*

Secondly, workers on site are subject to a physically challenging working environment. Until the work has progressed to an 'enclosed' state, in which the structure is erected and the cladding fixed into place, then workers on the site will be subject to an environment open to the elements.

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The physical environment plays a limiting role in terms of the Tools available to the Foremen on site. Changing weather conditions and work area development also influence the Activity of the site personnel.

The need for the Foreman to make on-the-spot decisions is a result of the tight scheduling and costing of this complex project. Foreman 3 noted that *we are like other building companies and run our jobs on a tight budget.* Many of the work practices developed, such as informal agreements between the Foreman and Subcontractors, is a direct result of the urgent nature of their work.

The tight budget has resulted in a change in the work practice of the Foreman. As noted by Foreman 1: in the past, the Foreman would carry a site instruction book and issue instructions to the Subcontractors directly. Due to the tight budgets, the Foreman had issued site instructions to Subcontractors which allowed Subcontractors to claim costs; however, these were not honoured by management. The Foreman did not believe that this was fair and now refused to issue the instructions. This is left to the Site Engineers.

6.6 Information Sources and Access for the MKW: Reviewing the Construction Industry Case Study

Several Construction Site Workers were identified as decision makers who worked in a mobile manner, such as the Leading Hand, Foreman, Site Engineer and other design Consultants, such as the Architect. During the interviews and collection of data, it became apparent that the Foremen were associated with most of the decision making at the site work area and consequently these workers became the main subject of interest.

Making decisions at the site work area is the responsibility of the works supervisor, and in the case of the construction site this falls upon the Foreman. Although the duties of the Foreman varied between the two construction sites, a commonality was that the Foreman was the overseer of work, maintaining the time, cost and quality of what was being built. On Site 1, the Foreman was required to carry out the documentation work for the management of the project, whereas on the larger project, Site 2, the duties of the Foreman were to specifically oversee the construction works and the majority of the documentation management was done by the Site Engineers. The main decision making MKW in the construction case study is the Foreman.

6.6.1 Foreman and Information Tools

The site office and information

On both construction sites, all documentation to administer the specific construction project and support decisions, whether digital or paper-based, is stored and accessed from the established site office. Plans, specifications, contracts, and correspondence with Consultants such as requests for information (RFI), together with records of

work completed such as the Foreman's site diary, are all important references used in the organisation and production process of a construction project.

The Foremen on both construction sites accessed digital information when they were in their site offices. The Foreman on Site 2 spent less of their working day in the site office; however, they acknowledged that when they did return to the office, they spend time on their computers. Digital information was accessed via their proprietary project management systems and the interaction with the computer also enabled them to use email for formal correspondence with Collaborators.

On Site 2, Foreman 3 noted that he did not use a computer in his work; he did not have a computer at his desk and used the Site Foreman he was working with to undertake all work associated with digital information. The Site Foreman accessed information on his computer and passed it on verbally or in printed form. Formal communication with project Collaborators such as Subcontractors and design Consultants was undertaken in a similar manner with, in this case, the Site Engineer acting as the conduit.

Where issues arose regarding construction and a decision was required, the site staff would delay decisions as far as possible in order to return to the site office and consult the stored information. The Foremen have access at the site office to both Tools and Collaborators; the Foreman on Site 1 consulted the Project Manager, and on Site 2 the Foremen consulted with other Foremen, Site Engineers, the Contract Administrator and Site Manager.

Plans

The use of plans on both construction sites played a major role in decision making at the site work areas; the plans were the main documents used by the Foreman while working around the site work area in a mobile manner. In both cases, the plans were distributed between organisations in digital format using email and the proprietary

document management systems of the two companies. However, while working in a mobile manner at the site work area, the Foremen used a paper form with the full sized plans on A1 size sheets.

The size of the plan that is used has been developed over time to be a prominent, useful Tool. Using A1 size plans allows detail to be easily read while allowing the overall context of the details to be clearly visible. The expectation of the information that will be included on the plans is consistent among the Foremen and other site staff.

Sketches are a form of plan that depict specific details not provided for in the main architectural or engineering design drawings. Sketches can be hand drawn by various site staff such as the Foreman or Subcontractor, or by the Architect. They are official documents and are also stored and distributed in a similar way to the plans.

On both construction sites, plans would often suffer from reliability issues because of incorrect details or issues associated with versioning. To minimise versioning issues, the construction organisations modified their work Activity.

- In both cases, the Foreman reviewed the plans in full size format at the site office plan desk at the beginning of the day. The plans were further reviewed throughout the day when the Foreman returned to the site office, for example, for morning tea or lunch.

- The plans were reproduced for use in mobile work. In the first case study the Foreman maintained a second set of plans and would take the relevant plans to the areas in which he was working. On the second site, pertinent plans were also copied and taken on site by the Foremen, and a full set of reduced (A3 size) plans were also kept in a storage box in the work area. The

preference was to view the full size (A1 size) plans, as detail was difficult to read on the reduced plans.

- A system of audit-checking Subcontractors was used to ensure the correct plan versions were being used.

- Site meetings to disseminate information and review changes were implemented. The Architects and client Project Manager noted that they would attend, along with the Foreman and relevant Subcontractors.

- The Site Engineer on Site 2 printed out new plans and documents when they were issued. He would hand these copies directly to Subcontractors in the work areas and review the changes to ensure they understood the changes. The distribution of plans and documentation on this project was done using email. The electronic distribution of plans should mean that all parties associated with the project received new or altered documents and plans instantly; however, the Foremen noted that often the Subcontractors would be using the wrong version of plans.

Despite the best efforts by the Head Contractor's site staff, the Foremen acknowledged that dealing with incorrect plans continues to occur on a regular basis. Furthermore, the plans being carried by the Foreman to the work area of the site will usually be relevant to that construction work in that area, but a complication arises in an unanticipated area of work, or an unexpected issue comes to light, the Foreman will not have the appropriate plans.

6.6.2 Foreman and Collaboration

Collaboration played an important role in decision making by the Foremen. Collaborators were found to be an important source of information and had the

potential to assist the Foremen with their decision making. The Foremen noted the ability of Subcontractors to spot problems associated with their work and to offer solutions.

Collaborators also have the potential to create frustrating information blockages, as noted by the Project Manager on Site 1 and the Site Engineer on Site 2. For example, a delayed response to a RFI by a design Consultant creates an information hole and delays in work. The benefits associated with a reliable Collaborator were recognised by the Foremen (see section 6.5.4). An existing working relationship was identified as a key to reliability. Site Engineer 1 and Foreman 2 (Site 2) noted that the organisation for which he worked maintained a list of Subcontractors. This list also had notes about previous workmanship and reliability, made by the Foremen. Using Subcontractors not previously known to them often created more work for the Foremen. Foreman 2 noted that he would be obliged to watch the Subcontractors closely, which was a distraction from other work.

The importance of the Subcontractor as a source of reliable information is such that the Foremen on both construction sites had developed informal interaction processes to develop an understanding of the Subcontracting Collaborators. The Foreman on Site 1 sold cheap drinks from the site office to enable him to discuss work informally with Subcontractors, and the Head Foreman on Site 2 administered the site inductions, during which time he monitored the Subcontractors for their reliability.

Development of good working relationships and trust also applied to Consultants. Foreman 1 on Site 2 noted that he formed a relationship with the design Consultants early, so that when he needed information he could contact them directly by phone. Going through the formal RFI process is a much longer exercise and creates delays in work. The attitude toward developing a working relationship and trust between the Head Contractor's staff and the design Consultants is supported by the Architects interviewed.

Extending the site office

The site office is the location at which all documentation, paper-based and digital, is stored and most often accessed for both case study construction projects. The client's Project Manager and Architects interviewed in this research also acted as MKWs by attending on-site meetings. In a similar manner to the MKW Foreman, all the Consultants indicated that they preferred not to make a decision on-site but to return to their office where they accessed information and colleagues to assist in the decision making.

