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The Role of Social Networks and Artefacts in Technology Appropriation

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Abstract

This paper examines the role of social networks and artefacts in technology appropriation in an educational environment. We use a qualitative research method to illustrate that social networks and accompanying artefacts form an integral part of the process of appropriation. Our findings suggest three ways in which people appropriate technology for successful longer-term use: 1) adapting work practices to fit the technology, 2) adapting both technology and work practices and 3) integrating technologies and redesigning work practices in work environments. Findings also suggest that, for effective use of technologies, social networks alone may not be enough in encouraging technology use. A combination of social networks and manual and automated artefacts is necessary in supporting and enabling productive technology use. Further, it's important that managers, IT professionals and trainers realize that lead users play important roles in creating new social-artefact networks and enable new and effective ways of using technology.

Keywords

Technology appropriation, technology use, social networks, artefacts, adaptation

INTRODUCTION

Information and Communication Technologies (ICT) form an integral part of the work that both individuals and groups perform in organisations. Even though the introduction and implementation of new technologies are considered to bring about positive change in organisations, the way in which users adopt and continue using a technology often turns out to be more complicated than expected. This complexity is often exacerbated by the more complex nature of applications, the higher use expectations from users to support specific work practices, and need for applications to be integrated with other tools and systems. Over the last two and a half decades, a number of studies have richly contributed to our understanding of adopting, adapting, diffusing and using technology in organisations. Examples of such theories include the Technology Acceptance Model (TAM) (Venkatesh and Davis, 2000; Venkatesh et al., 2003), Adaptive Structuration Theory (AST) (DeSanctis and Poole, 1994; Orlikowski, 2000), and the Diffusion of Innovation theory (Rogers, 1995). More recently some studies have focused on longer term use of technologies (Ciborra, 1996; Leonard-Barton, 1988; Orlikowski, 2000). In particular, the above mentioned theories have deepened our understanding of technology acceptance and adaptation when new technologies are rolled out in organisations. However, little is known about the way in which social networks and artefacts support the adoption and longer term use of technology.

Studies have shown that formal organisational structures and activities form an integral part of how people use the technology (Orlikowski, 2000). One such study indicates that IT artefact is often taken for granted and that the effect, context and other aspects surrounding the technology are often ignored (Orlikowski, 2001). Other studies have also suggested that the combined role of *informal organisational networks* such as people-to-people networks or social networks and accompanying artefacts are central to knowledge sharing activities associated with technology use (Bosua and Mendoza, 2008; Bosua and Scheepers, 2007). Most of the studies in social networks concentrate on quantitative techniques to analyse strength and density of ties in these networks. Little is known about the combined role of social and artefact networks in encouraging adaptation as a part of technology use.

In this study we define an 'artefact' as a manual and/or digital object users create and actively use in day to day work practices. It could either be the actual technology-in-use itself or a combination of the technology-in-use together with unstructured information or codified knowledge that supports technology use. Further, technology appropriation is defined as "*the way that users evaluate and adopt, adapt and integrate a technology into their everyday practices*" (Carroll et al., 2002). Our previous findings published elsewhere, has focused only on social networks in encouraging long term use of technology (Bosua and Mendoza, 2008). In this paper we extend our previous work by refining our understanding of how a combination of social networks and artefacts impact on technology use over time. We use a qualitative, exploratory study to address the following research question: *What is the role of social networks and artefacts in encouraging users to appropriate a technology over time in an educational setting?* We explore this question by first discussing theories related to technology appropriation

and social networks. We then describe the research method followed by the findings and their implications. We also give concluding remarks and implications for future research.

THEORETICAL BACKGROUND

Technology Appropriation Theories

Technology has become an integral part of work practices among individuals and the organizations as a whole. In the last few decades, information systems studies have focussed on technology acceptance, use and diffusion of innovation (Davis et al., 1989; Moore and Benbasat, 1991; Rogers, 1995; Taylor and Todd, 1995; Thompson et al., 1991; Venkatesh and Davis, 2000). The success and failure of technology adoption and acceptance has been related to how receptive users are to the technology and their intention to use the technology (DeLone and McLean, 2003). The studies have mainly concentrated on adoption decisions and acceptance in terms of use intentions, frequency of use, extent and time of use, maintaining user beliefs associated with use, feelings and attitude factors that figure largely in the success and failure to adopt technology. However, these studies have used the same set of variables to understand acceptance and continued use of a technology, assuming that once a technology is accepted initially, an individual will continue using it as a part of the adoption decision process. Also implicit in such variance approaches is an assumption that two of the key concepts, use and technology, are unchanging over time.

