Multitasking: the Uncertain Impact of Technology on Knowledge Workers and Managers

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Abstract: While the productivity paradox has now been officially pronounced dead, the argument and the evidence for this assertion are both at a macroeconomic level. What has been less closely examined is the microeconomic impact of recent developments in ICT on the productivity of office and knowledge workers. There is an assumption, readily seen in many advertisements for mobile technology, that multi-tasking, WiFi connected laptops, Blackberrys, smart phones and so on are good for business and make people more effective and productive. This may be true some of the time and there is some (albeit limited) research which supports claims that these technologies increase productivity. However there are also emerging concerns that, in certain environments, these technologies may actually reduce productivity in both the short and the long term. This paper examines this problem and research to date and proposes a framework for further investigation of this phenomenon.

Keywords: multitasking, multicommunication, productivity, effectiveness, efficiency, ICT evaluation.

1. Introduction: Implicit assumptions

1.1 A multitasking world

In October 2007 a video entitled "*A Vision of Today's Students*" was posted on *Youtube*1. The video includes a series of views of students in a contemporary lecture theatre. As the camera turns to each student in turn, he or she holds up a card or a laptop showing a personal message such as "*I spend three and a half hours a day on-line*" or "*I will read 8 books this year*". One such card simply says "*I am a Multi-tasker*".

In another video in the same vein, a black and white photograph of an old fashioned classroom from early in the last century is shown. The accompanying text argues that the type of learning depicted was designed for people who would spend their lives working in a factory on a production line. A clear subtext in both of these videos (and many others readily found on the Internet) is that today's students will be working in a multi-career, multitasking world and that schools and universities need to re-invent their pedagogy in order to prepare them for this.

There are two aspects to the views proffered in these videos. First, it is implied that multitasking in the classroom with multiple media, computer enabled self and group learning is a better form of pedagogy than the traditional teaching approach where the entire class is required to focus on and attempt to absorb some of what the teacher is saying. Second, computer enabled self and group learning will develop young people's multitasking skills and that these are the skills they will need in today's and tomorrow's workplaces. These ideas reflect the view that multitasking is not only a trend in the workplace, but the assumption that multitasking is a better and/or more effective way of working than more traditional single-task-focused forms of activity.

This transition is readily visible within the computing era. Forty years ago green screens and dumb terminals tended to restrict those office or knowledge workers fortunate enough to have access to a computer at the time to a single task. The concepts of scientific management and work design proposed by Taylor (2003) back in the 1920s, which involved training workers in discrete tasks and supervising those tasks carefully, were adapted for the computer age. By the mid 1980s however, graphical user interfaces, through the metaphor of the desk, and later web browsers, facilitated multitasking in a variety of ways from having multiple windows open on screen at once to hyper linking and instant messaging. Several recent technologies including SMS texting, social networks and chat rooms have further facilitated this type of workplace behaviour. Many if not the majority of office staff now work with their e-mail systems active and an increasing number work with on-line messaging and chat rooms active as well. People commonly come to meetings and place their mobile 'phones on the table and/or open their laptops and connect to the wireless network. Anybody who has attended meetings where this happens, will have seen people texting (sometimes not even surreptitiously), reading their mail or 'chatting' while they are supposed to be attending

[1] http://www.youtube.com/watch?v=dGCJ46vyR9o

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to the business in hand. Students will openly admit to exchanging e-mails or even playing on-line games during lectures (Fried, 2008).

1.2 The impact of ICT?

Multitasking in the workplace long predates ICT, but ICT, if not a prerequisite for multitasking, is a significant enabler and amplifier of multitasking. From an ICT evaluation perspective, it is therefore pertinent to ask:

- Whether such modes of working (learning is a separate question) are better in some (or any) sense than monotasking? and
- When and if is multitasking a beneficial development in the workplace?

There is, as will be seen below, a body of research addressing the first of these questions, but little research which looks at the second. Furthermore, only a modest portion of this research is to be found in the IT evaluation literature (or in the wider IS literature). There is a embryonic body of research into the impact of multitasking on some specific types of work and this research is discussed below, but this is a topic that is worthy of more attention from the IT evaluation community than it has received to date. The purpose of this paper is to explore the impact of multitasking. In so doing, it will be argued that there are many different types of multitasking situation and that these have different characteristics which justify separate study. This is not so much a single question as a family of questions. This paper will propose a taxonomy of such situations and suggest a framework for further research in this area.

2. Defining multitasking

This paper is concerned with *conscious* multitasking and it is important, before engaging with this topic in detail, to distinguish between this and subconscious multitasking. The conscious mind can only focus on one task at any point in time. The subconscious, on the other hand, can cope with a number of simultaneous tasks[2]. A simple example of subconscious multitasking is driving a car and changing gear whilst turning a corner and listening to music on the car radio at the same time. The subconscious can control the movement of both feet on the pedals, one hand on the gear stick, one hand on the wheel and ears listening to both the music and the sound of the engine while both eyes focus on where the car is going. Only one of these tasks can have the attention of the conscious mind at any point in time. The subconscious can do the remaining tasks simultaneously because it has been trained to do them to the point where they have become routine. In certain circumstance, the conscious mind is not necessary in this process at all. Many readers will be aware of the experience of having been driving a car for some time without being conscious of driving and/or of letting their mind drift away from the act of driving whist still at the wheel.

As with any moderately complex task, the first time an individual drives a car it requires enormous concentration as the conscious mind has to attend to every necessary action. In time, and with practice, most of the actions required to control the car become programmed or automatic so that a driver does not have to think about the physiological mechanics of changing gear for example. His or her full attention can therefore be on the road. However if the driver's conscious is diverted by something else that requires its attention, such as a telephone call, this can be dangerous because, as noted above, the subconscious must now take over the non routine activity of watching the road. It was precisely for this reason that the use of hand held mobile 'phones while driving was outlawed in the United Kingdom in 2003[3]. The Royal Society for the Prevention of Accidents (2008) summarises the dangers of such distractions in one of its reports:

> *"When mental (cognitive) tasks are performed concurrently, the performance of both tasks is often worse than if they were performed separately, because attention has to be divided, or switched, between the tasks and the tasks must compete for the same cognitive processes. When a driver is using a hand-held or hands-free mobile phone while driving, she or he must devote part of their attention to operating the phone and maintaining the telephone conversation and part to operating the vehicle and responding to the constantly changing road and traffic conditions".*

It is interesting to note that in their efforts to eradiate the use of the mobile phone while driving, the UK law enforcement authorities in 2007/8 fined 165,000 drivers. This is thought to be a small fraction of those actually breaking the law. The fact that people are in jail because the law takes the dangers of multitasking while driving so seriously, is indicative of the importance of the impact of multitasking on task effectiveness when driving. If it affects driving, it will also affect many other types of activity.

[2] Typically from four to seven tasks.

[3] http://www.crimereduction.homeoffice.gov.uk/vehiclecrime/vehiclecrime38.htm

3. Multitasking in the office

While subconscious multitasking is common amongst workers engaged in manual occupations, it is not what is normally understood when applied to office or knowledge workers. What is meant here is carrying on several activities more of less simultaneously, all of which require the attention of the conscious mind. This type of multitasking involves continual switching of attention between tasks and devices/other people. An analogy with computers is helpful. A modern, single core processor simulates multitasking by switching between tasks so quickly that the user does not notice. On older PCs with early versions of Windows, this switching was sometimes noticeable; as the user moved from one window to the next, there was a visible delay. Humans switch their attention in a similar way and incur an analogous time overhead and delay in so doing. This switch may happen voluntarily, for example somebody may stop reading to look at their e-mail, or it may be interrupt driven such as when a user stops what they are currently doing to take a telephone call. If they are not suitably configured, computers that use multitasking to support multiple users or tasks can become overloaded. This phenomenon occurs when the switching activity takes up all or almost all of the processor's time, leaving no available capacity for application tasks. A term sometimes used by computer professionals for this is 'thrashing'. Humans, when they try too much switching, can experience an analogous phenomenon. So much time is taken with juggling tasks that little, if any, productive work takes place. Understanding the implications of this for organisational productivity requires an understanding of the nature of work in that organisation. The impact of multitasking on productivity will depend on the context. Some jobs are naturally interrupt driven[4] (managing is frequently cited as an example). However many jobs are most effectively done without interruption.

The problem of task interruption continues to be compounded by the emergence of new forms of interruption. While there is much research into multitasking (see section 4), the phenomenon has become steadily more complicated as both additional technologies appear and a generation which has grown up with these technologies moves into the workplace. The following is a list, in rough historical order, of some technologies which either facilitate multitasking and/or voluntary and involuntary interruption in the workplace:

- Land line telephones;
- Pagers;
- Conference calling;
- Video conferencing;
- e-Mail;
- Real time data streaming;
- Real time alerts;
- Graphical user interfaces (i.e. multitasking operating systems);
- Digital dashboards;
- Mobile telephones;
- SMS/text messaging;
- Digital cameras;
- Browsers (the Internet/Web);
- Chat rooms;
- On-line messaging;
- Social networking.

If one were to plot these on an historical graph, most of them would be concentrated in the last 20 years. Some, which have been around for a long time (such as e-mail and video conferencing (which dates back to the 1960s) have only come into widespread use in relatively recent times as costs have fallen and the infrastructure to support these activities has been laid down. Some of these are also more ubiquitous than others and what might be called *the business value to disruptive capacity ratio* of each varies. In more general terms, as Tang (2005, p1) puts it:

> *"… current trends in the deployment of ubiquitous computer lead to a world where computers pervasively vie for our attention".*

[4] A technical term used in computing to describe systems where processing of a given task may be interrupted by a higher priority task, but sometimes used as a metaphor for similar phenomena in the human world.

A parallel phenomenon is the growing emphasis on real time information such as that provided by digital dashboards (Malhotra 2005). To extend a point made above, ICT has not only increased people's ability to multitask, it has also created new forms of multitasking via such technologies as e-mail and mobile telephony. The pervasiveness of these technologies makes the nature of their impact on productivity and quality of life in the workplace an important issue to understand.

4. Research into multitasking

Research into multitasking can usefully be divided into a number of categories. First there research carried out in fields such as medicine and psychology into the neurological and mental processes involved. Secondly there is research into human multitasking generally, i.e. multitasking which is not necessarily IT enabled or driven. Thirdly there is research looking at the effectiveness of IT enabled multitasking as a productivity tool. Each of these literatures is briefly reviewed in this section.

4.1 Research in medicine and psychology

Research into how the brain processes material when it multitasks is relatively recent. It suggests that when the brain switches from a single task to multiple tasks, the locus of activity in the brain shifts from the hippocampus which stores and recalls information, to the striatum which takes care of rote or repetitive tasks (Kirn, 2007, University of California, 2006). The research suggests that when humans attempt conscious multitasking, the effectiveness of the brain is considerably reduced. In addition people engaging in multitasking become more fatigued, do not recall details of what they have been doing and exhibit raised stress and adrenaline levels. The evidence is summarised by Dzubak (2008, p11) who concludes that, while there is evidence that the ability to multitask improves with practice:

> *"…there is unequivocal evidence that depending on the task, degree of thinking, and the need for future application, we might want to do some things one step at a time, free of interruption, and do them well."*

In plain English, it takes more effort as well as more time to do three tasks simultaneously[5] than it does to do the same three tasks sequentially. There is ample empirical evidence for this effect (Dzubak 2008, Hembrooke and Gay, 2003). In general the findings of psychological research parallel or complement research in neuroscience. This research too supports evidence of greater fatigue as a result of switching. Rubinstein *et al* (2001) call this process of conscious switching, 'executive control'. A conscious switch is a decision to move from task A to task B. This is different from an unconscious switch where task B interrupts (a pager beeps for example). Meyer, cited by Lohr (2007), observes:

> *"Multitasking is going to slow you down, increasing the chances of mistakes. Disruption and interruption are a bad deal from the standpoint of our ability to process information".*

There is a compelling volume of research in the medical and psychological literature demonstrating that at the level of the individual, multitasking slows people down, reduces task effectiveness and takes more cognitive effort than monotasking. A full review of this is beyond the scope of this paper.

4.2 General multitasking research

While the neurology of multitasking is a relatively new research field, for over 40 years human multitasking has been the subject of extensive research in fields ranging from organisation theory to management science (González and Mark, 2004). One of the most striking and consistent findings from this research is the remarkably short time spent by what are called information (what might today be called knowledge) workers on a given activity before switching to another. As far back as the early 1970s, Mintzberg (1970, 1973) showed that managers carry out many tasks each day and sometimes spend less than a minute on a given task before they are interrupted. In their more recent research, González and Mark (2004, p119) state that:

> *"What somewhat surprised us was exactly how fragmented the work is. In a typical day, we found that people spend an average of three minutes working on any single event before switch to another event."*

[5] Performing tasks which require conscious attention simultaneously normally requires time-slicing. Time-slicing is a computing technique which involves doing small part of a task in a number of steps before transferring processing to another task. A number of steps in this second task are then completed before processing is switched to another task and so on. This differs from classic batch processing when one job is done at a time. While time slicing shares the computer's time resources more equitably between users (as opposed to everybody having to queue for the processor) the time spent in swapping jobs in and out of memory is a non productive overhead.

On the other hand, there are many knowledge based tasks where interruption is undesirable and where workers need to stay focused on one task. These range from writing computer code to giving a lecture. Between the person who has little or no control over the level of interruption, such as somebody working on a helpdesk, and the person whose work should ideally never be interrupted, such as a surgeon performing a complex operation, lies a large part of the working population, many of them office and/or knowledge workers. It is this group that is of most interest. For such workers, interruption and multitasking are often seen as a business necessity. It is at this group that so-called 'office productivity' and similar tools are aimed and, as already noted, traditional office equipment is now supplemented by a variety of emerging technologies. As far back as two decades ago, Reder and Schwab (1990) went so far as to suggest that:

> *"The multimedia approach to workstation design is definitely the right development model"*

More recently, Su and Mark (2008) have argued that so-called interruption management systems need to be designed to transform interruptions so that they are less stressful for workers and Galicia et al (2007) argue that ICT needs to be designed to support this type of work.

Nonetheless, the cost of interruptions is high. The US technology research organisation Basex Inc. (2005) claimed that:

> *"… interruptions take up more than two hours of the working day amounting to a cost of £588 billion a year to the US economy".*

While such numbers need to be regard with caution, it is indicative of a sizeable problem. At a micro level, Mark *et al* (2005) state that, following an interruption, it takes the average worker up to 25 minutes to refocus on a task that they were doing before the interruption. Clearly there is a trade-off here.

To complicate the picture even further, Reinsch *et al* (2008) examined the related phenomenon of multicommunicating. Multicommunicating, as the term suggests, is multitasking involving communications with several different people or groups. This, the authors argue, is the most complicated form of multitasking. In their analysis, they use structuration theory (Giddens 1986) to examine technology both as a stimulant and an enabler of behaviour. A key concept they propose is what they call *compartmentalization*. Compartmentalization is the ability of a technology to keep different lines of communication separate. Consider two simultaneous conversation between A and B on the one hand and A and C on the other. There are three possible situations (illustrated here with examples):

1. A, B and C are in the same room so both sides of both conversations are known to B and C.
2. A is on the phone to B and on a separate phone to C. Here B and C may be aware of A's part of the other conversation, but not the other part of that conversation.
3. A, B, and C are communicating by on-line messaging using separate windows. Here B may be unaware that there is another conversation taking place between A and C and C likewise unaware that there is a conversation taking place between A and B.

(There are other possibilities of course, but they are not of concern here). On-line messaging systems, like e-mail allow full compartmentalisation. Telephones and conference calls allow full or partial compartmentalisation. Face-to-face communication allows none, indeed Daft and Lengel (1986) suggest that the increased richness, typically associated with face-to-fact or video conferencing, is not always a good thing in multitasking situations when back channel or off-line conversations may be helpful. When it comes to communications therefore, there is a multiplicity of options which can be tailored to different situations and which may or may not enhance productivity, depending on the circumstances.

4.3 ICT and multitasking

While there is a reasonable body of research into general human multitasking, research into the impact of computer technology on human multitasking is still at an early stage. Spink *et al* (2002) claim that research into ICT and multitasking is a rapidly growing field and it is likely that knowledge of this phenomenon will grow. This may be so, but at the time of writing what is available remains limited. The reason for this may be seen by looking at a good example of the type of research that is required, namely the study by *Aral et al* (2007) of the impact of multitasking on productivity in an executive recruitment company. Multitasking was measured in terms of e-mail activity. Three findings emerged from this study:

1. Workers who multitasked more were more productive. Productivity was measured by individual financial contribution to the firm.
2. Workers who engaged in higher levels of multitasking were slower to complete projects. It is not clear from the research why slower completion was associated with higher productivity, but one explanation might be that such workers were working on more projects simultaneously.

3. The productivity impact of multitasking followed an inverted U curve. Productivity improved when workers moved from single tasking to multitasking. As the number of tasks increased, productivity levelled off and after a critical number of tasks was reached, productivity declined precipitously.

There are, as Manglesdorf (2008) points out in a review of this research, limitations in the research which constrain its generalisabilty. A critical limitation is that it was carried out in a single firm in a single industry and it used only one measure of multitasking. There are other, more subtle, problems which Manglesdorf does not discuss. The research shows correlation, but although it is suggestive of causality, there are other possible explanations for the phenomena observed. For example, it may be that staff who are more effective at selling tend to use the e-mail system more or that their levels of e-mail activity were higher because they had more contacts and therefore more prospects at any given time. While, therefore, the research is suggestive, it is not entirely convincing. The study also shows the challenges involved in measurement. The authors evaluated approximately 125,000 e-mails over a ten month period. To protect privacy, the content (but not the authorship) of each e-mail was encrypted which meant that behaviour had to be deduced from patterns in the data rather than from actual content. The research was only possible because of the availability of these data in an archive. All of this makes replication of this study difficult.

Nonetheless, this is a sufficiently important phenomenon to warrant further research. In the following section, a framework for such research will be proposed.

4.4 An evaluation perspective

From an IT evaluation perspective, an important question is whether multitasking is productive, counterproductive or neutral (i.e. the benefits broadly speaking match the costs/disbenefits)? The evidence from psychology and neuroscience is unequivocal – in terms of individual productivity, people are less effective and efficient at particular tasks when they multitask (of course change also relieves monotony which can aide productivity). On the other hand, there is some tentative evidence that at least some types of activity benefit from multitasking when measured at the level of organisational output. Furthermore, in certain circumstances, multitasking may have the advantage of occupying more time with productive activity. Downtime is a common problem with monotasking which is why, for example, work scheduling is such a critical aspect of production and project planning. The research challenge posed in the opening section may be focused as follows:

- The implicit assumption of many individuals is that multitasking is a better and more productive mode of work. Is this true, if so is it true in all circumstances and if not, is it true in specific circumstances?
- Multitasking operating systems could, and can continue to, avail of the growing processing and storage capacity of computers. Unlike machines, the processing capacity of humans does not change significantly over time. Is there some optimum level of multitasking and if so, how might it be identified?
- Is there a trade-off between single task efficiency and total productive output and, if so, on what basis should workers and organisations make this trade-off ?

Because conscious multitasking is tiring, there are, apart from immediate efficiency losses, also losses due to a decline in effectiveness resulting from fatigue. It does not follow, however, that multitasking is a less efficient form of work in terms of human time and effort (Iyer *et al* 2005). Multitasking can have the advantage of occupying more time with productive activity (Wasson 2004). A already noted, downtime is a common phenomenon when monotasking. A worker with a single task to do may have to wait for somebody to return a call or for the computer to respond to a complex query. Likewise, she may sit idle in a airport or spend 'non productive' time travelling between locations. So the fact that multitasking has drawbacks as a mode of working, does not automatically lead to a conclusion that serial monotasking is a better form of working even in those situations where it is practical (which is not in every situation).

Two further observations are worth making. First, many individual workers appear to assume implicitly that multitasking is a better and more productive mode of work and second, even if they do not make this assumption, many people multitask without ever considering whether or not this is what they should be doing. In the video referred to in the Introduction, the young woman who held up a card stating "*I read 8 books a year*", then held up a second card saying "*and look at 2,500 web pages*". Workers often complain of unproductive time and not having enough hours in the day. As people try to manage high workloads, the instinct is to juggle, to try to make some progress on all or several tasks rather than completing one before proceeding to the next. Often this is driven by external pressures. For many people, it is easier to say to a customer or a manager "*I am working on that*" than "*I have not started on that yet*". On the other hand, while a single task batch processing makes the most efficient use of raw computing power for the duration of a task, it may not be the most effective use of the machine's processor power, so from an organisational

perspective, monotasking may not be the most effective use of human resources. Consequently it is not self evident that multitasking is either a good or a bad practice in a given situation. In an extensive review paper looking at the impact of open office design, Roper and Juneja (2008, p19) say that:

> *"The research underpins the need for cost analysis of the impact that distraction have on knowledge workers".*

Applebaum and Marchionni (2008, p1313) argue that:

> *"Despite the detrimental effect that multi-tasking has on specific task completion, the paradox is that this does not seem to have an effect on overall organisational productivity"*

However their argument would appear to be based on the fact that (according to the authors) growth in overall productivity in the US economy has been averaging 4% over most of the past two decades. The fact that there may be many other contributions of ICT to productivity which are masking a possible negative effect of multitasking does not seem to occur to them.

In summary, there is little research to date which attempt to provide a meaningful evaluation of the impact of multitasking on organizational productivity or into the financial impacts of continual interruption and task switching. This is a significant gap in the research literature. Multitasking is an important phenomenon affecting, as it does, the working habits and patterns of a large number of knowledge workers around the globe. There is an often quoted saying in business, "work smarter, not harder". Unless the impact of multitasking is well understood, it will be hard to gauge what working smarter means. There is therefore a need for more research. The next section outlines a model that might be used in this task.

5. A taxonomy of multitasking

When it comes to work practices It is often useful, from an evaluation perspective, to categorise different forms behaviour. In order to analyse the impact of multitasking, it is helpful to break it down into a number of forms. Figure 1 shows what might be called the multitasking space, i.e. the various forms that multitasking and interruptions can take. This is a discrete space with 36 theoretical situations.

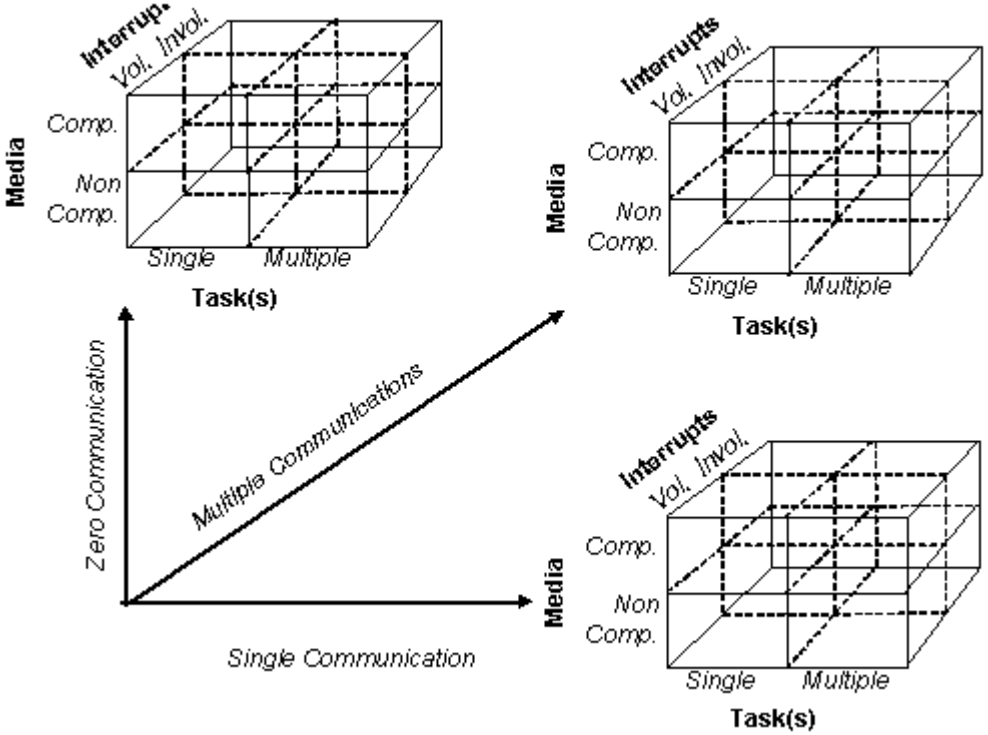

Figure 1: The multitasking space

The four dimensions of this space, with the number of possible values in parenthesis, are:

- Single or multiple activity multitasking (2);
- Zero, single or multiple communicating (3);

- Controlled (voluntary) or uncontrolled (interrupt driven) or both switching (3);
- Compartmentalised or non compartmentalised media (2).

(hence 2 x 3 x 3 x 2 = 36 possible situations). Not all of these situations are meaningful in practice as the nature of the media is not relevant in a zero or single communicating situation. In practice therefore many of these 36 possibilities may be collapsed into a single scenario. Furthermore, situations where a worker is subject *only* to involuntary interruption are likely to be rare. Most knowledge workers can and do involuntarily interrupt themselves, for example to think about another unrelated matter or to switch task. Consolidating and eliminating non relevant distinctions and unrealistic situations, there remain 20 possible different research scenarios which are illustrated in table 1.

Table 1: Analysis of real multitasking options.

			Communicating		
Type	Control	Media	Zero	Single	Multiple
Single	Voluntary	Compartmentalised		A	
		Non compartmentalised			
	Involuntary	Compartmentalised			X
		Non compartmentalised			X
	Both	Compartmentalised			
		Non compartmentalised			
Multiple	Voluntary	Compartmentalised			
		Non compartmentalised			
	Involuntary	Compartmentalised			X
		Non compartmentalised			X
	Both	Compartmentalised			B
		Non compartmentalised			

X	Rare or impractical
	Feasible scenarios

Two of the feasible scenarios are illustrated in the following examples.

- A worker may be engaged in single activity multitasking with single communication, voluntary interruption only and noncompatmentalized media. For example, an analyst is preparing a report with a colleague in a meeting room using a single laptop which is not networked, with no telephone in the room and a 'do not disturb' notice on the door. Here there is single line of communication and both workers may be using a word processor, a spreadsheet and a graphics tool where they may be changing numbers on the spreadsheet and then cutting and pasting the result into the document (or using hot linking to do the same thing). Switching is almost completely controlled. It is a non compartmentalised environment, but that is not relevant as there is only one form of communication. This situation is marked by the letter 'A' in table 1.
- Another worker may be in an environment where she is multitasking and multicommunicating with a number of other people by e-mail and telephone whilst, using two computers and being likely to be interrupted by calls from clients at any time. This form of working might be typical in areas such as share dealing, trading or sales. In this case, the business imperative may be to respond quickly to a rapidly changing external environment or to short term market opportunities. This is clearly a more complex environment than that in the preceding example. In such an environment, compartmentalisation may or may not be essential depending on the nature of the activity. 'B' in table 1 shows the positioning of such an activity for which compartmentalisation is necessary.

The nature of multitasking quite different in these two examples. Consequently the problem of evaluating the impact of this form of working on productivity is different in each case. While, in both of these examples, intuition suggests that these forms of multitasking will have a positive impact on effectiveness and output, if the environments were to be reversed, i.e. the first worker was trying to produce his report while simultaneously communicating with several other people on other matters, it is probable that his effectiveness would be considerably diminished.

A final factor, which might be considered a fifth dimension not shown in figure 1, is worker's ability to multitask. Research suggests that this skill varies by individual. For example Dzubak says that there is some evidence that multitasking capability improves with practice. Craik and Bialystock (2006) on the other hand suggest that multitasking ability disimproves with age (though in a rather interesting aside they suggest that this effect is less marked in bilingual people). Dzubak also claims that some young people are highly skilled at multitasking by the time they reach university level. To date, there is no convincing evidence that such people learn any more effectively than those who are less skilled at multitasking. Nonetheless, it is possible some people will be more effective at switching and multitasking than others. There are certainly people who are uncomfortable when faced with multiple tasks.

6. Evaluating multitasking

The above discussion leads to the proposed research framework in figure 2:

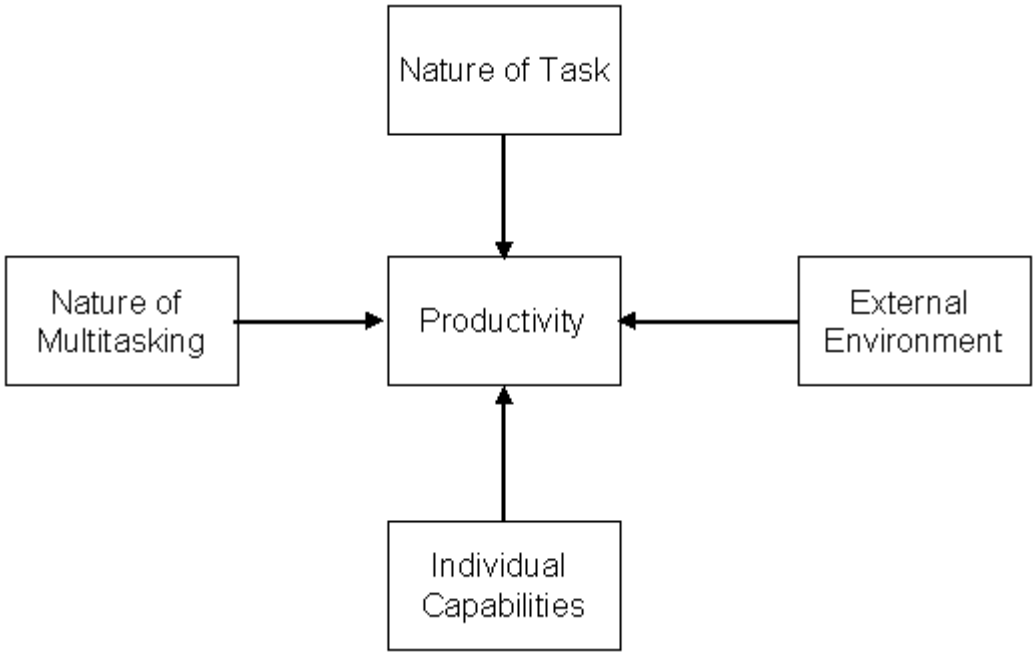

Figure 2: Research framework for multitasking evaluation.

While it may be possible to treat this as a multivariate analysis problem, this analysis suggests that generalised statements about multitasking may less useful than studies of specific work types and conditions/contexts. For example, the research by Aral *et al* cited above only looks at one of the 20 possible situations (multiple tasks, compartmentalised media, multicommunication and involuntary interruption – situation B in table 1). A researcher wishing to study multitasking will need to select which values on each of the four dimensions in table 1 (s)he wishes to examine even before considering individual capability. It may well be that findings for one scenario can be extrapolated into one or more other scenarios, but, *a priori*, this is not self evident.

7. Conclusion

As noted above in section four, while there is a large body of research into multi-tasking and worker distraction in other fields, there has been relatively little research to date into multitasking from an ICT evaluation perspective. There is evidence that the prevalence of multitasking as a style of working (and living) is increasing, although some claim that after a period of popularity, it may be about to go into decline (Kirn 2007). What is clear is that there is a need for research at several different levels into this phenomenon and how it impacts on the effectiveness of knowledge workers. The conjectures arising from this paper are, therefore, that:

1. Assumptions that are commonly made about multitasking and multi-communicating for knowledge and office workers are not necessarily untrue, but are not well founded;
2. There are considerable gaps in the ICT evaluation literature with regard to the impact of multitasking on productivity and
3. The research problem is complex with several dimensions. It is not obvious that findings in one situation are generalisable to others.

It is proposed that four types of research need to be considered:

1. The first is the type of case study carried out by Aral *et al*.(2006). There are several challenges that arise in this type of research. Not the least of these is that one needs an accessible and suitable set of data. This is only likely to exist for certain specific types of data (such as e-mails or maybe telephone calls). There may be little or no data on, for example, unscheduled interruptions hyperlinking or people 'digressing' while looking up something on the Web. Nonetheless, there is scope here if the right data can be found in a suitable organisation.
2. A second possibility is a longitudinal study. The problem is that for the purposes of comparison, data needs to be gathered before and after the introduction of the technology. If the pre-implementation data does not exist, such a study would have to take place in a situation where a technology was scheduled for introduction in the near future. The ethnographic approach used by Gonzáles and Mark (2004) falls into this category, but while their methodology was well suited to answer their research question (which was about how users 'blocked;' their work activities into what they termed 'working spheres'), it is hard to see how this could yield useful measurement of productivity impacts without the presence of an alternative model or control group.
3. A third possibility is set up an experiment with appropriate control groups. This would be the ideal solution, especially if groups of workers in the same organisation carrying out similar tasks could be used. This would require careful control to, for example, limit the tendency of workers to self interrupt. It would also be necessary to allow for different individual task efficiencies and individual's ability to concentrate. This could be done by, say, getting two groups to work in multitasking and monotasking (or low switch rate multitasking) modes and then switching them around after a certain period.
4. Fourthly, direct measurements of individual multitasking ability can be used (see, for example, Fisher et al (2003)).

A final complication is that in any study of the impact of ICT on knowledge workers, distilling out the impact of multitasking from other effects may be difficult.

Gezell (2007, p22), citing *Time Magazine*, notes that:

> *"Decades of research (not to mention common sense) indicate that the quality of one's output and depth of thought deteriorate as one attends to ever more tasks"*

Gezell advocates monotasking and the concept of a *point of concentration* (POC) which is something on which a worker should focus all of his or her attention for the duration of a task. It has been stressed in this paper that, whether widespread adoption of such a mode of working in knowledge organisations would prove more effective and productive over the long term is not self evident. There is a need for good empirical evidence and there are considerable opportunities here for well designed research.

This paper does not attempt to provide a definitive answer the questions set out in the opening section. What it tries to do is draw attention to the importance of this question and to provide a framework within which research into multitasking can be carried out. There is an implicit assumption by many businesses that multitasking and multicommunicating, even in situations that do not require it to achieve a single objective, is a good thing and that, if it has some drawbacks, then they are outweighed by the benefits. While this may be the case, it is by no means clear that it is so and the limited research to date has only considered highly specific conditions which are certainly not generalisable to the entire modern workspace.

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A Case Study of SME Web Application Development Effectiveness via Agile Methods

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Abstract: The development of Web applications is an important focus of the modern information enabled organization – whether the Web application development is in-house, outsourced, or purchased as '*commercial-off-the-shelf*' (COTS) software. Traditionally Web application development has been delivered via the dominant waterfall system. The waterfall system relies upon well-defined governance structures, linear phases, gating, and extensive reporting and sign-off documentation. An increasing number of development stakeholders criticise the waterfall system for web application development. The criticisms include a disproportionate focus on governance and process at the direct expense of flexibility and, most importantly, reduced productivity. One consequence of these criticisms is the increasing adoption of Web application development via agile-system methods. This agile-system approach centres upon smaller design teams, fewer development phases, and shorter development time tables.

This case study examines the implementation of the agile-system approach as used by a Small-to-Medium Enterprise (SME) software developer. The case study data collection involves interviews and observations across three different SME sources: project managers, Web application programmers, and customers. The case study analysis synthesises the experiences of these managers, programmers and customers to produce an overall assessment of the usefulness of Web application delivery via agile-system methods. The major conclusions from the case study are that a '*default*' agile-system approach may be tailored or fine-tuned to fit an individual developer's software process. This tailoring is based upon the developer's assessment of best practice from the overall agile-system methodology. This tailoring, however, delivers a software development process that exhibits efficiencies and risks. The efficiencies include a more fulfilling role for each development team member, greater richness and continuity in design, a simple management system that delivers key information on a timely basis to all stake-holders, and increased business and technical quality within the delivered application, and a relatively low cost for actioning changes to user requirements. The risks pivot upon experience levels, skills levels, and the quality of interaction within – and between - both the development team and customer organization.

Keywords: project management, information systems management, methodology, agile-system

1. Introduction

Information system (IS) development is a much studied, heavily practised activity. The term '*IS development*' is used in this paper to describe the overall evolutionary life-cycle of an IS. That is, capturing and validating user requirements, estimating feasibility, analysis, design, testing, implementation and maintenance. The term '*method*' is used in this paper to denote an overall strategy that is used to guide and manage an IS life-cycle.

As outlined in (Boehm, 2004), the history of IS development has been characterised by three distinct generations or paradigms of IS development methods – and consequential '*method wars*'. The paradigm comprising structured analysis and design methods initially found its voice in methodologists such as Tom Demarco, Ed Yourdon, Larry Constantine, Harlan Mills, Michael Jackson, and many others. The subsequent era of object-oriented analysis and design methods found its voice in proponents such as Jim Rumbaugh, Ivar Jacobson, Peter Coad, and many others. The current '*post-dot-bomb era*' has seen a new method paradigm emerge – championed by individuals such as Kent Beck, Martin Fowler, Robert Martin, and many others. This new method paradigm is referred as '*agile methods*'.

The current dominant software development paradigm has evolved from the structured analysis and design methods of Demarco et al. and the object-oriented analysis of Rumbaugh et al. This paradigm is referred to as the traditional approach or waterfall model and is characterized as plan-driven and process oriented. (Boehm, 2004) states that the traditional approach is perhaps best exemplified by the Capability Maturity Model for Software (SW-CMM) (Paulk, 1993) and its evolutionary successor the Capability Maturity Model Integration (Version 1.2) described in (Chrissis, 2006). As stated in (Boehm, 2004), "*Thousands of organizations have embraced the SW-CMM and have found that their software development became less chaotic.*"

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During the post 2000 era, the environment in which software is conceived, specified, created, and maintained continues to change rapidly and significantly. Software systems continue to grow in size and complexity. Software system delivery is now achieved through a broad mix of in-house, outsourced, and commercial-off-the-shelf (COTS) development strategies. Software is truly ubiquitous – it is routinely found in our business, leisure, and home lives. Software quality, ease of use, and time-to-market are very important to both developers and users. Very significant emphasis has been placed on the demand for flexible development methods (Lee, 2005) that can handle this rapid environmental change and increasing complexity (Lycett, 1999). This view is echoed in (Boehm, 2004) who states "*In the past few years, the mainstream software development community has been challenged by a counter-culture movement that addresses change from a radically different perspective. This new approach, called 'agile' by its proponents, is best exemplified by their Agile Manifesto:*"

We have come to value:

Individuals and interactions over process and tools;

Working software over comprehensive documentation;

Customer collaboration over contract negotiation;

Responding to change over following a plan.

That is, while there is value in the items on the right, we value the items on the left more.

(Boehm, 2004) describes agile methods as encouraging "programmers to shed their heavyweight process chains, embrace change, and escape into agility. Advocated methods have short cycle times, close customer involvement, and an adaptive rather than predictive mind set." (Highsmith, 1999; Fowler, 2001) describes agile methods as a "just enough" method strategy because agile methods aim to avoid prescribing cumbersome and time-consuming processes that add little value to the software product and actually elongate the development process.

Whilst it is generally accepted that there are some perceived shortcomings with the traditional/plan-driven IS development process (Grisham, 2005), it is very important to all IS stakeholders that agile methods are not prematurely or unjustifiably seen to be the latest '*silver bullet*' solution to existing problems in software development. Whilst there is a growing body of research into IS development via agile methods, it would seem that this work focuses upon large organizations and/or industrial product settings. The quantitative survey described in (Rumpe, 2002) focused mainly on the IS developer. (Macias, 2003) compared developer effort under both the traditional and agile methods. Productivity was investigated in (Wood, 2003), defect management/maintenance described in (Poole, 2001), and the customising of agile methods within the software process of Intel Ireland in (Fitzgerald, 2006).

This paper describes a Small-to-Medium Enterprise (SME) case study focusing upon the efficiency of Web centric information system (IS) development. The case study SME implements a software process via a combination of two agile methods (Scrum and Extreme Programming or XP). Specifically our two research objectives were to investigate the following:

- How the methods were used in practice – with an emphasis placed on any fine-tuning or tailoring of each method
- The efficiencies and risks of agile development as implemented within the context of the case study SME.

This paper unfolds in the following format. Section two firstly provides an overview of currently available agile methods, and then proceeds to describe Extreme Programming (XP) and Scrum in greater detail. Section three discusses the research method underpinning this paper. Section four presents an analysis of the results from this research. Section five concludes the paper.

2. Agile methods

All agile methods are described in (Abrahamsson, 2002) as displaying the following attributes:

- *Incremental development*: small software releases with rapid development cycles.
- *Cooperative development*: close customer and developer interaction.
- *Method simplicity*: easy to learn, modify and document.
- *Adaptive development*: simple and effective change management at any point within the overall software life-cycle.

This section will firstly describe in overview the most commonly encountered range of agile methods. The methods will be introduced in alphabetical order. The section will then treat in more detail the two agile methods underpinning this research (Extreme Programming, or XP, and Scrum).

2.1 Agile methods overview

Adaptive software development: ASD (Highsmith, 2000) promotes a change-oriented strategy to the software development of large, complex systems. The method encourages incremental and iterative development with constant prototyping. (Abrahamsson, 2002) states that "*ASD claims to provide a framework with enough guidance to prevent projects from falling into chaos, but not too much, which could suppress emergence and creativity.*"

Agile modeling: (Ambler, 2002) describes the key points of AM as the agile practices and cultural principles. The AM modeling practices encourage developers to produce sufficiently advanced models to meet design needs and all documentation purposes. The cultural principles promote communication, team structure organization and team work practices.

Crystal family: (Cockburn, 2000 and 2002) describe a framework of related methods that address the variability of the environment and the specific characteristics of projects. The term "*Crystal*" is used as a metaphor to describe the "*color*" and "*hardness*" or "*heaviness*" of each method. The appropriate Crystal method is selected according to development team size and project criticality. Crystal methods share two fundamental values: the appropriate level of effective communication and a high tolerance of change within the project.