In both the construction site studies, the site workers made use of Tools and Collaborators to bridge the physical gap between the office, or information store, and the site work area. A combination of Tools and Collaboration allowed for the office to be brought to the work site area and for the work site area to come to the office. The structure of the organisation and the Activity, or work, of the Foreman are consequences of the need for information in order to make decisions. The connection between the two work areas was facilitated by the following:

1. Use of Tools such as mobile phones and walkie talkies allowed verbal exchanges between the Foremen and other staff, such as the Site Engineer and Project Manager, operating in the site office. It also allowed direct contact between workers on site and design Consultants working from their off-site offices.

2. Regular site coordination meetings held in the site office so that details could be reviewed before going on-site. The coordination meeting is used to bring Collaborators such as Subcontractors and Foremen who are involved in the construction works to the information hub in the site office. It also enables the design Consultants to directly disseminate information to the site workers.

3. On Site 2, the Site Engineer acted as a conduit to the site office for the Foreman. When an issue arose at the site work area the Foreman would call the Site Engineer on the mobile phone or 'walkie-talkie'. The Site Engineer would go to the work area to examine the issue and then return to the office, where they would check the plans to provide information to the Foreman. The Site Engineer would also contact the design Consultants, write the RFI's to the Consultants, and write all the instructions to the Subcontractors.

4. On both construction sites the Leading Hand would act as the 'eyes and ears' of the Foreman on site. They would refer most decisions to the Foreman, only making minor decisions themselves. The Leading Hand could be compared to the Nurse in the Doctor case study, as they carry out the instructions of the Foreman, report on what has happened during the day and monitor work when the Foreman is not present.

The Foreman on Site 1 seemed to combine the roles of the Site Engineer and Foreman on the second site. The Foreman on Site 1 was required to spend more time documenting and managing the project from the office. A heavier reliance was placed on the Leading Hand as an extension of their supervision of work. To accommodate the increased dependence on the Leading Hand, a morning walk around the site was conducted with the Foreman, during which time information and work instructions were passed from the Foreman to the Leading Hand.

6.6.3 The Foreman and the Environment

In the Doctor and Reporter case studies, I propose that the Environment acts as a source of information which is used by the MKW for decision making, Much like the other sources of information, the Tools and Collaborators, the Environment

imposes a mediating effect upon an Activity and materialises in two forms, physical and social.

I further classified the Environment into two types: Controlled Environments and Open Environments. In a Controlled Environment, the MKW is able to specifically place information sources that assist in their decision making, in the form of Tools and Collaborators, in the work Environment. At the same time, they can limit or even eliminate unexpected or unwanted elements from that work Environment. In an Open Environment, the MKW has little or no control over the elements in the Environment.

Construction sites operate in a Controlled Environment. The only people that have access to the site work areas are workers directly involved in the construction work, and these workers are monitored by the Foreman (note the site induction and Foreman's diary which records Subcontractor details).

Socially, there exists a high level of urgency among all the workers. Site workers (Foreman, Site Engineers, Project Managers and Subcontractors) are clearly upset by delays caused by waiting for Consultants to return RFI's. The impact of such urgency of work manifests in the practice of proceeding with work without the consent of the design Consultants. When an issue is identified by the Foreman he will often send a solution with the RFI for approval but will commence the work using the suggested solution prior to receiving that approval.

A complication on both case study sites occurs in the ever-changing environmental conditions, such as changing weather conditions or delays in the delivery of materials. The changing environment resulted in the Foreman having to change the planned work and redirect workers.

In the construction case study, I found that the Physical Environment acted as a variable which to varying degrees complicated the work of the MKW, requiring the Foreman to make decisions.

With this being a Controlled Environment, assistance from Contributors did not materialise. A Contributor is someone who has the potential to supply information to a MKW in an opportunistic manner and who exists outside the organisation in which the MKW works.

To overcome these complications, the Foreman made use of their experience and used the
Subcontractors as a knowledge source to identify issues as well as to work out a solution.

6.7 Reviewing the MKW Model

There are consistencies with the MKW Activity Model proposed in Chapter 5 and Foremen working on construction sites in terms of accessing information sources to assist in their decision making. The consistencies are summarised in Table 6.9 below.

MKW Model Component	Findings of Foreman Activity
Information Sources	• Main information (Tool) support while at the work area on site (working as a MKW) was hard copy / paper-based plans. • Digital information (Tool) stored and accessed from computers in the site office • Collaborators including Subcontractors, Leading Hands, other Foremen, Site Engineer, Contracts Administrator, Project Manager, design Consultants such as Architects and Engineers • Information sources that the Foreman used to assist in decision making were subject to rules dictating how, what and when the source would be used. For example, although plans were the main information source it was generally accepted that they were subject to 'versioning' issues and would often be incorrect; as such, they were often used as a guide to work as opposed to a directive to be followed absolutely.
Use of the Office	• As with the Doctor and the Reporter, the Foreman uses the site office as a central store of information. • Where possible, the Foreman accessed the information in the office. This was achieved either by delaying a decision until they had returned to the office or by accessing information remotely using other personnel specifically placed to assist in gathering information;

	e.g. Site Engineer (Site 2)
Importance of Collaborators	• Collaborators at the site work area such as Subcontractors are an invaluable source of information for the Foreman. The information passed from Subcontractors is considered to be invaluable, as these workers are the experts in their field of work. • Site Engineer 1 (Site 2) suggested that the Subcontractor would not only notice potential problems, they would also propose solutions. • Many informal agreements were made between the Foreman and Subcontractors based on a level of trust and familiarity.
Immersion of a mobile assistant	• In the case of the Doctors, Nurses were used as a Collaborative Tool intentionally placed on the ward in order to maintain connection with their patients when they are attending to other duties. In a similar manner, the Foreman used the Leading Hand to provide feedback across the different site work areas. Similar to Nurses, the Leading Hand makes minor decisions and alerts the Foreman in the case of higher order issues.
Contributors and Collaborators	• The construction site is similar to the ward in that it is a controlled work area. It is possibly a more tightly controlled area in that no unauthorised personnel are allowed on to the site work area and all workers at these areas are monitored. No Contributors were identified by the Foreman at the site work areas.
Environment	• The Foreman MKW was often called upon to make on the spot decisions due to the urgency of their work. Considering this, the Environment played a role in mediating the way in which the Activity was performed.

	• A theme which became apparent with the Foreman MKW is that the Physical Environment is not necessarily an information source but acts like a variable condition which must be accounted for in an Activity (see Section 6.7.1 on emergent themes for more detail)
Reliability of information sources	• In both the Doctor and Reporter case studies, the reliability of information was considered to be important to the MKW. The same can be observed of the Foreman; for example, when the Foreman had previously worked with a particular Subcontractor and built up a certain level of trust, he noted that he knew the level of quality of workmanship he could expect. However, if the Foreman did not trust the Subcontractor he would *have to check every detail to make sure it was right* (Foreman 2, Site 2).
Experience of Foreman	• The experience of the MKW was associated with their ability to make correct decisions and was treated with a high degree of respect. On Site 2, for example, all the Foremen in the Head Contractor organisation were expected to use the proprietary project management system, which involved keeping a digital diary, formally corresponding with Consultants and Subcontractors using email and so on. Nevertheless, Foreman 2 did not make use of a computer. Although he was not the Head Foreman (which was Foreman 3), he was revered for his knowledge and consulted on the many issues on site. The respect for his abilities were valued above the organisational work practices.