A few other studies have focused on a process approach to understand adaptation as a part of technology use (DeSanctis and Poole, 1994; Majchrzak et al., 2000; Tyre and Orlikowski, 1994). The studies have shown how users change their skills, beliefs, attitudes, expectations, modify their work practices (Leonard-Barton, 1988; Majchrzak et al., 2000) and sometimes re-invent the technology in unanticipated ways (Griffith, 1999; Leonard-Barton, 1988). Further research in technology appropriation by Carroll et al. (2002) focussed on both adoption and use of technology in her Model of Technology Appropriation (MTA). According to the MTA, a technology that is introduced in a work place (technology as designed) is changed over time. The technology shapes the users' practice and in turn, is shaped by users' actions. This changed technology (technology in use) is an outcome of the process of appropriation, which involves users' trialling, evaluating and adapting the technology to suit their personal needs based on their perceptions and various other influences. Thus the MTA suggests that the influences on users' actions are not static but may change over time and it includes changes both in the technology (from Technology as Designed to Technology in Use) as well as in users' actions. The MTA was developed by examining young people using mobile technologies. Despite all these theories, the lack of an increased understanding of how people engage with various technologies in their everyday practices and the evolving dynamics of changes in technology use is a theoretical concern (Orlikowski, 2000). There has been little research, into both social networking and use of artefacts in encouraging appropriation of a wide range of technologies used by different cohorts of users, over time.

Social networks and artefacts

The social nature of the adaptation process as a part of appropriation highlights the role of people-to-people or social networks (Orlikowski, 1992). Appropriation in organisations is mostly realized through technology use by individuals and teams that develop informal patterns of communication through social network structures. Most of the research in social networks concentrates on their role in the generation of social capital and the creation, sharing and transfer of knowledge (Adler and Kwon, 2002; Inkpen and Tsang, 2005; Nahapiet and Ghoshal, 1998). Other research in this realm concentrate on the role of social networks in learning and legitimate participation through Communities of Practice, developing and nurturing of trust in knowledge-sharing networks and the improvement of information flows and knowledge reuse in teams (Cross et al., 2006; Huysman and Wulf, 2006; Lave and Wenger, 1991; Newell et al., 2002; Wenger and Snyder, 2000). The common idea shared by all these research streams is the collection of nodes (or humans) and ties (or links between humans). The nodes and ties constitute a social network or collective structure that enables and facilitates the sourcing of expertise from other humans in the network through brokering and sharing activities. Social networks also enable the flow and reuse of information and knowledge through the networks ties (or between humans in the network).

Social networks have proved to be instrumental in analysing various structural qualities of nodes such as centrality of nodes and the density of ties in teams to get more insight of the various roles, groupings and sub groupings in teams. Most of the social network research have been quantitative in nature and identify key connectors (e.g. leaders, isolates, clusters and cluster members, and core and peripheral actors in teams) and patterns of communication in social networks (McPherson et al., 2001). There is a lack in a deeper, rich understanding of how social networks facilitate, enable and foster longer term use of technologies.

Studies have suggested that individuals and teams often encode and externalise individual knowledge in a codified form as an 'artefact' (Zack, 1999). Empirical work has also shown that many of the more formal artefacts capture the day-to-day shared context of teamwork which are often stored electronically in file or Email

structures on servers (Wenger, 1998). These artefacts are useful in cueing human cognition, and often replace face-to-face knowledge sharing activities in teams or networks (Bosua and Scheepers, 2007).

Social networks, artefacts and technology appropriation – a need for research

As yet, little is known about the synergy between social networks and artefacts in encouraging adaptation as part of the appropriation process. Some prior research has investigated the use of a new Information System and the role of the organizational unit's social networks on technology use (Sykes et al., 2009). In their research these authors propose a model of acceptance with peer support, and concur that valued network density and network centrality are important elements. Both these elements take into account ties to those with relevant expertise and collectively form coping and influencing pathways that have an effect on system use. However, their study is quantitative in nature and ignores qualitative aspects that influence technology appropriation by using social networks. Additionally, the use and role of artefacts in combination with social networks has not been investigated. In this paper we explore the combined role of social networks and artefacts as structures that surround technology and explore how their synergy influences the longer term use of technology. The next section describes the research methodology followed and case studies used in this investigation.