Dynamic systems development method: (DSDM Consortium, 1997) and (Stapleton, 1997) describe more of a framework for developing software rather than a particular method. The five phase DSDM life cycle provides for project management activities and risk management. (Abrahamsson, 2002) states that: "*The fundamental idea behind DSDM is that instead of fixing the amount of functionality in a product, and then adjusting time and resources to reach that functionality, it is preferred to fix time and resources, and then adjust the amount of functionality accordingly.*" DSDM is consistently described as the first truly agile software development method.

Feature-driven development: FDD (Palmer, 2002) focuses on simple process, efficient modeling, and short, iterative cycles. (Boehm, 2004) describes how "FDD depends heavily on good people for domain knowledge, design, and development. A central goal is to have the process in the background to support rather than drive the team." FDD does not assign collective ownership of project tasks (including code base) unlike other agile methods including Extreme Programming. (Boehm, 2004) states that the FDD focus on architecture and "getting it right the first time" is very much the "antithesis of XP's collective ownership" and that "this makes FDD strong for more stable systems with predictable evolution, more vulnerable to nonpredictable 'architecture-breaker' changes."

Rational Unified Process: RUP (Kruchten, 1999) works closely with the Unified Modeling Language (UML). Indeed RUP and UML were designed concurrently by Rational Corporation (now a division of IBM). RUP is characterized by a large volume of process guidelines and is therefore often viewed as a plan-driven, "*heavy*" process. RUP does, however, also display many agile philosophies and is therefore better classified as a "*hybrid*" – incorporating ideas from the agile and disciplined/plan-driven paradigms (Boehm, 2004). RUP addresses business workflows and development economic factors that are usually not specifically covered in other methods. (Boehm, 2004) states that "*RUP is currently being extended to address customer economics and return-on-investment considerations.*" RUP is consistently described as better suited to large projects.

2.2 Extreme programming (XP) and scrum

Section 2.1 overviewed the range of agile methods that feature most prominently within the existing software development environment. This section will now describe the two agile methods that have been studied within this case study research. The two methods are Extreme Programming and Scrum

Extreme Programming (XP) is the most widely recognized agile method (Boehm, 2004). XP has been pioneered by Kent Beck and is described in (Beck, 2000) as "*a light-weight methodology for small-to-medium-sized teams developing software in the face of vague or rapidly-changing requirements*". XP originated as a prototypical C3 payroll system development project within the Daimler-Chrysler organization. XP is based on four values and an initial set of twelve practices. The four values are as follows:

- *Communication*: Most project problems occur because of poor communication – therefore XP strongly promotes communication in a positive fashion.
- *Simplicity*: Develop the simplest product that meets the customer's needs.
- *Feedback*: Developers must obtain and value feedback from the customer, from the system, and from each other.
- *Courage*: Be prepared to make hard decisions that support the other principles and practices.

The twelve key practices of XP are shown in Table 1.

Table 1: XP Twelve key practices

Key Practice	Explanation
The planning game	A quick determination of the scope of the next software release, based on a combination of business priorities and technical estimates. It is accepted that this plan will probably change.
Small releases	Produce a simple working system quickly, and then release new versions on a very short cycle.
Metaphor	Guide all development with a simple shared story of how the whole system works.
Simple design	The system should be designed as simply as possible at any given moment of time.
Continuous testing (or Test driven development)	Programmers continually write tests, which must be run flawlessly for development to proceed. Customers write function tests to demonstrate the features implemented.
Refactoring	Programmers restructure the system, without removing functionality, to improve non-functional aspects, simplicity and flexibility. Refactoring strongly focuses upon the removal of code duplication.
Pair-programming	All production code is written by two programmers at one machine.
Collective ownership	Any programmer can change any code anywhere in the system at any time.
Continuous Integration	Integrate and build the system every time a task is completed. It is a fundamental requirement to always have an up-to-date working prototype.
Forty hour week	Work no more than 40 hours per week as a rule.
On-site customers	A customer representative (i.e. a subject matter expert) works full time within the development team.
Coding standards	Adherence to coding rules that emphasise communication via program code

Scrum (Schwaber, 1995; Schwaber, 2002) is depicted in Figure 1. Scrum is a simple low overhead process for managing and tracking software development. Scrum has a very clear project management emphasis. Scrum is predicated on the concept that software development is not a cleanly defined process, but a series of '*black boxes*' with complex input/output transformations. The Scrum process begins with the creation of the *Product Backlog* comprising the prioritized product features required by the customer. The next phase of Scrum centres upon a series of 30 day Scrum *Sprints*. During each *Sprint* the Scrum team will complete a working set of features that have been selected (during a Scrum *pre-Sprint* planning session) from the overall *Product Backlog*. Short (e.g. 15 minute) meetings are held by the Scrum tea m on each day of the Scrum *Sprint*. Each daily meeting allows the team to monitor project status and discuss problems and issues. The conclusion of each 30 day *Sprint* involves the software demonstration of the product features that have been completed during that *Sprint*.

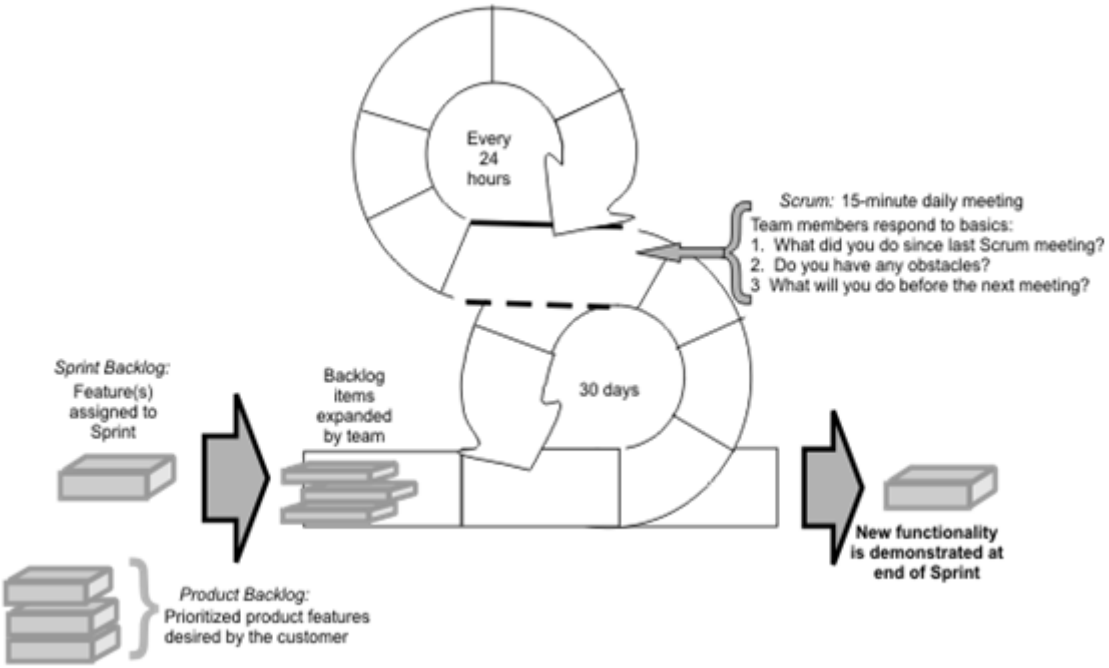

Figure 1: Scrum (Source: ControlChaos.com)

3. Research methodology

The objective of this research was to examine the use of agile methods within a SME software developer, and to gain an understanding of the enabling and limiting factors associated with the usage of these agile methods. The research study has been carried out between November 2007 and March 2008. The SME software developer deploys a project team of seven staff (plus one consulting customer representative) to produce software that is best characterised as web driven client service interfaces to back end database services.

In overview, an interpretative, exploratory case study research methodology was adopted for this investigation. An interpretive methodology is considered appropriate in relatively new and evolving fields such as Information Systems (Walsham, 1995a, b). Within the overall IS area, agile methods have only recently attracted research attention, and little or no research is available as to the efficiencies and risks of agile methods within the SME software development sector. (Travers, 2001) also states that interpretivist research is considered most appropriate when it is necessary to consider the "*often complicated relationship between people, ideas and institutions*". Case study research is comprehensively discussed in (Yin, 2003). (Benbasat, 1987, Yin, 2003, Marshall, 1989) suggest the case study approach is appropriate where the research has a descriptive, exploratory focus. (Yin, 2003) promotes that case studies can be very valuable in generating an understanding of reality, and describes the single, in-depth case study as the "*revelatory case*". (Mintzberg, 1979) strongly recommends a single case study strategy. (Zelkowitz, 1998) describes how case studies in software engineering facilitate the testing of theories and the collection of data in "*an unmodified setting*". This is also very much the view of (Kitchenham, 1995) where case studies are viewed as "*research in the typical*". The case study of this research is exploratory and therefore the results obtained cannot be immediately generalised to any other settings beyond the studied SME and the specific development project. Whilst this result suggests a lack of external validity within this research – it is stressed that the exploratory nature of this investigation aims to generate findings that may subsequently be used to generate hypotheses suitable for testing in a more quantitative fashion.

The data collection within this case study was conducted via qualitative research methods. A series of primary and secondary personal interviews were conducted over the four months of the case study with the SME project manager and several key project stake-holders. Primary interviews averaged two hours in duration. Secondary interviews averaged twenty minutes duration and were used to clarify and refine issues as they emerged. Primary interviews were semi-structured (Patton, 1990) and comprised open-ended questions relating to the use of XP and Scrum within the overall SME software development process. Questioning centred upon a factor listing of all individual components within the '*default*' XP and Scrum processes. Interviewees described how each factor list entry had been implemented within the project and

also assessed the enabling/limiting issues associated with the specific entry. Each interviewee was then requested to assess each factor list entry according to the following set of ordinal values: {*strongly helpful, helpful, improvable, difficult, not-workable*}. Interview transcripts were then coded and analysed using the Glaser-Strauss' *constant comparison* method (Glaser, 1967) to elicit the major efficiency and risk themes. The summarised themes were presented to all research participants at project end to validate the semantic analysis. These summarised themes are presented as research results in the next section.

Concurrent protocol analysis was used to investigate and quantify the cost of requirements change (measured in effort, i.e. person/hour) occurring within the software development cycle up to (but not post) product delivery. Concurrent protocol analysis is an empirical research method for studying the cognitive behaviours and thought processes used by problem solvers (Ericsson, 1993). Concurrent protocols are generated when the problem solver verbalises his/her thoughts while working on a specific task. The verbalisations are recorded during the process and analysed at a later time. Two requirements relate to the validity of concurrent protocol analysis. The first requirement is that the verbalisation of thoughts will not affect the problem solving process. Whilst research continues in relation to this requirement, (Ericsson, 2003) has concluded that concurrent verbalisation does not alter the structure of thought processes. The second requirement is that the problem solving process has a conversational characteristic and therefore lends itself to subsequent semantic analysis by the researcher. This requirement is met in this research by reducing the language/protocol tokens (i.e. the words spoken and recorded) to the following simple language/protocol described in Table 2.

Table 2: Protocol analysis verbal tokens

Date : time started	[**dd:mm and hh:mm**]
Activity Type	[**Design Change** OR **Refactoring** OR **Error Fix**]
Activity Task	[**Analysis**] OR **[Coding]** If coding: **[Class Name:name] [Method Name:name] [Line Number(s):nn]**
Date /time ended	**[dd/mm and hh:mm]**

The verbal tokens described in bold font in Table 2 ensure that the protocol remains very lightweight, non-intrusive upon developer concentration/thought, and easily learned. The developer verbalises the starting *date:time* – then verbalises the current activity type and current activity task. If the developer verbalises **Analysis** then nothing further is required until there is a change of activity – or the session ends. If the developer verbalises **Coding**, then the developer verbalises the **Class Name:name**, **Method Name:name**, and **Line Number(s):nn updated**. A protocol analysis session may iterate through one or more instances of Activity Type and Activity Task. The differentiation of **Analysis** and **Coding** enables separate data capturing for '*thought'* process effort (i.e. Analysis) and coding effort (i.e. Coding). The developer verbalises the end time when the session has concluded. The recorded sessions are then analysed and the relevant data collected.

4. Research results

This section will firstly present project data to normalise this investigation within the overall paradigm of agile method case study research. This normalisation is important because exploratory case study research results cannot be generalised beyond the studied SME and specific project. Normalisation will mitigate this limitation in as much as the results from this research may be compared within an overall context of agile method case study investigation.

This section will then present the major deliverables from this research: the description of how XP and Scrum have been tailored (i.e. fine-tuned) within the SME software developer, and the research assessment of the overall SME software development process.

4.1 Normalisation

Normalisation of this case study is based on the Extreme Programming Evaluation Framework (XP-EF) presented in (Layman, 2006). The XP-EF comprises eight dimensions: *developmental factors*, *sociological factors, project-specific factors, technological factors, ergonomic factors, geographical factors, planning adherence metrics*, and *testing adherence metrics*. This normalisation section will use two of these eight

dimensions: *sociological factors* (Table 3) and *project-specific factors* (Table 4. It is felt that the data treated in the remaining six dimensions will be largely covered by the results presented within the Section 4.2 (*Tailoring and Research Assessment*).

Table 3: Sociological factors

Sociological Context Factor	Value
Team size (number of developers)	7 + 1 tester
Team education level	Bachelors: 7 + 1 tester (customer/business expert) PhD: 1
Team experience level	1 to 5 years: 6 + 1 tester (customer/business expert) 6 to 10+ years: 1
Domain expertise	Medium
Language expertise	Medium to High
Project management expertise	High
Personnel turnover	12.5% (defined as the percentage number of weeks of incoming new staff – relative to the overall project staffing number of weeks)
Morale factors	None (defined within this case study as personnel issues requiring managerial or staff association intervention)

The *sociological factors* in Table 3 show that the project team within this case study were technical competent and led by and experience project manager. The personnel turnover resulted from two people leaving the project (and being replaced immediately) at the eight week mark. Morale throughout project life was very good.

Table 4: Project specific factors

Project-Specific Context Factor	Value
New and Changed User Specifications	18
Domain	Web interface client – database service
Relative complexity	Moderate
Total Component Classes	350
Total Component Methods	482
KLOEC (thousand lines of executable code)	71

The *project-specific factors* in Table 4 show a small size project of moderate complexity. *New and Changed User Specifications* represent the effort expended in capturing user requirements for the software application (i.e. business analysis/requirements engineering).

4.2 Tailoring and research assessment

This section will firstly discuss the tailoring of Scrum within the targeted SME's software development process. The section will then discuss the overall research assessment of the tailored Scrum/XP software development process as measured by the investigative approaches outlined in Section 3.

Tailoring of Scrum and XP within the SME development process is shown in Figure 2.

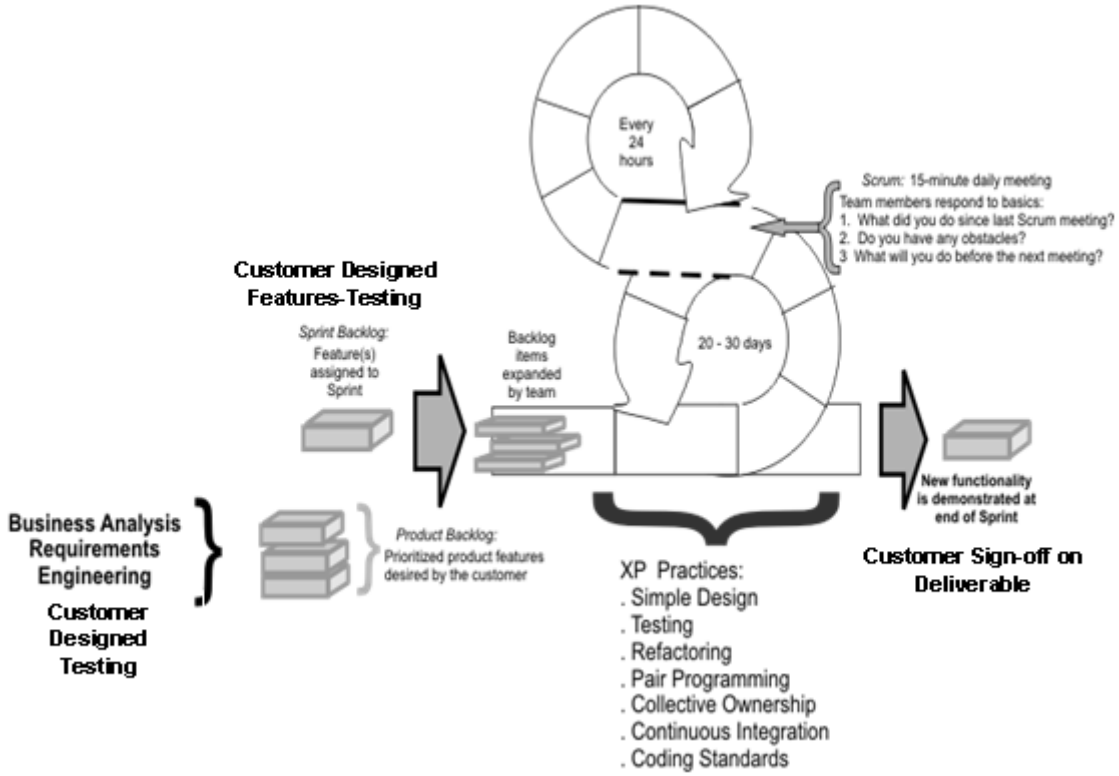

Figure 2: Scrum and XP Practices as implemented within SME

This tailoring described in Figure 2 involves (1) the Scrum *planning* or *front end* stage, (2) the *pre-Sprint* stage, (3) the *Sprint* stage (in which seven of the twelve XP practices have been incorporated), and (4) the Scrum *closure* stage.

Tailoring of the Scrum *planning* or *font end* stage is as follows:

- The addition of a detailed *Business Analysis* of the proposed software application by the project manager and the customer. This analysis aligns the business model, the required business functionality and business processes (both existing and proposed) with the proposed software project automation. It complements the *Requirements Engineering* that is conducted during the Scrum *planning* stage to provide the developer with an overall project management context.
- The addition of *Customer Designed Testing*. This addition is the logical extension by the SME of '*test driven development*'. The test suite is written by the customer (with the assistance of the project manager) and reflects the overall business process functionality of the project deliverable.

Tailoring of the Scrum *pre-Sprint planning* stage is as follows:

- The addition of a *Customer Designed Features Testing*. The test suite is written by the customer (with the assistance of the project manager) and tests the business process functionality of the specific project features that have been selected for the imminent (i.e. next) Scrum *Sprint*. The test suite will be used during the *Sprint* stage. This test suite will be complemented by the conventional *unit-tests* and *integration-tests* that will be developed by the project developers with the aim of gauging code integrity/correctness.

Tailoring of each Scrum *Sprint* stage is as follows:

- The SME has inbuilt further flexibility to each *Sprint* timetable. The *Sprint* duration is planned for 20 days, but can expand to a maximum of 30 days. This timetable flexibility is an explicit risk management control. It is specifically applied to the *Sprint* stage (as contrasted with the overall Scrum cycle) because the SME considers the *Sprint* stage to be the most undefined, complex management component of the overall software development process.
- The *Sprint* stage comprises the following XP practices: *simple design, testing, refactoring, pair programming, collective ownership, continuous integration*, and *coding standards*. The following XP practices have not been incorporated: *planning game, forty hour week, short release cycles*, and *metaphor.* The XP practice *on-site customer* is not included in the Sprint stage. The customer is '*on-site*' as a consultant with the development team during Scrum *planning* stage, the *pre-Sprint* stage, and the

closure stage. The customer does not significantly co-locate with the development team at any stage during the project.

Tailoring of the Scrum *Sprint closure stage* is as follows:

- The *Customer Sign-off on Deliverable* has been inbuilt into each Scrum *Sprint closure* stage. This sign-off applies to unit deliverables, integrated deliverables, and ultimately, the final product deliverable.

The research assessment of the tailored Scrum/XP software development process is now presented. Table 5 shows the tailored Scrum process assessment. Table 6 shows the tailored XP process assessment. Table 7 shows the research assessment of those XP practices that are either partially implemented or not implemented within the SME software development process. Each table is structured as follows:

Table 5: Research assessment of tailored Scrum processes

Stage/Practice	As outlined in Section 3, each interviewee (i.e. all project members, including the customer) was requested to assess each Scrum/XP stage/practice from the following set of ordinal labels: {*strongly helpful, helpful, improvable, difficult, not-workable*}. The Overall Assessment represents the modal value from this data set.
Overall Assessment	
Efficiencies	Interview transcripts with all project members were coded and analysed using the Glaser-Strauss' *constant comparison* method (Glaser, 1967) to elicit the major themes (both positives and risks). Efficiencies describe the major positives identified by the analysis.
Risks	Interview transcripts with all project members were coded and analysed (as outlined above in Efficiencies) facilitating the identification of the major risks associated with a particular stage/practice.

Stage/Practice Overall Assessment	Efficiencies	Risks
Scrum Planning *Strongly Helpful*	Business Analysis (BA) and Customer Designed Testing produce richer and more accurate specifications, with fewer subsequent changes, for customer and developer. BA facilitates a business process redesign approach that more fully captures (for the customer) the potential efficiencies of proposed software automation. Builds stronger trust – at the earliest stage - between customer and developer. Facilitates risk management from the earliest stage.	Customer - project manager disconnection: at social, cultural, geographical or business levels. Project manager deficiency: BA technical competency, social and management skills, software development experience, consultative decision making, continuity for project duration. Customer deficiency: business process knowledge, level of authority within business, consultative decision making, continuity for project duration.
Scrum pre-Sprint Planning *Strongly Helpful*	Alignment of overall project goal with individual milestones. Allows different methodologies for various project estimations. Facilitates risk management and contingency planning within next Sprint (based on the minimal 20 day Sprint duration). *Customer Designed Features Testing* aligns business functionality with software correctness – the right product for customer.	Over-complex planning (e.g. intricate task inter-dependencies) Project personnel difficulties (vacancies, recruitment of experienced developers). Customer deficiency: business process knowledge, level of authority within business, continuity for project duration. Overdesigned customer features.
Scrum Sprint	Assessed in terms of individual XP practices (see Table 5)	
Scrum Sprint Closure *Strongly Helpful*	Confirms quality (i.e. business process accuracy and technical integrity) of each project component as completed. Simplifies integration of the produced components. Better and timelier information for customer.	Changed/changing (i.e. since *Sprint* commencement) business environment or business processes within customer organization.

Table 6: Research assessment of tailored XP practices

Stage/Practice Overall Assessment	Efficiencies	Risks
Pair Programming *Improvable*	Increased quality (lower defect densities) and productivity (earlier reaching of milestones). Increased technical problem solving. Simpler code design. Greater adherence to programming standards. Increased morale within well matched programming pairs.	Not productive for simple coding tasks. Non-compatible programming pairs (on social level, problem-solving/analytical level, experience level). Inappropriate work load allocation to unevenly matched pairs. Difficult to align with induction of new project staff.
Continuous Testing / Test Driven Development *Strongly Helpful*	Alignment of business functionality and software quality – the right product deliverable for the developer and customer. Timelier and more accurate design specifications. Fewer changes to design specifications.	Customer's business process knowledge not aligned with project module currently under design. Difficult to establish the correct number of tests.
Refactoring *Helpful*	Reduced debugging time. Simpler and cleaner software architecture.	Time delay problematic. Complicated by inadequate design specifications. Ineffective automation tools. Incompatibility with some quality control standards.
Simple Design *Improvable*	Delivers necessary and sufficient end product.	Can create an over-reliance on the code being the documentation. Difficult to establish a generalised standard or protocol.
Collective Ownership *Improvable*	Promotes team work – flatter (less hierarchical) project team. Greater knowledge of overall software architecture. Increased adherence to software architecture standards.	Incompatibility with some quality control standards. Does not scale well in terms of project team numbers.
Continuous Integration *Improvable*	Greater knowledge of overall project architecture. Increased capability for integrated testing. Increased flexibility in personnel management of project team.	Does not scale well in terms of project team numbers or project size/complexity. Complicated by complex, over-engineered module interfaces.
Coding Standards *Very Helpful*	Ensures readability of software architecture. Increased quality control automation.	Acclimatisation time for new project members.

Table 7 below shows the '*default*' XP practices that have been either not implemented or partially implemented (*on-site customer*) within the SME software development process.

Table 7: 'Default' XP practices that have been either not implemented or partially implemented.

Stage/Practice Overall Assessment	Reasons for Non-Use
XP Planning Game *Not-workable*	Considered to focus exclusively upon technical issues (code quality, etc) and personnel issues (staff continuity, expertise, etc). Does not focus adequately on business analysis and building trust between developer and customer.
Small Releases *Not-workable*	Very difficult to produce feature-rich, working software in short time cycles. Non-attractive cost/benefit analysis from customer perspective.
Forty hour week *Not-workable*	Considered unworkable by all project members (including customer). Over-regulation of staff, '*blunt-instrument*' approach to personnel management.
Metaphor *Not-workable*	Concept lacks definition for practical application. Considered too-simplistic and one-dimensional for achieving quality outcome for customer and developer.
On-site customer (full-time) *Not-workable*	Non-attractive cost/benefit analysis from customer perspective. Organisational and resourcing difficulties. Emphasis on a significant trust link between project manager and customer – not practical to establish same link between customer and all development team members. Partially implemented: customer/project manager dialogue during the Scrum Planning, pre-Sprint, and closure stages.

The investigation of the overall development method effectiveness within this case study included a strong focus upon quantifying the cost of requirements change that occurs within the development cycle up to (but not post) product delivery. The cost of requirements change would be measured by developer *effort* – which really is a proxy for *person hours*. That is, the research would measure, for each change to the project design, the total number of *person hours* expended in implementing the change. In designing the case study it was also noted that implementing change comprises multidimensional elements. The researches decided to measure two of these elements:

Analysis effort	The '*thought*' effort that is expended in understanding the change and then planning the integration of the change into the existing design.
Coding effort	The effort that is expended in actually expressing the code with correct syntax quality assured via successful unit testing.

The Research Methodology section described how *protocol analysis* – via a very simple *protocol* design – was utilized to capture the required data for analysis. The protocol design provided for the developer actioning the change to flag what activity (i.e. analysis OR coding) he/she was undertaking. Each recorded session was then analysed and data collected.

Figure 3 shows the total cost of implementing the sixteen changes that were required during the project's development life (excluding the maintenance stage) – and the timing of these changes in relation to the five *Sprint* stages comprising the overall project. Figure 3 also shows a typical cost of change curve that is routinely associated with a plan-driven software development. The plan-driven cost of change curve was initially reported by several US corporations in the 1970s. The initial findings reported a consistent 100:1 ratio between a *post-implementation* stage change cost and a *requirements* stage change cost. (Boehm, 1981) found that while the 100:1 figure was generally true for large software development projects, a 5:1 figure was more in tune with the cost of change in small projects (i.e. 2 to 5 KLOC or Thousand Lines Of Code). More recently (McGibbon, 1996) reported a cost of change range from 70:1 up to 125:1. The plan driven cost of change curve in Figure 3 uses a 5:1 figure.

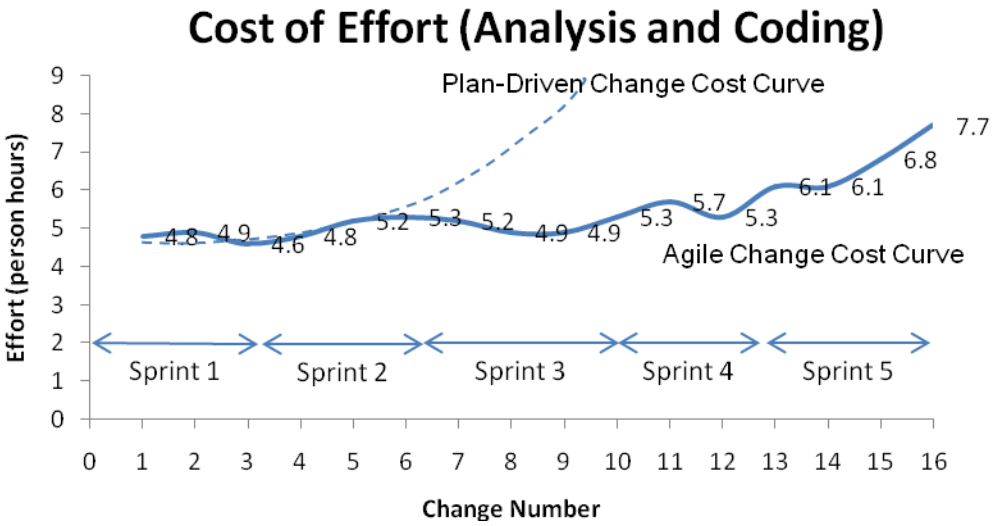

Figure 3: Cost of change curve comparison (agile and plan driven)

As stated earlier in this paper, very little empirical data has been reported within the literature. Indeed (Boehm, 2004) states: "*Although Beck and others have provided anecdotal data on agile change experiences...no empirical data was found for small, agile projects.*" The *anecdotal data* within Boehm's quote refers to the agile cost of change curve presented in Figure 1 of this paper (Introduction).

The agile change of cost data described in Figure 3 initially appears quite impressive. It should be noted, however, that the increase in effort from change 1 (4.8 man hours) to change 16 (7.7 man hours) represents a compound increase of 2.9%.

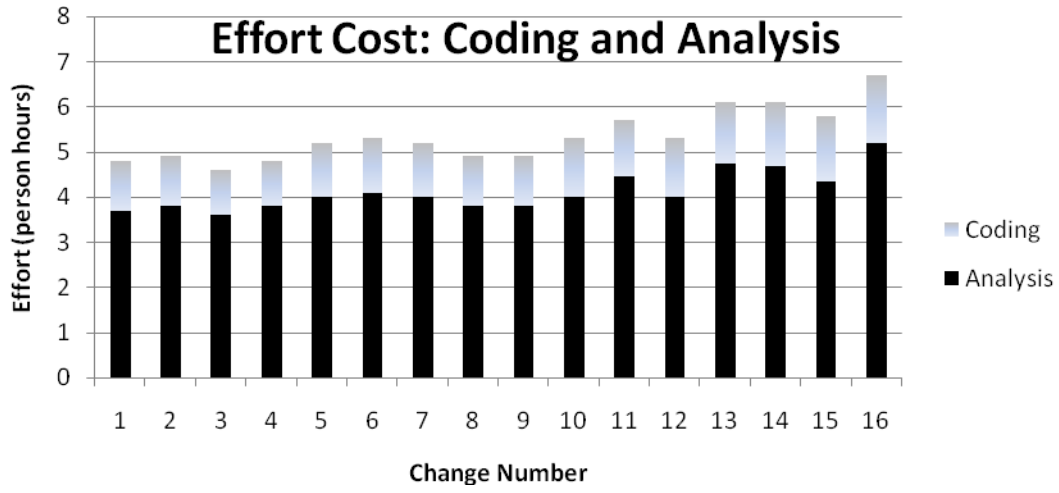

Figure 4: Cost of coding effort and analysis effort

Figure 4 shows the effort costs (again expressed in person hours) for coding and analysis. The compound increase rate for analysis is 2.1% (per change). The compound increase rate for coding is 1.9% (per change). The development team was not surprised by these figures at the post-project review. The development team view was that analysis (meaning the 'thought' that precedes code changes) would consistently be the more time-consuming task.

5. Conclusions

The goals of this case study research were to describe how Scrum and XP practices had been tailored for use within a SME software developer, and to assess the efficiencies and risks of this tailored use. The research results describe those practices that have been '*cherry-picked*' by the SME from the full spectrum of Scrum/XP practices. This is consistent with what is reported in the literature as an emerging trend (Fitzgerald, 2006) with respect to agile methodology usage. The research results also report the major considerations of the SME project team and customer as to why specific practices have been selected in or

out. These considerations confirm that business software development within the SME sector is a complex mix of people, technology, and business processes that at best can be described in a highly abstracted format. The results also reveal some interesting data trends in relation to the cost of requirements change within the development cycle. Change does cost even when using agile methodologies. The designer of XP stated in (Beck, 1999): "*If a flattened cost curve makes XP possible, a steep change cost curve makes XP impossible*". The results in this case study show that change did increase as a function of development cycle time. Consequently change – and its cost – must be carefully risk managed during the project life. Agile development methodologies within the SME business software process contribute many efficiencies – whilst still leaving significant risks for control.

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Improving the Benefits of IT Compliance Using Enterprise Management Information Systems

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Abstract: During the latest years, IT governance has become more and more important. More of the attention on IT Governance is captured by compliance, owing to the recent financial scandals and the severe rules regarding information systems audit and control. Companies need to comply with these rules, but it requires important investments, considered not only strategic but necessary (Remenyi et. al. 2000). However, companies should analyse the compliance requirements to implement an IT governance system, not only to comply with legal rules, but also to improve the strategic alignment between IT and business and to optimise value creation by IT compliance investments (Ventrakaman and Henderson 1996, Van Grembergen 2003).

However, companies have difficulties in implementing IT compliance initiatives, because they are complex and require an integrated approach all over the organization. But IT compliance initiatives often lack an integrated, strategic approach: they only try to comply with the increasing rules affecting IT operations, thereby limiting the value of compliance investments.

To optimise IT compliance, companies should develop an IT compliance strategy, aiming not only to accomplish with regulations, but also to bring processes into compliance. That is, to realise a full integration between operations, risk control, data reliability. To reach this result, compliance automated solutions are indicated, like GCR (Governance, Risk and Compliance) applications. However, standard solutions fail to support specific problems and the individual value proposition of each company: an EIMS (Enterprise Information Management Systems), developed in house, allows automatically managed processes, data and information security, to access control and system performance and to improve data usability, in accordance with company specific organisation and needs.

In this paper, IT compliance is introduced, to define how to orient it to value creation; GRC systems. EIM systems are described, with their different cost and benefits for companies. The aim of the paper is to define how to develop compliance automated systems, to save money and enhance information integration and value. Observations and conclusions derive from practical experience of the author, participating to a project of EIM implementation in a major Italian company.

Keywords: IT governance, risk management, accounting information systems, IT compliance, knowledge management

1. Implementing IT compliance

IT compliance is a required activity for public companies. Indeed, owing to important financial scandals occurred in the past few years, stock exchange authorities all over the world issued regulations to grant higher affordability to financial disclosure. The most known regulation about these topics is Sarbanes-Oxley Act (SOx), issued by USA in 2002 and pursuing a more strict internal audit on accounting and financial documents issued by public companies. All the most industrialised countries issued similar regulations, to regain the trust of investors in financial markets.

Regulations about financial disclosure and internal auditing also affects information systems, because nowadays all the accounting processes are highly computerised. It is impossible to audit accounting without auditing the accounting information systems; it is impossible to grant the affordability of financial disclosure without facing the risks deriving from the use of IT systems.

So, regulations about financial disclosure aim to grant affordability and correctness of financial data and documents issued by public companies; they require an intense activity of audit and control about all the accounting practices. Also information systems should be submitted to the same auditing, and specific controls on IT systems should be implemented to comply with regulations (ITGI 2004).

These duties are really heavy for companies, because all the accounting activity and all the IT systems regarding accounting should be strictly controlled and controls should also be documented, proved and periodically assessed. It requires a big effort to map all the accounting processes, define controls, apply them and report about their functioning. This effort is not efficient if it is focused only on compliance with regulations; it should be important that companies find synergies between IT compliance initiatives and IT strategic goals, to improve the return expected by the implementation of IT compliance framework (Damianides 2005).

To accomplish with regulations, companies should define a complex framework, structuring all the controls necessary to realise the required audit about accounting information systems. These controls are of two types:

- IT general controls;
- IT applications controls.

IT general controls regard the functioning of the IT infrastructure; they should reduce the risk of systems failure, unauthorised access to programs and data, but also assure the systems integrity after operations such as acquisition, implementation, configuration and maintenance of operating systems, database management systems, middleware, communication software and utilities that run the system and allow financial applications to function.

IT applications controls aim to verify the correct functioning of financial applications, but also of ERP systems and of each other process software producing accounting entries. These controls assure completeness, accuracy, authorization and affordable disclosure for each financial information.

Obviously, all companies already have such controls, because they want to secure the correct functioning of their information systems and accounting systems, independently by the new regulations. But SOx and other laws about financial disclosure requires both a more stringent control and documentation, prove and assessing of their effectiveness; few companies already have such an IT control framework, that is, all the information systems auditing should be totally redesigned.

To reach the result of a well conceived IT compliance framework, companies should primarily define a roadmap, describing the processes and activities to exploit, to reach the desired result. This roadmap includes the following steps (Fig. 1).

1. *To define the scope of IT compliance*. Regulations about the reliability of financial disclosure involve information systems only regarding accounting entries. The scope perimeter includes therefore only applications producing or processing financial data. However, enterprise systems create integrated databases and sets of applications, so that almost all the IT applications are included in the scope of IT compliance. It means that the scope of IT compliance is very large and controls should be wide-ranging respect to the information system.
2. *To map and document in-scope IT components*. After defining the IT compliance perimeter, companies should map all the operations composing the processes and document them, outlining the processing regarding each financial data. This map of the accounting information system could be already available in the company, or it could be a good occasion to produce it.
3. *To design the controls*. Companies should then assess the existing risks and threats for data integrity and design a specific control to prevent each of them. Controls are developed and integrated into the accounting applications or in the security systems. All applied controls should be clearly documented, both to demonstrate their existence and to permit their evaluation and monitoring.
4. *To evaluate controls*. Companies should evaluate the good functioning of each control and the solidity of the whole IT compliance framework. It needs to notice the application of controls and to detect malfunctioning of IT systems and accounting applications; it is also necessary to evaluate if controls are able to remediate to systems failure, unauthorised accesses or human mistakes in accounting. It requires to define an evaluation system, but also a responsibility and accountability schema, to attribute the malfunctioning to the manager responsible for it.
5. *To report about the IT compliance activity*. All the IT compliance activities should be reported and documented and results should be clear and available both inside and outside the company. It requires the complete traceability of each computerised operation regarding accounting and financial disclosure.

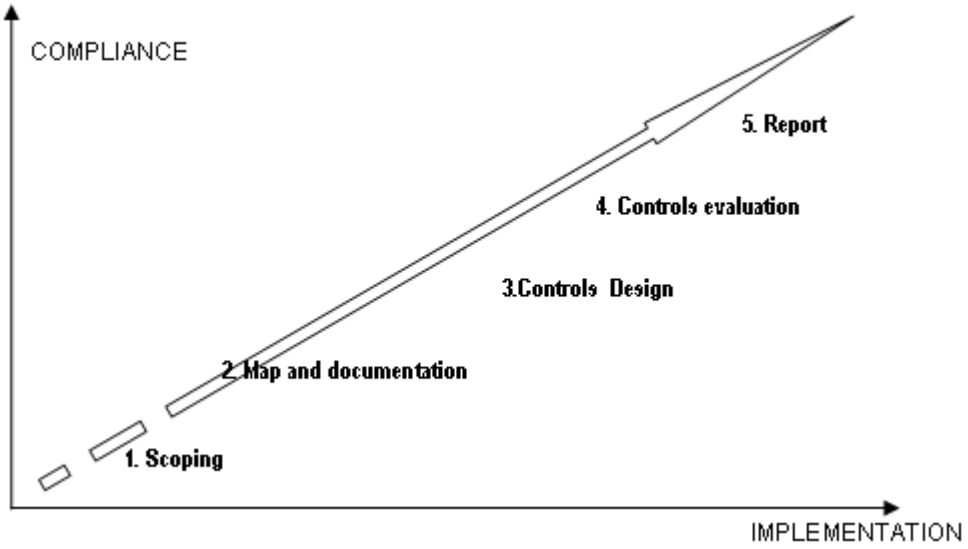

Figure 1: The IT compliance roadmap

2. The standard for IT compliance: they are not the answer

The IT compliance activity is really complex, especially for large companies, with subsidiaries in different countries and listed in different stock exchanges. To support IT compliance, standards are available, to drive companies in doing the right things saving money. These standards are COSO and COBIT.

Committee of Sponsoring Organizations of the Treadway Commission (COSO) is a USA private-sector initiative, formed in 1985. Its major objective is to identify the factors that cause fraudulent financial reporting and to make recommendations to reduce its incidence. COSO has established a common definition of internal controls, standards, and criteria against which companies and organizations can assess their control systems.

COSO framework is designed for internal auditing, but it well supports also IS auditing and drives towards the accomplishment of regulations. Indeed, also for IS auditing it is necessary:

- to asses risks regarding both IT infrastructure and applications, to understand the range of the required IT compliance effort;
- to design not only controls, but a control environment that governs IS security and compliance in an integrated way;
- to define controls and control processes, well explaining the duties to follow and the goals to reach;
- to inform company's people about the compliance activities and to communicate efforts, activities and reached results to external stakeholders and financial markets;
- to monitor the effectiveness of IT controls and to use information about it to review the risk assessment and to continually improve the IT compliance framework.

The Control Objectives for Information and related Technology (COBIT) is a set of best practices for information technology management created by the Information Systems Audit and Control Association (ISACA), and the IT Governance Institute (ITGI) in 1992. COBIT provides managers, auditors, and IT users with a set of generally accepted measures, indicators, processes and best practices to assist them in maximizing the benefits derived through the use of information technology and developing appropriate IT governance and control in a company. The COBIT framework aims to supply an integrated set of instruments to manage all the stages of the life cycle of information systems: plan and organize, acquire and implement, deliver and support, monitor and evaluate.

Applying COBIT, a company could realize a well conceived and integrated control system, able to manage all the processes regarding IT. It is easy to include IT compliance in a COBIT framework, because:

- processes are mapped and documented;
- policies and activities regarding IT and applications are defined and formalised;

- responsibilities and duties are assigned and accountability is assured;
- a detailed monitoring and evaluation framework is applied.