Table 6.9: Consistent themes between the MKW model and Foremen

6.7.1 Emergent Themes from Construction

Rules

Rules which mediate work Activities are the result of the experience of the Subject. Training plays an important role in the development of relevant knowledge, or Rules, as training allows for the transfer of experience from one person to another (Vygotsky, 1978). Vygotsky (1978) notes that problem solving under the guidance of more capable peers is improved in this 'zone of proximal development' (Vygotsky, 1978, p.86).

Foremen benefit from both formal training as well as proximal development. Foreman 3 from construction Site 2 explained that becoming a Foreman requires formal training as an apprentice carpenter for four years. During this time, apprentices will work on a construction project and on graduation work as a carpenter. After some time working as a carpenter, that worker may be promoted to Leading Hand, and if they develop enough skills, they will again be promoted to Foreman.

The Foremen noted that they are experienced, having worked between 15 and 34 years in construction; the Leading Hands had worked a relatively shorter period of time of five and seven years. The Foreman noted that they make use of their experience to make decisions and overcome issues such as erroneous plans. Foreman 2 (Site 2) noted:

> *Most of the time I make the decisions, and when I make decisions I am prepared to take the consequences. It is due to my experience and knowledge.* (Foreman 2)

Other site personnel noted the importance of experience in decision making. Site Engineer 2 noted the role which experience plays with respect to Foremen and their decision making:

> *Most of the Foremen on this site are quite skilled because they have been in the industry for a long time...He's* [Foreman] *the best. He left school in Year 10. He worked as a carpenter and then stepped up and I think that makes him so good because he knows everything, he knows how it all works and a lot of the decisions and a lot of the information he gives you is based on experience. If I've ever got a problem, then I say, 'mate, I don't understand' he'll draw a diagram and say this is how it is...*[Foremen reach a decision based] *purely on experience. It's almost like it's second nature and I think that that is what makes a good Foreman as well...* (Site Engineer 2)

Data, Information and Knowledge

In considering the MKW and their interaction with information sources and Activity mediators, elements such as Tools tend to provide information and others such as Collaborators offer a higher level of assistance than just information.

There is a great deal of literature on the differentiation between data, information and knowledge, much of which is conflicting. For example, Blair (2002, p.1019) states that data 'are simply facts and figures that are meaningful in some way', whereas Meadow and Yuan (1997, p.701) are of the opinion that data 'usually means a set of symbols with little or no meaning to a recipient'. Pohl (2001) uses a description of the weather to differentiate between data, information and knowledge, noting that:

> Data are defined as numbers and words without relationships. The words town, dog, Tuesday, rain, inches and min, have little if any meaning without relationships.

However, linked together in a sentence such as, "On Tuesday, 8 inches of rain fell in 10 mins", these words become information. If we then add the context of a particular geographical region, pertinent historical climatic records, and some specific hydrological information relating to soil conditions and behaviour, we could perhaps infer that: "Rainfall of such magnitude is likely to cause flooding and landslides." This becomes knowledge. (Pohl, 2001, p.3)

For the purpose of this research the following distinctions between data, information and knowledge will be used:

- Data are sets of symbols which unless considered collectively have little or no meaning.

- Information, as noted by Drucker (1989) consists of data which has been organised for a practical purpose. Furthermore, data can be defined here as potential information, as noted by Meadow and Yuan (1997).

- According to Belussi and Pilotti (2002), knowledge implies the application of data and information to a framework of specific interpretation and understanding which is based on personal experience. Knowledge takes data or information, and is then applied for use by a person (Blair, 2002).

In reconsidering the original information sources which are used by the MKW for decision making (the various Tools, Collaborators and Environmental sources of information) according to these distinctions between information and knowledge, the information sources can be refined and represented as **knowledge sources** and **information sources** (see Table 6.10 below as applied to the Foreman).

Information Source	Refined Classification
Plans	Information
Documentation	Information
RFI	Information
Weather	Information
Subcontractor	Knowledge
Site Engineer	Knowledge

Table 6.10: Refined support classification for Foreman: information / knowledge source

The distinction between the knowledge source and the information source is that the knowledge source comes specifically from the Collaborators, while the Tools are information sources.

A further point to note is that the value placed on the support offered by a Knowledge Source is a higher level than that of the Information Source. For example, the plans are the main Tool used by the Foreman for decision making when working in a mobile manner. This Tool is often defective, but the deficiencies of the plans are accepted as commonplace and the inaccuracies are overcome. As Foreman 1 (Site 2) noted:

> *There's a lot of frustration in it because when we get the information from the Engineers to us, we decipher the best way to attack it. Nine times out of ten you will go there to attack it you'll get 85% of the work started and then there'll be a mistake in the design or whatever and you'll have to go back or stop...You know as good building practice, which is the right way to do it...You'll get a basic idea of how it all goes together.* (Foreman 1, Site 2)

When asked about support from Subcontractors, the Foreman all responded that when the Subcontractor was reliable and they had a good working relationship, they would make the construction work easier. They provided not just a reliable source of

labour but a source of knowledge which they could interact with to assist in decision making.

Based on the above observations it would appear that there is a distinct value to Collaboration that greatly outweighs the value of any other information source, i.e. it would appear that the value of support provided by reliable and trusted Collaborators outweighs the value of the support provided by information Tools.

6.8 The evolution of the Activity Framework: A view from the MKW

Following the model developed in Chapter 5 and taking into consideration the Foreman case study, a model which depicts information sources and interaction with the Foreman MKW in his work Activity is illustrated below (Figure 6.2)
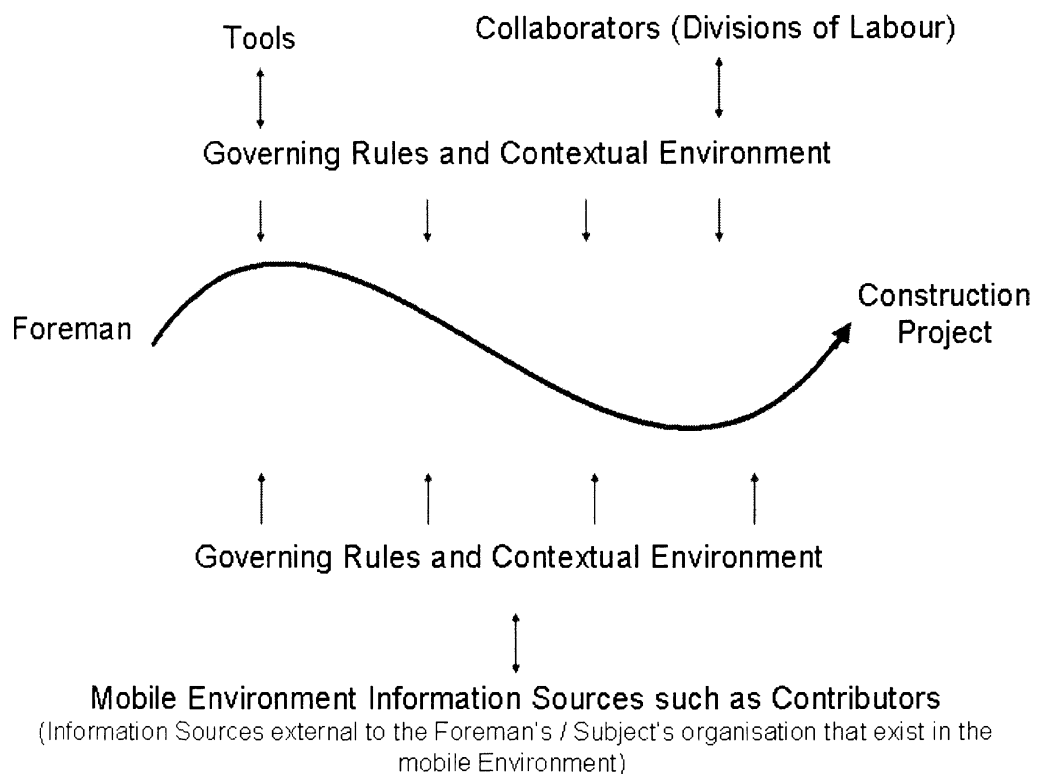
Figure 6.2: Model of information sources and interaction forces for the MKW Foreman