RESEARCH METHOD

This exploratory research was of a qualitative nature and followed a case study approach. We were interested in gaining a deeper understanding on how individuals adopt and then use technologies in light of Carroll's definition of appropriation (Carroll et al, 2002). In particular, we focused on the supportive role of social networks and artefacts as individuals appropriated technologies to fulfil their day-to-day work practices. We were interested in gathering rich data of human interactions with manual and IT artefacts used in their natural settings (Yin, 2003). Three case studies were conducted from 2005 – 2007 in different departments of an Australian University. Two of the case studies investigated technology use in a Helpdesk environment while the third focused on the adoption and use of EndNote, a software publishing and bibliography management tool used in a department of the University. The case studies were chosen because in all three cases a new technology was introduced in the workplace. The unit of analysis in this study were individual users.

Interviews were conducted with the managers and each of the team members in the case studies. The initial data collection was followed at a later stage by a series of observations and follow-up interviews. In addition, key documents used by the participants were also analysed. Table 1 summarizes the number of participants, data collection techniques and the issues explored for each case study.

Case study	Number of participants	Data collection techniques	Issues explored
Case study 1: Helpdesk support related to use of new Enterprise-wide Information System	Team Manager and 4 team members (=5)	Interviews, participant observation and analysis of documents	<ul style="list-style-type: none"> - User actions and behaviours of how social networks were harnessed during technology use - Reasons for combining artefacts with social networks - The role of technology in user's work practices - Different types of artefacts created and used by participants - Reasons for using and managing artefacts - Codification to support technology use
Case study 2: EndNote use as a departmental library catalogue system	1 manager and 9 members (=10)		
Case study 3: Adoption and use of an integrated system to support Helpdesk activities	Team Manager and 5 team members (=6)		

Table 1: Case studies, number of participants, data collection techniques and issues explored

With the consent of the participants, all interviews were audio-recorded while field notes were taken by the researchers during the interviews and observations. All data was transcribed and descriptive codes were used to generate general and specific patterns and themes. Diagrams were used to display, analyse and refine themes emerging from the data (Langley, 1999; Miles and Huberman, 1984). Themes and patterns were linked to existing theories on social-artefact networks and technology appropriation. The next section describes each of the cases in more depth in terms of its specific focus and use of the technology.

Case study 1:

This case study was conducted in 2006 at a helpdesk-unit located in the IT services department of the University. It was established to support the ongoing calls and enquiries of 2 500 staff members as they started to adopt and use the newly created ORACLE-based Enterprise-wide Information System (EIS). The EIS was developed to provide automated support for the documentation and management of Finance, HR, Research and Environment, and Health and Safety processes at the University. To coincide with the rollout of the first new EIS modules, the university's IT services recruited staff from HR, Linguistics and Administration to provide ongoing support to the new users of the EIS. In this case study we focused on the support staffs that were new to the technology. Apart from using the EIS, the support staff also had to handle problems and queries via a phone-in service. To handle phone-in services, they had to adopt and use a specific customer relationship tool (*REMEDY*) to

log/monitor issues or problems. Alternatively users could log problems via a Web application or directly by sending an Email. At the time of conducting the case study all staff were learning to use both the EIS and Remedy tools. In this case study, the Team Manager and four helpdesk team members participated in the study.

Case study 2:

This case study was conducted in 2005 in the History Department of the University. It examined the implementation and use of a software application called EndNote in the department's library. EndNote is a bibliographical software package to maintain and manage collections of bibliographic resources. The department had a localised library which held books, journals and other sources related to the discipline. Prior to rolling out EndNote in the local department library, it was used by individual academics in this department to support their research activities. One of the academics who managed the local library had prior experience with EndNote and took on the role of the local librarian in this department. The library activities required the maintenance of a manual catalogue and providing support to staff in their searching and retrieving of specific sources. In order to alleviate the library-associated workload and create a more effective environment, this academic decided to introduce EndNote as an online library catalogue database to support library-associated tasks. In this case study the 'librarian' (1), academics (5) and students (4) were participants.