To implement both COSO and COBIT, it is necessary to put together the two frameworks and to link them with the regulations requirements, for example SOx requirements, as in Fig. 2. It means that to realize a secure IT compliance framework:

- regulations requirements define the scope of the compliance;
- COSO components describe how to do;
- COBIT controls define what to do, that is, the IT management processes interested by the compliance activities.

Figure 2: SOx, COSO, COBIT: an integrated framework

Despite the effectiveness of COSO and COBIT, it is not easy to implement them. Companies trying to realize an IT compliance framework designed reflecting COSO and COBIT found it very expensive and hard to do. COBIT is a very complete instrument to obtain a strictly managed and controlled IT environment, but it means:

- to reengineer all the processes of the IT life cycle;
- to formalize all the activities related with IT, submitting them to the strict control of a fixed procedure;
- to standardize each operation on IT, adapting it to the COBIT practices.

The result is:

- on one side, a well formalised, standardized and evaluated IT management system;
- on the other side, a rigid, unspecific and muddled framework, forcing IT people and managers to uncritically execute the established procedures, without opportunity to adapt them to changes or specific situations.

It is therefore important to understand if it is really necessary to implement COSO and COBIT, or if it is possible to use these frameworks to analyse the specific needs and characteristics of a company, and to define a tailored IT compliance environment, able to better fit the business information systems and the unique IT strategic goals of each enterprise.

3. How much does IT compliance cost?

One of the more important consequences of IT compliance duties is the cost of an IT compliance framework.

To implement an IT compliance system is indeed very expensive, because this framework does not impact on a sole application, but it regards a very large portion of the information system. The use of ERP and integrated management information systems, pervasive respect to all the organization, enlarges the scope of

IT compliance and forces to include in the compliance perimeter almost all the IT infrastructure and the applications portfolio.

Moreover, IT compliance cost is not a “one time cost”, but a “in progress cost”. Indeed, regulations requires to asses the IT risks impacting on financial disclosure in every time of the life of a company and to maintain the effectiveness of the control environment when information systems are changed, updated, expanded. It means that IT compliance is a continuous process and that its cost could be like a permanent fee detracting financial resources from the IT budget, that is from strategic, innovative IT investments.

Some researches are already available, to better understand which cost are generated by IT compliance, their amount and how to reduce them.

A survey realised by Financial Executive International in 2007 revealed that extra cost for IT compliance for companies listed at the NYSE are average 4,36 M US $ in the first year of implementation, about 39% higher respect to the companies expectation. The main cost driver is the audit activity, which requires a very high effort. Indeed, companies often have not enough competences to face this task by themselves and therefore they resort to consulting companies, even if their fees are very expensive.

Gartner in 2006 analysed the composition of IT compliance cost and stated that the main item is just the consulting cost, followed by cost for software acquisition or development and cost for staff training. The total amount of expenses for IT compliance is estimated about 1% of revenues and the cost of maintaining the IT compliance environment will amount at 7000 US $ a year per employee.

It means that:

- companies should invest very large amounts in IT compliance;
- if IT compliance initiative are developed only to accomplish duties, no return are expected from these investments, except to avoid sanctions deriving from laws and regulations;
- the IT compliance cost will be a continuous flow of unproductive IT investments during the time;
- IT compliance investments reduce the innovative IT investments or require to increase the IT budgets.

To face this, companies should see at IT initiatives not like a duty to accomplish, but like an opportunity to exploit, to improve their awareness of accounting information systems, to reduce IT risks, to enhance the value of financial information and to gain the trust of investors and financial markets. That is, companies should transform IT compliance from a cost driver to a value driver, aligning IT compliance initiative to their own IT strategic goals and investments.

In the meantime, companies should try to reduce IT compliance cost and expenses, both for the first implementation and for the maintenance of the framework. To reduce the first implementation cost, companies could regard at best practices, rationalise their processes and application portfolio, standardize accounting system, obtaining scale economies. To reduce maintenance cost, companies could learn from past business cases and create experience economies, but also computerise the IT compliance activities, both acquiring an on-the-shelf IT compliance software or developing it in house. Both the solutions, as we will see, have their pro and con (Fig. 3).

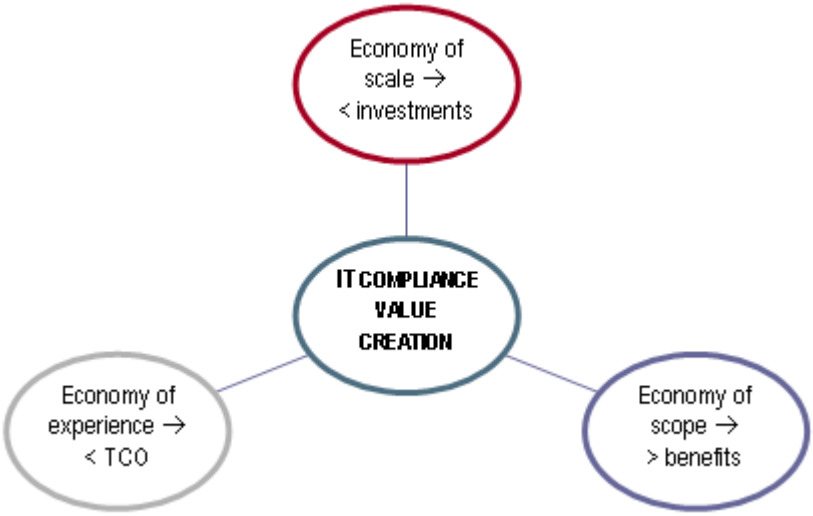

Figure 3: IT compliance and value creation

4. How to create value by IT compliance

If a company wants to create value by IT compliance, it should pursue three goals at the meantime:

- to monitor and reduce cost of IT compliance implementation;
- to improve the scope and benefits of IT compliance initiatives;
- to computerise the IT compliance process along time and space.

4.1 To monitor and reduce the cost of IT compliance

Even if IT compliance is very expensive, it is possible to reduce its cost by applying some standards and techniques improving the efficiency and effectiveness of compliance processes.
Four key words define the cost reduction guideline:

- standardization;
- reuse;
- analysis;
- risk monitoring

The most important word is standardization: indeed, business processes standardization is very helpful to implement a good IT compliance framework, saving money in the meantime. However, standardization here doesn't mean merely to redefine all business processes pursuing a rigid and theoretical model; but it implies to analyse and to define all business processes and IT applications using a unique language. It seems very simple and granted, but it is not. Several companies have heterogeneous information systems, developed for several years or decades and never harmonized. In this case, each process, each software, each data flow, each operation should be controlled by itself, without the possibility to apply formalized and standard controls. Also the map of the information systems could be very difficult to delineate. In this scenario, to apply IT compliance controls costs really a lot of money! On the contrary, to apply controls to standard, harmonized and well designed processes, software and data flows is easier and cheaper.

Before to apply IT controls for compliance, is therefore better to standardize the conceptual models and representation languages to define IT operations because in this way the IT compliance activity could be formalised and executed faster and cheaper.

The second key word is reuse; if IT processes are standardized and IT compliance policies and activities well conceived and formalised, it is possible to implement them a first time in a case study and then to reuse them all over the company. This behaviour creates scale economies which contributes to reduce to cost of compliance. Indeed it optimises:

- the cost of processes analysis and mapping;
- the cost of software development;
- the cost of controls implementation and of staff training;

- the effectiveness and quickness of audit activities.

The third key word is analysis. It means that the first steps in defining the IT compliance framework are the most important, because it is crucial to design a well conceived compliance environment from the beginning. Indeed, a bad arranged IT compliance framework requires continuous maintenance and improvement, increasing the cost of its implementation. Moreover, it is very difficult to generate reuse and scale economy, if the first applications of the framework fail. A good and deep analysis of all the accounting information system and an exhaustive documentation about accounting processes and data flows are the better basis on which to built an effective IT compliance framework.

Last but not least, the fourth key word is risk monitoring: implementing IT compliance framework is useful to a better awareness and monitoring of all IT risks, not only the ones impacting on financial reporting. Processes mapping and documentation are valid instruments to support an effective risk management; synergies deriving from unifying IT compliance and IT risk management could contribute to reduce cost.

4.2 To improve the scope and benefits of IT compliance initiatives

To create value it is possible to increase the benefits deriving from the IT compliance investments. Indeed, IT compliance activities may have a larger scope, not narrowed by regulations and duties, but included in the IT vision of the company and oriented to value creation.

To pursue this goal, it is necessary to include IT compliance in IT governance; in this way, the same management practices applied to all the IT initiatives are applied also to compliance initiatives and harmonized into the company's IT initiatives portfolio.

To include IT compliance in IT governance means to follow a well defined behaviour to optimise the realisation of value from IT investments. This behaviour is summarized in the following principles.

- *Define policies*. To gain maximum value from IT compliance investments it is necessary not to uncritically apply regulations and standards, but to define a general policy driving the whole compliance processes, both at present and in the future. It permits to better focus the IT compliance initiatives on the strictly necessary measures to implement and to harmonize the IT compliance choices with the IT strategic vision of the company.
- *Assign responsibility*. One of the main principles of IT governance is to assign responsibility about decision making and reached results. Also for IT compliance it is important to assign power and responsibility in a very clear manner and respecting the segregations of duties. It permits to gain better results, because each manager is well aware of its own charges.
- *Apply accountability*. To verify reached results it is necessary to define an evaluation framework, to be applied to IT compliance initiatives. The more useful could be a Maturity Model, to understand the status of IT compliance framework and of its implementation. Maturity Model supports the identification of best practices and necessary improvements, from a disorganized process to an automated IT compliance activity. Moreover, the evaluation framework could include also performance goals and metrics, demonstrating how IT compliance processes meet business and IT goals. Accountability is the weapon to built a measurement-driven IT compliance activity, aiming not only to comply with regulations, but also to do that creating value.
- *Pursue the higher value from each IT investment, also in compliance*. IT value is the result if three dimensions: systems capability and coverage, control about risk and compliance, alignment with business mission and goals. Each IT investment should be optimised respect to all these three dimensions, not only one of them. Also IT compliance initiatives should be compared with the mission of the company, to search to better alignment, and the systems capability, to optimize the IT service quality.
- *Communication*. Communication is necessary to inform about IT compliance initiatives, both inside and outside the company. Communication inside the company aims to create awareness about compliance and obtain desirable behaviour from human resources involved in the compliance process; it produces a more effective compliance activity and better results at lower cost. Communication outside the company is intended to inform about the commitment of the company to assure affordable financial disclosure and produces a higher trust by investors and financial markets.

4.3 To computerise the IT compliance process along time and space

IT compliance activities are to be performed along the time; companies should therefore define durable processes to accomplish their duties. However, IT compliance is a repetitive activity, so that it could be computerised; using IT applications to automate compliance:

- reduces complexity, as it requires standardization of both business processes and accounting policies, and of IT compliance processes;
- lowers compliance costs, because creates scale economies deriving from the use of standard solutions for compliance implementation and maintenance;
- improves reliability, because compliance software are able to face the weakness of accounting operations.

IT compliance software are called GRC systems: Governance, Risk and Compliance Management Systems. They are complex solutions that encompasses the use of several IT technologies: content management, compliance reporting systems, workflow and controls automation techniques. All these instruments are used to support audit, financial management, operational risk management and reporting processes. GRC systems could especially automate three fundamental compliance activity: processes analysis, documentation, controls monitoring.

Two different solutions are available to automate IT compliance: to acquire standard solutions or to develop in house solutions. Both of them present benefits and costs, virtues and vices. In the following paragraphs, they are analysed and explained in details.

5. GCR systems

GRC systems are IT solutions aiming to automate all the activities related to: govern IT systems, prevent risks and accomplish with rules and regulations. Their scope is wide and they cover different aspects (Fig. 4):

- finance and auditing, supporting controls applied to accounting and financial disclosure;
- IT, realizing automated controls applied to IT infrastructure and applications;
- risk, implementing the risk management relating data access and authorization;
- industry specific, such as Basel II for financial institution, etc.

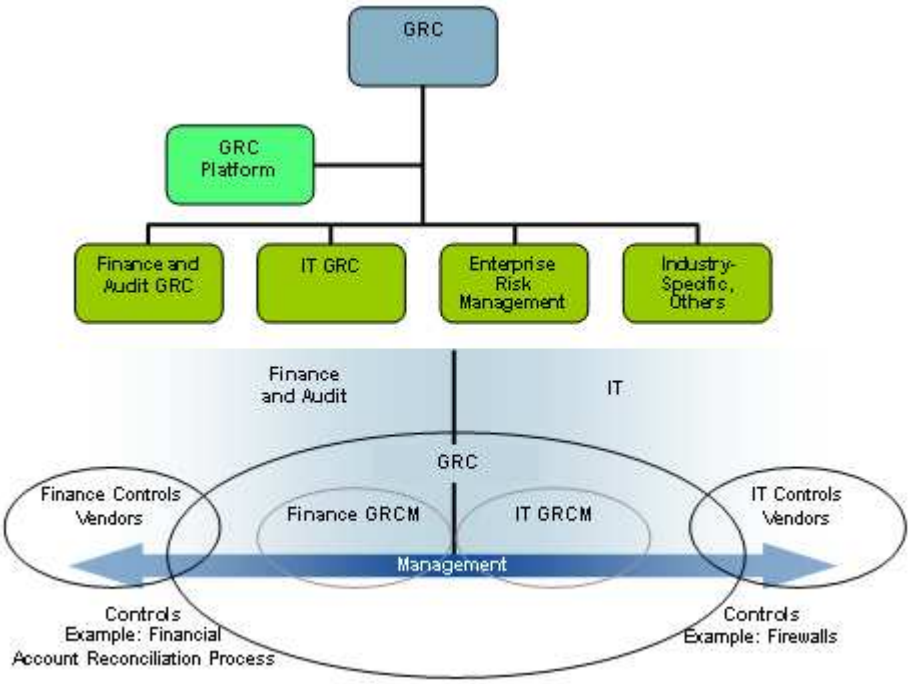

Figure 4: GCR systems scope

GRC systems integrate auditing aspects and IT aspects and cover all the processes in the enterprise, extending controls also outside the firm's boundaries, to vendors and external partners.

The GRC solutions market is broad, with many different vendors using the term GRC to name their products, that are very heterogeneous in scoping and performance. A complete GRC solutions should cover these different tasks:

- user and operations management, implementing controls on access to the systems and on the correctness of data entry;
- records and data management, implementing controls on data security and database integrity;
- change management, implementing controls on applications life cycle and detecting changes impacting on the in scope operations;
- configuration and system management, implementing controls on the correct functioning of IT infrastructures;
- documentations, producing processes and activities maps and reporting about control activities.

A GRC system comprehends the following modules.

- Finance GRCM solutions support the management, workflow, dcumentation and reporting associated with financial controls.
- Audit Management system regards internal audit work papers, task management and workflow.
- Audit Data Extraction and Analysis is a set of tools for extracting data from business applications and running ad hoc analysis or queries.
- Segregation of Duties (SoD) is a system for ensuring that personnel do not have access to data in a way that creates the potential for fraud.
- Business Rules Management (BRM) liberates the logic governing operational decision making from individual applications, where it had been locked within programming code. It delivers substantial savings in application time to market and total cost of ownership. BRM implies monitoring transactional data in accordance with business rules established as controls. Business rules can be anything your organization uses to make an operational decision.

To acquire standard applications for GRC has several benefits: it reduces complexity and grant transparency and affordability, applying best practices and technologies. However, it requires companies to well align their specific risks with the GRC solution. This is not so easy: on one side, companies should well analyse their own risk profile and organization, mapping IT compliance goals and identifying key controls; on the other side, they should shop judiciously, selecting the best solution for their specific case, facing the complexity of GRC solutions marketplace. As GRC are not mature applications, they are still very heterogeneous and there are no well known standards to refer to. This spending is therefore a perilous step, to be done carefully.

6. EIM systems

IT components of standard GRC solutions are often not aligned with the specific control objectives of each company. On the contrary, the good alignment between GCR systems and business processes, compliance duties and IT mission is the basis for a successful IT compliance initiative. Moreover, may be GRC solutions don't cover all the requirements a company needs; but companies should invest in complete solutions, not just in technology.

In this case, to develop an in house specific IT compliance application is the best solution. Companies could tailor their own IT compliance integrated model, able to cover their specific compliance duties and to govern the use of each piece of information available in the information system. The IT compliance application should be integrated in the Enterprise Information Management system: a system granting documents sharing and secure access to data, information and databases.

The EIM system integrates information, processes, people and IT services; its aim is to enhance the value of the business information repository, granting their security in the meantime. The EIM should efficiently manage the company's knowledge base, authorizing access to information in a unique point.

The EIM system could be organized like in Fig. 5. The Enterprise Portal assure the unique access point to all the company's information, both structured and unstructured data. The Enterprise Search Engine searches data and information inquired by the user; it also executes the audit data extraction and analysis tasks. The Collaboration Module manages documents and produces logs and report for the monitoring of in scope systems and processes. All the applications are integrated in the EIM systems, because all data and information are managed inside this framework; however, only some applications are in scope respect to

compliance: Administration & Finance, Audit & Compliance, Process & Activity Management. The Process & Activity Management Modules automate processes analysis and mapping, also for IS auditing and compliance. The Audit & Compliance Modules exploit the Audit Controls and Segregations of Duty. The whole EIM system is framed in the Security system.

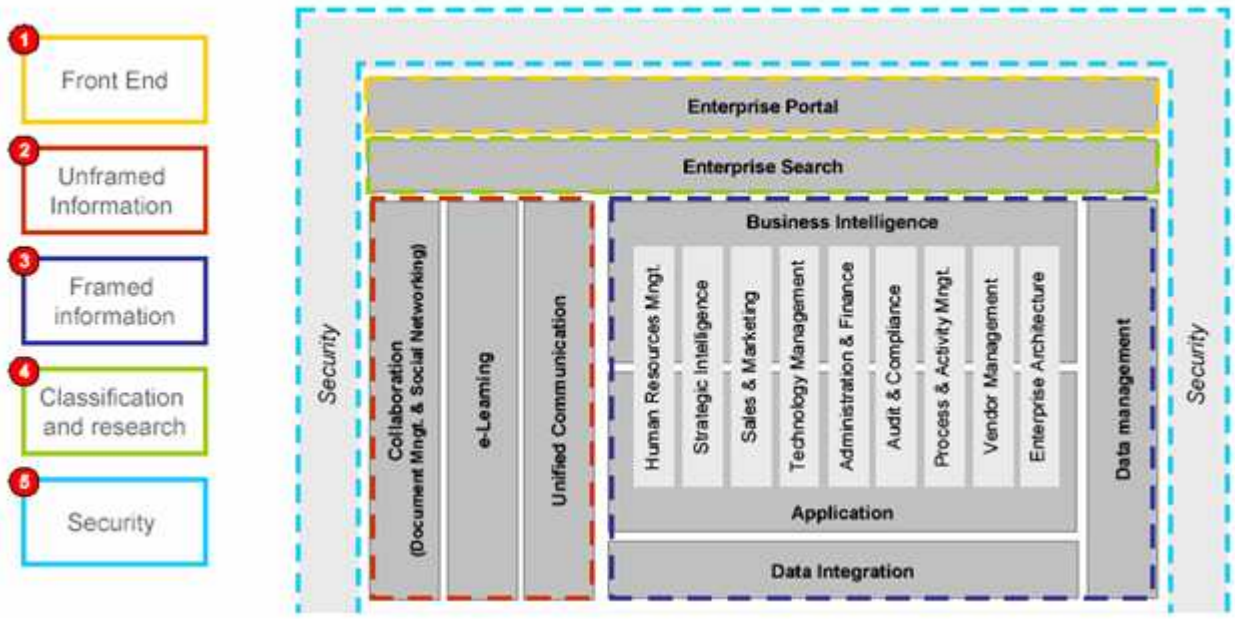

Figure 5: An EIM system

The functional schema of the IT compliance system embedded in the EIM systems is shown in Fig. 6. the system is composed by three layers.

- The presentation layer includes modules to support the navigation into the system and to access to information.
- The business logic layer execute the compliance tasks, that is:
  - it runs the rule based engine, to apply the controls to the in scope data processing;
  - it report about the non compliance operations and alerts about unauthorised accesses, mistakes in accounting and so on;
  - it controls the changes to the in scope applications;
  - it manage the logs and the traceability of each in scope operation.
- The repository layer manage the knowledge base; it includes several databases:
  - The compliance requirements contains all the laws, rules and regulations to be complied;
  - The compliance environment describes infrastructures and system configurations ;
  - The compliance documents repository contains all the policies, compliance documents and activities descriptions;
  - Compliance related events records all the logs and reports issued by the system;
  - Processes risks and cross references contains the list of all the reasonably anticipated risks and then related control objectives.

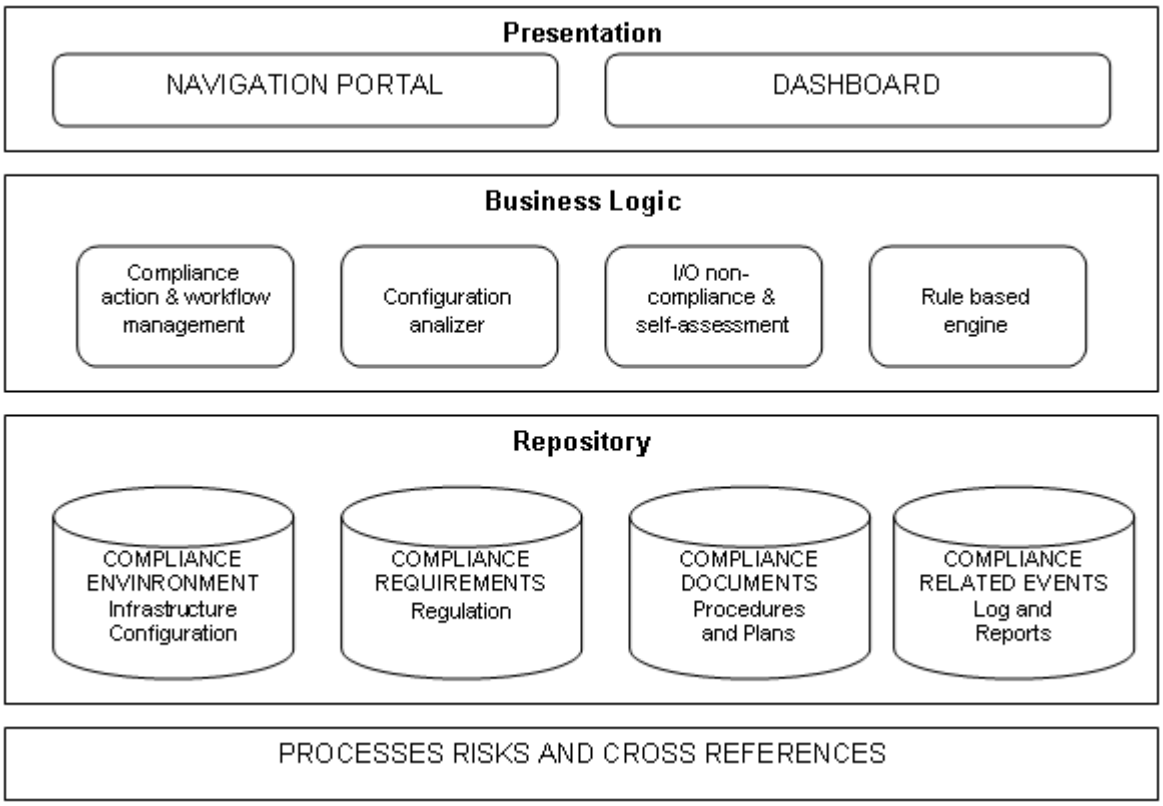

Figure 6: The EIM compliance module functional schema

7. Conclusions

IT compliance is a veritable challenge for large companies, both for the high costs of IT auditing and for implementation difficulties. Such a huge effort in money and work needs to return better results, than to simply accomplish financial rules. To obtain the best return from IT compliance activity, company could act in two opposite directions:

- to reduce the cost of IT compliance activities;
- to enhance the return of IT compliance.

To gain efficiency and reduce cost, companies could use an automated IT auditing system; the best solutions are GRC systems, that is, integrated IT systems able to assure in the meantime organization, control and protection for accounting information systems. The initial investments in GRC systems produce important savings in the lifecycle of IT compliance.

To enhance the return from IT compliance, companies could use the GRC system also to create an Enterprise Management Information System, that is, to integrate all the financial information about the company and to put them at disposal of all the interested workers all over the organization.

To reach these goals, companies should carefully analyse both the structure of their information systems and databases and their IT governance framework; it means that, indirectly, the implementation of GRC and EIM systems produces also an improvement of the architecture of Information Systems and of the effectiveness of IT governance.

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National Survey of SMEs' Use of IT in Four Sectors

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Abstract: This paper examines the adoption and use of information and communication technology (ICT) in small and medium sized enterprises (SMEs) across four sectors in the UK. In the paper we report on a survey that explores the factors facilitating or hampering the successful adoption and use of ICT by SMEs. We find that SMEs are generally satisfied with their investments in ICT but that they are concerned about the cost of such investments and are uncertain about the business benefits. Much of the investment in ICT is directed at meeting bottom line issues of cost and productivity but little use is made of potential strategic applications. A particular case in point is the diffusion of ecommerce in which firms report increased consumer interest but there is little evidence in the survey to suggest that interest is being actively managed by SMEs. One concern that emerges from the survey is the SMEs' perceived dependency upon consultants. SMEs appear to be encountering knowledge/competency gaps related to ICT. They may be too small to be able to employ a dedicated ICT expert and lack the experience to have confidence in its reliability of consultancy advice. They often have limited experience in selecting, implementing and evaluating suggested ICT solutions. To help correct this gap in the provision of services, the government has tried to provide support with mixed success. Certainly, the UK government has had a strong interest in helping and supporting the SME sector. However, State sponsored solutions to meet this competency gap appear to be failing with little awareness or take up of such solutions by the SMEs that we surveyed. Something that remains unclear is whether this failure by SMEs to avail themselves of advice and guidance made available by the State reflects the quality of solutions offered or a more basic lack of awareness by SMEs.

Keywords: SMEs, ICT, technology adoption, ecommerce

1. Introduction

Small and medium sized enterprises (SMEs) are an important part of the UK economy. Out of the nation's 4.3 million business enterprises 99% are SMEs, accounting for well over half of employment (58.9%) and turnover (51.9%) (DBERR, 2007). At both the European Union (EU) and national level, SMEs lie at the heart of policy making with the emphasis on encouraging enterprise and promoting business growth. SMEs are an important link to boosting the levels of innovation in the national economy and fostering greater competition both domestically and increasingly, internationally.

In this context, the adoption and use of ICT is widely seen as critical for the competitiveness of SMEs in the emerging global market. Given this backdrop, how can SMEs better equip themselves to use ICT? Are SMEs in the UK making adequate use of ICT? What factors enable or inhibit the successful adoption and use of ICT by SMEs? This paper addresses these issues through a survey of SMEs in the UK. The aim was to identify the diffusion of ICT within the SME community and to build a picture as to how SMEs currently use ICT in their business

2. ICT adoption and use in SMEs, a brief review of the literature

We know that SMEs generally struggle with limited resources in terms of time, money and expertise (Wymer & Regan, 2005). Juggling competing demands, SMEs are often cash poor and most lack the range of internal expertise available to the large firm. It is the skill and enthusiasm of the owner-manager that typically drives the business forward and shapes the character of investment decisions. We also know that most SMEs lag behind the large firms in their use of ICT, both operationally and strategically. SMEs characteristically lack the managerial skills to conceive, plan and implement ICT and reluctantly update technology (Caldeira & Ward, 2002). Constrained by resources, hemmed in by competing demands, caution and suspicion often greet new technological opportunities. Large firms for example, have adopted ecommerce much faster than SMEs (Pool *et al.,* 2006).

Nonetheless, a number of studies have found a strong relationship between ICT use and firm size, innovation, product development and R&D in traditional sectors such as manufacturing and clothing in the UK. The implication being that in terms of ICT use, the smaller size of the SME places it at a disadvantage to the larger firm. Not all SMEs are alike; they differ regionally in a number of key characteristics including innovation rates, profitability, size and ownership structure. This affects technology adoption rates. For

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example, in Yorkshire whilst 63% of SMEs were connected to the Internet, 46% had a website and 36% traded on-line, 30 % (mostly micro businesses with less than 10 employees) did not use computers at all (Pritchard, 2006). Those SMEs that do decide to opt into the digital economy often encounter further problems stemming from the complexity of their business operations when seeking to enter on -line trading or collaboration with supply chain partners (Brown *et al,.*2005).

Much of the research on ICT adoption by SMEs finds investment driven by the operational concerns of cost and efficiency (Levy et al., 2001). However, ICT decisions are not necessarily an exclusively operational agenda. ICT also offer the SME the potential to improve other dimensions of business performance such as innovation, marketing, quality and customer responsiveness. There is some, albeit limited, evidence that SMEs *can* behave strategically. In the West Midlands for example, some SMEs considered strategic intent when considering investing in e-business (Levy, Powell & Worrall, 2005). Although far more commonly, the owner-manager's attitude and lack of relevant knowledge and skills drives ineffectual strategic use of ICT (Pavic *at el.,* (2007). This tends to make UK SMEs as a group reactive to technology adoption rather than proactive.

There is certainly evidence that SMEs are reacting with caution to the possibilities of ecommerce, considering it a high-risk strategy (Al-Qirim, 2005), introducing ecommerce very slowly into their existing set of operations (Eriksson & Hultman, 2005). Often, SMEs may not view ecommerce as strategically important (Bharadwaj & Soni, 2007), although this may not be the case for all SMEs. A European report suggests that some SMEs are beginning to see ecommerce in a strategic light (E-Business Watch, 2004). The net effect however, is to suggest that all in all SMEs lag behind the pace of technological change as set by the larger companies.

3. Methodology

Data for this survey was collected using a structured questionnaire administered through telephone interviews. A contact list was generated using the FAME database, with respondents selected on a random basis. The survey concentrated upon four economically significant UK sectors populated by high numbers of small and medium sized firms: food preparation, clothing, manufacturing and financial services. For manufacturing we used SIC codes 30-33 to give us a focus on high technology manufacturing (electrical, optical and communications equipment). The telephone survey was conducted by a UK based software consulting company, and ran from March to August 2007. In total, we approached 4380 firms and 519 firms gave us usable replies. Of those 519 firms, 245 replies were received from manufacturing, 110 from financial, 85 from clothing and 79 from food processing.

The typical respondent was either the owner-manager or the designated person responsible for ICT. Together they accounted for 69% of all respondents. In three out of the four sectors surveyed, the majority of firms were quite large (50+ employees) within the SME context. The exception to this is the financial sector in which a majority of firms employed 10-50 people. Our findings are thus weighted towards the small to medium firms' spectrum rather than the micro firm. Most of our respondents (80%) are firms that have successfully traded for ten years or more. Finance again proved the exception with a slightly lower preponderance (60%) of long lived firms. Generally, the firms that we report on in this paper are mature, long established businesses.

4. Key findings

Here we report on the findings from the survey. For reasons of brevity we concentrate on the general results across the sectors but where important differences emerge, we will also report on individual sectors. Perhaps the first thing to note about the firms surveyed is that they are overwhelmingly in favour of ICT. A very high majority (93%) considered their investment in ICT to be good value for money. Such investment was most likely to have been less than £10k during the previous year.

4.1 Types of technology implemented and application use

Figure 1 shows the type of ICT used by the SMEs in our survey. Across all four sectors, firms reported extensive use of email, internet and company websites. Most of the firms were also large enough (10+ staff typically) to justify an internal network and many had put in place their own intranet. More surprisingly, the survey also reveals reasonably high rates of use of wireless technology. However, a much smaller proportion of surveyed SMEs use more complex technology such as an extranet or electronic data interchange (EDI).

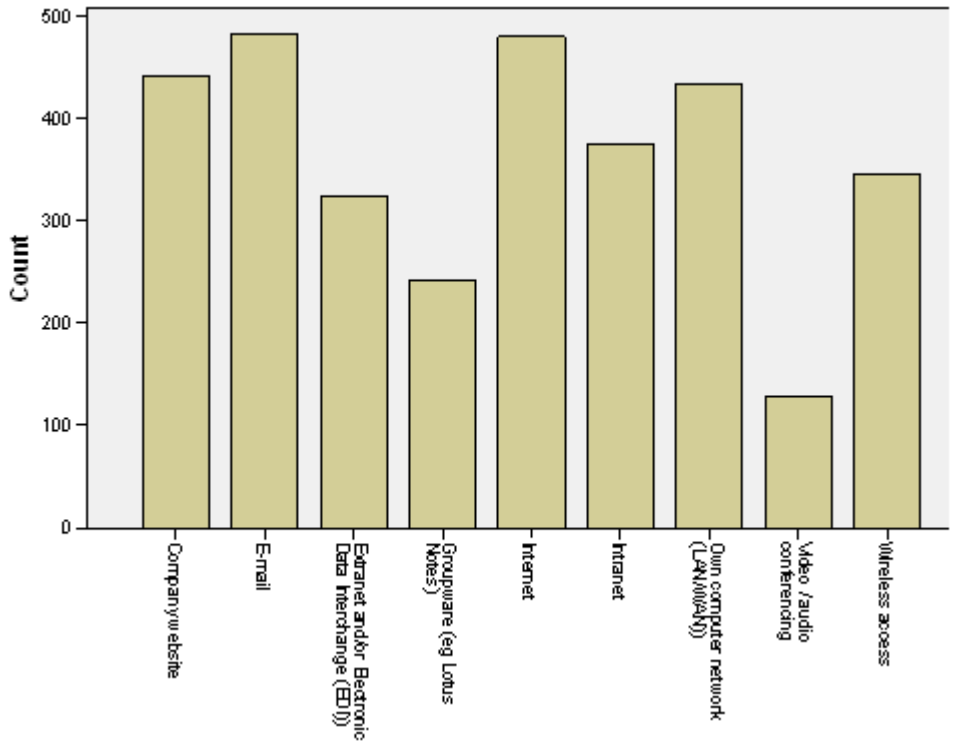

Figure 1: Type of ICT adopted

As Figure 2 shows, ICT was most popularly used to automate the recording of sales and the processing of orders received. A high proportion of the 519 firms surveyed also used ICT in general accounting and finance tasks, as well as in document management. Somewhat unexpectedly, the automation of accounting and finance tasks appears to lag behind the recording and processing of sales and orders. Computerisation levels in other tasks such as human resource management, production control and enterprise resource planning (ERP) were more modestly spread across the firms surveyed, as too in business intelligence and design.

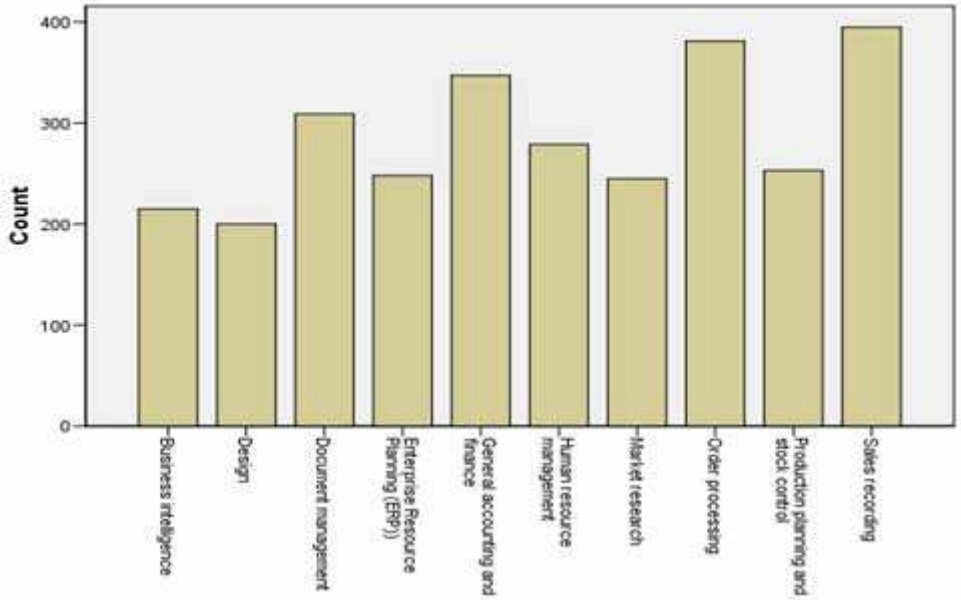

Figure 2: ICT application

4.2 Motivations and barriers for ICT use

What do the SMEs in our survey hope to gain from their investment in ICT? General motivations for ICT investment are shown in Figure 3. The answer to this question for many of our SMEs (almost 40%) is to increase their operational efficiency, followed by keeping up with competitors (about 20%) and then more or

less equally to improve customer service and improve staff satisfaction (both about 13%). Very few of the SMEs surveyed invest in ICT because of external pressure, either from the authorities or from customers. When we look at the responses within each sector, some exceptions to this broad pattern emerges. First, manufacturing SMEs are more likely to invest to try to keep up with competitors than any other sector (61% of SMEs in manufacturing compared to 30% in financial and food and 40% in clothing). Second, investing in ICT to increase staff satisfaction is the second most popular reply in finance (41% of SMEs) and clothing (34%). Third, investing to keep up with changing regulations appears as a reasonably important factor for manufacturing and food (16 and 19% respectively) but is unimportant in clothing (only 5% of clothing SMEs).

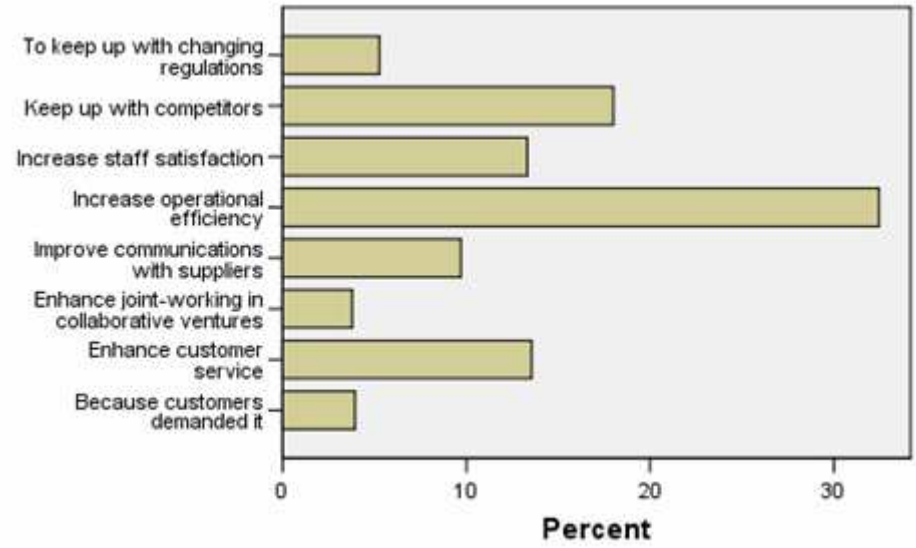

Figure 3: General motivations for ICT investment

We also questioned SMEs as to their perceived barriers to ICT investment. Figure 4 shows the aggregate replies that we received to this question. Unsurprisingly, cost was the largest single barrier cited by firms in our survey (about 34%). More interestingly, SMEs also cited uncertainty over the benefits to their business as a factor (25%). When we asked firms whether they used any form of formal investment techniques to evaluate ICT investments, the use of such techniques varied with the sector. Perhaps most surprisingly, just 24% of all SMEs in the finance sector applied formal techniques compared to 45% of SMEs in both clothing and manufacturing and a much higher 57% of SMEs in the food.

The broad patterns identified in the preceding paragraph also hold when we look at the individual sectors. There is however one exception. Whereas the SMEs in the clothing, food and manufacturing sectors identify their three most popular barriers to be costs, uncertainty and competing priorities, SMEs in the finance sector have a slightly different ordering. Here, the third most popular barrier is concern over security (32% of SMEs in the sector). This barrier does not appear to be strong in the other sectors, with the range of replies varying from 8% (clothing) to 14% (manufacturing).

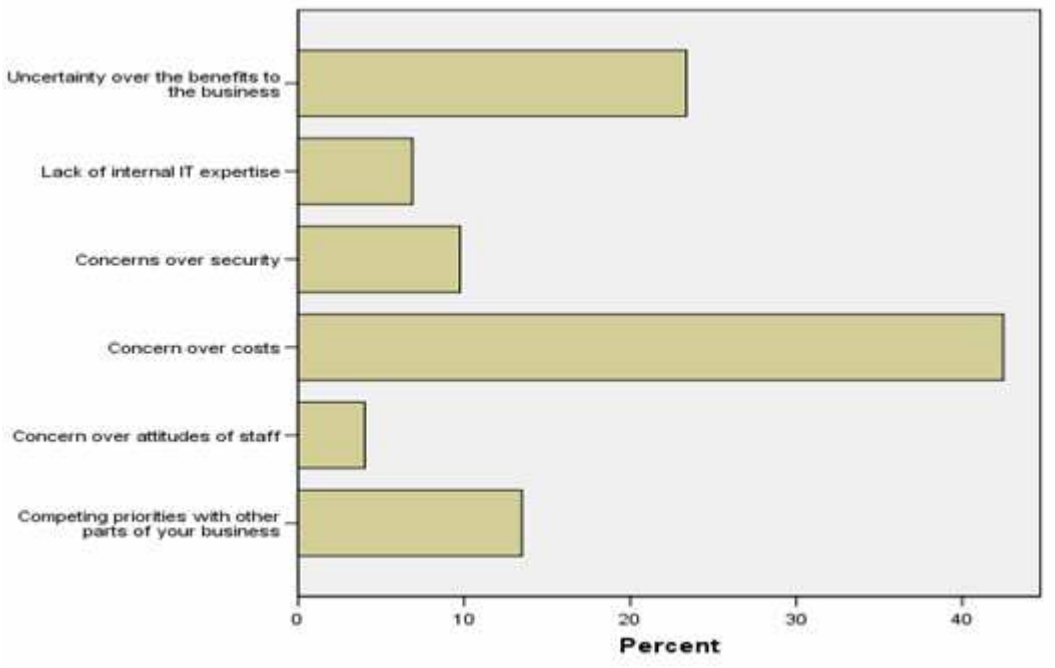

Figure 4: Barriers hampering ICT investment

4.3 Experience of ICT

Here we report on the actual benefits and problems encountered with their ICT investments by our respondents. Mindful of the high levels of satisfaction over value for money (93%) reported previously, the flip side to this statement is the very low proportion of SMEs reporting no business benefits arising from ICT adoption (less than 3%). As our next figure shows (Figure 5), the most popular benefit experienced as a result of ICT adoption is greater productivity. Close to 30% of all replies highlighted productivity as a benefit. The second most experienced benefit is improved quality of service or product and then related to this, a faster response time to customers. More surprisingly given the supplier and sub contract nature of much of the SME sector, the firms in our survey did not typically report improved collaborative working with other firms as a benefit of ICT adoption. Similarly, given the tight resource constraints that SME generally work under, ICT does not appear as a popular vehicle to reduce staff numbers. At least, if that is an intention of ICT adoption, it does not appear to be realised once adopted.