The model of Activity Theory proposed by Engestrom (1999) takes into account the mediation upon a Subject in an Activity which is provided by Tools, Rules and the Community of Practice. In doing an Activity, the Subject will be influenced in the way they undertake the Activity by the Tools that they use and the Rules. Tools and Rules are a reflection of the Community of Practice, as these are developed over time by the group. Collaborators come from the Community of Practice, described as the Divisions of Labour, and assist the Subject in the Activity (see Chapter 3 and Figure 6.3 below). Hasan and Gould (2001) applied Activity Theory to knowledge work and decision making to describe the mediating components of it in an Activity as Tools and Community of Practice (see Chapter 5).
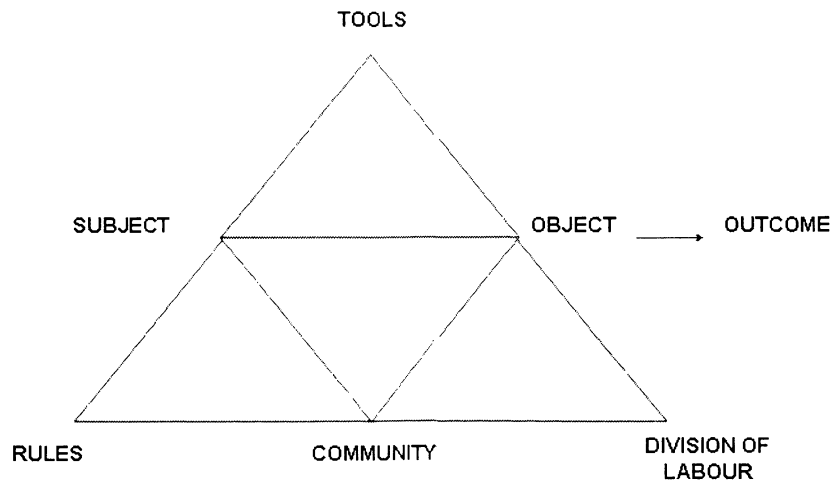
Figure 6.3: Y. Engestrom's Model of Activity (1999)

In the Chapter 5, I developed a view of the information sources and interaction for the MKW based on the model of Activity Theory. This model has since evolved based on the three case studies (Doctors, Reporters and Foremen). From this study I found that three sources of information are:

1. Tools: man-made sources of information developed over time by workers in the same field

2. Collaborators: other professionals within the organisational framework that are deliberately consulted

3. The Environment: this is acquired through observation of the environment and 'Contributors'.

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The concept of the Environment was not previously accounted for in Engestrom's model (1999) or that proposed by Hasan and Gould (2001). Of particular note is the emergence of the Contributor. As observed in Section 3.5, the Community of Practice, Divisions of Labour and Rules have been described as the organisation in which the Subject operates, with the Subject being the focus group or individual of interest (Barab et. al, 2001; Engestrom, 2008).

The Contributor emerges in the case of the MKW operating in an Open Environment. In an Open Environment, there is the possibility of interaction between the Subject and unexpected people who assist with the supply of information, such as in the case of the Reporter. In the case of a Controlled Environment (Doctor and Construction Site Worker case studies) the anomaly of the Contributor does not exist.

The three forms of information sources in the MKW cases are also described as mediators of work because they guide decisions.

The interaction with the information sources are regulated by Rules and the Contextual Environment, both physical and social, which are ever changing in the case of the MKW (see Figure 6.4 below).
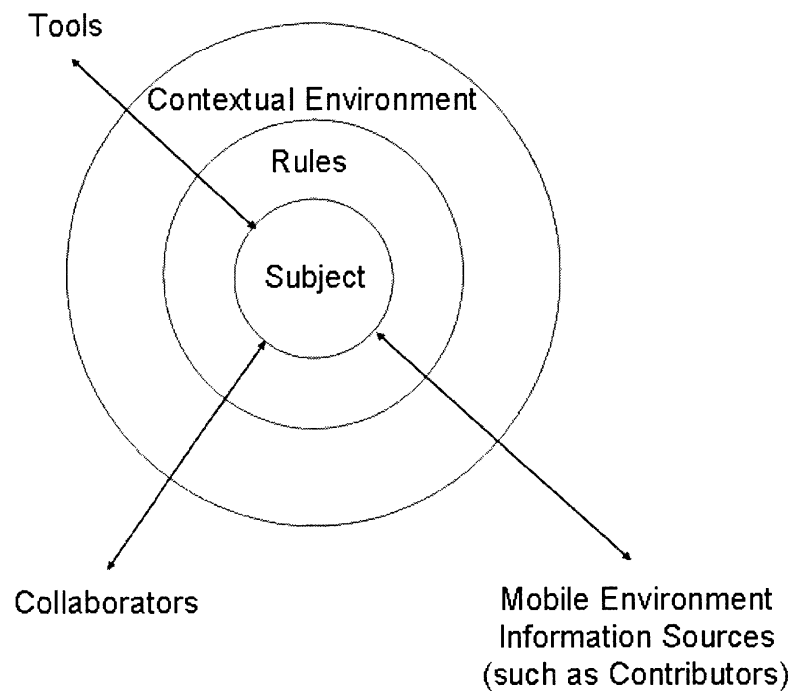
Figure 6.4: The MKW Subject and interaction with information sources

Rules govern the interaction between the Subject MKW and the mediator information sources. Rules are cultural and historical in nature in that they are developed by the Subject group based on experience.

The second governing force which has an effect on interaction with the information sources is the Physical and Social Contextual Environment. For example, if a matter is urgent and requires immediate attention, the work Activity will differ from issues that can be dealt with later. A second social condition identified in the case studies is the 'forgiveness' of the profession. An error by a Doctor can potentially be fatal, whereas an error by a Reporter has less dire consequences which are easily remedied by a retraction in the publication. The work of the Doctor demands a relatively higher level of precision and care.

The Physical Environmental Conditions and their interference with information sources such as Tools are well documented. Bowden and Thorpe (2002, p.40) note that on construction sites, information support systems Tools such as mobile devices are subject to a harsh working environment: 'The construction site is a tough environment with sunlight, rain, mud and heavy handling to contend with'.

A model describing the information system of the MKW encapsulates the sources of information as well as the interaction with these sources. This model includes the information sources (Tools and Environment), knowledge sources (Collaborators), the Rules and contextual Environment which govern interaction between the Subject (Foreman, Doctor or Reporter), the information and knowledge sources in decision making and the changing nature of Activity of the MKW (see Figure 6.5 below).
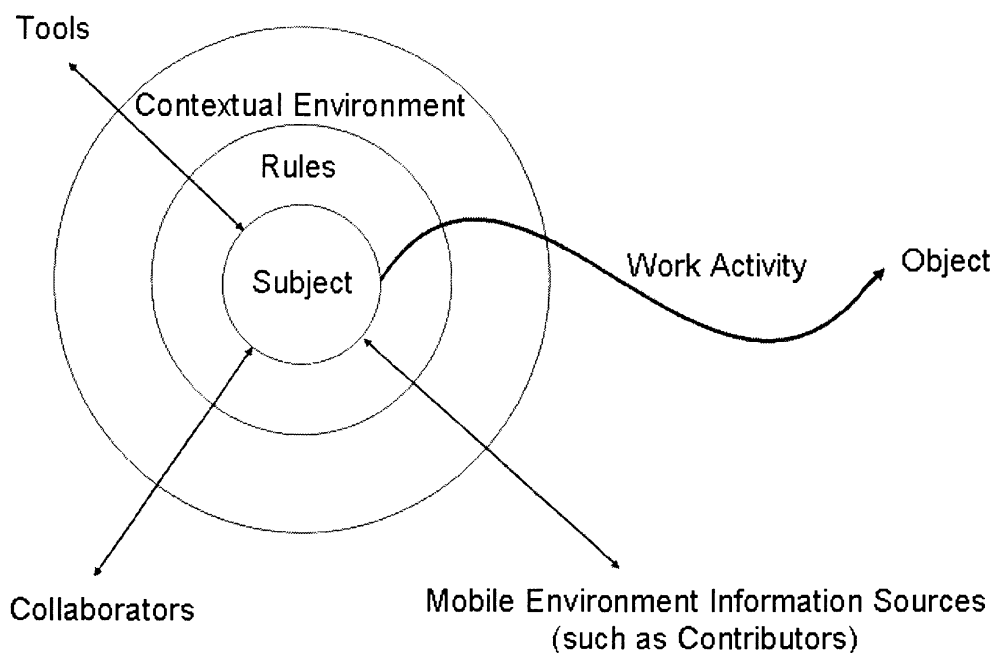
Tools