Case study 3:

This case study was conducted at the helpdesk-unit of an academic department in the Science faculty of the University. At the time of conducting the case study (2005) the helpdesk served about 500 students and 28 academic staff in solving daily Technical and Administrative problems. Apart from helpdesk-related problems, work activities also included the management of tutorial and laboratory spaces and the lending of audiovisual and digital equipment to students and staff (e.g. PC's, digital cameras and audio-recorders). What is unique about the helpdesk, was that all the staff members worked 3-hour shifts from 9 to 8pm each day and each staff member was alone during his or her shift. New staff were not required to have any prior helpdesk experience, however all new staff had to attend a compulsory training session prior to the start of their employment. To support all the different workflows, training and helpdesk related activities, a series of automated databases had been created for helpdesk staff to log activity-related data and information. This information was open and accessible to all staff across all shifts. A front-end application was created to consolidate all the databases and allow staff to access, maintain and retrieve helpdesk-related information. A Web interface was added to this application to allow workers to access the data from anywhere. In this case study the Team Manager and five helpdesk staff participated in the study.

The next section describes how participants from each case study adopted and used the respective technologies and how they relied on and drew on social networks and artefacts to support their adoption and use of the various technologies.

RESEARCH RESULTS

This section describes how EIS, EndNote, and an integrated set of databases were used by participants in their work environments. Findings, based on themes identified during the data analysis, are reported in the next three sections, followed by a summary of our findings.

Case study 1:

In this case study it was noted that participants (team members) had to understand, learn and change some of their existing activities and procedures with the introduction of the new EIS. For example one of the participants said, "*As a support officer for the new system, I see my role as one of answering questions, learning and providing training*". Observations indicated that participants had to change their work practices to suit the EIS. At times they did not have adequate knowledge of specific procedures to do so. Hence, participants' had to contact their individuals in their self-established informal network of experts to gain insight on how some of the procedures worked, "...*I know who to ask for certain areas, [Sally] has the most knowledge in that area and she is the one that I trust the most to ask strange questions...because I know how the University works I know who to ask*". In addition, it was also observed that some participants often developed their own 'yellow pages' that could connect them (or the other team members) quickly to experts in some areas: "...*but I have also got a list (my own Yellow pages) in the back of my exercise book or you know from various areas with Emails phone numbers, my own list. I have been building that over time*". Further observations indicated that some participants either used their peers to get in touch with other experts outside their own informal networks "...*you will eventually find someone who can bring you in touch with the correct person and I guess that is what I depend on*", or they acted as experts in the network to help peers connect to other experts "*Sometimes I just refer people on [to solve problems]*". With time and experience it was noted that participants gained specific expertise on various EIS procedures which enabled them to develop and document workarounds to solve some of the existing problems they had with the technology, "*I know how to do it and what the workaround is to do it... we verbally share, when we come up with something [a workaround] we make an effort in saying its either this way or that*".

or if there is a new procedure or something that I come up with that I know everybody else needs to know I send out email to all [members in my network] with the workaround to be followed with all the information they need to know”.

Most of the participants indicated that documentation helped them to learn how to use the EIS, *“You get something down in writing it helps you and I suppose the others to broaden their knowledge”*. The idiosyncrasies of using the new EIS forced participants to document specific workarounds which were stored as so-called ‘cheatsheets’. The cheatsheets were shared among users when required to complement telephone conversations about workarounds. For example, the team manager commented, *“We use a cheatsheet ... it is basically a step by step guide on how to perform a particular function”*. Over time, the more difficult procedures associated with the EIS use were explained in detail in the so-called ‘broadcasts’ which were sent by Email to all users. The team manager also commented on their use of bulletins, *“We use a bulletin which I know everybody reads - you get it down on paper and you can refer people to it as well, say you know there’s this problem [using the technology] that has been linked to a bulletin you can now refer to it as Helpdesk bulletin number 2 in which we mentioned this and that - sort of brief them to it in some way”*. Further the manager said that by logging problems using REMEDY, the team could identify repetitive problems that arose while using the EIS and used this information to develop dedicated learning workshops for groups of users, *“so it [the training] is useful for the new users on their first job and we have got other people that we know who need specialist training - there are heaps of people often coming back that ask for help”*.

The participants designed a large collection of documents to capture key knowledge related to: helpdesk support, learning materials, procedures, workarounds and other related topics. Initially documents were disorganized and scattered all over the internal server, and in some cases even replicated. One of the participants became the ‘content organizer’ and with the input from the other participants, he organised this collection using a filing structure that closely resembled work-related categories. All the documents were consolidated across the newly-created filing categories to decrease search time, *“There was just no structure on the server, things were not classified properly... the categories we now have are more [closely related] to do with the day to day running of the helpdesk”*. It was observed that the strong social network and variety of artefacts created by the team were important to support the team in adapting their work practices to fit the new technologies.