Again, if we turn to the sectors themselves, the broad pattern outlined above holds with some exceptions. First, it is striking that the SMEs in the clothing sector are far less likely to report improved collaboration (1%) than the other sectors (between 10-11%). Second, both clothing and manufacturing SMEs report in proportionately larger numbers (13-15%) that ICT has enabled them to reduce staff numbers than SMEs in finance and food (about 10%). Finally, SMEs in the clothing and food sectors are less likely to report that their ICT has yielded no business benefits (less than 3%) than SMEs in manufacturing and finance (about 6%).

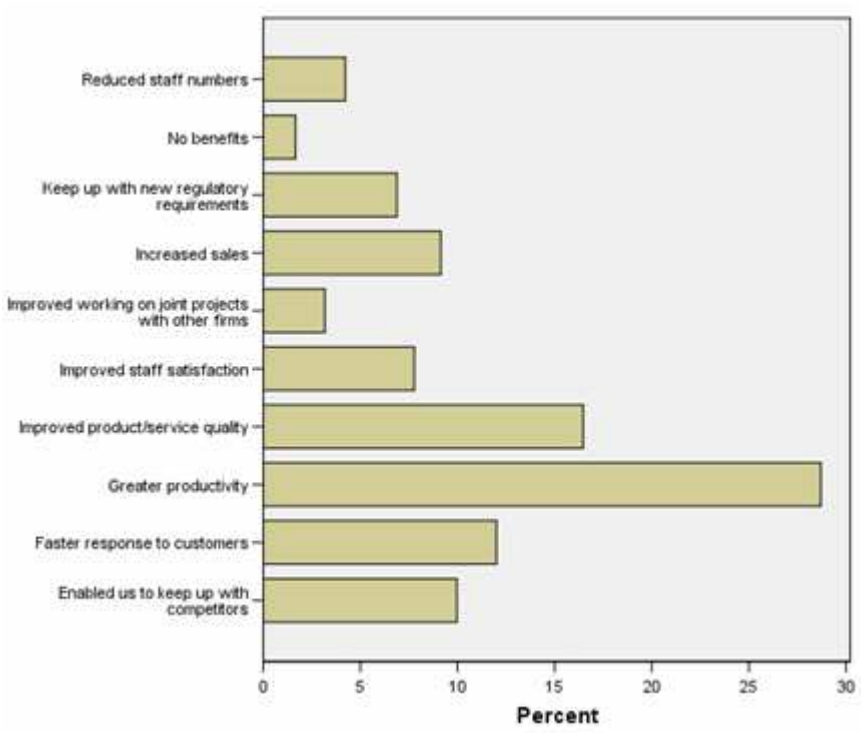

Figure 5: Benefits gained from ICT

Given the high levels of satisfaction, it is perhaps unsurprising that the single largest group of SMEs in our survey report no problems with their existing ICT systems. As Figure 6 shows, almost 40% of all the firms that we surveyed report no problems. Of the problems reported, the most pressing difficulty is dependency on an outside ICT consultant (almost 20% of all replies), followed by system crashes (about 12%). Less problematic appears to be cost and technical complexity issues. Cost is particularly interesting here because in the previous section, respondents highlighted cost as a barrier to potential investment in ICT. However, according to the experience reported on here, mangers are possibly over exaggerating cost as a barrier. The more technical problems of storage, security, connection and network compatibility are not issues highlighted in our survey.

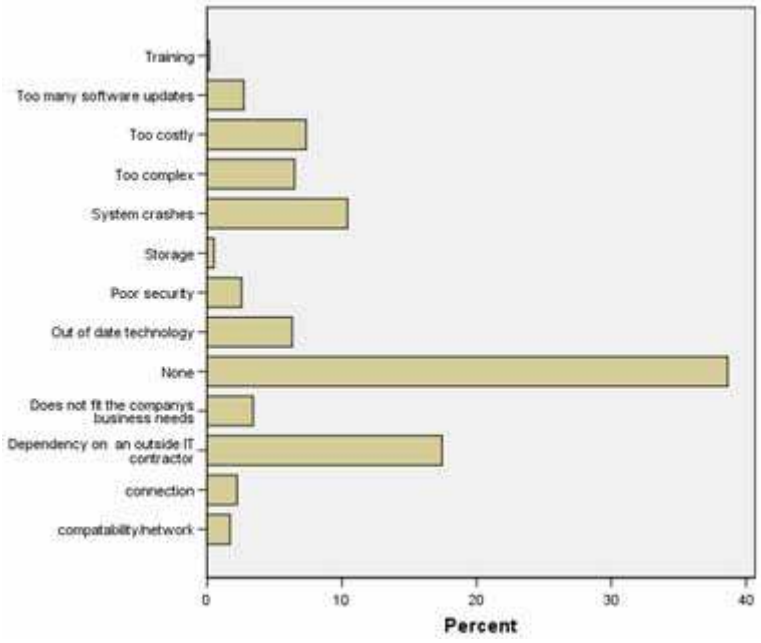

Figure 6: Reported problems with existing systems

4.4 Ecommerce and use of the internet

In our survey, 78% of all SMEs used the Internet in their business either to attract customers or to help communicate with suppliers or other firms. Manufacturing recorded the highest percentage of use with 82% of all SMEs in that sector using the internet and clothing the least with 71%. Generally, across all four sectors, SMEs use the internet by a very high majority. Of the SMEs that are not using the internet in their business, very few (less than 5%) have plans to introduce the internet in the next three years.

What are the firms we surveyed doing with the internet? Figure 7 shows that in general, the SMEs in our survey are using the internet to share information with both customers and suppliers but particularly customers. They are also using the internet to gather information on the activities of their competitors, their sector and their markets. However, what is also evident is that the SMEs are not using the internet in high numbers to make or receive either orders or payments. Across all four sectors, there is a poor diffusion of automated ordering or payments using the internet. Figure 7 shows that SMEs in aggregate are using the internet in slightly higher proportions on the customer side and less so with suppliers but in both cases, the numbers involved are proportionately low.

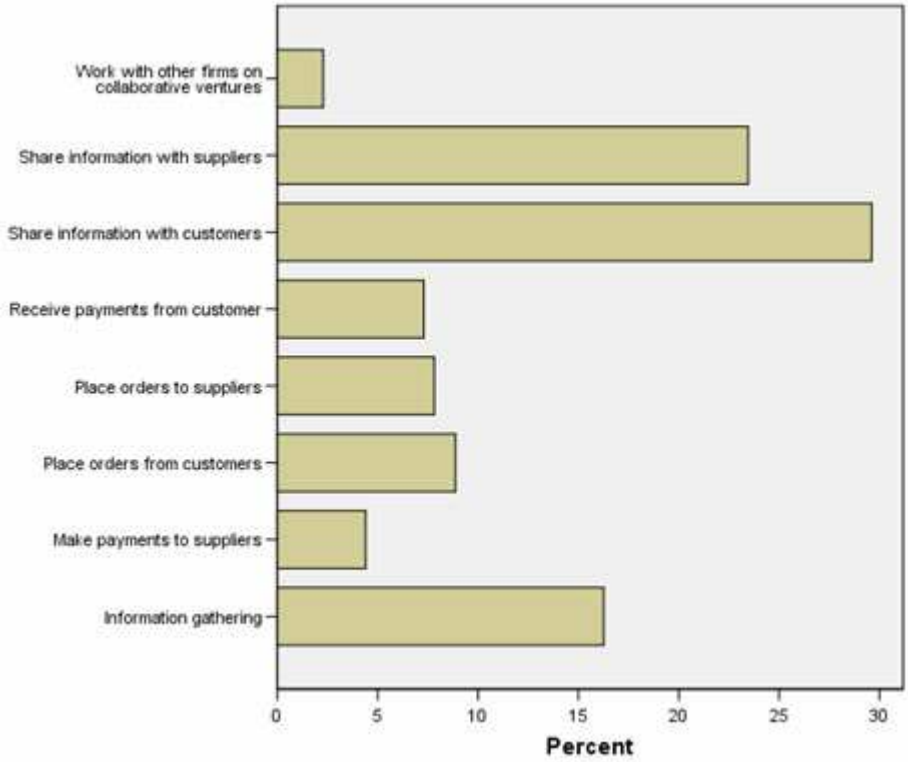

Figure 7: Reasons given for using the internet

Turning to the individual sectors, again the broad pattern holds with some exceptions. Across the sectors, all report high rates of using the internet to share information with customers (at least 80% of firms in the sector). The highest rate of use is in food where 95% of SMEs surveyed use the internet to provide information to customers. Food also makes the highest use of the internet to share information with suppliers (82% compared to 66% of all SMEs in manufacturing). In contrast, manufacturing firms make the highest use of the internet to place orders from customers (30% of all manufacturing SMEs). Consistent with this, manufacturing SMEs also report greater use of the internet to receive payments from customers (26%). Finally, SMEs in the financial sector are most likely to use the internet to gather information (63%); whereas manufacturing SMEs are least likely (43%).

What have been the problems and challenges that the SMEs in our survey have found in implementing ecommerce? When looking at the aggregate responses in Figure 8, perhaps the first point to note is that more than 25% of the firms in our survey encountered no problems. The biggest barrier to putting ecommerce in place appears to be persuading customers to change. Interestingly suppliers appear as a lower barrier to customers. Following customers, expertise and skills appear as a set of issues whether expressed as the difficulty of getting good technical advice from outside or the problem of lack of appropriate

internal staff. In contrast, connection costs and security failures appear less inhibiting as a barrier to ecommerce for most of the SMEs surveyed.

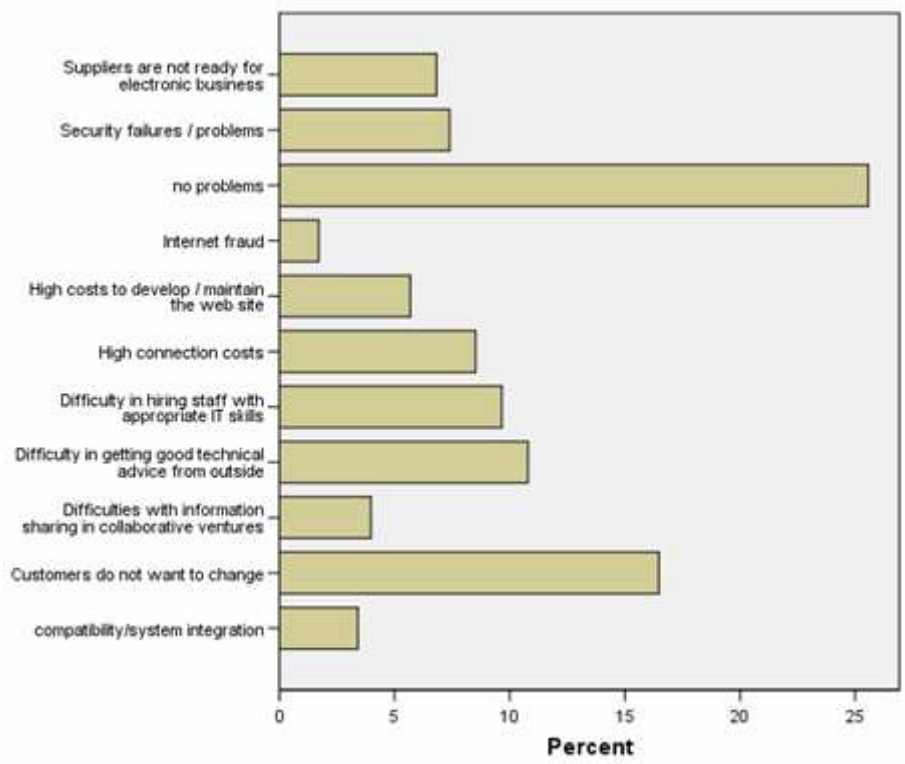

Figure 8: Challenges in Ecommerce implementation

We find that this broad pattern just discussed fragments more readily when examining the responses of SMEs within individual sectors. Looking across the sectors, each sector displays a varying pattern of responses. Clothing SMEs for instance, identified difficulties in hiring appropriate staff as the single most popular barrier to ecommerce implementation (33%) and failed to identify customers as a barrier at all. Similarly, finance SMEs found it more difficult to hire in good technical advice from outside (25%) compared to customers resistance (17%). SMEs in the finance sector also cite high connection costs as the second most popular barrier to ecommerce use. In contrast, 38% of all SMEs in the food sector and 27% of manufacturing SMEs identified customers as the single largest barrier.

The results from our survey suggest that the effect of the internet appears focused on attracting new customers rather than boosting sales from existing customers. Almost 50% of the SMEs who used the internet found that it had attracted new customers from within the UK. Just over 25% found that the internet had attracted new customers from outside of the UK. All four sectors identify attracting new UK customers as the most popular effect of the internet on sales. The food sector produces the most pronounced trend in this respect, in which 74% of all SMEs here cited increased UK customers. By contrast, 52% of SMEs in manufacturing cite an increase in UK customers as an effect of the internet.

Although we could generally conclude that the effect of the internet on sales is broadly positive, what degree of impact is the internet having? The answer to this question is more disappointing. Our survey suggests that the aggregate effect in terms of the proportion of sales arising from on-line orders is quite small. At present, on-line orders as a proportion of total sales is likely to be 5% or less. Further, the number of firms in our survey enjoying this degree of on-line ordering is a minority of the total firms surveyed (about 18% of the total survey). The pattern is similar for supplies ordered on-line. Although the overall numbers of firms ordering their supplies on-line is slightly higher (20%), the data suggest that the majority of firms in our survey make very little or no use of on-line ordering in terms of their supplies.

4.5 ICT advice source and choice of supplier

In this last section, we examine where the firms get advice about ICT, together with the factors affecting their choice of supplier. From Figure 9, we can see in aggregate terms that the single most popular source of advice is ICT consultants (about 38%). After that, personal sources, suppliers and the media are also

sources that the SME turn to for advice on ICT. It is also apparent that very few of our SMEs have internal sources of expertise ready to give advice (less than 5%). Given the use made of the internet to gather business intelligence discussed earlier, it is intriguing that the SMEs in our survey made such poor use of the internet as a source of information. Also, note that the trade associations appear to play a minor role as information providers in this area.

We find a similar pattern in the individual sectors although manufacturing SMEs are less likely to use personal sources for ICT advice. Instead, the media and suppliers are more likely sources of advice (27% and 26% of manufacturing SMEs respectively) than personal sources (21%). However, manufacturing and finance SMEs are proportionately more likely to have access to internal sources of expertise (8%) than SMEs in clothing and food (4%). Interestingly SMEs in the food sector are proportionately most likely to have used "official" government or local authority advice than the other sectors (5% compared to 3% in clothing and 1% in manufacturing).

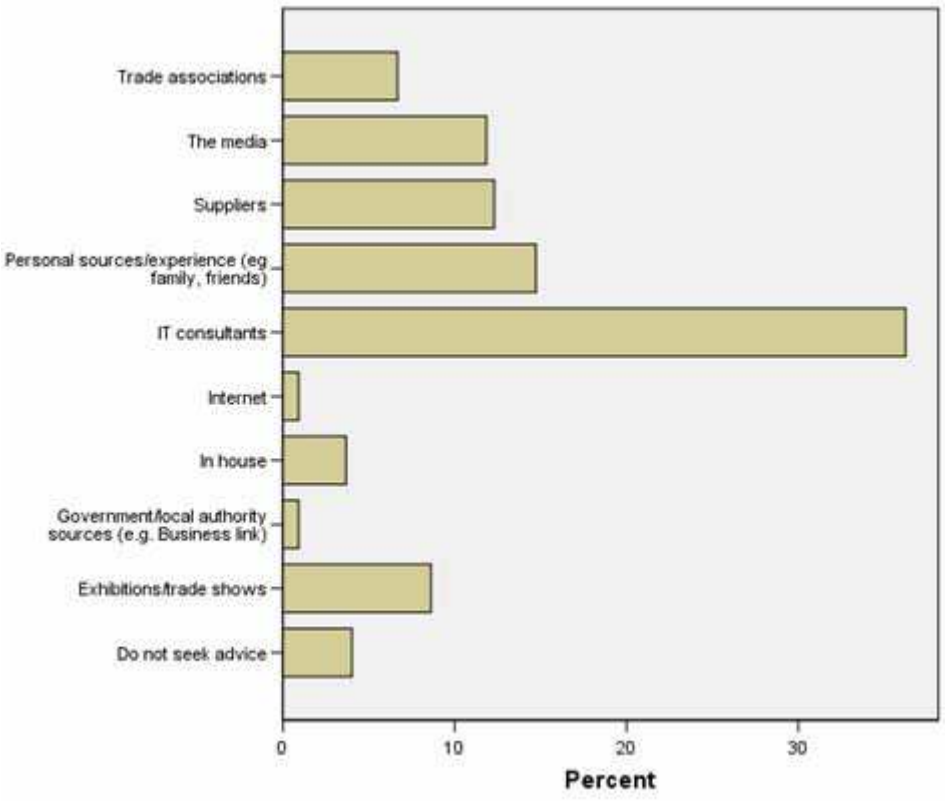

Figure 9: Reported sources of ICT advice

Finally, having sought advice on ICT, what dictates the choice of supplier? Figure 10 shows the aggregate range of responses. Two factors appear most important, previous experience (28% of all SMEs in the survey) and cost (26%). Following this, the technical features of the product and the use of personal recommendations are also factors influencing the choice of ICT supplier. The availability of after sales service appears to be less important to our SMEs. This is intriguing given that most of the SMEs in our survey lack internal expertise.

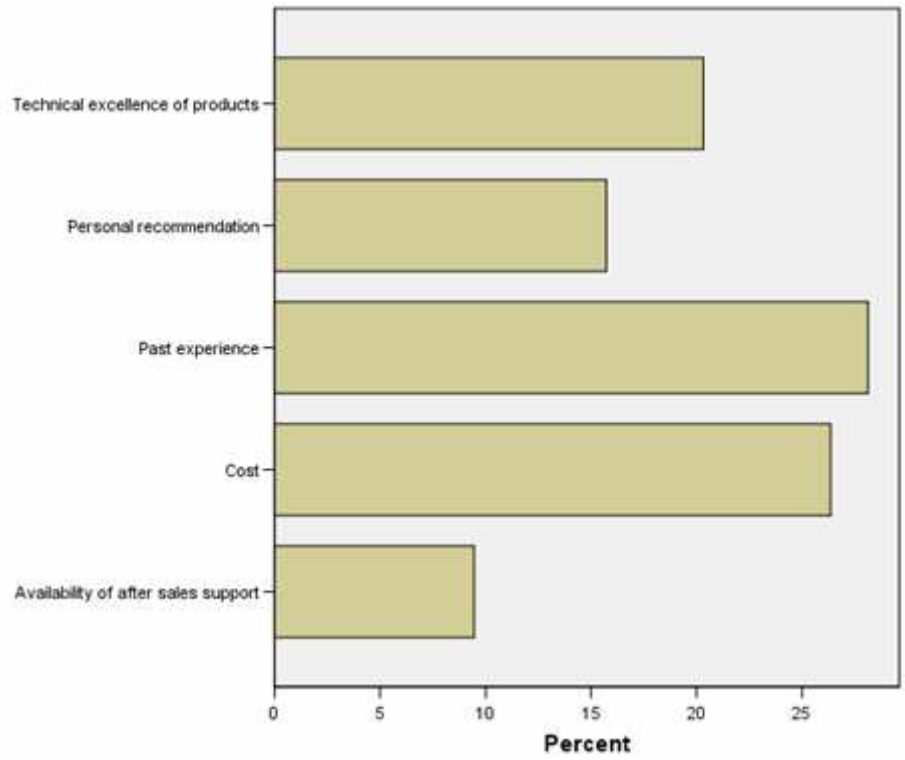

Figure 10: Reasons given for choice of ICT supplier

5. Discussion

There is a general reluctance by firms to engage fully with the possibilities that ICT could offer their business. SMEs in our survey remain uncertain over the business benefits that further investment in ICT could yield. Competing resource demands and a general lack of formal investment skills exacerbates this uncertainty. For many of our SMEs, basic investment appraisal techniques are either missing within the firm or are not used. SMEs in general fear losing control of their ICT spend and are distrustful of the aspirations of ICT consultants. ICT consultants are commonly perceived as part of the problem rather than as part of the solution.

Nonetheless, the overall picture that SMEs report is overwhelmingly positive. Almost all the SMEs surveyed thought that their ICT investments offered good value for money. The SMEs in our survey had experienced increased productivity and improved quality of service or product. Most of the SMEs have a website and many find that such a presence has brought in additional UK customers to their existing sales base. There is widespread computerisation of simple general tasks such as sales recording, document management and accounting operations. In general, the attitude of staff to ICT is encouraging and not perceived as a problem, and in some cases, SMEs use ICT to enhance staff satisfaction.

However, given these positive factors, contradictions exist. Most of the SMEs in our survey want to expand in some way, chiefly in increased sales; about 40% of all replies that we received indicated this as a business goal. Second most popular reply that we received indicated a desire to reduce costs – about 25% of total replies indicated this. Therefore, perhaps unsurprisingly, the most pressing plans of the firms that we surveyed focused on the bottom line issues of sales and cost. When it comes to the next most popular business plan there is then a divergence according to the sector. Both food and clothing favour expanding the number of business locations but financial and manufacture prefer increasing collaboration with trading partners and growing the number of markets that they trade in respectively. Very few firms in our survey want to retain the status quo of their existence. Few firms though have embraced the potential of the internet wholeheartedly. Most firms do not use the internet to receive customers' orders or to order on line themselves. Those that do, typically only use the internet for a small fraction of their total sales or supplies. Equally, the typical SME is likely to be a small clog in a much broader supply chain. Very few of the SMEs surveyed though are using ICT for collaboration. This may represent a lost opportunity to pool resources and increase effectiveness.

Perhaps the biggest contradiction is over the use of ICT consultants. While SMEs may view consultants as a potential problem, they are also most likely to use consultants as a source of advice. This reflects the constraints on resources that hinder the development of internal sources of expertise. Externally, the SMEs have access to the internet and use the web to gather business intelligence but this is unlikely to extend to ICT advice. More generally, SMEs in our survey are very unlikely to use "official" external sources of expertise, particularly the government, local authorities and trade associations. What is unclear is whether this reflects a lack of visibility on the part of official bodies or is an indication of the quality of advice offered.

6. Conclusion

Our survey suggests that SMEs have yet to grasp the full potential of information technology. There is a widespread diffusion of relatively straightforward technologies such as emails, internet access and websites but the spread of more complex technologies such as electronic data interchange is more restrained. Much of the focus of application is on securing productivity gains through the back office automation of recording and retrieval of information. Our survey has produced very little data to indicate that SMEs are also deploying ICT to enable strategic gains. Information on product and services for example is provided over the internet but very few firms actively manage consumer interest by building customer databases or offer on line ordering and payment.

SMEs are important to the UK economy, providing over 33% of GDP and over 50% of employment. They are also the source of future growth and innovation. The advent of the digital economy has made the adoption and use of ICT, including e-business, a significant issue for most SMEs. Yet, our survey suggests that many SMEs find themselves in a difficult situation. The general lack of resources means that while there may be an aggregate demand for IT service and advice, individually, the varying nature of that demand makes it uneconomical for other firms to provide a service meeting that demand. To help correct this gap in the provision of services, the government has tried to provide support with mixed success. Certainly, successive UK governments have had a strong interest in helping and supporting the SME sector. Nonetheless, successive governments and sometimes many different initiatives within the lifetime of a single government, have failed to build a common view as to the appropriate instruments and mechanisms of support for the SME community.

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Reward Systems in the Post Digitization Era: Possible Benefits and Risks

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Abstract: The last decades have been characterized by extremely intense digitization – in the shape of investments in administrative and embedded IT together with advanced Internet solutions – as regards companies and organizations worldwide. Today, however, most establishments are already highly digitized, which affects the conditions for work and organizations' forms and functions.

Thus, based on an empirical investigation of the health care sector, this paper addresses the notion of the post digitization era through specifically examining IT-based reward systems. This, of course, is not a novel phenomenon, but new ways of using the reward system concept – together with IT and original ideas – in order to increase efficiency, effectiveness, and productivity are considered. This, in turn, might have great implications concerning core strategies and the organization of work. In order to fulfill the paper's purpose of identifying possible benefits and risks associated with digital reward systems, especially in health care, a case study built on semi-structured interviews was performed.

The findings of this study indicate that there are several possible fields of innovative application – including both developments of existing solutions and potential future utilizations – concerning digital reward systems in health care. Moreover, in order for reward system implementations to be successful, organizations have to define, measure, valuate and evaluate input, output and performance appropriately, and the process of doing so is also affected by the present stage of digitization. This too is contemplated throughout the paper. Finally, important associated matters such as risk-reward trade-offs and quantity versus quality are discussed.

The results presented in this paper are based on a limited material. Still, they are valuable and original because of the empirical foundation derived from an important industry/sector. Furthermore, they illustrate modern implications of reward systems in highly digitized contexts, and put forth novel views on possible fields of application of IT-based reward systems, and associated potential benefits and risks.

Keywords: reward systems, post digitization, information technology, health care

1. Introduction

Today, most establishments are digitized, which effects how work is organized. That is why the notion of the post digitization era is presented in this paper. Although new IT-innovations will continue surfacing, it is not that they are digital per se that will generate the vital effects. Instead it is matter of how IT is handled and incorporated in its organizational context that will be decisive to its impact and importance (Zammuto et al. 2007; Bannister and Remenyi 2005; Carlsson 2004; Peitz and Illing 2006; Orlikowski 1992).

Even though some allege that IT is becoming a commodity, not generating significant competitive advantages or productivity benefits (Carr 2005), there is another side to IT. Novel digital solutions will always be produced and benefit certain players, but, in a more general sense, the importance and value of IT will be manifested through innovative utilization and creative thinking (Lucas 2005; Bannister and Remenyi 2005; Horzella et. al 2006).

This paper, however, addresses the post digitization era through specifically examining IT-based reward systems (see e.g. Kerr and Slocum 2005; Bartol and Srivastava 2002; Jansen and Von Glinow 1985; Eisenhardt 1985). This, of course, is not a novel phenomenon, but new ways of using the reward system concept – together with IT and original ideas – in order to increase efficiency, effectiveness, and productivity are considered here. This, in turn, might have great implications concerning core strategies and the organization of work. Thus, it is believed that reward systems and adequate performance measurements can be a vital part of strategic organizational change. This conviction is strengthened by the notion that IT and organizational change are highly intertwined phenomena, and can work as catalysts for each other (Volkoff et al. 2007; Zammuto et al. 2007; Orlikowski 1992).

Through empirically investigating the health care sector, several possible fields of innovative application – including both developments of existing solutions and potential future utilizations – are identified. Moreover, in order for reward system implementations to be successful, organizations have to define, measure, valuate, and evaluate input, output, and performance appropriately, and the process of doing so is too

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affected by the present stage of digitization. This, as well, is contemplated throughout the paper. The key research question is the following: Which potential benefits and risks are associated with modern digital reward systems, especially in health care?

The choice of the health care sector as the main target of the study is based on previous research (Kollberg 2007; Fryk 2007), indicating that it offers interesting opportunities for investigating digital reward systems. Primarily this is so because health care is fairly recently digitized, which results in new ways of handling information. Furthermore, the health care field brings to the fore important moral and ethical problems in the current context.

The paper begins with short descriptions of the methods and the research object. Then the results are presented as some general remarks about health care and reward systems, followed by possible benefits and risks, using empirical examples from health care. Finally, a summarizing discussion – together with suggestions for future research – is put forth.

2. The empirical investigation and methods

The general research object in this study is digital reward systems, but, in order to empirically investigate them, the major target is Swedish health care and the specific one is Danderyd University Hospital in Stockholm, Sweden. Thus, this is a classic case study, which can be very useful when doing exploratory and explanatory research like the one at hand (Yin 2003; Ammenwerth et al. 2003a; Eisenhardt 1989; Benbasat et al. 1987). The Hospital is public and fairly large with over 3,000 employees, more than 37,000 treatment events, approximately 230,000 health care appointments, and a 2.3 billion turnover.

So as to examine digital reward systems, health care professionals – with respondents from all age groups, key formal competence levels, and professional categories – were interviewed using so-called repeated semi-structured qualitative interviews. Also, afterwards, additional interviews were conducted if considered necessary, and the respondents had the opportunity to provide feedback. This method has been proven suitable when trying to generate rich and truthful depictions of implementation efforts and their effects (Levine and Rossmoore 1993; Yin 2003). The research, however, is complemented with material gathered at Gynekologkliniken in cooperation with Capio St Göran's Hospital, Löwenströmska Hospital, Märsta Närvård (a health care center situated approximately 25 miles north of Stockholm), Stockholm County Council and Apoteket Ormen (a pharmacy in Stockholm), together with on-site observations, informal interviews, and reviewing of secondary sources, the Internet, and related research. Primarily, though, the material on which the presented findings are based is derived from interviews with 24 respondents, lasting for approximately 1-2 hours each. Further details of many of the fundamentals such as the research object, Swedish health care, and the respondents are found in Fryk (2007).

Several other studies recommend this kind of bottom-up perspective, or micro-level approach, when aiming to understand complex digitization effects in health care (Edmondson et al. 2001; Timpka and Bjurulf 1989; Fryk 2007). It is simply a matter of studying the use of novel IT, in the shape of digital reward systems, through the eyes of the actual users together with on-site observations. Of course, relevant documentation – sometimes based on more aggregated data – is also considered.

3. Post digitization reward systems and health care

An inclusive and traditional definition of reward systems is presented by Kerr and Slocum (2005, p. 130), where they conclude that "Reward systems are concerned with two major issues: performance and rewards. Performance includes defining and evaluating performance and providing employees with feedback. Rewards include bonus, salary increases, promotions, stock awards, and perquisites". In the current paper this is considered true, but with two major differences: First, the reward systems discussed here are exclusively digitally based. Second, the rewards are not always monetary. Of course, rewards such as salary increases and bonuses exist in health care, but, since traditional corporate factors like revenue and competitive advantages do not always apply in health care, at least not in the public sector, rewards are mostly based on work related perquisites and benefits. Thus, it is rather a matter of rewarding adequate behavior through facilitating the work situation, acknowledging ideological or humanitarian wins, and professional satisfaction in connected to, for instance, increases in patient health, shortened convalescence, and better health care quality. In other words, there is a clear difference between health care and e.g. manufacturing or finance companies, due to varying incentives and purposes. Health care, especially as regards the public sector, is more about cost reduction, efficiency and effectiveness, and primarily high quality care.

Moreover, there are several ways to change peoples behavior – through rewards, threats, or persuasion – and two major aspects to consider when deciding on what to reward, namely behavior and/or results (Rapp and Thorstenson 1994). In health care one cannot focus solely on results, because of measurement difficulties, but rather start by changing behavior. Furthermore, health care professionals often perceive threats and persuasion as counterproductive. Especially since health care is driven primarily by humanitarian goals and not monetary wins.

So, traditionally, the purpose of reward systems is to monetarily reward desirable behavior (Bartol and Srivastava 2002; Rajagopalan and Finkelstein 1992). This empirical investigation, though, clearly indicates that modern digital reward systems in health care can be built on a new relationship between performance and reward. For instance, by using a more time efficient patient administration system, the reward for physicians is that they get more time to spend with each patient while they still get the same monetary compensation. Also, the system can be used to see changes in patients' healthiness and personal satisfaction concerning the health care. The actual reward system in this case is the part of the entire solution that keeps track of time spent with patients and the outcome in the shape of health care quality.

Another important observation, which became evident when talking to the respondents, is that what constitutes what here is called the "post digitization era" is that in most parts of all industries – whether it is a matter of business or the public sector – there has been a shift from digitization to consolidation to improvements as regards IT-investments. In other words, first, the main goal was to invest in IT in order to automate business processes or make information handling more efficient in connection to administration. Second, it was a matter of consolidating systems, making input and output compatible, and unifying internal and external parts of organizations' processes so as to facilitate communication and realize possible collaboration benefits. Now, however, most organizations have a widespread and functioning IT-infrastructure and the previous competitive advantages or productivity benefits spawn by IT are not as important. In that sense IT has become a commodity or a General Purpose Technology (GPT), not unlike electricity or telephones (Rosenberg and Trajtenberg 2001; Nahuis 1998). The present study, though, shows that improving and tailoring existing IT – together with innovative and strategic use – can be decisive to organizations' survival and/or success.

To sum up, one strategic, and possibly innovative, IT-solution is digital reward systems. This applies to most industries, but I limit my discussion to health care due to identified interesting aspects that can be highlighted using this perspective. Moreover, because of today's affordable advanced information systems, it is fairly easy to handle information (collect, store, process, recall, and communicate data, text, images and speech), which makes it possible to keep track of various kinds of input, output, and performance, and reward behaviors accordingly.

4. Promising benefits

Now when most organizations have IT-infrastructures, and customized solutions, investments in IT can be focused on valuating, implementing, and evaluating strategic digital information systems (Gardner 2000), such as reward systems. When it comes to health care, the opportunities are many. Early on, Barley (1986) showed that the introduction of clinical IT can support health care as regards organization, treatments, and patient and employee satisfaction. Looking at health care today, most parts are digitally connected: The processes relying on administrative (e.g. patient information systems), embedded (IT in tools and machinery), and medical (information systems for diagnosis and treatment) IT are intertwined both concerning the actual work flows and the digital networks. This makes it possible to strategically choose which parts of the processes to focus on when analyzing performance and rewards. Given that adequate measures are established and accepted, there are really no technical limits to how input, output, and performance can be measured, valuated, and evaluated. Additionally, when such conditions are present, the information can be used for strategic scenario analysis through simulation and modelling (Young 2005; Ivatts and Millard 2002; Moroza 2006). This, in turn, can be used to lay the groundwork for intelligent digital reward systems.

These opportunities exist due to a kind of IT that cannot be deemed a commodity. In health care, innovative reward systems can help cut costs, increase time efficiency, enhance health care quality, shorten convalescence time, boost patient satisfaction, and promote creative thinking in connection to treatments and technical development. One has to recognize, though, that the reward part of the system is somewhat complicated. The incentives cannot always be monetary based. Health care professionals themselves

propose combinations of different rewards depending on the health care institution at hand, and its specific financial, organizational, political and legal conditions. Examples of rewards might be: Acknowledgement of ideological or humanitarian wins, personal professional satisfaction, official displays of appreciation from management, additional time off, greater individual freedom as regards work and time flexibility, favorable resource allocation, traditional monetary rewards, and various perquisites such as interesting conferences, and social events.

One case of a modern digital reward system found in the current empirical investigation is the so-called "smart-list", an information system for choosing good medicines when writing prescriptions. The system is based on a database that includes medicines presented in FASS – a list of all approved medicines in Sweden. When a physician or nurse is about to write a prescription, he/she fills a form on the computer screen. The typed text includes information about the patient, his/her medical history, and the diagnosis, and when the form is submitted the system automatically generates a list of preferred medicines based on effect, quality, and price. The lists are regularly put together by the county councils and different experts, and recommended to health care institutions. Furthermore, when the medicine and dosage is determined, the system produces a complete prescription ready for printout. This system has many advantages: It helps health care professionals choose a good medicine, it facilitates prescription writing, it saves a lot of time, it lowers cost, and it eliminates confusion due to bad hand writing. This is important because health care personnel spend lots of time writing prescriptions, and the medicine administration is complicated. Since the entire system is digital, it is also fairly easy to keep track of system usage, the number of prescriptions written, the amount of time required for writing each prescription, and the overall medicine consumption. In this aspect the performance part of the reward system is measurable. The rewards for using the system vary between different health care institutions – some are content with the fact that the average working day has become less administratively complicated, and that health care professionals get more time to spend with patients, while others have chosen to reward usage through events such as minor social happenings. This reward system, of course, relates to a rather small fraction of an organization like a hospital, but that is one of the major points: In the post digitization era, an organization's reward systems portfolio can be made up of a suited combination of numerous customized systems.

Another information system that, with some efforts and adjustments, can be the base for reward systems is the digital registration of time consumption during the health care processes. It keeps records of health care professionals' time spend with patients, time between patients, and patients' waiting and convalescence time. The produced information can be used to reward certain behavioral patterns, and this can be a great strategic tool for effective resource allocation and enhanced health care quality.

According to the respondents, there are also many reward systems possibilities – although not yet in use – connected to the diagnosis and treatment of patients. At this stage of digitization, information systems can be used for initial routine diagnoses and subsequent treatment suggestions. These, obviously, are rather delicate matters and the people in charge of the development need to proceed with caution. In health care, naturally, there is very little room for mistakes or failures, and the security regarding diagnosis and treatment of humans cannot be jeopardized by IT-implementations. Still, the more digitally refined these procedures get, more opportunities for reward systems arise. It is extremely important to recognize them, prepare for them, and use the technology to ensure patient security, health care quality, and cost effectiveness. Thus, this development is important to the future of health care. Researchers have already emphasized that reward systems is a significant piece of the puzzle of when working towards higher output quality (Ittner and Larcker 1995), and most likely, this will be even more true ahead.

5. Potential disadvantages and risks

Unfortunately reward systems in general, and perhaps in health care specifically, are associated with various problems – some more serious and fundamental than others. One practical dilemma is the lack of consensus as regards the use of standards and nomenclatures in health care (Jilert 2005; Kollberg 2007; Fryk 2007). It is not that there are no standards, in fact, according to the respondents, there are probably too many, but in order to define and measure input, output, and performance, the concerned parties have to agree on what to measure, how to do it, and how to present the results. Otherwise it is impossible to stimulate the preferred behavior, measure the degree of fulfillment, and reward it accordingly.

Furthermore, the health care aspect per se ads output complexity: How can healthiness, perceived wellbeing, patient satisfaction, and treatment efficiency be measured? How much is a healthy human life worth? There are no perfect answers to these questions, but this investigation indicates that health care

institutions, and other key actors, should work together continuously in order to establish common definitions and measures that, to the greatest feasible extent, resemble reality.

Consequently, the topic of performance measurement is highly intertwined with the definition and estimation of input and output. Kollberg (2007) and Fryk (2007) have found that measuring performance within health care is very intricate, especially due to the previously mentioned lack of consensus as regards standards and nomenclatures. In other words, when trying to implement, for example, management tools like balanced scorecard or total quality management in health care, there is a need for comparable measures, terms, calculations, and figures. So, today, there are many standards, but there is almost no agreement as to which ones to use. Instead, various local practices are predominant, which often makes the implementation and use of digital reward systems troublesome when it comes to valuation, evaluation, and comparability. Furthermore, Ammenwerth et al. (2003b) acknowledge the fact that all information system implementations – including digital reward systems – are associated with certain dilemmas and challenges such as difficulties regarding valuation, evaluation, definitions, standards, measures, and consensus. These problems need to be further researched using interdisciplinary approaches and including people from both academia and practice.

Typical performance measurements in health care identified in this investigation are locally established Key Performance Indicators (KPIs) such as number of treatment events per year, total cost/number of examinations, total staff cost/number of examinations, number of examinations/number of yearly employees, external revenues/total revenues, and bed occupancy. These measures, though, say very little about the actual health care quality, and patients' perceived wellbeing and satisfaction. Thus, in order to realize the possible benefits from digital reward systems, the health care establishments have to complement these traditional "hard" economic measures with "soft" estimations of output. Otherwise the reward systems may have inherently skewed effects, and there is a risk that the proclaimed goals of "the patients first" might be missed. Additionally, Rapp and Selmer (1981) conclude that the use of similar quota measures might be dangerous because they can lead to efficiency at the expense of effectiveness.

Another complex issue, that can be a potentially big problem, is that health care is built on strict and comprehensive moral and ethic codes that do not always mix well with the strive for monetary based efficiency and effectiveness. If the healthiness of patients is the main goal, witch most often is proclaimed, the incentive structure should promote work processes, resource allocation, priorities, and organizational forms and functions that support that goal in the best possible way. Thus, it is incredibly important that the digital reward systems do not undermine the moral and ethic codes of health care – e.g. by encouraging an unbalanced pursuit of efficiency, effectiveness, and monetary winnings, at the expense of patients, employees, and the development of health care. These reward systems related risks are imminent in most industries (Frey and Jegen 2001; Jansen and Von Glinow 1985), even though the potential consequences might not be as devastating as human suffering or lost life.