Contextual Environment

Rules

Subject

Work Activity

Object

Collaborators

Mobile Environment Information Sources
(such as Contributors)

Figure 6.5: Representation of the Activity of MKW and mediating influences of information sources

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6.9 Summary

This chapter has considered the decision making work by Construction Site Workers and in particular that of the Foreman. The case study was developed through interviews with construction workers on two different building projects, as well as interviews with Consultants such as the client side Project Manager and Architects. In analysing the findings, I found that the information sources used in decision making in this case study were relatively consistent with those of the two previous case studies concerning Doctors and Reporters.

Additional to the previous MKW model, however, were two emergent themes:

1. Rules and the Environmental Context mediate the interaction between the information sources and the Foreman (Subject)
2. The preference for Collaborators over Tools. Tools, such as plans, only provide information, whereas trusted Collaborators provide information which has been subjected to analysis (the application of the Collaborator's knowledge).

7. Summary and Conclusion

This chapter sums up the research and outlines the contributions. A critique of the weaknesses is given and the potential for future research is considered.

7.1 Beginnings of My Research

Mobility and mobile work are described in several different forms. One definition of mobile work is 'remote mobility' (Luff and Heath, 1998), which is characterised by the movement of the worker around or between different physical locations in the course of their daily work.

I define the Mobile Knowledge Worker (MKW) as a subset of the remote mobility genre; however, this group is differentiated from other mobile workers by the requirement to apply their knowledge in order to make decisions. As noted in Chapter 2, relevant information has the potential to assist in the MKW's decision making if it can be facilitated by mobile technology. However, to date the adoption and use of such technology has been limited.

Resistance to the adoption of technology is not a new phenomenon, and researchers have proposed a plethora of explanations and solutions. Technology researchers who group themselves in the Human Computer Interaction (HCI) field believe that the issue with the adoption of a new piece of technology is one of understanding the 'users'. Many technology developers, including corporations such as Nokia, spend large amounts of capital designing and developing the function and features of the technology, while others are inclined to suggest that the success or failure to adopt technology can be attributed to organisational and social factors.

Many researchers across the broad spectrum of technology, computer and information systems development such as Norman (1988), Morgan (1997), Engestrom and Nardi (1999), Isaacs and Walendowski (2002), Sellen and Harper (2002), Shneiderman (2002), Gordon and Gordon (2004), and Gebauer and Ginsburg (2009) emphasise that an important component in development is acquiring a perspective of the end user, the way work is currently done and the composition of the existing information system. Through my reflection on such literature, developing a framework which describes the information system of the MKW became the central theme of my research.

7.2 My Research

To facilitate a description of the information system used by a MKW two research questions were posed. Firstly, what are the major sources of information which comprise the MKW's information system and secondly how does the MKW's interaction with this information system affect their work?

Noting that access to information assists decision making by MKWs and that the supply of information to these workers is generated by the information system, a review of the decision making by the appropriately identified research subjects was undertaken.

The research methodology selected for my research was qualitative in nature and took the form of interpretive case studies (see Chapter 4). Activity Theory was selected as the lens of interpretation, assisting with the assessment of the information system of the MKW (see Chapter 3). As a platform for evaluating data, Activity Theory seems an appropriate choice as it takes a holistic view of interpreting work, and therefore the application of decision making in work, which includes Tools (including technology) and the Community of Practice (including Collaborators) as well as the forces which govern the work (both formal and informal Rules).

A fortuitous consequence of using Activity Theory as an interpretation tool was the contribution to the evolution of the theory from the point of view of its application to the MKW group. This contribution is summarised in 7.4 Contribution to Activity Theory.

Three MKW case studies were developed in succession. The pilot case studies were developed to gain a perspective of the MKW Activity and their decision making, and included:

1. Doctors on their ward rounds
2. Newspaper Reporters reporting in the field

The final, major case study examined Construction Site Workers. The focus of the Activity (Subject) was revealed to be the Foreman, with other workers both on and off site providing collaborative support in his decision making.

7.3 Main Findings

Decisions made by the MKW result in changes in the work Activity. The Object remains the same, but the approach to obtaining the Outcome changes. Decisions made by the MKW are supported by information. Consistent with Activity Theory and previous research by Hasan and Gould (2001), information for the MKW comes in the form of both Tools, as documents or digitally stored information, as well as Collaborators from within the Community of Practice (see Table 7.1 below).

For example, the Doctor monitors the condition of patients on the ward with the support of Tools such as electrical monitoring equipment (ECG) and Collaborators (nursing staff), the results or reports which are analysed in order to make decisions

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about the treatment for the patient, such as which drugs to administer, in what dosage and when.

MKW	Examples of Tools	Examples of Collaborators
Doctor	Case notes, ward based monitoring patient monitoring equipment, laboratory test results returned to the nursing station	Other Specialist Doctors, Laboratory Staff, Nurses
Reporter	Printed material from the office, mobile phone access facilitating contact with library and other reporting staff	Other Reporters (both within the organisation as well as Reporters from competitor publications), Editorial Staff, Copytakers
Foreman	Plans, mobile phone and walkie-talkies facilitating contact with Collaborators	Leading Hand, Site Engineer, Project Manager, Design Consultants

Table 7.1 Activity Theory and information sources for the MKW

The MKWs in the case studies all operated in a mobile manner as well as in a central office setting. The office in all cases was the central repository for information in the form of Tools, such as documents and digitally stored information, and accessibility to work colleagues or other Collaborators. Complex decisions, however, were made while the MKW was away from the central information source. Office based information in each of the MKW case studies was important and useful in decision making as part of their work Activity. The following sums up the findings:

- In each of the cases a key component of the mobile worker's work is to gather information which is only available in the field, away from his or her office. Whenever possible, decisions are delayed until the MKW returns to

the office. As noted in both Chapters 5 and 6, the MKW accesses support information in the office before making a decision.

- There is clear evidence that the MKW attempts to remain connected to the office. Doctors ring secretaries in their consulting office to access information as well as to pass on information to collaborating Doctors. Reporters develop access to information sources such as the in-house library as well as to editing services such as that offered by Copytakers, using phone contact. Foremen make use of workers such as the Site Engineer to act as an intermediary in researching or accessing information from site work areas.

- In the Controlled Environments (the hospital ward and the construction site) the MKW took advantage of strategically located satellite offices (the nursing station on the ward and toolboxes in the construction site office) from which they accessed information reproduced by the main office.

Collaborators serve as an important source of information for the MKW. The use of collaboration by the Subject MKW was found to be dependent on the level of trust that the Subject had in the Collaborator. This trust is developed over time from the experiences between the Subject MKW and potential Collaborators .