From this case study, it was evident that users of the EIS had to adapt their existing work practices to fit those of the new technology. They were reliant on their informal, formal and peer social networking as well as knowledge brokering and advocacy roles. Artefacts such as yellow pages, cheatsheets, Email broadcasts, training materials and reusable procedures were used to support the social network activities.

Case study 2:

In this case study, it was noted that the librarian made the decision to adopt EndNote to automate and manage the local history department library. EndNote was available free of cost and could be downloaded from the university library web site as, *“The university has negotiated a licence which enables you to download it to your computer”*. Further, the librarian’s decision to use EndNote as a library catalogue system was based on prior experience with it. The librarian also perceived that academics and researchers in the department had prior experience with it. Some of the librarian’s comments were, *“My feeling was that the department encouraged students and academics to use EndNote for the production of bibliographies in their thesis and research”* and *“I developed a considerable familiarity with it”*. In addition, the librarian commented that handling the former manual library catalogue was cumbersome, needed a person to staff the library and manually maintain a log book, *“The library used to have a staff member who sat there all day everyday and students actually used it as a study space. Also, it had a large volume of collections around 10,000 volumes. The books actually supplemented what was available in the University library....The person who was there would have to tell students if the books were there, where they were and had to maintain a log book because the books weren’t catalogued”*.

The librarian could easily set up EndNote as the local library catalogue system because it had features that support searching, retrieving and sorting needed for easy access to information stored in the EndNote database. In addition, EndNote’s IMPORT feature allowed access to and the import of information from the Central university library catalogue into this localized EndNote library catalogue system, *“I was able to import records from the Central library catalogue because there is nothing in the History department library that is not in the Central library except the honours thesis”*. Additional bibliographic information not stored in the Central University catalogue was manually entered using EndNote fields such as title, year of publication, call number and so on, *“The honours thesis I actually constructed the entries myself but for all the others you just simply import them...using it [EndNote] gave me the capacity to import the records from another library. So the selection of EndNote was quite intuitive”*. Therefore, the librarian adapted her work practices to use many of the features provided by EndNote.

Once automated, a central EndNote icon was made available on each staff member's desktops as a central point of online entry to the department's catalogue system. Further, automating the library catalogue system meant that, *"the library is no longer staffed... students are given the library room key individually in exchange for their cards and they enter, ... Now, they go in and use the automated catalogue system to search and retrieve books"*. Students and academics were provided with an instruction sheet on how to use the system, *"...there is a large instruction sheet, I put it up there - on how to access the catalogue system"*. It was therefore observed that the librarians, students, and academics' work practices (i.e. accessing and searching information from the library) had changed with the implementation of EndNote as a library catalogue system. In addition to providing an automated library catalogue system for students and academics, EndNote changed the way academics and students communicated among each other. Academics could access the local history department library catalogue system via an icon on their individual office computers. The librarian who set up the system commented, *"The whole point of getting the EndNote fired up in the history department wasn't so much to have a computer in the library but it was so that for members of staff could access EndNote from their offices"*.

The EndNote icon also served as a central artefact that drew staff and students together to collaborate, network and share knowledge. For example, during meetings, supervisors and students used the EndNote icon on the desktop to discuss and browse important sources and shared their knowledge *"...time and time again students come up to me [supervisor/lecturer] with an argument in an essay and i would say 'somebody said that and you should look at this person's honours thesis'"*. Also, a participant (student) commented that his supervisor referred him to a book and he used the catalogue system to search and retrieve the information, *"...I went to the office and they gave me a room key...there is a computer which has all the titles and we can search for information.... I would just scroll thru' the titles alphabetically....he [the academic] told me there was a piece of work related to my topic in the library and so that's how I got to use it...."*. Interestingly, some participants (academics) commented that they did not access the icon on their computer to search and retrieve books. This was due to their uncertainty about the accuracy of information stored in the EndNote catalogue system, *"Every staff member had an icon on their desktop to access the catalogue, but I felt it easier to go there and pick it [book] up and use it....I was not sure if it was updated [the catalogue]...that's why I have not used the icon"*.

Further, the EndNote catalogue system was used along with manual artefacts such as instruction sheets and manual loan registers. Students were allowed to borrow books. The loaned books were recorded manually in a register (book) instead of using EndNote. According to the librarian, this workaround was devised since EndNote could not support loan transactions, *"When I was there, I used to note loans in a log book, now, each person borrowing the book writes down the book they borrowed in a loan book because EndNote does not handle the loans"*. Participants (students) were reliant on the instruction sheet to get acquainted with procedures of using the technology, *"They just come in here and look at the instructions and then they can search using EndNote, take the keys to the cupboards and pull out the thesis to read it"*. One of the participants (student) said, *"I read the instruction sheet, scrolled thru' the catalogue system to find a book I needed"*.