One failed digital reward system – which was revealed during the study – in Stockholm is the monetary compensation system where health care organizations get paid per treatment event, without recognizing the actual time per event. This has caused huge problems for health care organizations that, for instance, are responsible for many immigrants that sometimes do not know the Swedish language very well, and/or old and/or very sick patients with complex medical histories, which makes appointments take more time. These problems – brought about by a poor reward system – have led to unjust compensation allocation where certain geographical areas are disadvantaged due to the characteristics of their patients. Similar problems are discussed in Rapp and Thorstenson (1994), and this diametrically contradicts the moral and ethic codes of health care. The potential solution that is being discussed right now is a digital reward system that calculates financial compensation based on time spent with patients instead of number of encounters. This is possible due to the widespread and advanced IT-infrastructure together with innovative digital solutions. These are all features that distinguish the post digitization era.

6. Conclusions and future research

An innovative way of strategically utilizing novel IT is through investments in clever digital reward systems that can help steer organizations in desirable directions. In general, this is true for most industries, but the opportunities in health care are especially interesting because the digital reward system concept is rather new and few solutions have been tried. Parts of information systems seen in large corporations could be implemented in health care in order to keep track of data needed to stimulate preferred behaviors. The key issue is that the inherent functions of IT changes the way information can be handled, and this brings about

many possibilities for positive organizational change. The current investigation indicates that, presumably, this is especially true when it comes to health care and reward systems, irrespective of change strategy as regards behavior and/or performance.

Additionally, there are many areas in health care where digital reward systems could facilitate the achievement of the proclaimed goal to increase patients' healthiness and personal satisfaction. The IT-enabled ability to register time in different connections – e.g. time spent with patients, time between patients, patients' time spent in waiting queues – is especially interesting since this information can be used in reward systems that can improve efficiency and effectiveness. Subsequently this can lead to lower costs and improved health care quality.

Consequently, I predict the value of IT in the future to be closely related to innovative use and creative thinking. The main concern will not be achieving competitive advantages and/or productivity benefits through infrastructural investments in IT, but development through novel digital solutions – such as reward systems – that support organizations' unique desires. Thus, in the post digitization era, reward systems can lead to many positive results both in traditional companies and public organizations such as health care institutions.

Nevertheless, the risk-reward trade-off dilemma is imminent in health care. In this connection, quantity is good but quality is absolutely necessary, which calls for serious caution when establishing what to measure, how to measure it, and which behaviors to reward. Here is a great opening for future investigations. Research on the topic of moral and ethics in health care reward systems is scarce and any empirical contributions would certainly be appreciated. Furthermore, there still are no premium common definitions and methods for measuring input, output, and performance in health care, and it is essential to reach consensus regarding these matters in order to fully realize the possibilities presented by modern IT in the post digitization era.

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Bronze, Silver and Gold: Effective Membership Design in Customer Rewards Programs

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Abstract: Many companies use rewards programs to create so called "loyal" customers. Information Technology (IT) has made it possible to design such incentive programs in principle with endless variations at a low cost. It means that the company can, with the use of IT, offer non-linear incentives that create "loyal" customers more effectively than linear ones. Internet has also reduced the cost for the customer to search and compare products and services like air flights, hotels etc. In such a competitive context, the company can use the programs to gain an advantage with a differentiated offer to the customer and to create lock-in effects still at a low IT cost. Field observations show surprisingly that programs look very much alike and do not present as much variation as could be expected. Of special interest in this paper is the fact that companies typically offer three, or less, membership levels to increase the incentive for the customer to spend money at the company. These three levels come in different versions like, for example, "Bronze", "Silver" and "Gold" or with similar labels. The reward to the customer is generally associated and accelerated with membership level. In this paper, we analyze the consequences of using membership levels as a way to create both competitive differentiation and effective customer incentives. We suggest a model for understanding how the consumer decides on spending at a company that offers a reward program with different membership levels. The decision setting for the customer is described as a risky contract with a risky time-state-contingent claim. The contract is risky since the terms and conditions for membership can be altered by the company, without any legal penalties. The claim is risky since it is uncertain to the customer whether the state required for the membership will be achieved. We show with the help of this model that the present use of a small number of membership levels could be questioned as the most effective incentive mechanism.

Keywords: customer rewards program, customer loyalty, membership levels, incentives, differentiation, time-state-contingent claims

1. Introduction

Following American Airlines launch of its so-called "AAdvantage" program in 1981, other airlines, hotel chains, car rentals, bookstores, supermarkets, credit card companies, clothing retailers etc have followed suit offering "IT-based" customer rewards programs (in the following called CRP). In a standard CRP, customers earn points based on money spent at a particular company, a group of companies or CRP-partners. After having earned a certain number of points the customer can exchange these for some reward.

Basically, the programs can be seen as discount programs where the discount is typically paid in-kind after the customer has spent an accumulated amount of money. IT has made it economical for the company to "memorize" accumulated spending at a low variable cost for massive numbers of individual customers. Many programs are non-linear, i.e. they give increasing rewards for customers who spend more, typically designed as accelerated earning of points and more rewards on higher membership levels.

It is interesting to observe that many companies, at least in some markets or industries where CRP is frequent, use three or fewer membership levels. The phenomenon is even more interesting when we consider that the programs are IT-based and that the requirements for membership could easily be differentiated at a low cost by changing some code in the software. This paper attempts to analyze whether the practice of using a three-or-less-membership-level model is the most effective way to design "loyalty" incentives.

2. Previous studies

Earlier research has proposed various definitions of customer rewards programs (also referred to as customer "loyalty" programs or similar). Some examples of more or less different definitions are described in Table 1.

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Table 1: Examples of definitions of customer rewards programs

Source	Definition
Sharp and Sharp, 1997	Structured marketing efforts which reward, and therefore encourage, loyal behaviour
Leenheer et al, 2007	Integrated system of marketing actions, which aims to make member customers more loyal
Berry, 1995	Schemes devoted to create pricing incentives and developing social aspects of a relationship
Shapiro and Varian, 1997	Scheme rewarding customers for repeat purchases
Johnson, 1998	Marketing program designed to increase the lifetime value of current customers via a long-term interactive relationship
Youjae and Hoseong, 2003	Marketing program designed to build customer loyalty by providing incentives to profitable customers
Palmer et al, 2000	Identifiable package of benefits offered to customers which reward repeat purchases

From the definitions we see that they focus on the concepts of “loyalty” or “repeated purchase” as the specific aim of CRP. Whether “loyalty” is a good word for a customer who purchases repeatedly at the same company could be questioned. A customer could spend repeatedly at many competing companies offering different CRP. In fact, many customers seem to be enrolled in multiple programs according to Berman (2006). In such cases, it seems somewhat misleading to call a customer who spends repeatedly at many companies to be “loyal” to any of them. Also, if “loyalty” is partly an effect of a program that creates lock-in and switching costs, “loyal” does not seem to be the best description of the reason for the customer´s behaviour. It may even be the case that repeatedly spending customers are mistakenly viewed by the company as “loyal” customers, in the sense of having an overall positive attitude to the company, when they in fact may be the least “loyal” ones and only spending to get the rewards, as suggested by Reichheld (2006) and McKee (2007).

There seems to be a need for more generic criteria that gives the phenomenon CRP a distinct meaning. For instance, Dowling and Uncles (1997) assert that price promotions are one kind of CRP whilst Youjae and Hoseong (2003) argue for a distinction between price promotions and CRP. Criteria have been suggested by Sällberg (2004) and could be useful, in addition to a definition of the construct, to also further distinguish between what is and what is not a CRP. However, that is outside the scope of this paper. Our aim here is to introduce a way to describe CRP and especially the membership designs as time-state-contingent claims. The approach should be seen as a first step in a larger effort to contribute to a clearer understanding of the workings of CRP.

2.1 Studies of the value of CRP for the company

Researchers have previously pointed out a lack of research on the value of CRP for companies. Jain and Singh (2002) have called for research on CRP and the impact on company profitability. Sharp and Sharp (1997) have suggested that there is a lack of research on appropriate measures of effective CRP. Bolton et al. (2000) use time-series data, (collected on CRP members of a financial services company) in order to find out what effect a CRP has on repeated purchase. Their results do not indicate that CRP members show stronger customer retention than non-members. However, they conclude that the CRP members seemed to discount negative evaluations of the company vis-à-vis competitors, thereby increasing revenues. They also conclude that there is a lack of research on the effect of CRP on repeated purchase as well as its effect on the financial outcome for the company.

Several studies concern the relationship between CRP and branding, especially how a CRP can support brandings strategies. Dowling and Uncles (1997 p.74) even suggest that an effective CRP must leverage the brand’s value proposition to the customer: The authors argue that it is important for the company to fully cost the CRP and to design a reward scheme that maximizes the buyer’s motivation to make the next purchase.

O’Malley (1998) has suggested that CRP is developed for several reasons: to reward “loyal” customers, to generate information about customers, to manipulate customer behaviour or as a defensive measure to combat a competing scheme. O’Malley also suggests, that companies offer CRP because they believe that ”loyal” customers are more profitable, cost less to serve, are less price sensitive and generate positive word

of mouth. Despite that generating information about customers and manipulating customer behaviour might be explanations to why companies develop “loyalty” schemes; it does not explicitly show how customers value the CRP. Leenheer et. al. (2007) suggest that the effectiveness of a CRP may be related on the savings component, the discount rate and multi-vendor structure. The results of their empirical study indicated the savings component and multi-vendor structure to have positive impact while higher price discount rates were not indicated to have any impact on the effectiveness (measured as “store attraction” or “share of wallet”) of CRP.

De Wulf et. al. (2002, p.4) suggest that both the customer and the company have to accept costs to outweigh expected advantages. The customer has to give up some freedom of choice between different companies and sometime o pay en entry fee to join the CRP. The company has to accept a cost by giving some rewards but in return expects that this will be outweighed by the present value of future income from a long-term relation with the customer. They also suggest that it is unknown which CRP attributes are crucial in the mind of the customer and how these attributes influence customers’ intentions to participate in CRP. The authors hypothesize using the concept of equity (attitude) that personal data release, participation cost, purchase frequency, participation exclusiveness and participation efforts are customer inputs while program benefits, number of program providers and program duration are customer outputs. Their empirical hypothesis test indicated participation costs and program benefits to determine a customer’s choice to participate in a CRP for almost 70%. That is, six other attributes were indicated to be of minor importance as determinants of customer participation to a program. The discussion does not concern the question whether it is actually possible that both parties may benefit from a CRP and what conditions have to be met in order for that to be the case

Previous research has also concerned the determinants of the value of a CRP for the company. The critical determinants suggested by O’Brien and Jones (1995) differ from the ones suggested by De Wulf et al (2002). The latter suggest program duration, participation cost, personal data release, and number of program providers to be critical while the former do not. The former though suggest the cash value of redemption rewards as a determinant while the latter more generally emphasize program benefits. While Leenheer et al.’s (2007) empirical study indicates that the price discount rate has no significance for the effectiveness of CRP, O’Brien and Jones on the other hand argue for cash value of redemption rewards to be critical for valuing CRP. Neither argues that the brand’s value proposition has to be leveraged in order for the CRP to be valuable, which Dowling and Uncles (1997) do. While O’Brien and Jones and De Wulf et al. discuss determinants on a rather similar level O’Malley reasons on a more abstract level. O’Malley does not argue for any critical determinants within each abstracted level. This enhances the divergent picture on what drives the value of CRP. Some researchers, for example Mauri (2003), Byrom (2001), Dennis et. al. (2001), argue that the reason for implementing CRP is to get access to customer information.

More recently, Leenheer and Bijmolt (2008) have suggested that knowledge about a market segment or even individual customers can provide better customer value and develop stronger customer relationships specifically through e.g. optimization of loyalty program design. In Van Heerde and Bijmolt (2005), the distinction between members and non-members in CRP is stressed as important in order to understand how revenues can be generated and promoted more effectively.

The value of CRP to the company is clearly not unrelated to the value for the customer. O’Brien and Jones (1995) suggest that the combination of the following five elements determines the value of a CRP for customers:

E1: The cash value of redemption rewards.

E2: The range of choice of rewards.

E3: The aspiration value of the rewards.

E4: The subjective likelihood of achieving rewards.

E5: The scheme’s ease of use.

How these types of customer values are related to company values would be interesting to study further. Understanding the value and workings of CRP is not only an interesting topic for academic research but could also help companies to improve the design of CRP to the benefit of both consumers and companies. Dowling and Uncles (1997, p.1) even suggest that the increase in prevalence of CRP is an effect of that “*if you see a good idea copy it”* and that CRP can destroy rather than improve value for many companies. More knowledge on what determines the value of CRP could help companies to avoid such imitation.

3. The "Bronze, Silver and Gold" phenomenon

For a number of economical reasons, CRP is more or less standard in the air flight and hotel markets. Observations from the field show that these programs typically are designed in a similar fashion when it comes to membership levels. For example, in the "EuroBonus" program of SAS, there are three membership levels called: "Basic", "Silver" and "Gold". In Table 2, membership levels for some well known large airlines and hotel chains are described as an illustration of this observation.

Table 2: Examples of CRP membership levels (source: respective company)

Company			
	1st level	2nd level	3rd level
American Airlines	Gold	Platinum	Exec. Platinum
Continental Airlines	Silver Elite	Gold Elite	Platinum Elite
United Airlines	Premier	Prem. Exec.	Prem. Exec. 1k
SAS	Basic	Silver	Gold
KLM	Silver	Gold	Platinum
British Airways	Blue	Silver	Gold
Lufthansa	Freq.	Senator	Hon. Circle
Singapore Airlines	Kris	Silver	Gold
Best Western	Platinum	Diamond	
Hilton	Silver VIP	Gold VIP	Diamond VIP
InterContinental	Exec.	Ambassador	
Marriott	Gold	Black	Platinum
Sheraton	Gold	Platinum	

Table 2 illustrates that the use of exactly three membership levels are popular among large airlines. Among hotel chains, three or two levels are popular. It is interesting to note that the companies seem to, although in a limited way, use the membership labels to compete, e.g. the first level is called "Basic" by SAS and "Silver" by KLM. Also, it can be noted that a certain selection of precious metals seem to be preferred as a way of indicating order. Our main interest here is however the number of levels used. The observations seem to reveal a preference among companies for few rather than many membership levels. One reason for this may be that the company put a small value on differentiating its CRP. Another explanation may be that the companies consider programs that are easy-to-use and easy-to-understand (compare element *E5* above) more effective and therefore many membership levels with more complex reward models as ineffective. Previous studies have not focused primarily on membership levels but rather on broader issues. The approach in this paper aims to shed more light on the value of membership design for the company.

3.1 A structure of membership rewards

To structure the membership part of a CRP, we suggest that the designs can be generally expressed as a time-state-contingent claim. To illustrate with the example of American Airlines, the membership part of the program can be described as follows:

If you in *1 calendar year* (*time*)
fly *25 000 miles* with us (*state*)
then you can claim *Gold membership*. (*claim*)

For anyone who is slightly familiar with software code, it is obvious that the above type of rules is easily translated into a few lines of code. Also, it is clear that the time-state-claim variables can be set with almost endless variations resulting in a large number of possible membership levels. In the Hilton example, a new level could for example be:

If you in *2 calendar years* (*time*)
spend *5 nights* in our hotels XYZ (*state*)
then you can claim *Green membership*. (*claim*)

To execute any such contract, the only information requirement is that the system retrieves data about the individual customer's spending (amount, where, when). Without going into the many details at this point, we may say in general that a higher membership level usually requires more spending (miles, nights or similar) and gives more valuable rewards. We will presently return to this type of contingent claim structure when we analyze the effectiveness of membership designs.

4. A model of the value of spending to become member

The value of a CRP for companies is not unrelated to how customers value the scheme. We will adopt the definition of CRP by Shapiro and Varian (1997), and claim that the value of the CRP depends on how well it creates incentives for the customer to purchase repeatedly at the company.

The question is here how the membership design contributes to this incentive. We suggest that the value of the contingent membership claim *V* for the customer can be expressed as:

$$V = ps \times um \times pc$$

where *ps* is the probability that future spending will reach the required state for membership *m* in stipulated time, *um* is the utility of reaching membership *m* and *pc* denotes the probability that the contract stays valid, i.e. that the expected rewards can be contractually claimed.

If we compare with previous suggestions, it could be argued that our model includes four of the five elements suggested by Jones and O'Brien (1995) as described above. The suggested elements *E1*, *E2* and *E3* are included in our *um* and *E4* is included in our *ps*. The element *E5* needs to be explored further and is not explicitly represented in our present model.

4.1 Underlying assumptions

We assume that *ps*, *um* and *pc* are numbers in the interval [0,1]. This implies that the higher *pc*, *ps* or *um*, the higher value for the customer. It also seems like a reasonable assumption that *pc* does not change when the customer spends money at the company, i.e. we can treat *pc* as a constant without any effect on the incentive to spend. We further assume that customer prefers to become member sooner than later. We also assume that the customer maximizes value, which implies that the higher value of the contingent claim, the larger is the incentive to spend at the company, everything else equal. In other words:

> The customer has an incentive to spend money
> at the company
> if it leads to an increase in *V(.)*.

We argue that there is a significant cost for the company to increase the membership reward, i.e. *um*. This could be a reasonably general assumption but with some exceptions if non-substantial changes have effect on the CRP value. One example of this could be if the company just changes the membership label from "Basic" to "Gold" and this is evaluated by the customer as an increase in reward. We further argue that there is a significant cost to decrease the contract risk *pc*. One way of decreasing this risk would be to show a credible record of not having changed the CRP terms in history. A change of the terms would only be considered if the terms are ineffective. Staying with ineffective terms to increase *pc* implies that there is a cost to increase *pc*. Based on this, we will argue that there is one way for the company to increase the value of the CRP without incurring more costs, which is to increase the probability *ps* and reduce *um* less. In other words, to maximize the number of customers who aspires on a higher membership level.

4.2 Incentive to reach a membership level

Suppose we have a customer called *K* and a CRP with one membership level called *m* and the following generalized time-state-contingent claim:

> If *K* in time period *T*
> spends *X* amount at the company
> then *K* can claim the membership *m*.

As long as *K* has not reached *m*, either *ps* or *um* or both will increase with spending, hence, *K* will have an incentive to spend more money at the company. When *K* has spent enough to claim *m*, further spending will not increase *ps* or *um*, hence, the membership design does not create any further spending incentive for *K*. This is not a surprising result, since it says that the membership level has an incentive effect on spending but only for those who are not members (or otherwise risk to lose the membership). In other words, we can say that we model the assumption that a goal creates an incentive as long as it has not been reached. This would imply that there should always be one membership level that some customer aspires hence that no customer can achieve.

4.3 Spending incentive and opportunity cost

Given that one membership level works as incentive for non-members, the question is if many membership levels are more effective than one. We could claim from the result above that the total spending incentive is larger the more customers who aspires on higher membership levels. To develop the model further into being more realistic, we should introduce the possibility that the customer has a cost for spending at the specific company compared to spending at any other company, disregarding the expected value of rewards. Let us call this cost *C*. We now can develop our previous assumption into the following:

> K has an incentive to spend money
> at the company
> if the increase in *V(.)* is larger than *C*.

If *C>0*, then the CRP can only work effectively as an incentive if the customer aspires on a higher membership level, i.e. 0<*ps*<1. This implies that a company competing for customers, i.e. where *C>0*, should have as many customers as possible who aspires on higher membership levels. If the consumers differ in spending characteristics, this is more likely to happen, the more membership levels the program has.

5. Concluding discussion

If consumers in the market have different spending characteristics implying different membership levels aspirations, it means that the company should have *n+1* membership levels if the consumers have *n* different spending characteristics. Only if this consumer characteristic can be efficiently divided into two groups, then three membership levels seem effective. A perhaps naive explanation to why the companies seem to prefer certain number of levels could be that the companies are anchored in the versioning of their underlying primary products. If airlines have three versions of service, like “Coach”, “Business” and “First Class”, it may influence the membership design. Another reason may be that it is considered difficult to create membership labels expressing that all “loyal” customers are important on an increasing scale.

The result to have *n+1* membership levels is not surprising but could rather be seen as a special case of optimal differentiation of information products with insignificant cost for differentiation. However, also here we can often observe the magic of the number three, as for example in software sold in the versions “Home”, “Professional” and “Enterprise”. These kinds of versioning strategies are discussed by Shapiro and Varian (1997).

It is interesting to note that in other areas with insignificant differentiation costs, rankings are used with much finer grading. Take the case of Judo for example, where a nominal scale with up to 14 colours and colour combinations work as “membership” levels. Everyone who trains Judo can aspire on a higher level since the rank system, in theory, actually goes beyond the 10th degree (*dan*) of black belt, i.e. it has no upper limit. To our knowledge, a small number of *jūdōkas* worldwide have reached the 10th degree but no one has reached the 11th. There are probably a lot more examples of this type in different areas. The conclusion must be that there are different theories in use when designing membership levels or alike. It would be interesting to explore empirically the rationale for these different designs.

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Organisation Profiling and the Adoption of ICT: e-Commerce in the UK Construction Industry

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Abstract: This paper outlines the application of a model of business that has been developed from an amalgam of sources covering a wide range of research literature concerned with the relationship between electronic communication and the business. This model outlines what is termed an "organisational profile" profile and allows the analysis of the business with respect to its ability to perform in four distinct quadrants: management, processes, organisational culture and human resources. It is then applied to the adoption of ICT in the business and the supply chain using a case study of the UK construction industry. The results are analysed to show which elements of the model are important for success. The model shows that to be successful in the adoption of ICT a business must have threshold scores in each of these quadrants that show its make-up or "organisational profile" (OP). It is this OP that is the most interesting point of the research. It has been found that certain OPs are more likely to succeed in this adoption than others and that the likelihood of success can be shown by the movement of the business in the four quadrants: thus the model can provide a rough prediction of the future success in various activities - such as adoption of ICT but can also be extended to other activities because of the widespread nature of the model developed. It is also planned to apply the model to different problems in the same domain in the near future so that further insights can be gained from the model and its application.

Keywords: e-commerce, ICT adoption, construction industry, business modelling, organisational profile

1. Introduction

Previous work has seen the development of a model (Jackson and Sloane 2003, 2007) based on a number of sources (Gallier 1991, Wolvelaere et al 1991, Williams 1993, Emmelhainz 1993, Garcia-Sierra, Moreton, and Sloane 1994, Regan 1995, Lummus and Duclos 1995, Angeles, Nath, and Hendon 1999, Fearon and Philip 1999, Pawar and Driva 2000). This has incorporated a wide range of different research into the final tool – The "target" model of ICT (information and communication technology) adoption. This "target" model is based in four different areas of an organisation: process, management, human resources, and organisational culture. The various sectors of the model give an overall view of the organisational ability to benefit from the adoption and implementation of ICT – an organisational profile. This model has now been applied to a range of businesses in the UK construction industry and the results are presented in this paper.

2. The supply chain

ICT developments and new methods of electronic trade are constantly being introduced into the commercial arena. Electronic trading methods have been available for many years, Electronic Data Interchange (EDI) being the most widely accepted form particularly in the construction industry. It provides a governed formal structure for trading business documents. EDI has helped the development and expansion of partnerships between organisations to varying degrees. It has provided the media for developing electronic business communities and supply chains (E-Chains). It is a technology that has enabled change, development, and for operating cost to be reduced. It is a competitive market tool that the expanding use of the Internet can fuel, increasing the use of electronic trading methods.

In business, communication is central to operations and the formation of E-Chains. EDI permits the sharing of information throughout a supply chain by the seamless exchange of documents. For the effective utilisation of EDI, the integrated IT system requires a detailed analysis from both a breadth and depth perspective. This permits the effective co-maturation and development of the existing business with new technology. Research shows extensive business integration of IT developments, especially at the architecture stage, can provide substantial benefits in small and large companies alike.

To fully exploit opportunities bought on by, adopting electronic trading methods and developing business practices, a business analysis and constant monitoring of the individual organisation and the supply chain is required. This research supports a general shift towards inter-organisational relationships rather than stand-alone analysis to yield maximum business growth. Within this framework the individual business needs to be analysed to see how it fits in the supply chain and how it is fitted to adopt the technology.

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The model presented here is a necessary tool to analyse the individual organisation which will then feed into the supply chain model to give a more complete picture.

3. Model outline

It has been shown that there is a positive relationship between the higher levels of EDI implementation and achieving more significant benefits. The literature suggests (Jackson and Sloane 2003, Jackson and Sloane 2007) that both depth and breadth be considered when analysing an organisation for implementing a new technology. There have been four key elements repeatedly mentioned throughout the literature as vital for any successful adoption, they are; process, management, human resources, and organisational culture. The target model (Figure 1) examines an organisation as a single entity taking into consideration the elements mentioned and the degree of adaptability.

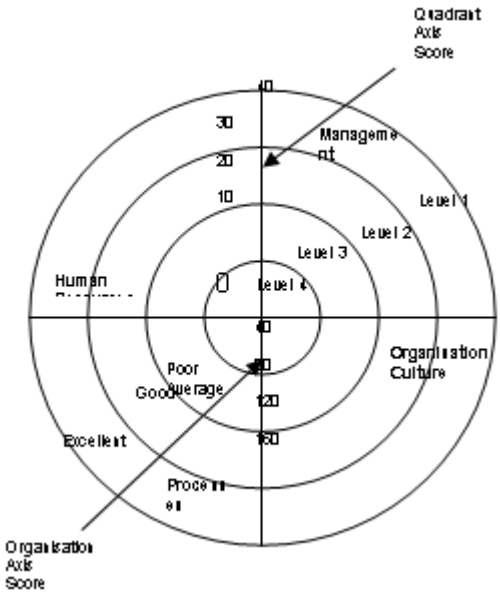

Figure 1: The target model

4. Results and analysis

This section shows the results of the development and application of the model. The results gathered are displayed and analysed based on organisational quadrant division. The analysis identifies the two lowest and highest resultant marks from each quadrant, an overall average quadrant score, and quadrant range score. The results are also analysed in holistic terms, thus providing an organisational score or ability to adopt new ICT developments into existing business framework.

The significance of the highest and lowest scoring statement is not obvious. The most simplistic view would be that the results show that the low statement has a lesser impact on the adoption of new technology compared to the converse returned by the high scoring statement. However another view could suggest that the low statement in itself is of lesser importance and the high statement result being of higher importance. The analysis is constructed on the premises that the highest and lowest recorded figures represent the most and least significant statements respectively based in each quadrant.

4.1 Quadrant results: Organisational culture

The data gathered from the organisational culture questions was averaged and applied to a bar chart to display the results by question (Figure 2)

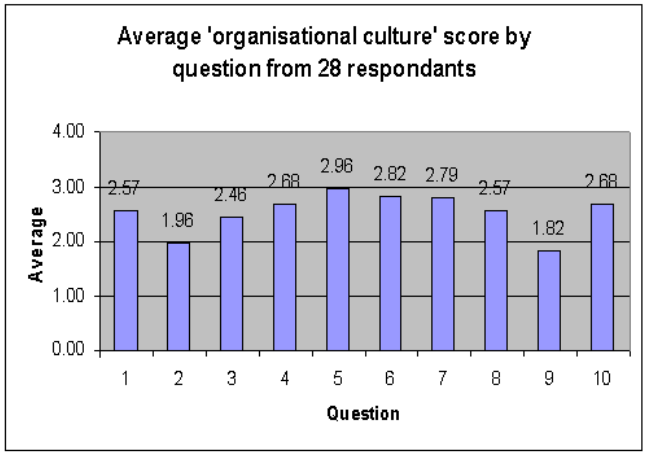

Figure 2 Quadrant results – organisation culture

The two lowest average marks were obtained by:

- Q9 (Value1.82) Best practice of our trading partners has influenced our organisational development path.
- Q2 (Value 1.96) Colleagues are willing to 'point the finger' concerning other's over known issues.

The two highest average marks were obtained by:

- Q5 (Value 2.96) People choose to work with others rather than in isolation.
- Q6 (Value 2.82) People become allies when development is proposed.

By examining and analysing the 'organisational culture' results it would suggest that best practise utilised by the respondents trading partners has had a low impact on the adoption and implementation of new technology in their own organisation; statement (9). This result combined with the well above average result from statement (7); 'Previously the organisation has coped well with change' and statement (10); 'Our organisational culture has positively influenced our performance and corporate strategy', suggests that although many organisations indicate they embrace organisational cultural change few are influenced directly by their current trading partners.

The highest score was gained by statement (5); 'People choose to work with others rather than in isolation'. The result indicated that most employees would rather form and work from with in a team to achieve a common goal than work on their own.

4.2 Quadrant results: Management

The data gathered from the management questions was averaged and applied to a bar chart to display the results by question (Figure 3)

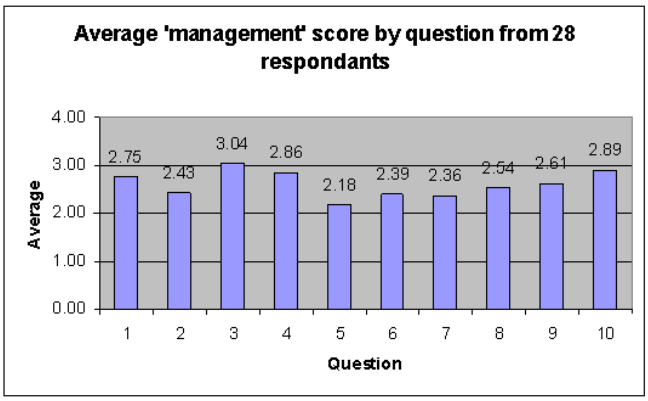

Figure 3: Quadrant results – management

The two lowest average marks were obtained by:

- Q5 (Value 2.18) Management provide adequate positive and negative stroking.
- Q7 (Value 2.36) Management stimulate an interest in work.

The two highest average marks were obtained by:

- Q3 (Value 3.04) Management determines resources and structure required for new adoptions.
- Q10 (Value 2.89) Management effectively resolves conflicts and differences (including resistance to change)

By examining and analysing the 'management' results it would suggest that the management and/or management style employed by the organisations tested provides a low level of positive stroking (statement 5: management provide adequate positive and negative stroking) and stimulating an interest in current business related work operations (statement 7: management stimulate an interest in work), thus resulting in a negative interest in the adoption of new ICT into an existing business framework. It is clear from the highest scoring result that management can clearly identify what is requirement for new ICT adoption (statement 3: management determines resources and structure for new adoptions). The second highest scoring result (statement 10: management effectively resolves conflicts and differences) suggests that any new adoption is managed carefully helping lower any resistance to change, a positive sign stance for any organisation to adopt.

4.3 Quadrant results: Processes

The data gathered from the process questions was averaged and applied to a bar chart to display the results by question (Figure 4)

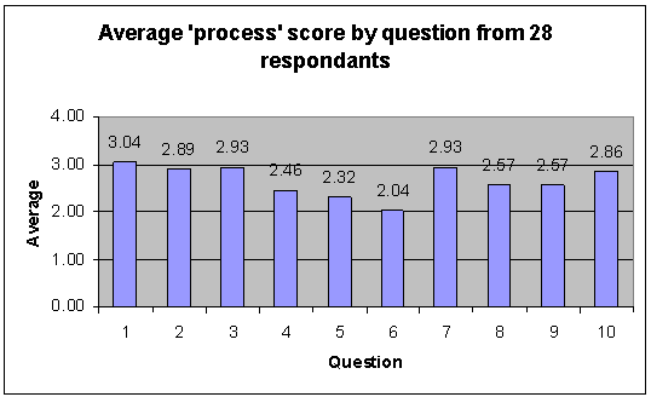

Figure 4: Quadrant results – processes

The two lowest average marks were obtained by:

- Q6 (Value 2.04) The organisation has a budget set for new technology adoption.
- Q5 (Value 2.32) Business process re-engineering is common.

The two highest average marks were obtained by:

- Q1 (Value 3.04) The benefits of new technology adoption is greater than the associated cost (cost – benefit analysis).
- Q3 & Q7 (Value 2.93) New technology adoption will add significant value to the business and improve productivity & New technology adoption makes commercial sense.

By examining and analysing the 'processes' results it would suggest that adopting ICT into an organisation is relatively low on the agenda. The two lowest results (statement 6: the organisation has a budget set for new technology adoption) and (statement 5: business process re-engineering is common) would suggest that the technology infrastructure is only adapted, changed, upgraded, or added too, on rare occasions, also it would seem unlikely that any new adoption would radically change current working practices. Conversely the highest scoring average results indicate that organisations observe the benefit of adopting new technology into current working practices and that the benefit outweighs that of the cost (Statement 1: the benefits of new technology adoption is greater than the associated cost). Further, any new ICT adoption would be seen to add value to the current business and makes commercial sense (Statements 3 and 7 respectively: new technology adoption will add significant value to the business and improve productivity, and new technology adoption makes commercial sense)

4.4 Quadrant results: Human resources

The data gathered from the human resource questions was averaged and applied to a bar chart to display the results by question (Figure 5)

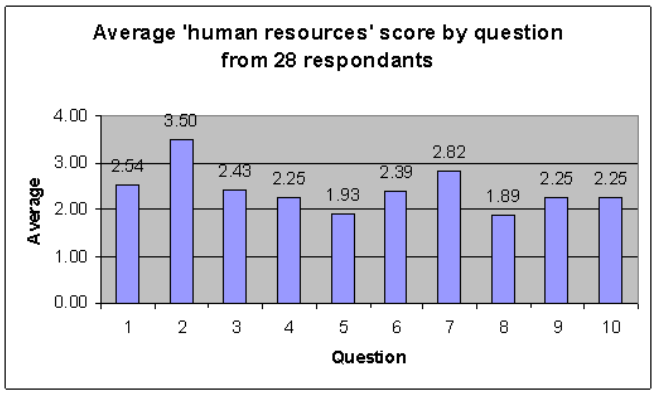

Figure 5: Quadrant results – human resources

The two lowest average marks were obtained by:

- Q8 (Value 1.89) The organisation operates a corporate integrated human resources program.
- Q5 (Value 1.93) The organisation operates an adaptive training program.

The two highest average marks were obtained by:

- Q2 (Value 3.50) People are a vital competitive resource.
- Q7 (Value 2.82) Human resources are committed to the good of the organisation.

By examining and analysing the 'human resource' results it would suggest that the organisations analysed thought that new technology adoptive success did not reply on employing an integrated human resources strategy (Statement 8: the organisation operates a corporate integrated human resources program). Also training or re-training has a low impact on successful new technology adoption (Statement 5: The organisation operates an adaptive training program). The very high, highest average score (statement 2: people are a vital competitive resource) indicates that an organisation values its human resources, possibly more than just as a commercial commodity as suggested by the second highest statement (statement 7: human resources are committed to the good of the organisation)

5. Analysis

The overall average results for each quadrant was the mathematically calculated average of the average score extracted from each quadrant. Table 1 shows the results.

Table 1: Summary of results by quadrant

Quadrant	Highest	Lowest	Average	Range
Organisational Culture	2.96	1.82	2.53	1.14
Management	3.04	2.18	2.60	0.86
Processes	3.04	2.04	2.66	1.00
Human Resources	3.50	1.89	2.43	1.61

5.1 Average scores

An analysis of the average score shows that the element 'processes' scores the highest average mark (2.66) closely followed by 'management' (2.60), 'organisational culture' (2.53), and lastly, 'human resources' (2.43). The difference in average marks could suggest either that the perceived weighting of the 'processes' statements were higher than that with the 'human resources' statements. There may be individual questions that have returned a very high or low result that is affecting the balance of results or, that a higher average score was generally recorded by the respondents as a more significant quadrant associated with the adoption of new technology into an existing business. Using this last statement and applying the results would suggest that 'processes' is the most important of all the quadrants for successful adoption to occur. This would concur with the model review and analysis. Previously of the many models constructed the central focus was the operations or process-develop issues concerning new ICT adoption. This could be seen as inherent in the business of today.

5.2 Range scores

The range result for each quadrant is the mathematical difference between the highest average and lowest average scores achieved this is shown in table 1.

The range analysis identifies the spread or range of recorded results. The table shows that 'human resources' achieved the highest range score (1.61) followed by 'organisational culture' (1.14), 'processes'(1.00), and lastly 'management'(0.86). There are a number of ways of examining the significance of the range result.

- The greater the range result could indicate:
- The more diverse the statements in a quadrant
- The respondent is unsure of the question meaning
- The less evenly weighted the statements are in a quadrant
- The less cohesion there is between the statement and business framework

Conversely; the lesser the range result could suggest:

- The more closely associated the statements in a quadrant
- The respondent has a passion or close relationship for a statement
- The more evenly weighted the statements are contained within a quadrant
- The more cohesion there is between statement and business framework

For this analysis the 'range' result is the diversity of statements asked in a quadrant in the questionnaire. Thus 'human resources' achieved the highest diversity of questions.

5.3 Summary of quadrant scores

Table 1 shows the results collected and collated from the questionnaire research. The table shows the quadrant results; organisational culture, management, processes, and human resources in a summary format, this includes the compiled results for the highest, lowest, average, and range scores.

The results for 'organisational culture' category suggest that this area of the business is not the most clearly understood, defined, and/or recognised by an organisation. The results show that it is clearly important to some organisations however, to others it is defined as of least importance. This perceived conflict of interest is common as perception and reality will differ between organisations. This is what makes an organisational culture unique.

The results for 'management' and 'processes' categories show that these two quadrants have the two highest 'average' grade positions and the two lowest 'range' positions suggesting that these areas of the business framework are the most clearly recognised and understood by an organisation. It may be suggested from the lesser extreme results that an organisation observes these categories with equal importance.

The results for the 'human resources' category shows an extreme high for the 'highest' and 'range' result. This suggests that this area of the business is the most misunderstood in terms of successful adoption of new technology. It lacks definition in the organisational context. The results indicate that some organisation view its human resources as vital to business success where as others do not. Further more, as discussed when reviewing 'organisational culture', the perceived importance and actual need of human resources is an area of dispute.

5.4 Holistic analysis

An organisation can be divided into a number of quadrants that collectively construct a business framework. However, when a new ICT adoption is to take place the organisational needs to be examined from a holistic view. For this purpose a polar chart has been used. The forty questions (ten from each quadrant) that were used to construct the questionnaire have been charted. This process pieces back together the business to produce a diagrammatical overview of an organisation based on the research conducted.

Figure 6 was constructed from the recorded results of three organisations used in the survey. The plotted points provide a clear picture of the difference between an excellent, average, and poor organisation.

The 'excellent' organisation scores very high (between 3 & 4) on all questions. This would suggest that the organisation is currently in a very favourable position for successful adoption of new ICT into its existing business framework. The 'average' organisation marks hover in general between the (2 & 3) mark. This indicates current flexibility and capability to achieve moderate success. Full adoptive success is possible but may take a longer period of time to realise or require an extra application of resource. The 'poor' result suggests that successful adoption of a new ICT development is limited, even prone to failure, unless additional resources in most quadrants are applied.

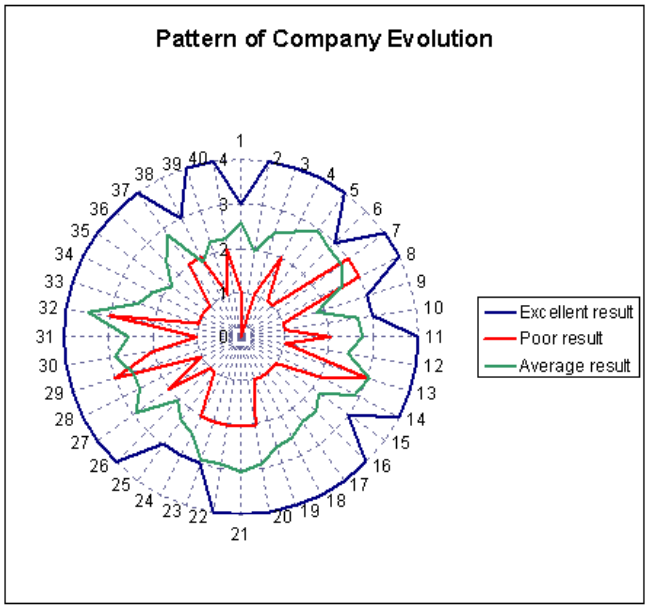

Figure 6: Pattern of company evolution

In general, the graphical representation of the results suggests, by its increasing area, the increasing possibility of a successful new ICT adoption into an existing business framework.

6. Conclusions

This paper provides results and analysis of the application of a newly created model of organisations in the construction industry sector based in the United Kingdom. The data gathered forms the basis for model testing and organisational analysis. It will also be used for further research developments.

From an 'organisational culture' prospective the results confirm that trading partners have had little impact on influencing supply chain developments or new ICT adoptions although the results clearly indicate that group/team working is essential to success. The 'management' results suggest that management in general provides a limited amount of feedback to its work force and the structure and resources are determined by management. The 'processes' results indicate that many organisations do not have a budget set for new ICT adoption, however suggest that the benefits of adopting new ICT developments is greater than that of the cost. The 'human resources' sector result identifies the greatest area of conflict and understanding from the organisations surveyed. The results suggest that many organisations do not operate an integrated human resources program however identify that human resources are an organisation's greatest competitive advantage.

The average and range results calculated from each quadrant supplied another dimension to the analysis. The average score is built on the premise: the higher the average score the more important the quadrant and that 'processes' are vital to success.

The study of previous models concurs that 'processes' or operations adoption is usually shown as key to success, many models only looking toward this area of the business framework for new ICT adoption. The 'range' result is the mathematical difference between a quadrants' highest and lowest average mark. The range result can be viewed in a number of ways. However for this thesis it can be described as the diversity of questions asked within a quadrant. 'Human resources' scored the highest range result, 50% greater than all the other quadrants, further investigation is required.

The summary of the quadrant results suggest that 'organisational culture' is not clearly understood or recognised as an impact of new ICT adoption. Management and processes are viewed by most organisations as very important and their impact is widely understood. It is clear from the results that the 'human resource' area of the business is the most misunderstood or simply seen as a non-significant entity in the role of successful new ICT adoption into an existing business framework.