An emergent theme in all the MKW case studies is that the information provided by trusted Collaborators is preferred and held in higher regard than that provided by information Tools. I found that the Collaborator provides information which is contextual and is borne out of the Collaborator's knowledge, whereas the information Tools only provide non-contextualised information which the Subject MKW applies to their given context.

7.4 Implications for Practice

The literature review (Chapter 2) reveals the point raised by Shneiderman (2002): that developers of technology should consider what the end user would like and avoid the production of technology which may never be used. The research presented in this thesis indicates the following implications for practitioners in the areas of mobile information systems development and mobile technology development:

1. The importance of the office was highlighted by my research. Subject MKWs not only recreated forms of their office in the mobile work place but, where possible, remained in contact with the office. The systems of information access in the office are maintained.

   Keeping this in mind, practitioners in the area of mobile technology development should aim to provide for a seamless connection to the office from any location, with information being accessible from any point of work.

2. In developing technology, the Rules and Contextual Environment must be considered as mediating influences between the Subject and their information sources.

3. The information supplied by trusted Collaborators is more valuable to the MKW. The information provided by a trusted Collaborator has been subjected to contextual analysis as a result of the knowledge of the Collaborator, and is held in higher regard than the non-contextualised information available from a Tool.

   For example, Foreman 2 (Site 2) recognised that tools such as drawn plans were often incorrect and only provided a guide to the work. The work that he did was based on support from experts in the field, or Collaborators and what he 'knew was right'.

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Taking this into account, there is a pressing need for technology development which provides and maintains communication with 'trusted' Collaborators.

4. Individual knowledge of the MKW Subjects in each of the case studies was well recognised and valued by management. The individual MKW accessed information from Collaborators, Tools and Contributors and then applied his or her knowledge to make a decision.

   The prized individual knowledge of MKWs involved in this research came from formal training as well as from experience gained 'on-the-job'. The acceptance of new technology by the MKW could be improved by the implementation of training in the use of the innovation, as well as the opportunity for the Subject end users to interact with the innovation.

7.5 Contribution to Activity Theory

Activity Theory was used as a lens to assist in the interpretation of the case studies. Consistent with Activity Theory was the idea that the work Activity was mediated by information supplied by Tools, Collaborators and Rules.

Activity has previously represented as a straight line between the Subject and Object (Kaptelinin & Nardi, 2006), as shown in Figures 3.1, 3.2 and 3.3. To account for the mediation that the information sources directly had on the MKW's decision making, Activity is represented as a variable line (see Figure 7.1 below).

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Rules

↓

Tools

↓ ↓ ↓ ↓

S ⌇⌇⌇ O

↑ ↑ ↑ ↑

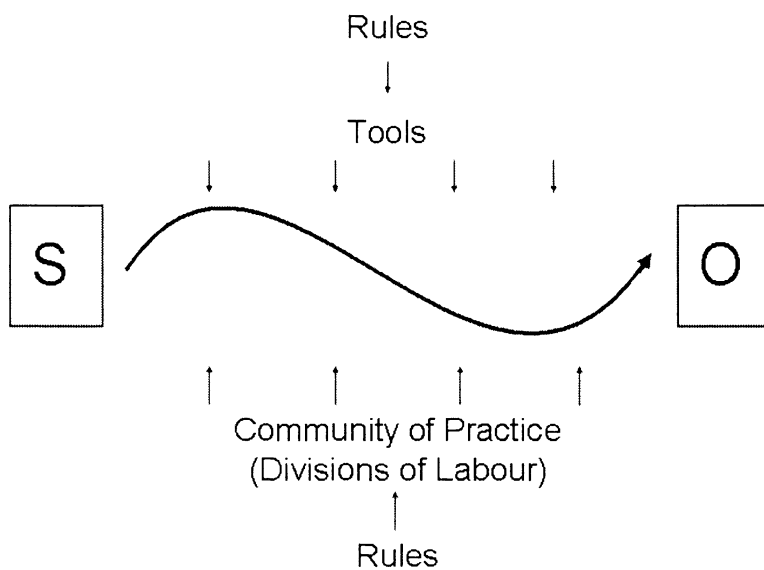Community of Practice
(Divisions of Labour)

↑

Rules

Figure 7.1: Representing mediation of information sources in Activity (replication of Figure 5.3)

Thematic analysis of the MKW case studies reveals an additional information source, which is the information provided by the Environment in which the MKW operates. A specific example of this type of information source is the Contributor.

The Contributor was identified in the Reporter and Doctor case studies. In both these work Environments, the MKW often interacts with other information sources, the Contributors, outside their organisation. The key difference between a Collaborator and a Contributor is that the Collaborator is a known quantity with defined attributes who is accounted for within the Subject's organisation.

It is important to recognise that the information provided by both Collaborators and Contributors should be treated with a level of caution in terms of reliability, although Collaborators are generally held in much higher regard than Contributors. I posit that this is due to the fact that Contributors are an unqualified entity and their ability to professionally analyse and communicate the environmental context is, therefore, questionable.

The presence of a Collaborator and Contributor varies and is dependent upon the work Environment. I classified the work Environment as being either a Controlled Environment or an Open Environment.

In the case of the Reporter, the potential for opportunistic interaction with Contributors is afforded. Contact with Collaborators in an Open Environment continued but was often maintained virtually (e.g., by using a mobile phone). In the Controlled Environment in which the Foreman operates, access to the workplace is closely managed by the Foreman. Approved participants, the Collaborators, are permitted to enter the work site, and there are no Contributors.

In a controlled environment, Collaborators such as the nurse and the Leading Hand were located at critical points to allow the Subject to monitor and maintain control across the entire work landscape. The positioning of such Collaborators in the controlled environment supports the importance of trusted collaborative information and the regard in which it is held.

The appearance of the Contributor is unique to the world of the mobile worker. The movement around different working environments supports their existence, which would explain why researchers such as Hasan and Gould (2001) would not have identified the Contributor phenomena.

My research indicates that the information sources supporting decision making for the MKW in the reviewed case study include:

1. Tools
2. Collaborators
3. Contributors

Interaction between the Subject and the above three information sources is mediated by:

1. Rules
2. Contextual Environment

Rules are well recognised by Activity Theorists (see Chapter 3). The Contextual Environment was developed to account for the variable instances of the dynamic physical and social Environment in which the MKW operates.

Researchers such as Bowden and Thorpe (2002) recognise the issues associated with the physical environment. As MKWs operate as required by their work in a mobile manner, their surroundings often change, to varying degrees. The way information is accessed is supported or disrupted depending on the situation. For example, in an Open Environment the Contributor may appear and disappear, which limits access to this information source, or in areas of poor reception, the mobile phone (Tool) which facilitates interaction with a Collaborator may be inoperable.

Socially, the Environmental Context encapsulates the social conditions under which the MKW's work Activity is undertaken. A clear example of this mediating force is the issue of Urgency (see Chapter 5) in the task being carried out. If the situation is urgent, the MKW may be forced into making an on the spot decision based on the information he or she has at hand, whereas if the situation is not urgent, the MKW can return to their office prior to making a decision.