It was therefore observed that EndNote was used as a collaborative library catalogue system or artefact instead of an individualized bibliographic tool. That is, both the technology and users' work practices were changed to suit the needs of the librarian, academics and students in the history dept. The way in which the EndNote catalogue system was set up, encouraged some amount of social networking among academics and students. Manual artefacts such as instruction sheets and loans register along with each user's EndNote catalogue system icon on the desktop were used to support users' everyday activities.

Case study 3:

In this case study, a manual system with logbooks was first used to log key helpdesk tasks. A new solution, consisting of a collection of linked databases with a web front end was designed by the prior helpdesk manager and integrated with the usual helpdesk activities. The new solution was designed because shift handovers were ineffective and the helpdesk manager wanted to shorten the turnaround time for handling queries, *"I think the system we have now is working so well that I wouldn't want it to change"*. All participants, but the Helpdesk manager, were new to the system. During the first two weeks of semester, the Helpdesk manager helped new participants to settle in and thereafter only dropped in occasionally to ascertain that activities were running smoothly. To facilitate and support all the different helpdesk tasks, an integrated technology solution consisting of thirteen linked databases were developed to log work-related and shift information. The new system required the helpdesk staff to redesign and adapt their work practices to be able to use the new system. Hence, the system was customized to automate and support the helpdesk-related tasks.

Initially, helpdesk participants had a steep learning curve - they had to learn to integrate the technology in their work practices, in addition to solving problems for others which sometimes proved tricky. Due to shiftwork, participants worked alone most of the time and had to rely strongly on their own individual social networks to source knowledge on how to solve problems. One of the participants commented on the value of her/his social

networks to support her/him in finding the right person to solve problems, "...I will start to ask around to get hold of someone that knows, and he doesn't always know the answer, so he would have to ask someone else anyway". Participants indicated that the strong bonds of their social network were useful in helping them to work more effectively. Additionally participants also learned from experts and could over time equip them with the required information and knowledge to perform their tasks: "... networking with persons helps you to do your job better, ... it helps me to serve the students with the most current info...it helps me to learn more about whatever the issue is...". Therefore social networks helped participants to learn the ropes while they were actually doing their work. "I learn a lot from others. Sometimes I come in 5 to 10 minutes early and talk to the other people... otherwise I just phone [john], he has made himself available to help me out.... I just ask Maryanne and she would either refer me to the right person or I will just get in touch with that person myself".

The helpdesk technology solution enabled each participant to integrate technology with their work practices through the logging of key information in 13 small databases. For example, one database called 'Lost Property Found' was created to log lost items found in specific places. Similarly another database was called 'Loans' logged borrowed equipment. Prior to the integrated solution, all information was logged manually, while the new system allowed each participant to log the most recent information related to a specific helpdesk task. As an example, the task of borrowing audio equipment required the logging of key data in a logbook specifically dedicated to this task. This facilitated shift work since the most up-to-date information was always there as the manager remarked: "If we have to book out equipment, we have to enter who checked it out, what time, what equipment. And if there is double bookings we can figure out from this why its happening... so you can go back to people and explain ...so you can go back and confirm with them if they are doing something wrong. And we can tell them how it should be done. This enabled participants to trace items and verify activities across shifts. The thirteen databases were carefully designed to closely fit and support each of the helpdesk-related work tasks. Interestingly, it was observed that one of the databases was dedicated to the logging of key shift-related information in the form of a blog. It was considered crucial in enabling smooth shift-handovers since a quick read of the daily blogging enabled each new shift worker to get a quick update on events associated with prior shifts. Unsolved problems could be described and 'handed over' to solve in subsequent shifts. The daily shift blogs turned out one of the most important elements to support helpdesk shift work as one of the participants remarked: "I would not be able to do my work without all the stored shift information". Observations confirmed the strong reliance of the team on the set of databases and the blogging artefact to transfer information and knowledge between shifts. The combination of social and artefact networks helped participants to integrate the various technologies in their work practices and formed the basis for redesigning the team's work practices to better support shift handovers.

In this case the artefacts created by staff members were tightly integrated with work practices (suite of database tables, the shiftwork blog and web interface). The shiftwork blog helped them transfer information between shifts. Informal social networks were helpful in sourcing knowledge to solve specific problems. In this case technology was integrated with shiftwork and work practices were redesigned to fit the technology.