The holistic analysis provides a pictorial overview with three organisations results plotted (excellent, average, poor). The organisations plotted are extracted from the results of the survey. The polar chart provides clear indication of the total area resulting from the plotting exercise. The greater the area results in a more dynamic, and flexible organisation that can accept new ICT developments easily into an existing business framework. Thus, providing:

- A greater rate of success
- A higher level of success (depth of penetration)
- In an ever reducing relative time period

It is clear that research discovers and uncovers more directions and questions to be asked: this research has been no different.

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Adoption and Evaluation of Mobile Commerce in Chile

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Abstract: Chile is recognized as the most wired or the most e-Ready country in South America and in the top quartile globally. Chile has the highest penetration of cell phones in South America, yet it has been slow in adopting mobile commerce. In this exploratory research, both electronic and mobile commerce adoption in Chile are studied. The survey questions are developed based on the previous studies on mobile commerce adoption. The results show that the group studied uses electronic commerce extensively but is not comfortable using mobile commerce, and complain than mobile access speed, service quality and price needs improvement.

Keywords: mobile commerce, mcommerce adoption, mobile commerce in Chile, electronic commerce in Chile

1. Introduction

Chile is recognized as the most *wired* or the most e-Ready country in South America, according to the 2006 Economist Intelligence Unit Rankings. The country is reportedly progressing steadily in its broadband penetration and mobile penetration (of over 75 percent). It is ranked higher than many European Countries in its Network Readiness in 2008 according to World Economic Forum Report. (Dutta 2004) (Dutta 2008)

Chile is commended by many global economic watch groups for their action in advancing the country towards IT (Information Technology) readiness. Chileans through public and private partnership are determined to make significant progress in becoming a leader in ICT (Information & Communication Technology) use in Latin America. In establishing its robust digital agenda, Chile has established many initiatives focusing on Access, Digital Literacy, eGovernment, e-transactions (eBusiness), and Legal framework. Digital literacy or human resource development is what the government coordinator for ICT considers as the biggest challenge. Chile has recognized ICT as an important instrument to gain economic growth and maturity. In establishing these goals, Chile has recognized that it needs to get itself ready in the transformation process from being a resource-based economy to a knowledge-based economy. (Alvarez 2005)

In planning its initiatives for this transformation Chile recognizes that digital literacy and self-efficacy in the use of technology are critical yet the biggest challenge. For instance, many reports show less than 15 percent of businesses and consumers indicated using eCommerce. Furthermore, although there is reported 75 percent mobile penetration, 80 percent of that uses it only for voice communication. Thus, both eCommerce (electronic commerce) and mCommerce (mobile commerce) have been very slow in the adoption. Both, the global and local technology-based companies have been constantly evaluating the acceptance and market maturity in the use of ICT among Chileans. The need for understanding the reasons for this slow adoption is important, yet there have been a few localized and comparative studies regarding mobile and electronic commerce adoption and use among Chileans. There have been many studies conducted regarding the factors affecting the successful adoption of mCommerce, especially in developing countries. In this study, authors have attempted to capture and analyze the perception and adoption of mCommerce relative to eCommerce among Chileans.

2. Background

2.1 Mobile commerce

While eCommerce is still growing, a rapidly changing technology promises to deliver even more value than the eCommerce. (Clarke 2001) This is made possible through mobile devices. Although mobile devices (as cell phones) have been useful for some time for voice applications, entertainment and gaming, the change to digital devices and the availability of variety of handheld devices with digital and information-based applications has been promising new growth in commerce through mobile devices or mCommerce. (Kini 2004) (Kini 2006)

Mobile commerce is defined in a variety of ways. The definition that is used in this research is that commerce done using a wireless handheld device using cellular or Wi-Fi or any other type of wireless network. The digital handheld devices have been converging allowing ever-expanding application base for consumers.

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(Stafford 2003) Scholars have been debating whether mCommerce is an extension of eCommerce using a handheld device or a channel that has far more value addition potential. Clarke states that a mobile device through ubiquity, convenience, localization and personalization delivers significantly higher value than the eCommerce channel. Furthermore, researchers have been projecting that with converging technology and expanding application base mCommerce will be a powerful channel. (Clarke 2001) (Lee 2003) (Kini 2004) (Jih 2007)

The value propositions theorized by Clarke (Clarke 2001) ubiquity, convenience, localization and personalization define the relationship between possible supplier offerings and consumer purchases, by identifying how the supplier fulfills the customer's needs across different consumer roles. The mCommerce value propositions explained above are opportunities available for mCommerce suppliers. Whether eCommerce users perceive these values is not known. In mCommerce research, it is important to validate these value propositions and the existence of such value space along the identified dimensions. (Leung 2001) (Kini 2004)

Giaglis (Giaglis 2002) in developing their framework for mBusiness research reported that the understanding of mCommerce market adoption and value network are very important in shaping the future of mobile business. In addition, the framework also included technology development, information privacy and security, business models, channel integration, and business alliances are other important factors that determine and shape the future of mobile business. (Kini 2004)

In one of the earlier studies comparing Finland, Germany and Greece, Vrechopoulos et al. found through an online exploratory research that Finland was marginally matured in their adoption of mobile devices; it was followed by Germany and Greece. They found significant difference in the adoption rates and consumer behavior toward mCommerce among these three countries. The critical success factors they found in gaining higher adoption and diffusion in Europe included better quality mobile devices, user-friendly shopping interfaces, applications that are more useful, and services, lower prices, better security, better coverage and higher speed. The authors warn, however, that these factors may need to be validated in other developing and developed countries. (Vrechopoulos 2002)

Jarvenappa et al, in their cross-cultural research study of mCommerce adoption in Finland, Japan, Hong Kong and the US elaborate that mCommerce is at crossroads. They conclude that while mobility has given users more freedoms psychologically, socially and physically, it has allowed creating disorder in freedom to deflect the true value of technology through tensions caused by connexity – connectedness and freedom simultaneously. The authors indicate that the connexity may have been dealt with in different ways depending on the cultural attributes where the demand on the technology is to gain freedom or connectedness. The authors suggest that the mobile industry should focus on “must have” technology rather than “nice to have” technology. They forecast that the success of mCommerce “… services is likely to depend on how flexible and malleable the technology is to allow users to shape it to their personal and group needs in various social and business contexts.” (Jarvenappa 2003)

There have been many other anecdotal studies reported on the value of mCommerce and its adoption. Recently, researchers have been presenting empirical studies on mCommerce adoption. Kini through the empirical study in the developing country of Thailand found that "good pricing" and "quality of service" are crucial in gaining the usage and traffic for mobile commerce. In addition, they also found evidence that ubiquity of mobile device is an important reason for people using it. These results were apparent from the study despite the weakness in the data relating to the quality of respondents (undergraduate students) and small sample size of mobile device users. (Kini 2006)

Jih, using a convenient student sample from Taiwan documents the significant influence of perceived convenience characteristic of mCommerce on the shopping intention. Jih points out that the practical implications of such studies are useful in understanding the consumer behavior and adoption of mCommerce. Jih recommends that such results need to be validated by replicating similar studies internationally in other countries. (Jih 2007)

In the following sections, an attempt at gaining the (comparative) perception and adoption between mCommerce and eCommerce in Chile, a developing country is presented. The importance of such a study may be warranted in Chile because, first, Chile has the highest network readiness score and may become the leader in Latin America in accelerating the mCommerce adoption, and second, Chile already has 75% penetration of mobile phones yet very little diffusion in the mCommerce except in ringtone downloads.

3. Methodology

3.1 Mobile technology in Chile

The 500,000 Chilean companies have been categorized as 99% small and medium and 1% large companies. Only 11% of the companies use eCommerce to buy and 6% use it to sell. More than half of companies using eCommerce are large companies, and, 80% companies of all companies are considered small or micro companies and account for 1% of total eCommerce. Furthermore, it is reported that less than 60% to a PC, and even less than 40% of the small companies have access to Internet, and, and almost no small company has tools like ERP or CRM. The reports also indicate that among medium companies, the situation is only a slightly better. These statistics reported in 2005 indicates sluggish technology acceptance in the leading Latin American network ready country. (Chamber 2004)

In 2005, Chile had 8.7 million cell phone users. This is a 55% penetration (55% of population and 75% of potential users) of the market and is the highest in the Latin American market. While Chileans used TDMA (36%), GSM (48%) and CDMA (16%), all three leading technologies; GSM usage grew by 400 percent. The 80% of Chilean cell phone users indicate they primarily use it for voice services. Although Entel, the leading cell phone company in Chile, allowed payment using cell phones for tickets to events and cinema, services to pay bills, stock trading, and vending machines, Chileans consumers remained concerned and did not accept readily. The general view is the mCommerce is for consumers with higher income. Despite the fact that Chile is the only country in Latin America where the rent per capita is comparable to European countries, anecdotal reports indicate mCommerce adoption is at crawling speed. (Chamber 2004).

Chile is on a path for mCommerce adoption unlike other developing countries. Electronic commerce adoption from companies has been slow. In the consumer market, cell phone penetration is high yet anecdotal reports indicate reluctance in adoption of new applications on the mobile devices.

The authors' interest in this study is to identify the level of adoption among Chilean graduate university students, the most comfortable early adopters of mCommerce, and to identify the currently perceived gap in the value provided by the mobile services. The identification of such a gap is extremely helpful in understanding factors that affect the adoption, and the focusing on the services that are sought by the mobile users in making the new technology useful. Thus, in this study, authors primary motivation make an attempt to understand and analyze the current usage, reasons for not using mCommerce, and improvements that are being sought by the current consumers and possibly measure the perceived value gap between eCommerce and mCommerce. (Kini 2004)

The questionnaire used was translated in to Spanish language and was distributed to MBA students in Santiago, Chile. The choice of university students as subjects, (rather than the general public or business professionals,) is mainly because of convenience and not deliberate. All of these students are full time working students. The data were collected between January and May 2005. This is a captive crowd and there is a little bias to be expected. Although this is not a good representative sample of Chilean population, this however is a sample of educated population with a tendency to have highest number in levels of income and highest level of adoption rate according to Hitt. (Hitt 1999) Thus, the authors expected to find more upper economic-class and early adopters of mCommerce in the university environment thus lending a high degree of efficacy to responses and results. (Kini 2004)

The questions were designed to capture the differences in the usage between desktops (on Internet) and mobile Internet capable devices. Questions were also used to capture the reasons for using mobile devices, the problems faced by users in using mobile devices, and improvements necessary in the mobile devices and services for increased usage. These questions were formulated to capture the strength of the respondent's perception and views using a 5-point Likert scale. The individual items were designed to capture the perception of the users in the relative value provided by mobile devices regarding speed, cost, ubiquity, convenience, localization, and personalization in comparison to desktop computers. The questionnaire was tested and validated using students in a public university in the US. (Kini 2004)This study includes 12 demographic questions, 36 eCommerce and mCommerce adoption-influencing questions that pertain to the perception of respondents why people use eCommerce and/or mCommerce. (Kini 2004) The analysis is based on about 180 responses from the eCommerce and/or mCommerce users.

4. Findings

Typical respondent is a male, 31-40 years old, studying part-time, working full time, a graduate student. He has an income of 1,500,000 CHP per year, and spends 200,000 CHP for internet access for each year. The respondent uses Internet primarily from work and spends approximately 16 hours per week on the Internet. (Table 1) All respondents have cell phones and about 40% of them have an extra handheld device. Currently, over 90% of the respondents use Desktop for Banking and Financial services, Information and news, and email and communication; while only 26 percent of Mobile device users use it for email and communication and all other applications are adopted by less than 15% of the mobile device users. The data showed that respondents are very conversant with desktop eCommerce, and over 60% use applications using desktop. For whatever reasons mobile device users have stayed away from using mCommerce in large numbers. (Table 2)

When asked about the reason they are using eCommerce, over 50 percent indicated that they are using it because access speed, comfort, always available, its usefulness in business is very important to them. Mobile commerce users showed their preference to be always available by 17 percent of them indicating it is very important to them. In addition, mCommerce users also revealed that *everywhere available* and *comfort* are other two factors which are very important to them in adopting mCommerce. (Table 3)

When inquired about the problems faced while using eCommerce, nearly half of the respondents surprisingly showed their displeasure with access speed, along with about a quarter of respondents who showed concerns about the security and quality of service. The mCommerce user however did not indicate the problems they faced. Only 13 percent of the mCommerce respondents indicated that they faced problems with access speed and service quality. It is unclear why such a small percentage is indicating problems with mCommerce since large number have indicated they are not using mCommerce. A possible explanation is that they do not have the capability in their mobile devices to even use it for mCommerce applications, or that they did not venture into using its capabilities. This question would have given good insights in the mindset of mCommerce users but unfortunately did not deliver useful information. Mobile commerce users did indicate that high price 14% of mCommerce is a problem and may have deterred them from using mCommerce. (Table 4)

Table 1: Demographic data

Total Good Responses		183	%ge
Age	<20 Years	1	0.5%
	21-30 Years	61	33.3%
	31-40 Years	92	50.3%
	41-50 Years	26	14.2%
	51-60 Years	3	1.6%
	>60 Years	0	0.0%
Gender	Male	119	65.0%
	Female	64	35.0%
Student	Part-time	90	49.2%
	Full-time	18	9.8%
	Not Applicable	75	41.0%
Student Status	Undergraduate	18	9.8%
	Graduate	106	57.9%
	Not Applicable	59	32.2%
Working Student	Part-time	35	19.1%
	Full-time	117	63.9%
	Not Applicable	31	16.9%
Annual Income (CHP- Chilean Peso)	<CHP 400,000	19	10.4%
	CHP 400,001-900,000	19	10.4%
	CHP 900,001-1,500,000	43	23.5%

Total Good Responses		183	%ge
	CHP 1,500,001-2,000,000	37	20.2%
	CHP 2,000,001-2,700,000	31	16.9%
	CHP 2,700,001-3,600,000	18	9.8%
	CHP 3,600,001-4,500,000	9	4.9%
	>CHP 4,500,000	7	3.8%
Primary Location of Internet Access	Home	55	30.4%
	Work	124	68.5%
	School	2	1.1%
	Public Library	0	0.0%
	Friends/Neighbors	0	0.0%
	Mobile Device	1	0.6%
	Other	1	0.6%
Own a Mobile Device	Cell Phone	183	100.0%
	Palm (Cell + Palm)	61	33.3%
	Pocket PC (Cell + PPC)	12	6.6%
	All (Cell+Palm+PPC)	7	3.8%
	Not Applicable	0	0.0%
Average Internet Usage/Week		16 Hours	
Approximate Chilean Pesos Amount on Internet /Year		CHP 214,524	

Table 2: Current usage

	Internet (Desktop)	Mobile Device	
	Applicable	Applicable	Int. – Mob.
	% Responses	% Responses	Difference
Banking/Financial Services	94	11	+83
Shopping	70	5	+65
Entertainment	78	15	+63
Information and News	93	16	+77
Travel Booking	65	5	+60
Ticket reservation	64	5	+59
E-mail/communication	96	26	+70
Other	13	3	+10

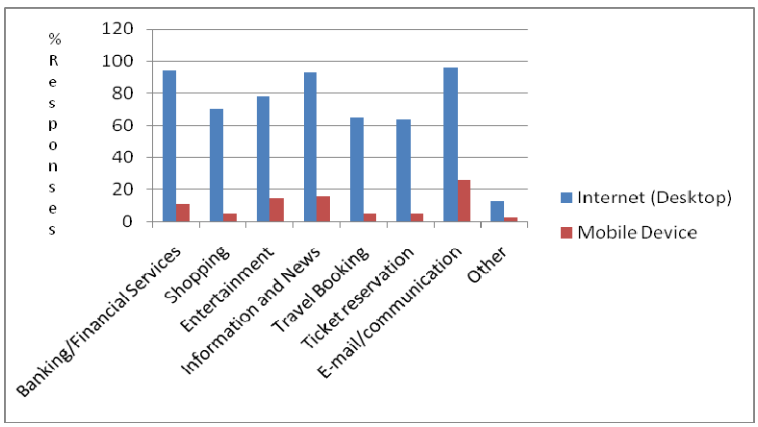


Table 3: Reasons for using

	Internet (Desktop)			Mobile Device			
	Very Important (1)	Aver-age	Least Important (5)	Very Important (1)	Aver-age	Least Important (5)	Aver-age Differenc e
	%ge		%ge	%ge	%ge	%ge	
Good Price	26	2.8	14	6	3.0	6	-0.2
Good Value for the money	26	2.5	10	5	2.9	4	-0.4
Access speed	72	1.6	8	14	1.9	3	-0.3
Comfort	70	1.6	8	16	1.9	4	-0.3
Always available	69	1.7	9	17	1.9	4	-0.2
Everywhere available	42	2.2	14	16	2.1	4	0.1
Curiosity	16	3.2	25	3	3.5	8	-0.3
Personalization	12	3.1	16	5	3.1	7	0.0
Better information	44	2.1	7	4	3.3	7	-1.2
It was fun	25	2.6	13	3	3.4	7	-0.8
It helped me in business	52	1.9	9	12	2.2	3	-0.3
Recognition among peers	9	4.1	48	5	3.5	10	0.6
Coding: 1 - Very Important, 5 - Least Important							

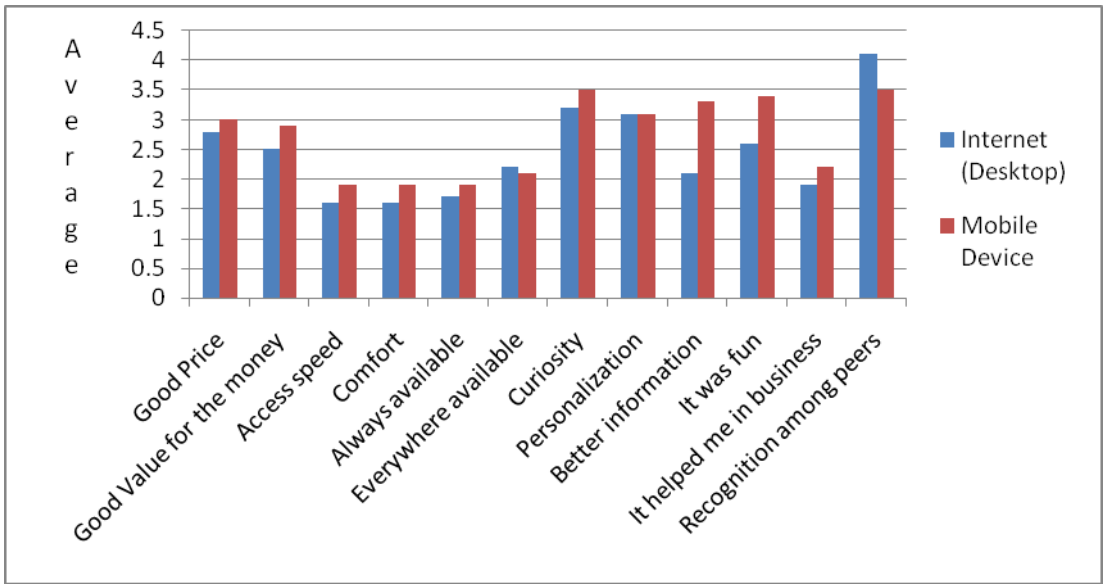
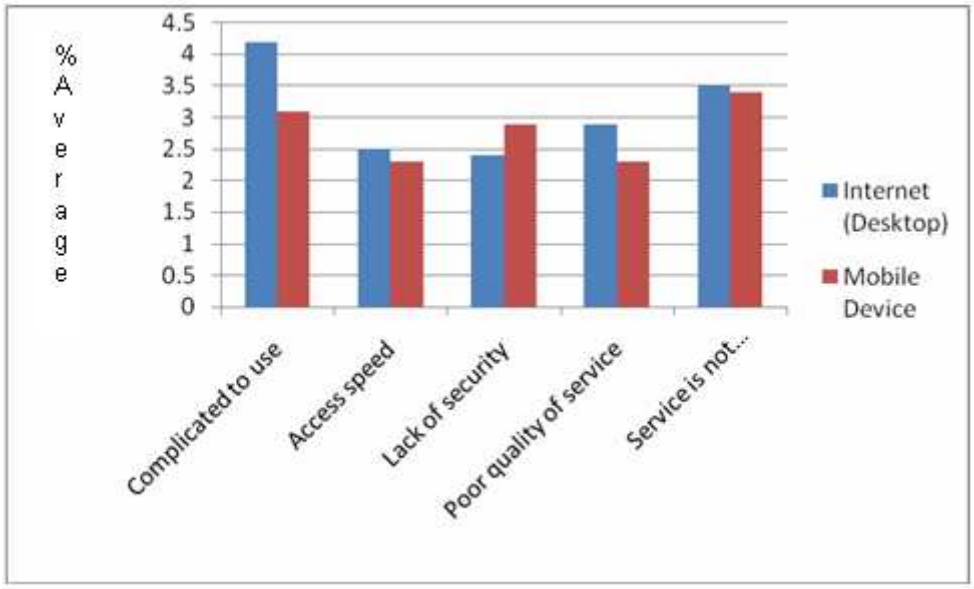


Table 4: Problems faced

	Internet (Desktop)			Mobile Device			
	Very Important Problem (1)	Aver-age	Least Important Problem (5)	Very Important Problem (1)	Aver-age	Least Important Problem (5)	Average Differ-ence
	%ge		%ge	%ge	%ge	%ge	
Complicated to use	8	4.2	53	9	3.1	10	+1.1
Access speed	42	2.5	20	13	2.3	5	+0.2
Lack of security	36	2.4	13	8	2.9	7	-0.5
Poor quality of service	21	2.9	20	13	2.3	4	+0.6
Service is not personalized enough	7	3.5	28	5	3.4	10	+0.1
High Price for mobile access				14	1.9	2	
Inconvenience in using mobile device				7	3.0	8	
Bad (too high) price	10	3.1	16				
Bad (poor) value for the money	8	3.3	19				
Coding: 1 - Very Important Problem, 5 - Least Important Problem							



When asked what improvements are important to increase the adoption and use of eCommerce, over 50 % of eCommerce users indicated their ever-growing need to have higher access speed and improved security while the over 30% asked for lower price along with customer support. Nearly, a fifth of mCommerce users demanded lower price and comfort with the device, along with a demand for improvement in ease of use, security, customer support. Again, here too mCommerce respondents did not show significant interest in indicating improvements needed to make mCommerce a strongly viable channel for ubiquitous commerce. (Table 5)

If one observes the pair-wise mean t-test results from Tables 6, 7, and 8 it is clear that there is clearly difference in the responses regarding eCommerce and mCommerce use in their responses to access speed and fun. In Table 6 where responses from eCommerce and mCommerce users are highly correlated in reasons for using fun item responses differed and mCommerce indicated strongly indicated it was more fun. In Table 7, mCommerce users indicated that they faced more problems in getting good access speed.

Finally, in Table 8, mCommerce users again indicated that access speed improvements are necessary to gain higher-level usage. Except in these cases, for all other items the responses from eCommerce and mCommerce are highly correlated. These pair-wise mean and correlation scores validate that the respondents did think there was difference in status of eCommerce in mCommerce environment in Chile, yet most respondents indicated there are some unique values that can be gained from mCommerce.

In Table 9, where the pair-wise difference means are shown it is apparent there is some perceived value difference between eCommerce and mCommerce. For example, with negative mean differences for *curiosity, better information and it was fun items* respondents pointed out why the desktop was more important for these items than handhelds. However, with positive mean difference for item *everywhere available* same group indicated value difference between mCommerce and eCommerce. In addition, with significant positive mean differences for *complicated to use, access speed, poor quality of service*, *improved ease of use, and lower price* items respondents identified where improvements are necessary to have higher level of mCommerce adoption.

5. Conclusions

From the discussion mentioned in the above sections, it was observed that Chileans are highly network ready and are adept at downloading many ring tones per year into their cell phones. This would have usually indicated their propensity to use mobile devices to conduct mCommerce. However, the results have not supported such arguments. Some of the factors they indicated for not adopting at a higher rate are access speed, service quality, and high price for mobile access.

From the above results, one can conclude that there is high level of usage of eCommerce among this respondent group in Chile. Consequently, one can assume this group to be technology literate, and if not adventurers are at least early adopters of technology. These results also give researchers indications that mobile device usage in Chile has not evolved significantly from voice communication application. However, respondents have *not strongly* indicated the problems they have faced in utilizing the mobile device. This conclusion supports the comments made by Jarvenappa et al (2003) that, “it will be the innovativeness of users and uses, not the innovativeness of the technology that will drive m-commerce growth to a new level”. The fact is that the respondents in this study are familiar with the technology and applications, yet have not transformed themselves to be appreciative and innovative users of mobile technology to leverage the *everywhere* and *always available* feature of the mobile technology.

6. Limitations

This survey has the obvious weaknesses like any survey that is conducted in a university campus using students as subjects. The research does use students as subjects, usually early adopters of mobile devices. Despite the fact that these subjects have moderate levels of income, *high access price, lack of high speed and lack of mobile applications and low penetration web-enabled mobile devices* may have given weak adoption rate results in this research. This research also suffers from a low sample size (using web-enabled devices) which prevented authors from applying more rigorous statistical techniques.

The questionnaire developed and used in this research is based on the earlier research on mobile commerce acceptance and adoption. Since the authors have not been able to capture the high quality responses from a quality respondent group, in the future, for research on this subject it may be important to rethink the approach in designing the survey to elicit the responses relating to personal innovative use of technology from the respondents rather than innovativeness of the technology (as per Jarvenappa 2003).

Table 5: Improvements necessary

	Internet (Desktop)			Mobile Device			
	Very Important Change (1)	Average	Least Important Change (5)	Very Important Change (1)	Average	Least Important Change (5)	Average Difference
	%ge		%ge	%ge	%ge	%ge	
Improves access speed	50	2.0	13	19	2.1	7	-0.1
Improved ease of use	20	2.9	20	18	2.4	8	0.5
Improved security	56	1.8	7	17	2.1	4	-0.3
Improved customer support	33	2.3	8	16	2.1	3	0.2
Lower price	38	2.2	8	23	1.7	2	0.5
Improved comfort device				21	1.9	4	
Innovative personalized applications				13	2.4	5	
Coding: 1 - Very Important Change, 5 - Least Important Change							

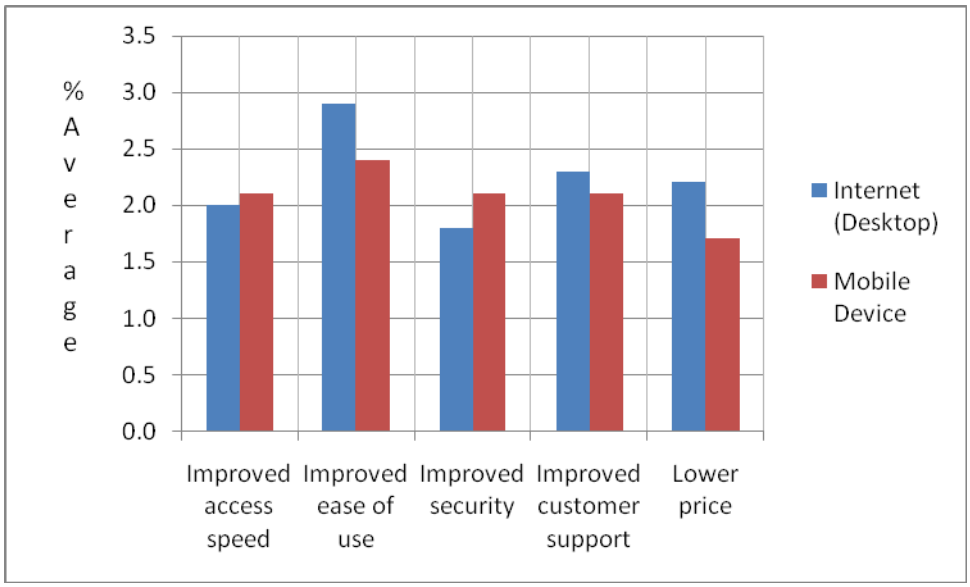


Table 6: Reasons for using

Paired Samples Statistics							
		Mean	N	Std. Deviation	Std. Error Mean	Correlation	Sig.
Pair 1	14A1	2.795	39	1.525	0.244	0.424	0.007
	14A2	3.000	39	1.504	0.241		
Pair 2	14B1	2.500	36	1.424	0.237	0.332	0.048
	14B2	2.917	36	1.422	0.237		
Pair 3	14C1	1.789	38	1.359	0.220	0.526	0.001
	14C2	1.868	38	1.398	0.227		
Pair 4	14D1	1.810	42	1.418	0.219	0.503	0.001
	14D2	1.905	42	1.445	0.223		
Pair 5	14E1	2.024	41	1.525	0.238	0.347	0.026
	14E2	1.780	41	1.475	0.230		
Pair 6	14F1	2.795	39	1.657	0.265	0.281	0.083
	14F2	1.846	39	1.514	0.242		
Pair 7	14G1	2.909	33	1.487	0.259	0.374	0.032
	14G2	3.667	33	1.291	0.225		
Pair 8	14H1	3.000	32	1.368	0.242	0.413	0.019
	14H2	3.156	32	1.483	0.262		
Pair 9	14I1	2.097	31	1.326	0.238	0.299	0.102
	14I2	3.387	31	1.585	0.285		
Pair 10	14J1	2.706	34	1.508	0.259	0.188	0.286
	14J2	3.588	34	1.373	0.236		
Pair 11	14K1	1.794	34	1.388	0.238	0.715	0.000
	14K2	2.118	34	1.552	0.266		
Pair 12	14L1	3.806	36	1.451	0.242	0.837	0.000
	14L2	3.639	36	1.588	0.265		

Table 7: Problems faced

Paired Samples Statistics							
		Mean	N	Std. Deviation	Std. Error Mean	Correlation	Sig.
Pair 1	15A1	4.05	40	1.648	0.261	0.572	0.000
	15A2	3.00	40	1.769	0.280		
Pair 2	15B1	3.00	40	1.797	0.284	0.225	0.162
	15B2	2.40	40	1.582	0.250		
Pair 3	15C1	2.62	39	1.532	0.245	0.345	0.031
	15C2	2.74	39	1.650	0.264		
Pair 4	15D1	2.90	42	1.650	0.255	0.465	0.002
	15D2	2.21	42	1.523	0.235		
Pair 5	15E1	3.24	37	1.535	0.252	0.862	0.000
	15E2	3.24	37	1.739	0.286		

Table 8: Improvement necessary

Paired Samples Statistics							
		Mean	N	Std. Deviation	Std. Error Mean	Correlation	Sig.
Pair 1	16A1	2.48	52	1.61	0.22	0.185	0.190
	16A2	2.21	52	1.63	0.23		
Pair 2	16B1	3.11	55	1.56	0.21	0.443	0.001
	16B2	2.51	55	1.69	0.23		
Pair 3	16C1	1.81	52	1.22	0.17	0.441	0.001
	16C2	2.13	52	1.47	0.20		
Pair 4	16D1	2.28	50	1.34	0.19	0.528	0.000
	16D2	2.16	50	1.40	0.20		
Pair 5	16E1	2.24	55	1.30	0.18	0.554	0.000
	16E2	1.76	55	1.15	0.16		

Table 9: Paired samples test - paired differences

	Mean	Std. Deviation	t	df	Sig. (2-tailed)
14F1 - 14F2	0.949	1.905	3.110	38	0.004
14G1 - 14G2	-0.758	1.562	-2.786	32	0.009
14I1 - 14I2	-1.290	1.736	-4.139	30	0.000
14J1 - 14J2	-0.882	1.838	-2.799	33	0.009
15A1 - 15A2	1.050	1.584	4.191	39	0.000
15B1 - 15B2	0.600	2.110	1.799	39	0.080
15D1 - 15D2	0.690	1.645	2.720	41	0.010
16B1 - 16B2	0.600	1.717	2.592	54	0.012
16E1 - 16E2	0.473	1.168	3.001	54	0.004

7. Acknowledgement

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Appendix 1

Partial Sample Questionnaire:

13. CURRENT USAGE:

Services Used: [Please put a check (✓) where applicable or put NA (Not Applicable)]		
	Internet (Desktop)	Mobile Device
A. Banking/Financial Services		
B. Shopping		
C. Entertainment		
D. Information and News		
E. Travel booking		
F. Ticket reservation		
G. E-mail/communication		
H. Other		
I. None		

14. REASONS FOR USING:

You use these Services because: (Please put a score from ***1- very important*** to ***5- least important*** to you, or NA-not applicable.)		
	1-Internet (Desktop)	2-Mobile Device
A. Good price		
B. Good value for the money		
C. Access speed		
D. Comfort		
E. Always available		
F. Everywhere available		
G. Curiosity		
H. Personalization		
I. Better information		
J. It was fun		
K. It helped me in business		
L. Recognition among peers		

15. PROBLEMS FACED:

The problems you faced when you used Internet (Desktop) or Mobile Device Services are: (Please put a score from ***1-very important problem*** to ***5-least important problem*** to you, or NA-not applicable)		
	1-Internet (Desktop)	2-Mobile Device
A. Complicated to use		
B. Access speed		
C. Lack of security		
D. Poor quality of service		

E. Service is not personalized enough		
F. MOBILE DEVICE ONLY		
G. High price for mobile access		
H. Inconvenience in using mobile device		
I. INTERNET ONLY		
J. Bad (too high) price		
K. Bad (poor) value for the money		

16. IMPROVEMENTS NECESSARY:

You will use Services on Internet or Mobile Device if there is/are: (Please put a score from ***1-very important change*** to ***5-least important change*** to you, or NA-not applicable)		
	1-Internet (Desktop)	2-Mobile Device
A. Improved access speed		
B. Improved ease of use		
C. Improved security		
D. Improved customer support		
E. Lower price		
F. MOBILE DEVICE ONLY		
G. Improved comfort device		
H. Innovative personalized applications		

Where is Information Ethics in Iranian Library and Information Science Publications and Services?

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Abstract: There seems to be very few signs of the politeness peculiar to Iranians, when considering information ethics in Iranian library and information science scene. An expressed dissatisfaction appears to exist with library services among users studied in some dissertations on user satisfaction in library and information science in Iran. In spite of this fact that might be at least partly related to misbehavior of librarians, the words "ethics", "moral issues", and "morality" are not found in almost all of the publications related to library and information science in Iran, even in the most formal ones. These publications and documents as well as the current attempts to develop the topic in Iran, including both publications and activities, will be studied in this paper. The social, economic, and ethical aspects of the issue including the misunderstanding of the concepts of who serves and who must be served, who pays the tax and who must obtain service due to tax paying, the overall dissatisfaction of librarians concerning their social status as well as salaries and wages, the low costs, if any, of library and information services in Iran, will also be considered to show why this negligence has occurred in the profession.

There are some efforts to be made however, to improve the situation. Library and information science educators firstly must do their best to show the significance of ethics in the profession. Their efforts must comprise the formal and informal teaching of information ethics to their students. Inclusion of courses of ethics in formal syllabi is among formal attempts. The demonstration of this ethics in LIS educator's behavior is an informal one. Publication of papers on information ethics is another duty of LIS educators. Setting up workshops on information ethics is a necessary step to be taken. Professional associations such as Iranian Library and Information Science Association (ILISA) can play an important role on the scene. The provision of an information code of ethics is a major responsibility of this association and is highly recommended.

Keywords: information ethics, Iran, user satisfaction, Iranian libraries

1. Introduction

Some define professional ethics as "A set of standards governing the conduct and judgment of librarians, library staff, and other information professionals in their work. The *ALA Code of Ethics* sets standards for equitable access, intellectual freedom, confidentiality, respect for intellectual property rights, excellence, accuracy, integrity, impartiality, courtesy, and respect for colleagues and library patrons" (ODLIS 2008). Having the above definitions in mind, one might be surprised when considering the issue of information ethics in Iran. Iranians are very polite people. Their Islamic beliefs as well as their long traditional culture make them quite polite, especially in relation to foreigners, who usually find Iranians very hospitable. But there seems to be very few signs of this politeness when considering information ethics in Iranian library and information science publications and services. Although results from researches on user satisfaction in different types of libraries show contradictory information, there seems however, to be a sensible dissatisfaction with library services among users studied in some dissertations and articles on user satisfaction in library and information science in Iran. What follows tries to examine firstly the situation in terms of the existence of any code of ethics, librarians as well as patrons' satisfaction rate, respect for intellectual property rights, and respect for colleagues and library patrons in Iran. The other issues concerning professional ethics as defined in ALA Code of Ethics will secondly be pointed out in brief when applicable.

2. Examination of some documents on the issue

In spite of the fact that the expressed dissatisfaction in the users' side might be at least partly related to misbehavior of librarians as one aspect of lack, or at least shortage of information ethics, in "A cyclopedic dictionary of library and information sciences", the most-frequently used encyclopedic dictionary in Iran, there is no entry for ethics or similar terms in Farsi, neither in the body of, nor in the English index to the dictionary (Soltani 2001). In the translation into Farsi of "Concise dictionary of library and information science" (Keenan 2000), however, the words: Ethics and Professional ethics have been presented. Also in a thesaurus on information science translated into Farsi, the word ethics is seen (ASIS 2001). Another dictionary entitled: "Basic dictionary of librarianship, information science and technology", compiled and translated from four English sources, the word ethics and the term professional ethics are also included (Tahavori 2005). As is

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seen, the words ethics and/or professional ethics can only be seen in the dictionaries or thesauri translated into Farsi, not in ones written originally in Farsi.

The same happens when studying the issue in books on research methods in library and information science. In a book entitled "Research methods in librarianship" (Dayyani 1990) as the first book in Farsi on research methods in librarianship, no words on ethics or morality is found. In a later book on the same issue called "Research methods in library and information science" (Kumar 1995), a translation into Farsi, in a chapter on the characteristics and abilities of a researcher, the author presents some pages on the research ethics. Although one might claim that there is not any strong relationship between research ethics and information ethics, since the act of doing research is done to produce information however, some relationships might be considered.

In the syllabi for undergraduate, graduate, and doctoral courses for library and information science in Iran, that have been approved by the High Council of Planning of the former Ministry of Culture and Higher Education (now: Ministry of Sciences, Researches, and Technology) in the years 1987, 1995, and 1993 respectively, as far as the author has checked word by word, there is no word of ethics in any kind, neither in the titles nor in the contents. Surprisingly even in the two revision projects of the syllabi for undergraduate and M. Lib. courses, undertaken by Shaheed Chamran University in Ahwaz, where the author is a senior lecturer, and Ferdowsi University of Mashhad, both finalized in the year 2005, the words "ethics", "morality", or other similar concepts are absolutely not seen. It should be noted that although these syllabi were approved after the Revolution of 1978, but they rooted in pre-Revolution era and went back to the year 1965 when the first official M. Lib. course was set up in the School of Psychology and Education of the University of Tehran by some American and British lecturers as well as some Iranians educated mainly in the United Sates and United Kingdom (Kiani Khouzestani 1996). While the librarians' code of ethics in the United States was prepared in 1939, the question is: why this code of ethics has not been reflected in the syllabi at that time in Iran?

There were only four articles on "ethics of library and information science" in "Library and information science index" (Niazi 1999) that covers some 1750 papers and reports in the period 1968-1999. Of the four, that is, %0.22 of the total papers and reports covered, two are translations and two are originally written.

A search performed in Farsi, in National Library and Archive of the Islamic Republic of Iran (NLAI) database (2008) that includes some 1155763 records, on 27 March 2008, yielded the results shown in table 1:

Table 1: The results of the search performed in NLAI database

Topic	Ethics	Morality	Professional ethics
Information science	0	0	1 (Non-related)
Librarianship	0	0	1 (2007)
Lib. & inf. science	1 (Translated. 2000)	0	1 (Translated. 2005)

As shown in the table, of the 1155763 records included in the NLAI database, only three records were found on the issue of which two were translated and only one was originally written. It should be noted that the search was performed in all databases, in all fields and for any kind of library material on the issue. Since the search was performed in all fields including controlled subject headings, the results imply that there have been no subject headings in any kind in the "List of Persian Subject Headings", the official subject heading list used by the National Library and Archive of the Islamic Republic of Iran.

Also No entry was found on "ethics", "professional ethics", and "morality" in the subject index of "Dissertations abstracts of library & information science" (Sadigh Behzadi 2000) covering some 776 dissertations in the period 1966-1999 both in and outside of Iran. Also an advanced search performed in a major governmental database Called Iranian Scientific Publications and Documentation Center (Irandoc) (Irandoc 2008) comprising some 510000 records yielded zero hits on the issue. The search was performed on 24 March 2008, and the databases for theses and dissertations as well as journal articles that held some 129892 and 124012 records respectively were searched. To make sure that the keywords are appropriate, the Farsi equivalents for the words "ethics", "professional ethics", and "morality" that are sometimes used interchangeably in the profession's literature, were searched in an AND Boolean search with both Farsi equivalents of words "librarianship" and "library and information science". The first phase of the search was done in subject field of the database. In the second phase, the same search was performed using all fields; the result however, was the same.

In the Encyclopedia of library and information science (Encyclopedia of library and information science 2003-2007), the only encyclopedia in Farsi of the profession, there is an entry for professional ethics at the end of which, there are seven references of which two are in Farsi. While there is absolutely no mention of the issue in Iranian situation in the body of text, of the two Farsi references only one, an article translated into Farsi on 1994 belongs to the necessity of commitment to moral principles in information science. The second Farsi reference belongs to philosophy of ethics in general.

Surprisingly the same impoliteness can be seen in the library softwares developed by Iranian computer experts in consultation with Iranian librarians. The usual polite sentences such as "Please wait while something happens" that usually appear when pop-up windows are opened are rarely seen in these softwares. Sometimes even the welcome phrases at the time when the program is starting are not seen.