Taking into account the original model of Activity as described by Engestrom (1999) and adapting it to account for the adaptations as described above, I arrive at a new framework of Decision Making Support for the MKW (see Figure 7.2 below).
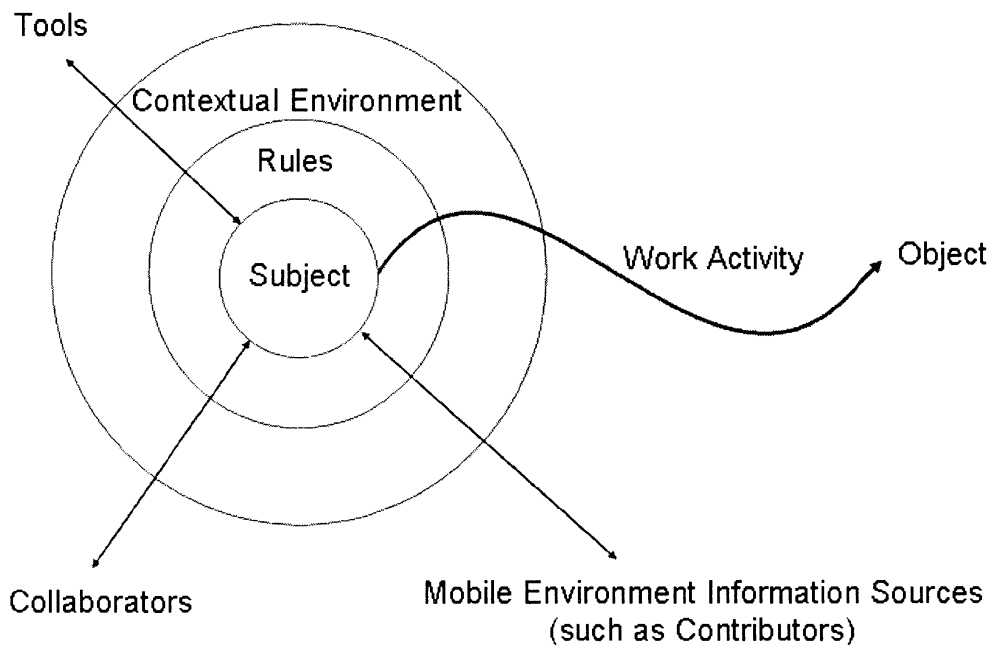
Tools

Contextual Environment

Rules

Subject

Work Activity → Object

Collaborators

Mobile Environment Information Sources
(such as Contributors)

Figure 7.2: Decision making support for the MKW (replication of Figure 6.5)

7.6 Weaknesses

The sample group data was collected using snowballing sampling methodology. It is recognised that this data gathering technique may be subject to bias, as acknowledged by Erickson (1978). The sampling is limited to the social network and contacts provided by the group of participants. To counter the issue of bias associated with snowball sampling I used two different contexts, the Reporters and the Doctors. Nevertheless, this weakness must be acknowledged.

A second possible weakness is the limited number of MKW contexts that were examined in this research, i.e. the only MKW contexts to be considered in this research were those of Doctors, Reporters and Construction Site Workers, and in the Doctors pilot case study, only a small number of Subjects were interviewed. Despite

this limitation, the model of the MKW's information access and interaction is a result not only of individual case study analysis but of across the field analysis, allowing for the identification of general themes.

A final weakness is the built in bias which is a result of my own knowledge and experience, particularly in the Construction Site Workers case study. In acknowledgment of this bias, I allowed for the initial development of themes relating to information sources and access by MKWs to be developed from two contexts with which I have less familiarity, those of Reporters and Doctors. Only after developing the initial description was the construction site context considered. As noted by Strauss and Corbin (1990), possessing background knowledge assisted me with understanding and interpreting the case studies, in particular that of the Construction Site Workers, and in reality such issues with bias cannot be avoided.

7.7 Future Research

Considering the evolved model of decision making Activity by the MKW outlined in Section 7.3, sources of information are categorised into three broad headings: Tools, Collaborators and Environmental (Contributors) sources. Interaction between the Subject and these three sources of information is mediated by Rules and the Contextual Environment.

Developers of mobile technology looking to improve the MKW's decision making capabilities should take the model of information in Figure 7.2 into account.

The Contributors are accessed opportunistically as sources of information and are only available in the Open Environment. Further, this information, although used by MKW such as the Reporters and Doctors, is viewed with a certain level of caution. Pursuing the improvement of this information source using mobile technology could prove to be fruitless.

The development of Tools, their impact on and possible benefits to the work of various MKW is another area of potential research. Enhancing access to Tools, such as the latest version of plans for the Foremen to use, around the clock access through virtual monitoring equipment for Doctors and in the field, and access to old articles from trusted publications for Reporters, could assist decision making.

Future research could consider the effect of the production and use of reliable mobile information tools on collaboration; for example, will it mean the end of informal work agreements between Collaborators and what will be the effect on trust between the MKWs and Collaborators?

Research into improving access to Collaborators and improving trust with Collaborators could provide the greatest decision assistance for the MKW. Collaborators appear to provide the information source that is most relied upon and trusted because it has been subjected to analysis by an educated cohort who is aware of the context of the work Activity.

Research could also be applied to the appropriateness of a Tool taking into consideration the Contextual Environment. For example, the Reporter would not break off an interview to consult notes or a PDA which could provide information; however, the use of a small Bluetooth ear piece, such as those used by television news Reporters, might enable information or direction to be provided unobtrusively. Finally the next generation who has grown up with pervasive mobile technologies may indeed find new and exciting ways to utilise its advantages in the work environment.

It is the intention of this Researcher to follow up the above research directions in the immediate future.

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9. Appendix

9.1 Appendix A: Ethics: Consent Authority

INDIVIDUAL CONSENT

I _____ *(participant's name)* agree to participate in the research project "Moving the centre of coordination from traditional work places to the point of work" being conducted by **Michael Er**, Faculty of Information Technology, University of Technology, Sydney, (02) 9514 8031.

I understand that the purpose of this research is to understand the possibility of moving the centre of coordination from traditional work places to the point of work through context based examination of existing work practices, perceptions and utilisation of mobile technology.

I understand that my involvement in this research project will include participation in an initial interview of approximately 60 minutes duration with the possibility of a follow-up interview of similar length. My involvement may also require the observation of my actions while undertaking work. I also understand that all interviews that I participate in will be audio recorded.

I am aware that I can contact **Michael Er** if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish and without giving a reason.

I agree that **Michael Er** has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

_____   ____/____/____
Signed by

_____   ____/____/____
Witnessed by

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer, Ms Louise Abrams (ph: 02 - 9514 1279, Louise.Abrams@uts.edu.au). Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

9.2 Appendix B: Sample Questions

Firstly explain research: Want to develop a model of how work is done at the work face of a building site in terms of decision making and inaccessibility of information.

Part 1

- Background – age / education / work experience
- What is your job (site manager / foreman / subcontractor etc) and describe how you do your work (What type of work do you do in a typical day)
- What physical documents do you use to help with your work? (Information Tools: Plans, work method statements etc)
- What is your interaction / work at the work face (what is your collaboration interaction with the foreman / leading hand)
- When / how often do you go to the site office?
- Are you isolated from information sources? How do you overcome issues associated with being mobile and isolated?
    - Describe the information disconnection (work face to information store) and ask how they make decisions with this in mind

Note: Look for informal work practices (ways of doing work) and how these informal procedures affect other informal practices and the way work is done

- How did you develop the systems / practices (did you learn this from someone else or did you develop it yourself)
- Are there any other Tools which help you with your work (decision making)
- What situations frustrate you the most with respect to decision making and information inaccessibility
- How do you (foreman / leading hand / site engineer) issue a site instruction?
- Versioning a problem?
- What is the biggest problem on site? Can you offer any possible solutions?
- Do you have enough resources on site?

Part 2

- What are some of the things that have changed over the years in terms of the way you do work?
- If not previously answered – what technology do you use at work and at home (socially or away form work)
- What (if any), mobile devices do you use (work or socially)? How have they (eg mobile phones) changed/ affected the way you do work?
- What do you think of mobile technology?
- Can you see any uses for MT in your work?
- Any issues – technical / physical as well as from the HCI (usability) and psychological – phobia?