Summary of findings:

Based on the results from the three case studies, Figure 1 shows key components that form part of social networks and different types of artefacts that can be combined to support and enable the process of technology appropriation. The combined effect of these, resulted in three different ways of using technology in the case studies namely: 1) adapting work practices to fit technology; 2) adapting both technology and work practices and 3) integrating technologies and redesigning existing work practices. Users in the three case studies used different combinations of social network components together with manual and automated artefacts to adapt technology as a part of the appropriation process.

DISCUSSION

This paper has addressed the research question: *What is the role of social networks and artefacts in encouraging users to appropriate a technology over time in an educational setting?* Based on our results shown in Figure 1 we found strong evidence that technology can be appropriated supporting prior studies (Caroll et al, 2002; Mendoza et al, 2007). Further our study suggests that a combination of social networks and artefacts were required to facilitate and support the technology appropriation process. We base our discussion on three different ways in which people used a combination of social networks and artefacts to appropriate technology namely - 1) adapting work practices to fit technology, 2) adapting both technology and work practices and 3) integrating technologies and redesigning work practices.

We found that social networks were instrumental in helping users adapt and change their work practices to suit a new technology. In case studies 1 and 2, the ability for individuals to contact experts in their self-established informal networks and gain access to other experts via knowledge brokers helped users in adapting work practices to fit the technology. In addition, our findings suggest that different types of artefacts in combination

with social networks are essential in guiding users to adapt their work practices to fit the technology. In case study 1 we found that cheatsheets, broadcasts, logged problems, *who-knows-who* contacts serving as yellow

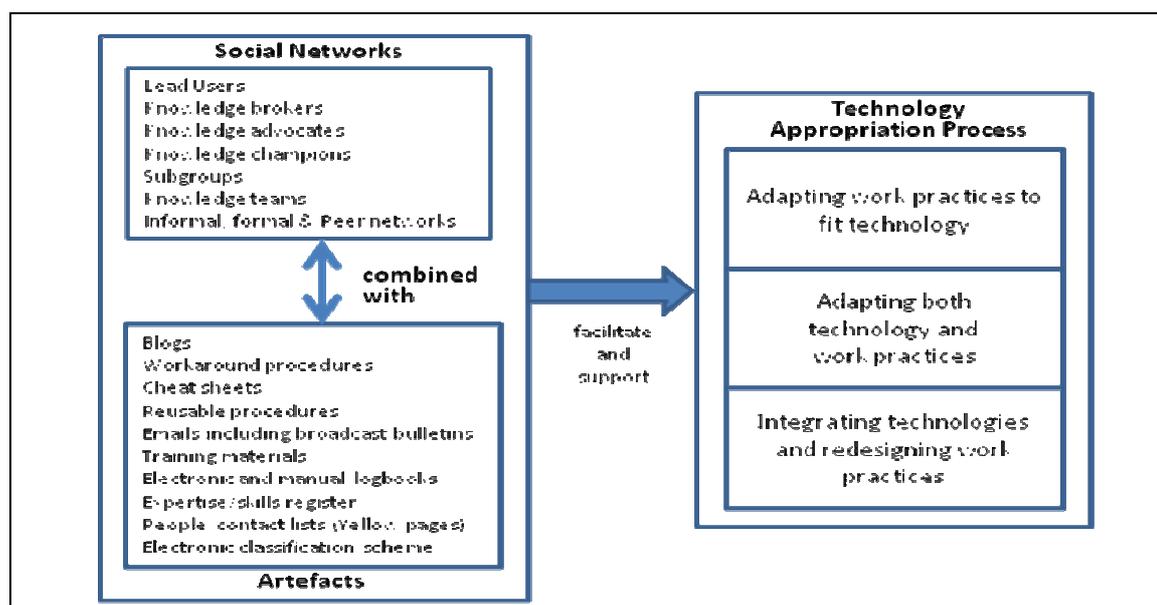


Figure 1: Social networks and artefacts that support technology appropriation

pages, documents capturing workarounds, procedures and other helpdesk-related support material formed part of the collective network of artefacts. It is therefore important that managers, IT professionals and trainers encourage users of new technologies to be part of new formal and informal social networks. In addition, mechanisms could be introduced and encouraged to share expert knowledge through the creation and use of artefacts in these new networks such as for example lessons-learnt, quick-tips and workarounds.