3. Some current attempts

Some current attempts to develop the issue in Iran, including both publications and activities, are worth mentioning here. In a recently-published book entitled: "Professional ethics for librarians and information professionals" (Qom Library Association 2007), after some discussions on the necessity of ethics, the meaning of professional ethics, the codes for professional ethics, and principles and codes of ethics in library and information science, the codes for professional ethics of library associations in twenty eight countries have been presented. Two appendices, one concerning the ethical principles for Iran's librarians and information scientists, and the other concerning the ethical principles of academic librarians end the book. The principles presented in appendix B, have been extracted from the contents of a workshop on library ethics that has been held in summer 2004 in the Ferdowsi University of Mashhad. That workshop was among few workshops on library ethics held in Iran, if not the only one. What seems worth mentioning is that in the preface to the book, the author of the preface has felt satisfied with the recent attention paid to professional ethics in Iranian library community and hoped to have more of the workshops and writings about the issue. Also in the introduction to the same book, the purpose of writing of the book has been stated as follows:

1. Filling the gap of not having a work that deals totally with ethics for librarians and information practitioners…,
2. Inspiring more survey, research, and reading in professional ethics, and
3. Suggesting the inclusion of a course on the topic at undergraduate level to make the students familiar with ethical issues and observing them.

As is seen, in a book concerning ethics for librarians in Iran and published in the year 2007, the authors admit that there is a gap of a book totally written on information ethics for Iranian librarians, and they also suggest the inclusion of a course on information ethics at undergraduate level to make the students familiar (not more familiar!) with ethical issues.

Suggesting the inclusion of a course on the topic at the undergraduate level is due to the lack of a course in undergraduate, graduate and doctoral levels in Iran. In the syllabi for undergraduate, graduate, and doctoral courses for library and information science in Iran, as mentioned above, there is no word of ethics or professional ethics, neither in the titles nor in the contents of the syllabi. There seems to be no words of ethics, code of ethics, or morality even in "Public services in libraries", the course that logically should contain some content on moral issues.

4. Final analysis

The main reasons for this lack of ethical or moral issues in Library and information science services and publications can be enumerated as the misunderstanding of the concepts of who serves and who must be served in Iranian libraries, who pays the tax and therefore is eligible to obtain service due to tax paying, the overall dissatisfaction of librarians concerning their social status as well as salaries and wages, the more or less violation of copyright, and the low costs of library as well as information services in Iran. These will be discussed in some detail below.

4.1 An overall misunderstanding of who must serve and who must be served

In Iran there is an overall misunderstanding of who must serve and who must be served in all aspects of trade. In spite of the politeness peculiar to Iranians, when one steps in an Iranian shop of any kind as a customer, although the shopkeeper knows that the customer, by paying money, must be served and the shopkeeper by respecting her/him can attract more customer's attention and gain benefit, behaves as if the

shopkeeper must be respected and served instead of the customer! An evident expression of this misunderstanding is the utterance of the word "Salaam", the Arabic word equivalent to the English "hello" that is used as greeting in Iran. The shopkeeper as the one, who must respect the customer and say salaam, waits for the customer's salaam. Otherwise, the customer won't be served properly! The same happens in Iranian libraries. The word used in Iranian libraries to describe library user is not the words "patron" or "client" as used most frequently in similar western situation. This fact implies that the library user does not even have the status of a usual customer. The circulation librarian usually waits to be greeted by the library user and seldom asks the polite question: Can I help you or how can I help you. The librarians are also not very much familiar with non-verbal communication skills. The need for changing this pattern of behavior has not been felt by the library and information professionals and thus not reflected in the profession's publications.

Also one reason why Iranian librarians do not feel the necessity to treat library users as clients lies in the fact that the issue of tax paying is not clear in the profession. In other words, the librarians do not know that they are paid by the taxes the users pay. If this concept becomes clear, then it is expected that the librarians' behavior changes towards better acceptance and service of users.

It should be noted that the trend is gradually changing towards better understanding of the issue and Iranian librarians become more and more hospitable of library patrons.

4.2 The overall dissatisfaction of librarians concerning their social status as well as salaries and wages

Iranian librarians are generally not happy with their social status. A research on the job satisfaction of some academic as well as special librarians in Iran indicated that their satisfaction rate concerning financial, educational, and security status were below average (Bagheri 1999). Another research carried out comparing the job satisfaction among some 206 Islamic Azad University (a non-governmental, profitable university) librarians with some 524 academic librarians employed in the universities and institutions under the Ministry of Sciences, Researches, and Technology illustrated a dissatisfaction rate below the average for both groups (Hariri 2002). The lowest satisfaction rate belonged to job payments in both groups. Another research on job satisfaction rate among some 177 women librarians employed in 12 central libraries of governmental universities in Tehran showed a total dissatisfaction among the librarians studied (Agha Shahi 2002). One of the most dissatisfaction aspects belonged to their payments although they were happy with their social status. Another survey on job satisfaction rate of some 75 librarians in the Institute for the Intellectual Development of Children and Young Adults in Tehran, the most important institute responsible for the Iranian children and young adults cultural affairs, revealed a total dissatisfaction with promotion and payment (Nafisi Kia 2000).

Special librarians are usually well-paid than other librarians in Iran, and academic librarians rank second in this regard. Academic librarians however, possess a better social status due to their working in universities where their presence is more felt and needed. Public librarians have the worst situation concerning both salary and social status. And the school librarians, who are seldom found in schools, rank the worst.

One of the reasons for the low social status of librarians in Iran is the word that is used to describe the job of a librarian. The Farsi equivalent for the English word librarian is kitabdār, a compound word consisting of the Arabic word kitab meaning book, and the Farsi suffix dār, meaning having or processing. The word generally signifies a person who is most eager to keep books rather than to deliver them for use, and is mostly if not entirely concerned with the traditional medium of book. Although the word kitabdār indicated a respectful job and was only given to prominent persons, mostly scientists, in Iran's even near past; the word is now most disliked by Iranian librarians specially the younger generations. Young librarians, who find they are working in the electronic age, do not like the word that represents them as keepers of a traditional medium, that is, book. The author himself has frequently heard this voice of dissatisfaction with this word among young students of the profession and believes that the word plays an important role in the lowering of social status of Iranian librarians.

One cannot deny the negative impact of this dissatisfaction with social status and salaries and wages on misbehavior of the librarians.

4.3 Violation of copyright

Although the copyright law for the protection of writers, composers, and artists in Iran was approved in 1968, there are still some books that are published without any contract, are made illegally from the original copy,

or collected from works of some writers or poets without any permission. Some translations are re-published under different or unknown titles, some works are translated and issued without the author being informed, and different kinds of plagiarism that occur, though not as intense as before, but more or less happen in Iran. The present author himself has been a victim of this violation. Three books of him have been published without any contract, and one of his published papers was published again in a newspaper without permission of the author. It is quite obvious that the violation of copyright lessens the value of information media and carriers as the commodity traded in libraries and information centers, the status of librarians as the personnel working in these places, and results more dissatisfaction of the librarians and probable misbehavior of librarians.

4.4 The low costs of library as well as information commodities and services

Library services in Iran are not as expensive as they are in west. Information carriers such as books and periodicals are also much cheaper compared to those in western countries. One impact of this is that users do not see any need to refer to libraries for their information needs, and thus do not understand the value of libraries and information centers. Table 2 might give some clue as to the price of books as the still-most-used information carriers in Iran (Horri 2007)

Table 2: The average price for first editions of books published in Iran (1992-2001)

Year	Average price for first editions (US dollar)
1992	0.26
1993	0.30
1994	0.51
1995	0.79
1996	0.91
1997	1.12
1998	1.35
1999	1.43
2000	1.69
2001	2.09

To give some more information on information commodities cost in Iran, table 3 illustrates the price of the last issues of some Iranian library journals (The titles of the journals have been translated by the author).

Table 3: The price of the last issues of some Iranian library journals

Title	Year	Price (US dollar)	Publisher
Librarianship	2006	0.65	Governmental
Informology	2007	3.26	Private
Library and Inf. Science	2008	1.08	Governmental
Book Quarterly	2006	1.30	Governmental

As can be seen, the prices are so low compared to those in western countries that the journals can be bought by almost anyone. The journals listed in the table are among the expensive journals in Iran.

The effects of low cost of information commodities on Iranian librarians are that they feel the commodity they are trading does not cost very much and therefore, their business is not very much alive. They gradually fell depressed and this depression is reflected in their misbehavior towards library patrons.

What mentioned above as reasons concerning lack of information ethics in Iranian library and information services and publications are but some of main reasons. These and the other reasons can be gathered under the umbrella of a broad misunderstanding: In Iran, library and information services are mostly thought of as techniques rather than services. When one thinks of himself/herself as a technician, what he/she tries to do at most is to do the technical job well. A librarian, who believes he/she presents some kind of service, is committed to observe ethics in his/her presentation of the services.

5. Some suggestions

Libraries and information centers in Iran work as subsystems under the super system of "culture". When the super system misunderstands the concept of service in all of its forms, the subsystem of libraries and information centers cannot be independent from it. Libraries and information centers are not isolated islands far from the general culture dominating Iran.

There are some efforts to be made however, to improve the situation within the subsystem. Library and information science educators firstly must do their best to show the significance of ethics in the profession. Their efforts must consist of formal and informal teaching of information ethics to their students. Inclusion of courses of ethics in formal syllabi is among formal attempts. The demonstration of this ethics in their behavior is an informal one. Publication of papers on information ethics is another duty of library and information educators. Setting up workshops on information ethics is a necessary step to be taken. Professional associations such as Iranian Library and Information Science Association (ILISA) can play an important role on the scene. The provision of an information code of ethics is a major responsibility of this association.

These efforts when mixed with traditional and Islamic politeness of Iranians can yield an appropriate result faster than expected.

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The Patient Data Analysis Information System: Addressing Data and Information Quality Issues

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Abstract: This paper reports on the development and initial end-user evaluation (after ten months in-use) of a Patient Data Analysis Information System (PDA-IS) for Geriatric Medicine. The development and evaluation is the first phase of a larger ongoing research project. The PDA-IS contains a set of high integrity patient data records (a local practice-based repository of clinical patient data) available for the Consultant Physician in Geriatric Medicine. The evaluation of the system identifies the wide range of benefits that were realised by the Consultant Physician and indeed could be expected in the future from the deployment and extension of such a flexible solution for all Consultant Physicians in hospital practice that need to collect patient data.

Keywords: geriatric medicine, patient-centric data, data integrity, relational data model, n-tier architecture, evaluation.

1. Introduction

In the editorial of the *Medical Informatics and the Internet in Medicine* journal in March 2007, the editor called for the need for more research illustrating the application of Information Systems/Technologies in specific clinical areas (Bryant, 2007). In this paper, we report on the development of a local practice-based repository of clinical patient data, as part of a larger ongoing research project. The Patient Data Analysis Information System (PDA-IS) provides functionality to a Consultant Physician in Geriatric Medicine in terms of storing and analysing high quality clinical patient data for the purposes of more informed and accurate decision making. The system's general aim is to support the Consultant Physician in improving the quality of healthcare delivery. Indeed, the most important objective of medical documentation in general is to contribute to the effective and appropriate medical care of each individual patient. This project involved several rounds of interviews between the academic development team and the end-user of the Information System (Consultant Physician) towards the specification of a suitable normalised data model and a User Interface (UI) to support an integrated approach to data capture and analysis. Following the development of the prototype, the system was in-use for over ten months after which time more interviews took place between the developers and the end-user to establish the range of benefits obtained from the application in-use and the need for extensions and further development. This paper reports on the prototype developed, its core features in support of the Consultant Physician's needs and the initial benefits from the PDA-IS in-use.

The paper is organised as follows. The next section presents an insight into the need for Information Management in healthcare. This is followed by a presentation of the critical contextual elements of the case that describe the context in which the decisions are made by the Consultant Physician in this study. Based on this scenario, we then explore how data quality can be ensured and describe the multi-tiered application we developed to meet the needs of our end-user. Finally, we present feedback on the use of the PDA-IS and explain the benefits that the application delivered to the end-user and additional developments that are planned for the future as a result of the Consultant Physician's feedback.

2. Patient information management

With rising costs and increasingly stretched resources, it is no surprise that the healthcare sector has become focused on strategies to improve the quality and efficiency of health services. Health care experts, policymakers, and consumers consider Health Information Technologies (HIT) to be critical to transforming the healthcare sector (Institute of Medicine, 2000; 2001; FACCT, 2003; Asch *et al*., 2004; Department of Health and Human Services, 2004; Epstein *et al*., 2004; Smith, 2004). However, while the benefits of Information Systems/Technology may be clear in theory, introducing new systems/technology to healthcare has proven difficult and rates of use are limited (Ash *et al*., 2003; Ash *et al*., 2004; Valdes *et al*., 2004). Central to these strategies to improve the quality and efficiency of health services is the implementation and the development of innovative systems, such as Health Information Systems (HIS), which support the collection, distribution and analysis of patient data. Indeed, while data quality is increasingly important to organisations across a variety of sectors, it is especially true in healthcare where cost pressures and the desire to improve patient care drive efforts to integrate and clean organisational data (Leitheiser, 2001).

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Assessing data/information quality is not an exact science although various aspects of quality and information have been investigated to date (cf. Kahn *et al*., 2002; Ballou *et al*., 1998; Kovac, *et al*., 1997; Strong *et al*., 1997; Pitt *et al*., 1995; Reeves and Bednar, 1994; Zeithaml *et al*., 1990). In fact, Wallis *et al*. (2007) argue that assessment criteria for data integrity and data quality will vary considerably by type of data and by scientific domain. However, decision-makers depend on quality data/information for effective operations and decision-making (Price and Shanks, 2004).

Using Information Technologies, but embracing a localised perspective, provides various degrees of intelligence towards generating diagnosis based on locally maintained patient data. However, as well as healthcare data being important to the individual patient, appropriate collection and analysis of multiple individual datasets can inform healthcare practice and promote the health of the local geographical population (Institute of Medicine, 2000; 2001; FACCT, 2003; Asch *et al*., 2004; Department of Health and Human Services, 2004; Epstein *et al*., 2004; Smith, 2004). Indeed, developing such systems raises a variety of issues, such as data modelling issues to begin with, as pointed out by Silverston (2001). He argued that healthcare entities need to track information about actors involved in healthcare, specifically patients, and presented a number of data models relating to the way that the specific types of data that need to be captured and tracked should be organised. From our perspective we argue that patient information on 'medical conditions and physical characteristics', 'health care visits, delivery, episodes, symptoms and incidents', and 'diagnosis and delivery outcome' is not readily available to the medical practitioner community at the local level and this opens the door to IS practitioners to address this issue and facilitate computerised data capture and analysis (information provision) in support of building a local practice-based repository of clinical patient data.

Szirbik *et al*. (2006) suggested that to better understand the resource use and population needs for health and social care services for the elderly, thorough Information Management (IM) is needed. In fact, as the world population is ageing (O'Connor *et al*., 2008; Gannon et al., 2007; Xie *et al*., 2006) the need for this greater understanding is immense, especially in the Republic of Ireland where the ageing population is set to place yet another burden on an already struggling health service. People aged 65 and over in the Republic of Ireland currently account for approximately 11% of the total population and this proportion is expected to increase over the next twenty years due to an increase in life expectancy; for example, it is expected that by 2031, there will be 1.04 million people aged 65 and above in the Republic of Ireland (Gannon et al., 2007). As commented by Sim *et al*. (2001, p.530) *"systems that provide both patients and clinicians with valid, applicable, and useful information may result in care decisions that are more concordant with current recommendations, are better tailored to individual patients, and ultimately are associated with improved clinical outcomes"*. To achieve Information Management there is a need to define a standard set of data and analysis techniques have to be developed and implemented. This problem of non-standardised data definitions has impacted on all types of organisations for several years and unfortunately still does today (see for example the emergence of the recent concept of Master Data Management). Interestingly enough almost twenty years ago Goodhue *et al*. (1988, p.373) reported that *"a major bank seeking to shift its strategy toward a focus on customers finds that it cannot determine how profitable individual customers are, or even what its total business is with each customer, because its customer codes are not common across branches or lines of business"*. Indeed, as can be observed in the context of our research project, a degree of separation needs to exist between the physical hospital locations and the required data definitions needed for the effective delivery of patient-focused health services. Indeed, Szirbik *et al*. (2006) further comment that irrespective of large scale nationwide IM projects, smaller academic projects (similar to our approach) should help establish models for data analysis and provide tools for practitioners related to the area (Geriatric Medicine in this case). Therefore, similar to Szirbik *et al*. (2006) we classify our PDA-IS as a repository for improved decision making in elderly healthcare.

3. Understanding the context of the problem

The Consultant Physician in Geriatric Medicine works across two hospital sites in Cork city in the Republic of Ireland. The Consultant Physician collects patient data from the following service areas: acute in-patients, out-patients, a Medical Rehabilitation Unit (MRU), and consultations. The structure of the overall service is illustrated in Figure 1. *Hospital A* and *Hospital B* operate as two separate independent entities; however, the Consultant Physician provides an integrated service across both entities. The service offered by the Consultant Physician is available to approximately 36,000 people aged over 65 years living in the Cork north Lee and south Lee health service areas.

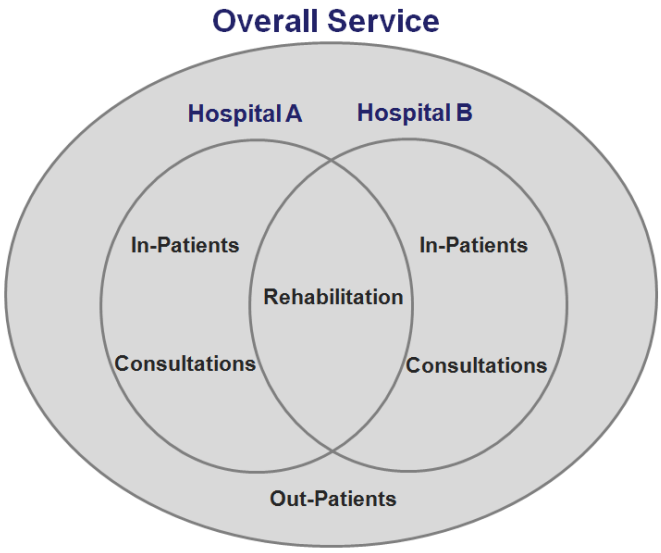


Figure 1: Operational environment

The independence of both hospitals creates its own problem for the Consultant Physician in that both hospitals use different Hospital Information Systems (HIS) for managing patient records; therefore, different data definitions are used to define a patient in *Hospital A* and *Hospital B*. In simple terms, a different patient record number (*ChartID*) is used in each hospital to identify the same patient. The practicality of this problem for the Consultant Physician is that patient mobility between the two hospitals is a common occurrence, and outside the boundaries of each individual hospital, it is extremely time consuming and inefficient to get an overall profile of a patient within the service. Unfortunately, for a number of years the Consultant Physician collected his patient data and logged his clinical observations in self-designed Microsoft Excel spreadsheets. This translated into the existence of at least five (heterogeneous) spreadsheets being maintained on an on-going basis for the service areas, which reflected a fragmented approach to data capture and resulted in the existence of information silos. However, taking on board the issue of different patient record numbers existing in both hospitals; this led to a data collection that was primarily hospital-centric as opposed to patient-centric, which mirrored the inefficiency inherent in the patient data definitions of the two Hospital Information Systems, and this further curtailed the ability of the Consultant Physician to view a patient's history across the service areas.

In the IS area, practitioners are well aware of the observation that an Information System is only ever as good as the store of data. However, it is also the fact that the use of incorrect data structures for storing data can significantly hamper its retrieval and analysis. The lack of a normalised data structure for instance can lead to data inconsistencies and redundancies that prevent associations and patterns in the data being identified during analysis. Indeed, in the context of our project despite the non-value-added nature of generating a patient history from the collection of Excel spreadsheets, there was also the issue of data integrity and the Consultant Physician's low level of trust in the accuracy of the information. Overall, the Consultant Physician's patient data was not defined in a uniform and standardised way and this poor categorisation of data resulted in the cumbersome production of low-value information. For example, where a patient was readmitted to hospital, the Consultant Physician collected his clinical observation data on the patient, however, this translated into a row being added to the Excel spreadsheet (a new record was created) illustrating that patient data was unnecessarily duplicated in these circumstances.

As a result of the inadequacies of the patient data and the process followed in analysing this data, the purposefulness and usefulness that the data could have possessed was diminished to the extent that the Consultant Physician had doubt about the data's reliability and trustworthiness. Furthermore, the Consultant Physician had limited querying tools available to him where he was limited to the use of filters in Excel. However, these Excel features were simply used to analyse the data, to abstract various facts of importance, and these results were used for personal clinical observations, as well as supplementing reports that the Consultant Physician produced. Therefore, the development of a localised custom-built Information System (PDA-IS) that would provide flexibility in design to facilitate the operations of this Consultant Physician in his collection, management, and analysis of patient data in Geriatric Medicine was undertaken.

3.1 Approach to developing the proposed PDA-IS solution

The PDA-IS was developed over a six month period from October 2006 – March 2007 and the prototype application has been in use since April 2007. In the first two month period of the project several rounds of interviews took place between the academic development team and the Consultant Physician, in an effort to establish the core user requirements. These user requirements were translated into a series of activity models and logical data model designs by the academic development team, which were then used as communication tools to agree the Information System's features with the Consultant Physician, in addressing the user's requirements. As a result, the activity models and logical data model designs were continually refined during each round of interviews until a complete set of models existed, embracing both stakeholder groups' understanding of the problem area, to guide the development process. Therefore, the remaining three months of the project timeframe was focused on the database and prototype software development activities. This three month development period would be best described as following an iterative prototyping approach in that when additional functional features were added to the PDA-IS the Consultant Physician was called upon to provide feedback following guided usability testing.

4. Functional and technical architecture of the patient data analysis information system

The technical deign of the application followed an n-tiered architecture (a five layer model in this instance) as illustrated in Figure 2. This five-tiered application architecture is state-of-the-art, although not always embraced in approaches to application development (see for example Microsoft: http://www.microsoft.com/belux/msdn/nl/community/columns/hyatt/ntier1.mspx). The rationale for such a design was motivated by the desire to allow for greater flexibility and scalability, as well as the maintainability and manageability of the application for the future. For example, each layer of the application was developed independently, adhering as much as possible to standards facilitating communication with the layers above and/or below. The application was developed in the Microsoft Visual Studio® 2005 Integrated Development Environment (IDE), facilitating the use of the .NET Framework 2.0. The .NET Framework is free to download and supports object-oriented programming, facilitating component development that can operate across a broad range of computing devices, including mobile devices (for example a pocket PC).

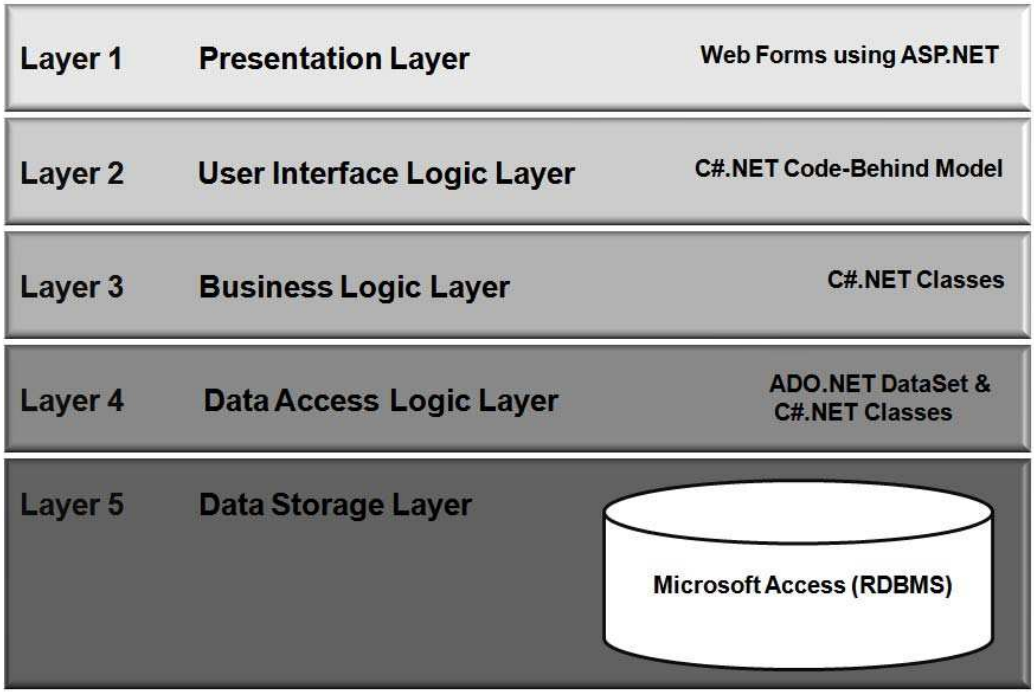


Figure 2: Five-Tiered Architecture of the PDA-IS

A more detailed explanation of each layer of the PDA-IS is provided as follows:

- Data storage layer

A highly complex and sophisticated relational data model, implemented in the Microsoft Access Relational Database Management Systems (RBDMS) is at the core of the application. The data model dictates the way

in which the data is logically structured and stored for retrieval. As previously discussed, the design of the data model was agreed following a number of requirements meetings with the Consultant Physician. As an example some of the patient-centric data dimensions that needed to be captured by the PDA-IS are illustrated in Table 1. Furthermore, several component parts of this comprehensive relational data model are discussed in section 4.1.

- Data Access Logic Layer

The Data Access Logic Layer is a reusable interface to the data source (Microsoft Access in this instance) which is also known as abstraction. Its existence facilitates an easier transition to an alternative data source (for example: Microsoft SQL Server, Oracle, MySQL, etc.).

- Business Logic Layer

This is the *'brain'* of the application and provides increased control over the operations of the application. This layer contains business rules, constraints, data manipulations, etc.

- User Interface Logic

This layer acts as a control for the Presentation Layer, for example it controls making ASP.NET components visible or invisible, enabled or disenabled, etc. Ultimately, this layer provides a specific logic to the particular *.aspx* Web Form.

- Presentation Layer

This layer provides a User Interface (UI) for the application. This layer works with the code-behind model (User Interface Logic) to handle the transformation of end-user input as well as application output. The *themes/skins* functionality of Visual Studio® 2005 was also used in order to create templates for all Web Forms and controls (User Interface components). Furthermore, Cascading Style Sheets (CSS) were used to control the style and layout of the User Interface. Therefore, the look and feel of various controls could be defined from one central source, so as to ensure consistency across the Presentation Layer.

Table 1: Patient-Centric data dimensions

Dimension	Description
Length of Stay	[Date Admitted] – [Discharge Date]
Discharge Destination	Home, Back to Nursing Home, Long Term Care (LTC), Hospital Transfer, Transfer to Team, Rehabilitation Unit, RIP, etc.
Home Situation	Lives Alone, Sheltered Accommodation, Hostel, Lives w/Spouse, Lives w/Siblings, Lives w/Brother or Sister, Lives w/Carer, Lives w/Other, Other, etc.
Mobility	Unaided, with Stick, with ZF, Bed-Chair, Bed-Bound, Other, etc.
Measure of Function	Tests are conducted and scores recorded on Admission & Discharge for the Barthel Index (BI). The change in the BI value is also recorded.
Measure of Cognition	Tests are conducted and scores recorded on Admission & Discharge for the Abbreviated Mental Test (AMT). The change in the AMT value is also recorded.
Reason for Referral	Rehab, Stroke, Respite, LTC, Medical Advice, Other, etc.
Department	Cardiology, Respiratory, Neurology, Clinical Pharmacology, Rheumatology, General Surgery, Gastroenterology, etc.

4.1 Managing high quality Patient-Centric data

There is often much debate about the value and methods of designing a normalised logical data model during the analysis phase of an IS development project. The obvious benefit of designing a logical data model is that it describes the functional, as well as data, requirements within the scope of the project's problem domain. In the context of this research project it was obvious at the outset of the project that data

was captured and stored using a hospital-centric as opposed to patient-centric perspective and there was no formal categorisation of master data elements existing in the Consultant Physician's Excel spreadsheets solution which led to the cumbersome production of low-value information. In an effort to provide the Consultant Physician with a patient-centric means of data collection and visibility of a patient's history across the service areas a comprehensive logical data model design was agreed for the PDA-IS. To focus on the key aspects of the PDA-IS in this paper, we are only explaining a subsection of the data model for the purposes of readability and clarity. These key aspects of the PDA-IS (namely: *patient-centric admissions* and *diagnosis and sub-diagnosis categorisation*) are discussed in sections 4.1.1 and 4.1.2 respectively.

4.1.1 Patient-Centric admissions

Figure 3 illustrates a portion of the overall data model that was designed for the PDA-IS and embraces a patient-centric admissions process for the service areas. By its design the data model allows for the realities that older patients may be admitted more than once across the various service areas and may be issued with more than one patient record number (*ChartID*), depending on the physical hospital location for each of these admissions.

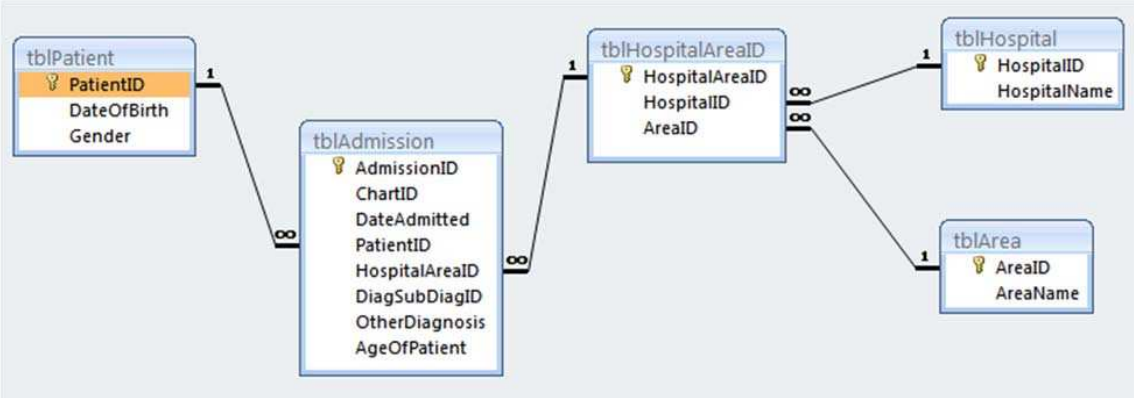


Figure 3: Patient-Centric Admissions for the Service Areas

To achieve this flexibility and meet a key requirement of the end-user, each patient is assigned a unique *PatientID* which is referenced each time a patient is readmitted throughout the various locations of the service areas. While the *ChartID* (a number generated by the hospital administration) is also captured for each patient's admission it is not the primary identifier of each patient in the PDA-IS data structure. Also, with the operation of the service areas split across two hospitals (as illustrated in Figure 1), this reality is captured by defining a master data category of *Hospitals* and *Areas*, thereby creating a combination of service areas to hospitals, as captured in the *tblHospitalAreaID* table. Therefore, each admission is classified against a *HospitalAreaID*; as an example, if an older person has been admitted to in-patients in the MUH, *HospitalAreaID* 2 is used; however, this patient may be seen again (readmitted) in out-patients at the SIVUH and would be categorised using *HospitalAreaID* 5. This *HospitalAreaID* relationship structure is illustrated in Figure 4 using a sample set of data records.

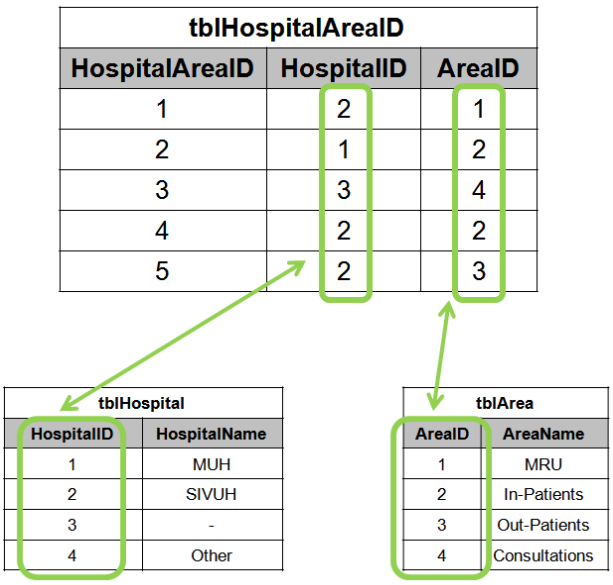


Figure 4: Logical Representation of Service Areas across both Hospitals

4.1.2 Diagnosis and Sub-Diagnosis categorisation

Each patient admission has an associated *Diagnosis* with *SubDiagnosis* categorisation. This provides a detailed and thorough categorisation of the older person's diagnosis and sub-diagnosis for each admission to the service areas. Figure 5 illustrates a portion of the overall data model that was designed for the PDA-IS and embraces a *Diagnosis* with *SubDiagnosis* categorisation for each patient admission to one of the service areas.

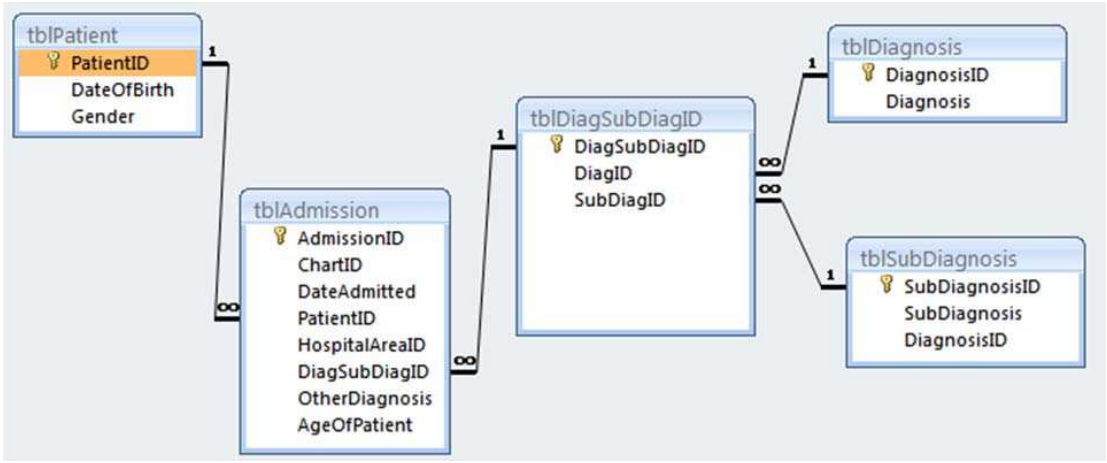
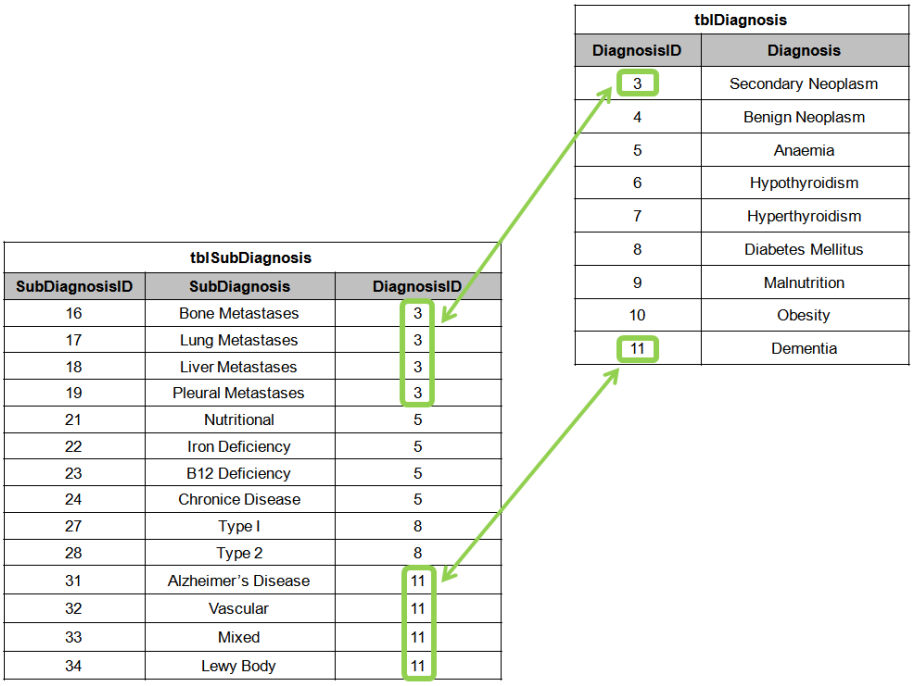


Figure 5: Diagnosis & Sub-Diagnosis Categorisation for each Patient Admission to the Service Areas

This *Diagnosis* and *SubDiagnosis* master data categorisation provides the Consultant Physician with thorough and insightful data to build an accurate patient case history across the service areas, and also provide an insight into the profile of patients across the service areas by types of *Diagnosis* and *SubDiagnosis* captured for each admission. Figure 6 illustrates this *Diagnosis/Sub-Diagnosis* relationship structure using a sample set of data records.



tblDiagnosis	
DiagnosisID	**Diagnosis**
3	Secondary Neoplasm
4	Benign Neoplasm
5	Anaemia
6	Hypothyroidism
7	Hyperthyroidism
8	Diabetes Mellitus
9	Malnutrition
10	Obesity
11	Dementia

tblSubDiagnosis		
SubDiagnosisID	**SubDiagnosis**	**DiagnosisID**
16	Bone Metastases	3
17	Lung Metastases	3
18	Liver Metastases	3
19	Pleural Metastases	3
21	Nutritional	5
22	Iron Deficiency	5
23	B12 Deficiency	5
24	Chronice Disease	5
27	Type I	8
28	Type 2	8
31	Alzheimer's Disease	11
32	Vascular	11
33	Mixed	11
34	Lewy Body	11

Figure 6: Example of Diagnosis & Sub-Diagnosis Master Data Categorisation

As an example, it can be observed from Figure 6 that *DiagnosisID* 11 (Dementia) has four possible sub-diagnosis that each older patient can be classified against, namely *SubDiagnosisID* 31, 32, 33, 34 respectively. Also, the Consultant Physician can continually add master data elements in the form of diagnosis categories and associated sub-diagnosis categories, using the administrative UI of the PDA-IS, as illustrated in Figure 7.

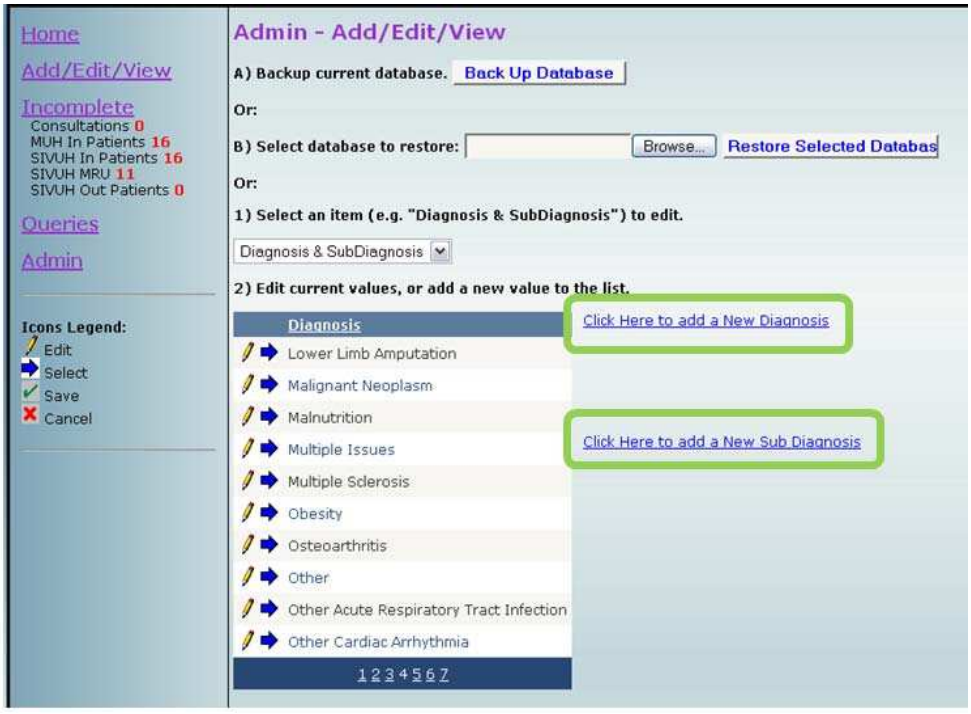


Figure 7: PDA-IS Administration User Interface (UI)

5. Benefits of the Patient Data Analysis information system

Identifying benefits can be considered a good communication tool and checklist for consensus-building in discussions on the role of IS in organisational contexts (in this case Geriatric Medicine). However, assessing the level of benefit realisation from the use of an Information System is a somewhat subjective exercise and

should be considered from the perspective of the end-user and their view on the value of the application in support of their activities. To put some formalised structure on the benefits discussed in this section we use the dimensions of the SOLE quality model discussed by Ozkan (2006) with regard to assessing IS quality. This high level assessment of the PDA-IS is presented in Table 2.