Note: Look for hidden issues – tacit issues not necessarily obvious to the interviewee
Interviews – try to snowball interviews irrespective of which stage

9.3 Appendix C: Analysis of data: A sample report produced using NVivo

In each of the documents analysed I reviewed the interviews allocating sections of data to themes. The Search below examined the thoughts of Foreman working on Site 2 and their use of plans as an information tool. i.e Search based on node: "Plan".

Document 'Foreman 1', 7 passages, 683 characters.

Section 1.1.1, Paragraph 24, 178 characters.

9 times out of 10 you will go there to attack it you'll get 85% of the work started and then there'll be a cock-up in the design or whatever and you'll have to go back or stop.

Section 1.1.1, Paragraphs 35-36, 69 characters.

How do you find out the information then?
- Go back to the drawings.

Section 1.1.1, Paragraphs 46-47, 58 characters.

What sort of documentation do you use?
- Mostly drawings.

Section 1.1.1, Paragraphs 50-51, 78 characters.

You don't carry it with you?
- No. I'd need to carry a file cabinet on my back

Section 1.1.1, Paragraphs 53-54, 112 characters.

What do you do? Read the plans and go out on the site and do everything off the top of your head?
- That's it.

Section 1.1.1, Paragraph 57, 133 characters.

we need to probably go to the plan batch and pull the drawing out related to the area and that information should be in front of us.

Section 1.1.1, Paragraphs 59-60, 55 characters.

come back to the office to look at it.
- Yes. Correct.

Document 'Foreman 2', 9 passages, 3076 characters.

Section 1, Paragraphs 29-31, 428 characters.

What types of documentation do you use in your job as a foreman?
- As finishings foreman, I check the drawings and walk over the site and check the requirements of the job 2 weeks before the start.
- Look at the architectal drawings, services drawings, mechanical and hydraulic drawings. Spend a couple hours looking over the drawings and another couple of hours walking around and looking over the site, planning for the job.

Section 1, Paragraph 46, 227 characters.

I know all the requirements of the job because I always check the drawings before the job starts. If I have 2 or 3 drawings I check them all step by step. If the drawings are wrong, then I am wrong the details are in writing.

Section 1, Paragraph 47, 198 characters.

I check the drawings and if I find a problem, I will call the architect and tell them or call management and say this is wrong, this is wrong... It is common for dimensions, small things to be wrong.

Section 1, Paragraph 48, 381 characters.

How do you do a job if you don't know the dimensions, you need to know the details. If you're doing the ceiling you need to know dimensions, if you're going to use an angle, aluminium angle, what's going on. You need to know so you question the detail. So when I go on site I question the subcontractor asks a question I respond because I know exactly. I can't afford to not know.

Section 1, Paragraph 55, 260 characters.

I carry all the plans for the floors that I am doing. At the moment I am doing the basement, 1, 2, and 3, the lower ground. In this case I carry all those drawings for those areas, so if someone asks me a question about services or whatever I can answer them.

Section 1, Paragraphs 59-62, 175 characters.

For this example I did not have the reflection ceiling drawing with me.

So you had to get it from the office.

· Yes. Because I need to make sure he is right and I am right.

Section 1, Paragraphs 74-77, 678 characters.

Say the issue is on the critical path and you need to make the decision very quickly. Would you still need to go to the office and write the instruction?

· No. I can make a decision immediately.

· If it were my fault, then my decision would be immediate. Say with the vanity installation, they have to be checked. Because you have the joinery drawing and you have to check before they put it in. If we didn't check that then I made a mistake and have to issue a site instruction. Then I say to the site engineer to issue the instruction. Management would question me because it's my fault.

· But for me, this doesn't happen because I am always checking my plans all the time.

Section 1, Paragraphs 91-93, 380 characters.

What if your sub contractors have the wrong version?

· Whenever a new version is updated, it is issued to everyone the same day.

· The sub contractor had this foreman and he never checked his drawings. We gave him the first drawing and he was always using that first drawing. But we always check and if I find a problem then I say move that wall, that ceiling, whatever, fix it.

Section 1, Paragraph 184, 349 characters.

I always go over the drawings with the subcontractor supervisor and he can call me any time. I say just 'do that' then he does it. But if I am not sure, something is not correct, then, I go to the office and check up with my engineer or architect. They say I'm correct and then I go back to the subcontractor and I say do that, I have to be correct.

Document 'Foreman 3', 9 passages, 4016 characters.

Section 1.1.1, Paragraph 21, 132 characters.

Generally I try to divide my day half time on site and half time in the office whether it be going through drawings or safety plans.

Section 1.1.1, Paragraph 93, 449 characters.

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Each foreman is different. Someone like Foreman 2 who operates without a computer comes in every morning to study the drawings. He gets to know the drawings back to front and a lot of his decisions he makes are based on this. He will carry a set of A3 drawings around for the area he is currently working in so he can refer back to it but he has a phenomenal gift of looking at detail combined with his experience he knows all the standard details.

Section 1.1.1, Paragraph 98, 256 characters.

A foreman should have a role/folder of drawings with them that is relevant to the work area so they can be out on the job and directing work on the coalface instead of sitting in the office downloading drawings going though web project correspondence etc.

Section 1.1.1, Paragraphs 105-106, 607 characters.

What about problems with different issues of the same plan? Like version problems. You may have version 5 but now they are up to version 6 or perhaps the sub contractor has version 5 and you have version 6. There's conflict there. The version in the office may not be the version you have.
·   Look at the form-worker. He's got a concrete outline drawing. He doesn't have access to project web. How will we know he is working off he current drawing? Other than going down and physically looking at the drawing and confirming this. Ok you're working off revision G and we're up to H already, we got a problem.

Section 1.1.1, Paragraphs 112-114, 984 characters.

Any changes to detail such as drawings, plans, specifications is communicated very well amongst the team. The engineer would normally get the details first via phone call from the architect or engineer. Then an email comes through depending on the urgency of the matter. We are very good in ensuring the foreman on site gets that information as soon as the engineer receives it.
·   For people like Mark, the foreman doing the structure, and if Josh receives the detail or a drawing update he is very good at making sure Mark has it on site straight away.
·   Where the system breaks down is if someone is not at work. For instance if the engineer decides to send a revised structural layout today for the deck we are currently   working   on   right   now,   the   information   will   sit   in   the database/computer/cyberspace somewhere until josh opens his computer. Josh won't turn on his computer until Monday by which time we will probably be half through pouring the deck and by then its too late.

Section 1.1.1, Paragraphs 116-122, 607 characters.

It's too late. What do you do in that case?

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·	This would very rarely happen. Because more than one person is copied on to the change.

But just because someone is copied on a change, doesn't mean it will be done immediately.

·	I think it's a break down from the consultants/client die of things.

·	If they are issuing a drawing that is directly making a major change to what we are immediately doing on site, the client should ensure the person on the coalface has got that information.

·	If they don't get a direct response from Josh within a certain time they should then follow up with the next person.

Section 1.1.1, Paragraphs 129-130, 569 characters.

When changes were done a hardcopy, you would get the drawings and have to sign the document transmittal. That is still covering yourself. It's just done in hardcopy form.

·	If the client is going to make those type of changes at the eleventh hour, and they know where we're at on the job (they are on he job everyday, so they know what stage we are current at), it is then up to the client whether it be the engineer, the architect, hydraulic consultant or whoever it is making the change, to ensure we have received, understood and are implementing that information.

Section 1.1.1, Paragraph 138, 234 characters.

There might be 5 or 6 people working from the one drawing. The foreman of the sub contractor and his leading hand who might then give it to his carpenter. Already there are 4 people who need to be copied on the change to the drawing.

Section 1.1.1, Paragraph 225, 178 characters.

I find a lot of sub contractors want a lot of drawings in triplicate one for their office, one for their estimator to see the variations and the other to their foreman on site.