Findings from our studies also suggest that a variety of social networks and artefacts not only encourage individuals and groups to adapt their work practices to fit a technology, but could help users appropriate the original design intent of the technology to fit user's work practices. In this study we found that lead users with experience acted as knowledge advocates and knowledge champions to encourage other users to shape the technology to fit their work practices. For example in case study 2 (EndNote), a bibliographic management software was introduced as a library catalogue system to support cataloguing of books, journals and conference proceedings by using database features provided by EndNote to enter, search and retrieve bibliographic information. It was noted in case study 2 that the lead user was the librarian who initiated the idea of re-inventing the way EndNote could be used. Lead users therefore play a vital role in encouraging technology use beyond its initial design intent. Further, findings from the study indicate that artefacts in addition to lead users could facilitate technology reinvention. For example, it was noted in case study 2 that logbooks, instruction sheets and the *appropriated EndNote artefact itself* created a new collaborative environment for users to share information. Thus, a combination of the appropriated technology, lead users in social networks and key artefacts could enhance effective use of a technology.

Further, we found that the lack of knowledge champions and advocates could discourage users from integrating appropriated technologies. In case study 2, some users of EndNote were not fully confident in using the newly created icon on their individual desktops to access the department's catalogue system. The knowledge champion (the librarian in this case study) did not fully advocate the use of the EndNote library catalogue system as a collaborative tool. Alternatively in Case study 3, it was noted that the Helpdesk manager campaigned and advocated widely for the use of the integrated technology solution to facilitate shift handovers. As a result, all participants actively used the blogging mechanism and databases to log key task-related information. In case study 3, the collective set of artefacts (the databases) was important in supporting social networking to solve helpdesk problems. We also found that along with work practices being automated with the use of technology, one or more manual artefacts could support adaptation as a part of the appropriation process. For example in case study 2, it was observed that the automated EndNote library catalogue system was used alongside a manual artefact (a loans register to enter relevant details of borrowed books) to effectively use the technology. Similarly in case study 1, manual 'cheatsheets' were actively used by the users of the EIS system as they adapted their existing work practices to be able to use the technology.

Furthermore, findings also indicate that users may integrate a suite of technologies (new and existing technologies) to redesign existing work practices. In case study 3, a collection of newly created databases and existing manual artefacts formed a new system that was key to redesigning users' existing work practices. These

artefacts were used in social networking activities for a smooth handover of shift information. Therefore, integrated technology together with artefacts often strengthen, extend and confirm social networking activities and facilitate redesigning of work practices and effective use of technologies.

Based on our three cases, we found that there was a strong link between social networks and artefacts in supporting the process of appropriation. Further, appropriation involves customization/personalization and re-invention of technology use, changing work practices to fit technology and integrating a suite of technologies. To support appropriation, a combined social-artefact network is needed to successfully encourage technology use. Hence, managers, IT professionals and trainers should encourage and nurture the formation of social networks and encourage the creation of accompanying artefacts to support effective use of new technologies.

CONCLUSION

Findings from this study indicate that technology can be appropriated. However, a combination of social network elements and accompanying artefacts are required to enable and facilitate the appropriation process. Firstly, we suggest that such a combination can support and encourage technology appropriation in three different ways namely 1) adapting work practices to fit technology, 2) adapting both technology and work practices and 3) integrating technologies and redesigning existing work practices. Further, the absence of elements such as knowledge champions, advocates and brokers in social networks can hinder adoption and use of technology. Secondly, for effective use of technologies, social networking alone may not be enough in encouraging technology use. A combination of social networks together with manual and automated artefacts may be necessary in supporting and enabling productive use of technologies. Thirdly, experienced lead users of artefacts often perceive new and effective ways of using integrated technologies leading to innovative redesign of work practices. Therefore it is important to identify experienced lead users in social networks (acting as knowledge champions, brokers and advocates) and key artefacts (manual and/or automated) to encourage effective ways of technology appropriation.

Finally, users work with technology in different ways and often re-invent new ways of using technology in their everyday work practices. It is therefore important that managers, trainers and IT professionals realize that encouraging effective use (sometimes even using technology in un-anticipated ways) involves 1) identifying and supporting lead users, 2) encouraging individual and collaborative social networking pools and 3) making resources available to encourage users to create and develop a variety of automated and manual artefacts to facilitate technology appropriation.

Future research is required to further our understanding of the combined effect and impact of social-artefact networks on technology appropriation in terms of the different types of artefacts that have the most impact, social networking responsibility roles and appropriate ways of disseminating knowledge in these networks.

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