Table 2: PDA-IS Assessment across the Dimensions of the SOLE Quality Model (after: Ozkan, 2006)

IS Quality Dimension	Description	The PDA-IS Case
Business Quality	If benefits offset costs, then IS quality is considered to be good	In monetary terms the PDA-IS was developed at zero cost. Although academics and a medical practitioner's time was involved, a rich collaborative culture has now been created, facilitated by the delivery the PDA-IS prototype
Use Quality	Defined by how well the IS does what the end-user wants it to do (focusing on requirement quality and interface quality)	Facilitates the collection and storage of patient-centric data of high integrity Facilitates the generation of standard and ad-hoc analytical patient- and service-centric queries using the query engine; therefore; delivering high quality patient- and service-centric information in a timely fashion
IS Work Quality	Considers the management tasks required to guarantee 'fruition and evolution quality' and 'user support quality' concerning all aspects of the way the IS serves the user	While the PDA-IS has been in use for over ten months, no performance issues have been reported and all maintenance and operations associated with the PDA-IS have been managed by the Consultant Physician

At the outset of the PDA-IS project it was clear what system functionalities were needed to support the Consultant Physician but it was somewhat uncertain as to the benefits that would be realised from the system in-use, and how these benefits would be measured. However, unlike Doherty *et al*. (2008) while we didn't strive, explicitly at the outset, to make benefits the focal point of our development project, it became apparent following the initial period of the system in-use that several benefits had materialised and were realised by the key stakeholder. Therefore, based on an analysis of the subjective views of the Consultant Physician in Geriatric Medicine, the PDA-IS was deemed to provide the following functional benefits:

- facilitates the collection and storage of patient data:
  - highlight patients that have incomplete data – this is facilitated through using the simplistic snapshot view of incomplete patient records on the application's menu bar (see Figure 8)
- facilitates the generation of numerous standard and ad-hoc analytical queries on the patient data to:
  - establish the profiles of patients based on their experience across the healthcare service areas
    - track the average length of stay of patients
    - track discharge destinations
    - track changes in BI & AMT (see Table 1) – these simple measures of function and cognition respectively are not collected in any other computerised system in Hospital A or Hospital B. In fact, these are the measures that highlight the complexity of a patient and they determine the dependence of a patient, for example influencing their length-of-stay in hospital, or indeed their mortality. Surprisingly, no provision is made in either hospital to collect and store these measures.
  - discover 'path patterns' or 'pathways' of patients in the healthcare service area
    - analyse patients with stroke, establish how long on average they are in hospital and if there is a difference between patients with different types of stroke
  - identify possibilities for improvement in healthcare provision
    - track the number of patients in different service areas
    - track length of time patients wait for MRU admissions
    - provide local patient analysis for Syncope Studies, Stroke Unit and Falls Clinic developments

Indeed, the power of the query engine developed at the core of the PDA-IS was deemed as one of the most valuable aspects of the application by the Geriatric Physician, specifically because of the flexibility it offered

in conducting data analysis. The design of the query engine allows the end-user to choose a pre-built 'basic' SQL statement and modify it with unlimited criteria (extending the *where* clause of the SQL statement) from the User Interface as illustrated in Figure 8. Therefore, the complexity and sophistication of the query engine design is represented to the end-user in a visually sophisticated and logically ordered easy-to-use interface.

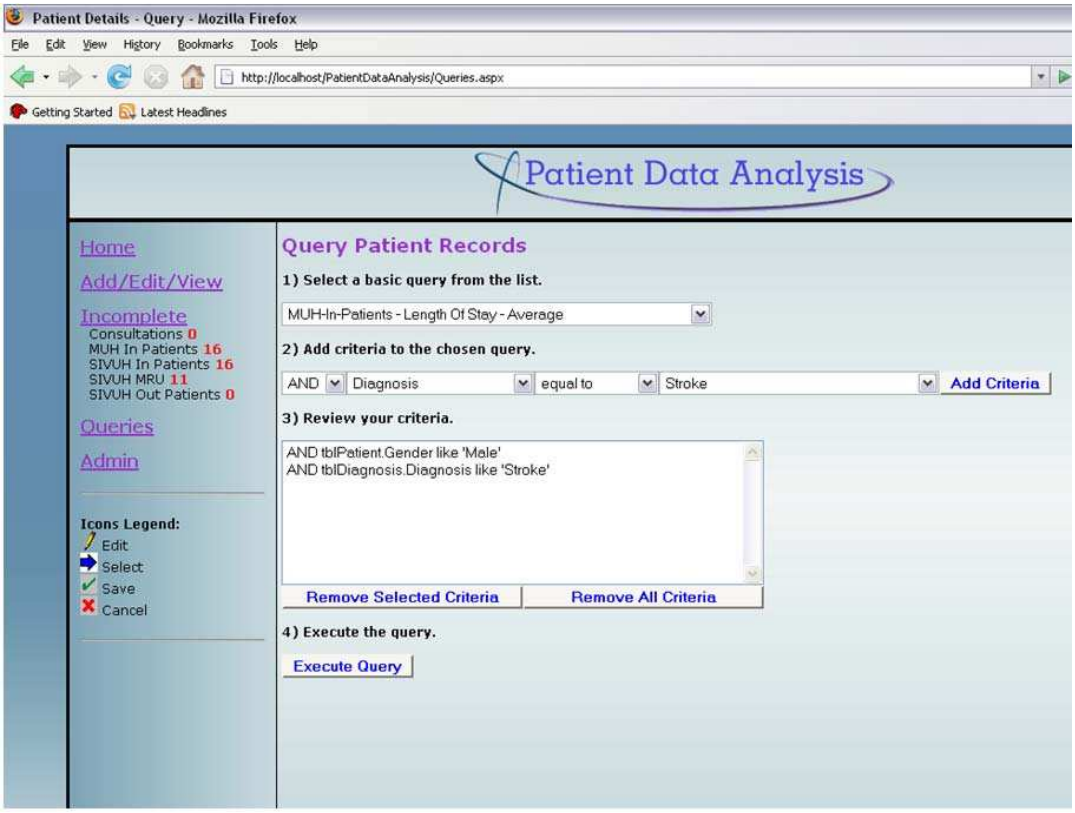


Figure 8: PDA-IS End-Users Query Engine User Interface (UI)

The querying process works as follows:

- Client chooses a basic query (SQL statement);
- Client chooses data parameters to query against e.g. gender, hospital, diagnosis, etc;
- Client specifies the criteria for that data e.g. equal to male, Mercy Hospital, Amnesia, etc.;
- Client executes the query:
  - A Query class takes the basic SQL statement and dynamically adds in the *where* parameters and criteria.
  - A Database Connection class executes the SQL statement against the database.

When the Consultant Physician chooses 'Execute Query' on the UI, the returned dataset is outputted to an Excel spreadsheet for immediate viewing and, if required, graphical representation. An example of such an output is illustrated in Figure 9. The rationale for using Excel is one of familiarity and the inherent ease-of-use of the application for the Consultant Physician.

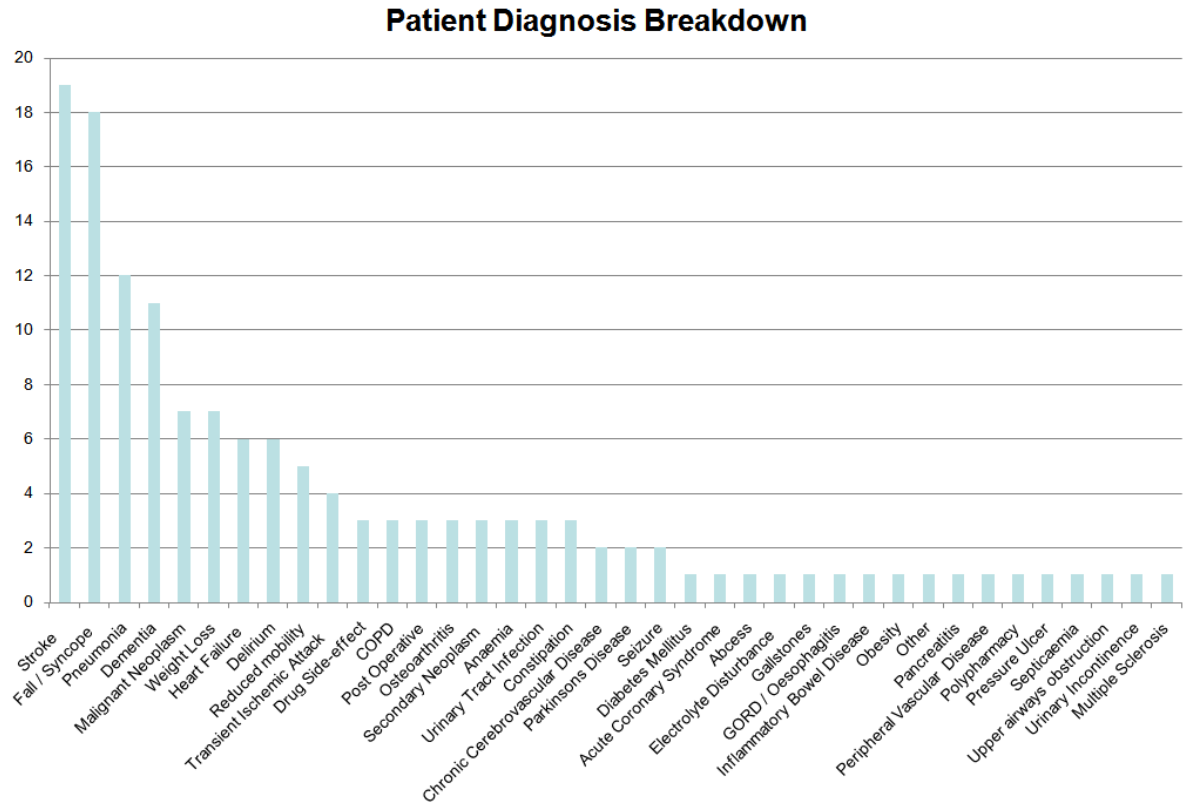


Figure 9: Patient Diagnosis Breakdown Charted in Excel

Overall, the Consultant Physician's feedback confirmed that the PDA-IS provides a number of easy-to-use User Interfaces (UI) facilitating accurate patient data entry and with the existence of the relational data model at the core of the application also has a standardised set of data definitions. Furthermore, the query engine and the flexibility it provides to analyse the data facilitates the representation of the complexity of each individual patient and indeed the local patient population which is the ultimate in terms of the provision of better healthcare at the local level.

6. Concluding remarks

To conclude we embrace the views of Kunene and Weistroffer (2006, p.984) when they suggest that "the vast and growing collection of healthcare data and the willingness of clinicians to explore different technologies and methodologies to analyse this enormous amount of data has recently opened up new analytical possibilities for clinicians, operations researchers as well as information systems researchers". Indeed, this willingness of medical practitioners to welcome new tools and techniques into their practices should be embraced by the IS academic community where both knowledge domains could be combined to produce patient focused solutions. By its design our PDA-IS can be easily extended to run on a national scale (e.g. throughout the Republic of Ireland) and cover the needs of all Consultant Physicians in Geriatric Medicine.

We believe that our approach to developing the PDA-IS is a step toward developing an informatics infrastructure to collect local practice-based evidence. This repository of local patient information can compliment the available scientific evidence (literature-based evidence). In addition, our modest academic project and the resultant system developed can be further extended through the formation of a practice-based research information network; however, we also appreciate at this current time that the PDA-IS in an individual solution to an individual problem. In addition, it must be stressed that this academic project was not funded by any agency, nor was it influenced by commercial stakeholders; in essence this development project was simply about meeting the needs of a Consultant Physician in Geriatric Medicine, who as a highly skilled professional was not benefiting from the efficient use and support of an Information System equipped to handle patient data analysis. Indeed, at the time of writing this paper, the Consultant Physician has continued to use the PDA-IS eight to ten hours a week on average, since April 2007; furthermore, the system contains almost 900 patient records (2007 & 2008) covering approximately 1,400 patient admissions. This is a true testament to the fact that the PDA-IS is a simple but effective tool developed to solve the Consultant Physician's problem regarding clinical patient data capture and analysis. It is also worth mentioning that the

Consultant Physician in Geriatric Medicine does not have to use this PDA-IS, it is a choice that he makes in support of his daily clinical activities. This project further illustrates the point that small localised projects of the nature of the PDA-IS (a local practice-based repository of clinical patient data) can have an impact in the medical area and can avoid the problem of trying to meet all 'larger nationwide' requirements from the outset, incorporating 'nice-to-haves' as well as 'must-haves', which can sometimes lead to an approach that seeks to ***'boil the ocean'*** in terms of what is being delivered, but ultimately ends up delivering very little!

Finally, upon near completion of the development of the PDA-IS it was revealed that several Consultant Physicians in Geriatric Medicine at the two hospital sites were faced with the same limitations with regard to the collection and analysis of their clinical patient data. This realisation is now further informing the next phase of our ongoing research project, the local impact of which is expected to be extremely positive in terms of introducing a larger group of Consultant Physicians to [1] an appropriate system to record patient data; and [2] a flexible analysis component; to provide the necessary information for the accurate and ongoing treatment of older patients. As a result of the successful completion of this phase of the PDA-IS project a vibrant research partnership has evolved and the development of PDA-IS (version 2) has commenced in October 2008, embracing a Co-Research approach to the development project (cf. Hartley and Benington, 2000).

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A Guideline for Virtual Team Managers: the Key to Effective Social Interaction and Communication

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Abstract: Globalisation has had an enormous impact on the manner in which teams operate. Traditional teams have been forced to adapt to their constantly changing environment in order to compete effectively with other business.

A vast number of IT professionals work in teams, which are characterised by distribution and diversity. It is the presence of virtual characteristics that may result in numerous social problems which can negatively impact team communication and productivity, demanding more effective team management. There is much potential for conflict in virtual teams as members work across cultural, geographical and time-bound environments. This conflict leads to ineffective communication and as soon as team members stop communicating effectively, barriers begin to form between them, which, leads to a decrease in productivity and interaction. Conflict resolution, and the extent to which it undermines performance, depends heavily on the conflict resolution approach.

This qualitative research is conducted by means of a literature review only, in which several managerial models available to virtual team managers are critically analysed and combined into a proposed theoretical model of general managerial guidelines for virtual team managers. Both current and proposed models discussed within this paper should be viewed within the limitations of this research i.e., the proposed model remains untested and should be viewed as a hypothesis for future research.

This research distinguishes virtual teams from traditional teams by defining characteristics that are common to virtual teams. These characteristics are: physical dispersion, crossing time boundaries, dependence on communication technologies, crossing functional boundaries, diversity, unstable team structure, non-routine as well as interrelated tasks. The research argues that teams are neither entirely traditional (local) nor entirely Global but may be placed on a continuum of virtuality according to the virtual characteristics the team possesses.

The theoretical model proposed by this research: Proposed Managerial Strategies, is intended to help IT managers overcome conflict and consequent social problems within virtual teams, which may otherwise lead to ineffective communication. The model provides managers with guidelines and strategies which may be implemented to enable effective social interaction and prevent future problems.

Keywords: virtual teams, globalisation, communication, distributed teams

1. Introduction

Social interaction forms a vital part of any team experience. Virtual teams are teams whose members are geographically distributed, requiring them to work together through electronic means with minimal, or in extreme circumstances, no face-to-face interaction (Malhotra, Majchrzak and Rosen, 2007: 60). Geographical dispersion, organisational differences and cultural diversity, which are traits of virtual teams, magnify problems relating to these teams' social interactions, by preventing development of understanding and relationships (Kankanhalli, Tan and Wei, 2007: 238). A combination of virtual characteristics compounds coordination problems by creating bottlenecks from distance, and communication problems arising from cultural differences and weak ties (Wong and Burton, 2001: 346). According to Kimball (1997: 1) managing a virtual team means managing the whole spectrum of communication strategies and project management techniques, as well as human and social processes in ways that support the team. Therefore it is essential that managers monitor these social issues carefully and at times, change their managerial style to suit their teams' distributed environment. Managerial models and strategies, available to managers, help them overcome these social problems and provide guidelines regarding the adoption of a distributed managerial style.

A critical review of literature, sourced mainly from academic journals, is synthesised into a current model. A new, proposed theoretical model is suggested as a means for addressing the concerns raised in the current model.

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2. Characteristics common to virtual teams

Virtual teams have unique characteristics that make it possible to differentiate them from both traditional teams and from one another (Bell and Kozlowski, 2002: 12). In order to define the characteristics common to virtual teams, it is important to understand what distinguishes virtual teams from conventional, face-to-face teams. This is illustrated in Table 1 below.

Table 1: Traditional versus Virtual Characteristics (Kimball, 1997: 1)

Traditional Characteristics	Virtual Characteristics
Fixed team membership	Shifting team membership
Members are drawn from within the organisation	Members can include people from outside the organisation
Members are only part of one team	Members are part of multiple teams
Members are co-located organisationally and geographically	Members are distributed organisationally and geographically
Teams have a fixed starting and ending point	Teams form and reform continuously
Teams are managed by a single person	Teams have multiple reporting relationships with different people at different times

The following characteristics were found to be common to virtual teams; these illustrate how the nature of teams has changed from traditional to virtual, in response to organisational demands:

- Team members are physically dispersed
- Time boundaries are crossed
- Communication technology is used
- Members have a common purpose
- Diversity is present
  - Cultural diversity (in the form of national or linguistic diversity)
  - Organisational diversity (hierarchical versus flat or egalitarian culture)
  - Age diversity
  - Gender diversity
  - Functional diversity (differences in education and experience)
- Structural dynamism is present
  - Functional boundaries are crossed
  - Shifting team membership
  - Teams form and reform continuously (lifespan is temporary)
  - Teams report to different people at different times
  - Members are part of multiple teams
  - Members bring different perspectives and skills
- Teams perform non-routine tasks
- Teams perform interrelated tasks

Virtual teams may be categorized into different types of virtual teams according to the characteristics that a particular team has. Teams, which possess more virtual characteristics, are placed higher on the continuum of virtuality than teams with fewer virtual characteristics. This continuum is illustrated in Table 2.

According to McKinney and Whiteside (2006: 84), distributed teams face all the traditional challenges that any other team faces, and in addition to this, still have to deal with new communication challenges. In general, virtual teams that are higher on the continuum of virtuality, possess a greater number of virtual characteristics, and will therefore be more sensitive to the social problems caused by these traits, than more traditional teams.

Table 2: Types of Virtual Teams and Degree of Virtuality. (Adapted from Kimall (1997: 3) and Bal and Teo (2000: 347))

HIGH

DEGREE OF VIRTUALITY

LOW

Team Type	Virtual Characteristics
Action	These teams offer immediate responses. Distance and organisational boundaries are usually crossed.
Management	Are separated by distance and time. National boundaries are often crossed but organisational boundaries are usually intact.
Service	Are now distributed across time and distance. Teams rotate so that there is always one team operating.
Work	Perform regular and ongoing work. Membership is clearly defined. Teams are now beginning to cross time and distance boundaries.
Project Development	Projects are conducted for customers for a period of time. Time, distance and organisational boundaries are often crossed. Tasks are usually non-routine. Exist longer than parallel teams, but membership is inconsistent.
Parallel	Carry out special tasks that regular organisations are not equipped to perform. Time, distance and organisational boundaries are often crossed. It has distinct membership and members usually work on a short-term basis to address specific issues.
Networked	Consist of members who collaborate to achieve a common goal. Time, distance and organisational boundaries are often crossed. Members rotate on and off the team as their expertise is needed.
Community of Practice	Support people who are working on common tasks. Membership is voluntary and teams are focused on learning as opposed to specific deliverables.
Executive	Consist of managers who are on the team due to their position in the organisation. These teams are usually semi-permanent and are responsible for specific functions in the organisation.

3. The social problems affecting virtual teams

Since virtual teams possess different characteristics, they will be affected by different social problems as well. In general, virtual teams that are higher on the continuum of virtuality, possess a greater number of virtual characteristics, and they will therefore be more sensitive to the social problems caused by these traits, than more traditional teams.

Kankanhalli, Tan and Wei (2007: 238) state that there is much potential for conflict in virtual teams as members work across cultural, geographical and time-bound environments. This conflict leads to ineffective communication and as soon as team members stop communicating effectively, barriers begin to form between them leading to a decrease in productivity and interaction. The following section describes factors that have a direct impact on the teams' social functioning:

3.1 Physical dispersion and time boundaries

Gibson and Gibbs (2006: 457) state that in highly geographically dispersed teams, it is more difficult to coordinate members, given that there are shorter windows of time for synchronous meetings, and many meetings take place outside of standard working time. Therefore, physical dispersion increases coordination requirements, which delays communication and productivity. They also believe that physically dispersed teams are more familiar with their own external context (environment) and have less shared contextual knowledge. This also creates complexity for team members, as they are unaware of issues present in another team member's environment. Kankanhalli, Tan and Wei (2007: 238) concur with Gibson and Gibbs (2006: 457) and believe that physical dispersion and time zone differences cause communication delays and can often lead to conflict, resulting in ineffective teamwork. Communication delays also result in misunderstandings and may even be responsible for poor relationships between members.

3.2 Communication technology

Reliance on computer-mediated communication reduces opportunities for monitoring team members, and makes it more difficult to interpret knowledge, as the context is not known (Gibson and Gibbs, 2006: 458). These authors explain that communication through technology reduces non-verbal cues about interpersonal affections such as tone, warmth, and attentiveness, which in turn contribute to message clarity and interpretation of feedback. Kankanhalli, Tan and Wei (2007: 262) believe the use of electronic media tends to

delay feedback. These delays may result in misunderstandings; causing negative feelings between members if they interpret the lack of response personally (members may feel they are being ignored). Wong and Burton (2001: 342) agree with Gibson and Gibbs (2006) arguing that electronically mediated communication in virtual teams may hinder understanding and complicate knowledge transfer, especially when the information is ambiguous.

3.3 Diversity

3.3.1 Cultural diversity

This characteristic is often the cause of major social problems experienced by virtual teams. Cultural diversity consists of both national and linguistic diversity. Gibson and Gibbs (2006: 460) define culture as characteristic ways of thinking, feeling, and behaving, shared among members of an identifiable group. They believe that national diversity creates different expectations for communication practices and reduces identification with the team as a whole. This may be responsible for many misunderstandings, stereotyping, and the inability to reach agreement or make decisions. Brett, Behfar and Kern (2006: 86) believe that cultural diversity is responsible for the following categories of challenges: direct versus indirect communication, trouble with accents and fluency, and conflicting norms for decision- making. Communication in western cultures is typically direct and explicit (Brett, Behfar and Kern, 2006: 86). The meaning is obvious and does not require interpretation; which is probably why westerners often have trouble understanding the subtleties used by non-westerners. Misunderstandings and frustration often occur due to accents or lack of fluency. Brett, Behfar and Kern (2006: 87), believe that this may influence members' perceptions of status and competence. Cultures differ enormously when it comes to decision-making - this often results in frustration. Kankanhalli, Tan and Wei (2007: 260) state that cultural diversity may provoke hostility between members, as mutual dislike, personality clashes, and annoyance becomes obvious. Other problems caused by cultural diversity are: ethnocentrism (belief that one's own nationality is superior); prejudice (critical perceptions of people from other nationalities); and stereotyping (generalisation of characteristics of people from other nationalities) (Kankanhalli, Tan and Wei, 2007: 260). All these social problems impede communication between virtual team members.

3.3.2 Organisational, age, gender and functional diversity

Members who belong to different organisations have differing attitudes towards hierarchy and authority (Brett, Behfar and Kern, 2006: 87). Members from organisations with hierarchical cultures usually feel that decisions need to be approved by managers on a higher level; while members who belong to organisations with flatter structures (egalitarian culture) are satisfied making decisions on their own. These differing attitudes often result in disagreements. Kankanhalli, Tan and Wei (2007: 241) state that functional diversity arises from differences in educational background, experience, and expertise among team members. Feelings of superiority or inferiority may arise due to the differences in members' backgrounds and may lead to communication problems. Kankanhalli, Tan and Wei (2007) believe that people like to be associated with others in the same social category; therefore, gender and age diversity can potentially create weaknesses and result in conflict.

3.4 Structural dynamism, non-routine tasks and interrelated tasks

Gibson and Gibbs (2006: 458) state that teams with a short history together tend to lack effective patterns of information sharing and working together, limiting the amount and variety of information that can be communicated to team members. A highly dynamic team structure increases uncertainty and perceived risk; this uncertainty results in hesitancy to share information, as the members do not fully trust each other (Gibson and Gibbs, 2006: 459). Bell and Kozlowski (2002: 30) believe that the lifecycles of virtual teams are largely determined by the nature of the tasks these teams perform. As tasks become more complex, integration among members becomes critical; therefore it becomes more difficult to introduce new team members and even more detrimental when existing members leave. Virtual team members may be required to perform numerous tasks and hold various roles; therefore they need to be able to adapt to a variety of virtual team situations (Bell and Kozlowski, 2002: 31). This may result in role conflict and ambiguity. Conflicts between multiple role expectations and individuals' abilities to satisfy such expectations cause role overload and negative work attitudes (Bell and Kozlowski, 2006: 40). Problems arise, as tasks become complex and require more coordination between members. Teamwork, communication and feedback become more important when members' roles are interrelated and coordination is required (Bell and Kozlowski, 2006: 31).

These social issues impact negatively on team communication and create barriers to effective teamwork by reducing information sharing and creating interpersonal conflict (Gibson and Gibbs, 2006: 459). Conflict needs to be managed effectively to ensure that virtual teams perform well and achieve their set outcomes. In order to overcome conflict and improve communication between team members, managers should make use of existing managerial strategies to help them adjust to their teams distributed environment.

4. The current managerial models for virtual teams

At times the distributed nature of virtual teams may require that managers change their managerial style to suit their teams' environment. According to Kimball (1997: 3) there are some critical aspects of a virtual team manager's mindset that must shift in order to be effective in contemporary organisations. Various managerial models will be discussed; these are divided up into two groups: general guidelines and specific strategies.

4.1 General guidelines

The following section describes general guidelines that offer assistance to managers of virtual teams:

According to Gibson and Gibbs (2006: 461) a psychologically safe communication climate may act as a moderating variable that helps to overcome the negative effects of virtual characteristics. They state that this environment should: provide opportunities for participation and open communication; encourage members to speak up, raise different opinions, and engage in informal communication; encourage members to remain open to other ideas and perspectives thereby avoiding early judgement of others; and encourage active listening.

Kimball (1997: 3) believes that managing virtual teams is not unlike managing traditional teams; managers should focus on developing norms surrounding the following: the purpose of the team; roles of members; team culture; conversation; feedback; pace of work of each member; entry and re-entry of members into the team; summarising different responses of members' opinions (weaving); participation of members; and flow of information. Kimball (1997: 7) is in agreement with Gibson and Gibbs (2006) and states that virtual team managers can help their teams by: recognising their importance; encouraging members to explore questions about how they are working together; supporting the creation of some kind of shared space (infrastructure); facilitating the coordination of technology, work processes, and the formal organisation of the team; recognising reflection as legitimate work; and supporting activities which make the informal network visible. Table 3 illustrates how virtual team managers' mindsets need to shift in order for them to be effective leaders of virtual teams (Kimball, 1997: 3):

Table 3: A New Management Mindset (Kimball, 1997: 3)

Old Mindset	New Mindset
Face-to-face is the best environment for interaction.	Different kinds of environments can support high quality interaction. What matters is how they are used.
Collaboration is what happens when teams interact at a fixed time and space.	Collaboration happens in an ongoing manner, and has no boundaries.
Being people-oriented is incompatible with using technology.	Using technology in a people-oriented way is possible and desirable.
When the communication process breaks down, blame the technology.	When the communication process breaks down, evaluate management and interactive strategies, not just technology tools.
Learning to manage virtual teams is about learning how to use the technology.	Learning to manage virtual teams is about understanding more about teams and the collaboration process.

Joinson (2002: 70) believes that managers should consider the techniques used to manage traditional, co-located teams. These actions should then be broken down and formalised so that they can be applied to virtual teams; issues such as how quickly an email should be answered, and who has authority to make decisions, should be addressed.

McKinney and Whiteside (2006: 83) have derived three main guidelines for maintaining distributed relationships. They encourage managers to: mix and vary communication media; build on prior relationships; and overcome the complexity of distributed tasks through technology that increases overall interaction, collaboration, and communication. Kankanhalli, Tan and Wei (2007: 240) describe three approaches to conflict resolution: integrative, solving the problem through collaboration; distributive, solving the problem

through assertion; and avoidance, ignoring the problem. Wong and Burton (2001: 356) propose that performance of virtual teams can be improved by increasing ease of communication, introducing routines to facilitate coordination, clarifying role expectations, and fostering a common team culture. Bell and Kozlowski (2002: 46) propose that virtual team leaders need to create infrastructures that facilitate information sharing, work planning, feedback, information processing, and decision-making and this allows members of the team to become self-managing.

In general, the authors are in agreement that a general set of guidelines is necessary when managing virtual teams, although some have differing opinions as to what those guidelines should be.

5. General managerial guidelines

This section examines the findings of previous sections and includes them all in a current managerial model. Table 5.1 illustrates the communication problems caused by each virtual characteristic, as identified by the literature review.

As discussed, virtual teams face all the challenges that any other team faces and they still have to deal with these additional communication challenges (McKinney and Whiteside, 2006: 84). From Table 4, it is obvious that the virtual characteristics responsible for the most social problems experienced by members, is the presence of diversity and structural dynamism. Diversity may result in particularly sensitive issues and is therefore very difficult to manage effectively.

It is interesting to observe that the characteristic, members have a common purpose, does not result in any communication problems; this characteristic is the only one common to both traditional and virtual teams. Since traditional teams do not have to contend with the communication problems caused by the other virtual characteristics, a lack of common team purpose would not cause a complete breakdown in traditional teams' communication practices - confusion could be resolved through informal interaction. However, virtual teams rely on this characteristic (common purpose) to ensure that team members have similar objectives and can overcome the problems caused by the other virtual characteristics by implementing solutions in line with these objectives. Therefore a lack of common purpose in virtual teams would have a far greater negative impact on team communication than a lack of common purpose in tradition teams.

The characteristics, teams perform non-routine and interrelated tasks, are responsible for very few communication problems in traditional teams. These characteristics do however become issues when members are physically dispersed, time boundaries are crossed and communication technology is used.

The general guidelines illustrated in Figure 1 provide a broad solution to the communication problems discussed in Table 4. However, it is agreed by the authors that these guidelines are still useful when attempting to overcome the communication problems affecting virtual teams as they reduce friction between members and promote effective virtual team performance.

Table 4: The communication problems caused by each virtual characteristic

Communication Problems	Characteristics of Virtual Teams							
	Team members are physically dispersed	Time boundaries are crossed	Communication technology is used	Members have a common purpose	Diversity is present	Structural dynamism is present	Teams perform non-routine tasks	Teams perform interrelated tasks
Trouble with accents and fluency (Brett, Behfar, and Kern, 2006: 86)					X			
Ethnocentrism (Kankanhalli, Tan and Wei, 2007: 260)					X			
Differences in educational background, experience and expertise (Kankanhalli, Tan and Wei, 2007: 241)					X			
Decreased team involvement (Brett, Behfar, and Kern, 2006: 86)	X		X			X		
Poor relationships between members (Gibson and Gibbs, 2006: 459)	X	X	X		X	X		
Poor message clarity (Kankanhalli, Tan and Wei, 2007: 242)	X	X	X		X	X		X
Delayed feedback (Kankanhalli, Tan and Wei, 2007: 262)	X	X	X			X		
Decreased productivity (Bell and Kozlowski, 2006: 32)	X	X	X			X		
Ineffective teamwork (Kankanhalli, Tan and Wei, 2007: 262)	X	X	X		X	X		
Poor interpretation of feedback (Gibson and Gibbs, 2006: 458)	X		X		X	X		
Negative work attitudes (Bell and Kozlowski, 2006: 32)	X	X			X	X		
Less shared contextual knowledge (Gibson and Gibbs, 2006: 457)	X	X	X		X	X		
Reduced identification with the team as a whole (Kankanhalli, Tan and Wei, 2007: 241)	X	X	X		X	X		
Lack of non-verbal cues (Gibson and Gibbs, 2006: 458)	X	X	X					
Stereotyping (Kankanhalli, Tan and Wei, 2007: 260)					X			
Few opportunities for monitoring team members (Wong and Burton, 2001: 342)	X	X	X			X		
Decreased job satisfaction (Bell and Kozlowski, 2006: 32)	X		X					
Complicated knowledge transfer (Wong and Burton, 2001: 342)	X	X	X		X	X	X	
Conflict between team members (Kankanhalli, Tan and Wei, 2007: 241)					X	X		
Different levels of mutual knowledge (Kankanhalli, Tan and Wei, 2007: 242)	X	X	X		X	X		
Lack of effective working patterns and information sharing (Gibson and Gibbs, 2006: 458)	X	X	X		X	X	X	
Role overload (Bell and Kozlowski, 2006: 31)						X		X

Role conflict and ambiguity (Bell and Kozlowski, 2006: 31)						X		X
Prejudice (Kankanhalli, Tan and Wei, 2007: 260)					X			
Differing attitudes towards hierarchy and authority (Brett, Behfar and Kern, 2006: 87)					X			

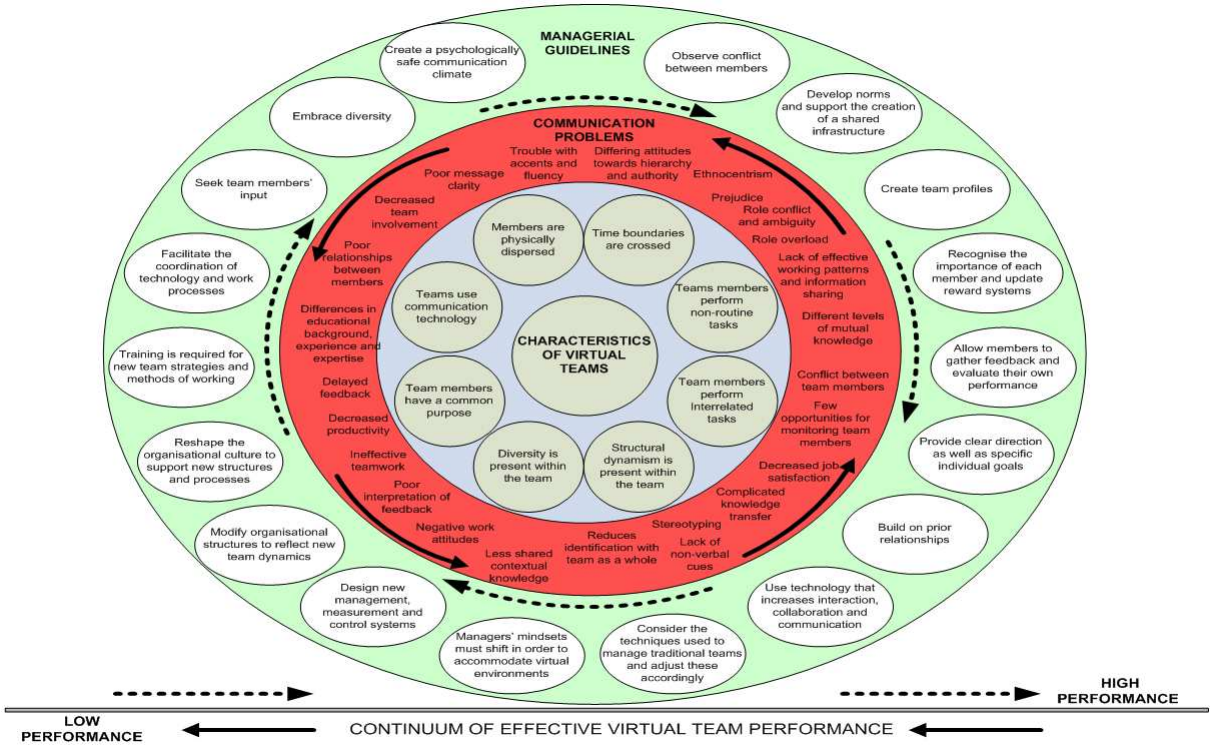

Figure 1: General managerial guidelines as a current model

6. Proposed strategies

A new dimension is added in this section; proposed strategies detailed below build on the managerial guidelines (previously discussed) and are intended to focus on a *particular* virtual characteristic and counteract the communication problems caused as a result of this characteristic.

The following section details how issues resulting from a specific virtual characteristic may be overcome by implementing the suggested steps. Note that each letter refers to a proposed strategy intended to overcome the problems caused by that virtual characteristic. Please refer to the diagram (Figure 6.1) for a clear illustration.

According to Joinson (2002: 69), virtual teams may counteract physical dispersion (**A**) by: planning and managing tasks, conducting virtual meetings and collaborating with each other. In order for these teams to use technology effectively (**B**) they need to understand the technology infrastructure, use appropriate tools and agree on standard technology to use for team work (Joinson, 2002: 69).

It is essential that team members have a common purpose (**C**); this may be done by creating a team charter and using visual forms of communication, which make common goals obvious to all team members (Joinson, 2002: 73).

In the previous section it was concluded that this characteristic (common purpose) of virtual teams is common to both virtual and traditional teams and did not result in communication problems. Therefore the strategy provided above should be used to ensure that this characteristic is present and clear to all members, and not to provide a solution to communication problems. Without this characteristic, members would not have shared objectives, and virtual interaction would be confusing and frustrating for team members.

Diversity issues are one of the most difficult problems for managers to overcome. In order to manage diversity within a team (**D**), managers need to: select members carefully (Kankanhalli, Tan and Wei, 2007: 268); identify fault lines (Kankanhalli, Tan and Wei, 2007: 268); adapt by acknowledging cultural gaps openly and working around them (Brett, Behfar and Kern, 2006: 88); using structural intervention, changing the shape of the team (Brett, Behfar and Kern, 2006: 88); using managerial intervention, setting norms (Brett, Behfar and Kern, 2006: 88); and as a last resort, exiting, removing a team member from the team (Brett, Behfar and Kern, 2006: 88).

Structural dynamism within the team may be controlled (**E**) by: setting up firm rules for communication to avoid loss of knowledge (Joinson, 2002: 73); encouraging mentoring relationships between members, as this allows members to adapt quickly and feel part of the team (Sadri and Tran, 2002: 232); and by encouraging knowledge transfer by having regular meetings.

Joinson (2002: 73) suggests that team leaders manage the performance of interrelated tasks (**F**) by: establishing regular times for group interaction; offering assistance on a regular basis; and encouraging informal, off-line conversation between members to ensure that they are comfortable working together. In order to manage the performance of non-routine tasks (**G**), Joinson (2002: 73) encourages effective communication in work groups and suggests that managers provide a virtual meeting room via intranet, website or bulletin board.

Finally, managers may avoid crossing time boundaries (**H**) by: setting up firm rules for communication; using email as a communication technology; and making themselves available to employees (Joinson, 2002: 73).

In order to mitigate conflict and improve teams' social interactions, managers should make use of the proposed strategies to overcome problems relating to a particular virtual characteristic. The managerial guidelines and these proposed strategies should be used in conjunction to maintain effective social interaction and prevent future communication problems.

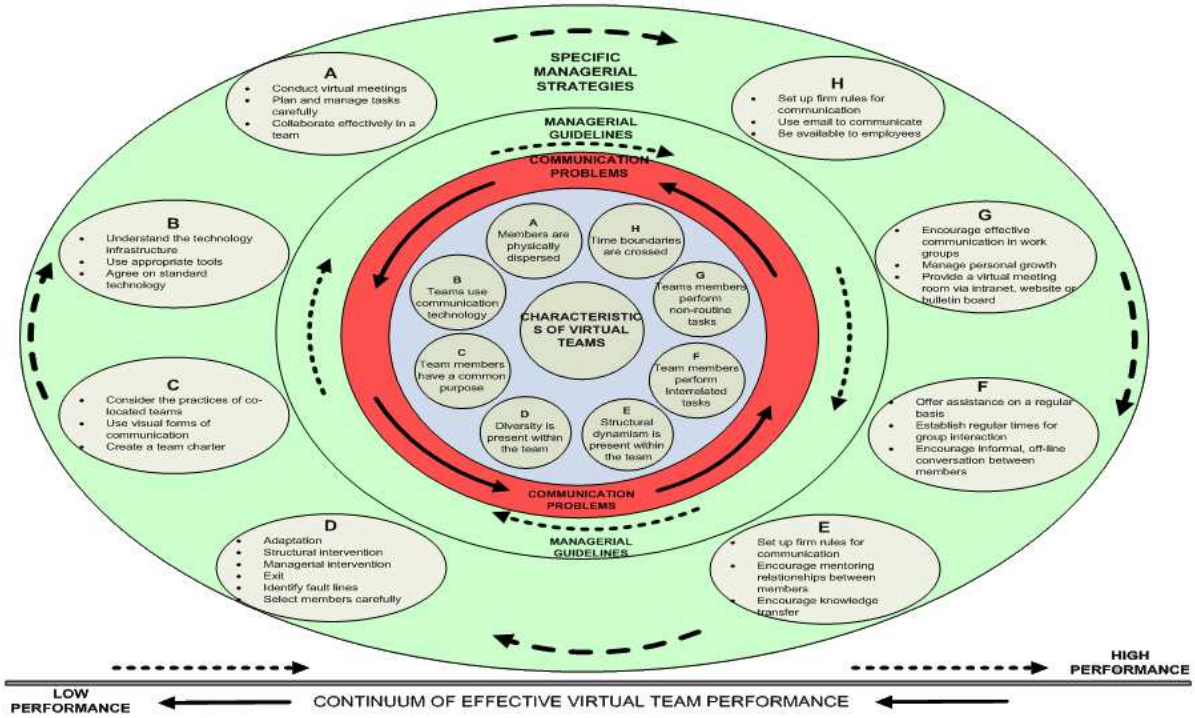

Figure 2: Proposed strategies as a New Managerial Model

7. Conclusion

Existing literature suggests that virtual teams may be placed accordingly along a continuum of virtuality, depending on the virtual characteristics they posses. Characteristics common to virtual teams are: physical dispersion, crossing time boundaries, dependence on communication technologies, crossing functional boundaries, diversity, unstable team structure, non-routine tasks and interrelated tasks. The presence of virtual characteristics results in numerous social problems which impact negatively on team communication

and productivity. In order to overcome conflict and improve communication between team members, managers should make use of existing managerial guidelines to help them adjust to their teams distributed environment. These general managerial guidelines are prescribed in order to overcome common communication issues.

Proposed managerial strategies, considered the contribution of the research, are intended to target particular virtual characteristics, and the problems associated with them.

8. Future work

There is a need for future research to assess the effectiveness of the proposed model put forward by this research as well as the extent to which this new model compliments the existing managerial models currently available to managers. Another important issue to consider is the type of technology currently used by virtual teams, and whether a chosen technology is the most effective technology for counteracting a team's communication problems.

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