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December 2005

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### Recommended Citation

Hasan, Helen and Suratmethakul, Wannapa, "Implementing systems in complex work organisations" (2005). *ACIS 2005 Proceedings*. 45.  
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## Implementing systems in complex work organisations

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### Abstract

*This paper describes research on a case of the introduction, into a large educational institution, of a complex timetabling system that was already well established in other similar organisations. The research has used a grounded theory approach to reveal details within complex phenomena in an organisation when a substantial new system was implemented. The study revealed three critical issues: Knowledge Transfer, System Capability, and Organisational Context that appeared to be related to the problems of implementing the new information system in the organisation. This research adds to the understanding of a common situation where management have an over simplified view of organisational work and assume that implementing a new computer based system can quite easily improve the performance of the organisation.*

### Keywords

Usability, organisational context, knowledge transfer, grounded theory, complex systems

## INTRODUCTION

The aim of the study presented in this paper is to confirm the importance of the context, not only for designing an efficient system for users and other stakeholders, but also for improving the productivity of employees and the performance of the whole organisation. Some of these issues may be overlooked in the processes of usability testing during systems development and implementation but are critical to its success in the complex settings of organisations.

To maximise the usability of a product traditional HCI wisdom recommends participatory design methods and usability testing of systems prototypes (see for example Ehn 1988; Bannon and Bodker 1991). These should start as early as possible in the design process and involve future scenarios of use with surrogates or representatives of real users. Even though designers of organisational computer-based systems are concerned about the context of their use, most usability testing takes place either a laboratory or under conditions which cannot take account of all possible contextual issues. As Thomas and Macredie (2002) suggest “most usability testing regimes assume the context of a person facing a computer, the luxury of the person’s full attention, and a comfortable environment with minimal distraction.” The organisational environment is dynamic, complex, changeable and unpredictable. People, particularly those working under pressure of tight deadlines and performance targets, will invariably interact with a system in different ways depending on the particular context at the time and place of use.

When an organisation is looking for a computer system or application to support part of their operation it is not uncommon for them to consider a system that is already in use in an organisation similar to itself. Those responsible for system’ acquisition are considerably influenced by any advice they receive on experiences with the intended system from those who have successfully used it. Such communications between organisations may only occur at management level so that actual end-users are rarely involved. Issues of system usability are therefore assumed to be unproblematic in the organisation, as the system has been used in a real world situation. Even less of a consideration is whether the context of use in the receiving organisations is similar to those where the system is currently being used so that systems transfer can take place with ease.

The case chosen for this research was the introduction of a comprehensive, computer-based timetabling system into a large educational institution. This choice of case study site was made shortly after the initial implementation stage of the project when it was recognised that severe problems were being encountered by several sets of stakeholders. No such problems had been anticipated by the project managers as this application was already doing well in several other similar institutions. The main aim of the research was to gain some understanding of the situation and identify issues that were making the successful generation of the timetable so difficult with the new system. It was therefore decided to adopt a grounded theory method of data collection and

analysis, which approached the study with no preconceived hypotheses and allowed core categories to emerge from data and which could be investigated further. This method could potentially produce original findings and not just verify or reject predetermined concepts.

The paper begins with a brief description of background of the case. It is followed by an explanation of the grounded research method before the data collection and analysis is described. The paper concludes with a discussion of the findings with some generalised implications for organisational managers.

## **BACKGROUND INFORMATION ON THE CASE**

The case chosen for this study was the introduction of a new computer-based system to substantially automate the timetabling process in a large educational institution. The scheduling of the annual timetable of classes in this large educational institution is a complex and time-consuming task. The number of students increases every year while resources are stretched to the limit demanding increasing efficiency in the fit of classes to space and time. Furthermore, class numbers and course offerings frequently change after the timetable has been created to match real-time demand. In order to achieve efficiency with the use of resources and produce an effective flexible timetable a sophisticated scheduling system is required.

In the chosen case, the new computer-based timetabling system had been purchased which promised to increase efficiency and transform the use of both physical and human resources by automating much of the effective timetable processes for classes. The vendors claim that the system was designed to automate all the logistical aspects of the teaching activities of an institution under every conceivable constraint, including the allocation of class space, time and teaching staff. This stated ability of the system led to a decision by senior management to purchase the system in order to revolutionise the running of the teaching program. The senior management and the registrar were also involved in the decision on the mode of introduction of the new timetabling system into the institution on advice from an external consultant. According to the external consultant, who had assisted with the introduction of this system elsewhere, the new system was successfully implemented in other similar educational institutions

In the timetabling process before the implementation of the new system, school timetabling officers would send information of each subject in their school in a spreadsheet form to the institution's timetabling officer. When the new timetabling system was implemented, the school timetabling officers were supposed to be able to enter data directly into the system on class details, resources needed and any special constraints. The timetabling officer only needed to check the consistency of the data from the system instead of collecting and entering data. Once all the data had been entered the institution's timetabling officer would run the system, which would then automatically allocate a time slot and space for all classes in an annual comprehensive timetable.

At the start of the research described below, the new process was underway but had completely broken down in two respects. Firstly, most of the school timetabling officers had found the system unusable and had not been able to enter data correctly. So the previous process had been reinstated with most data entry done by the central institutional timetabling officer who was an expert user. He was eventually given the services of an extra assistant for this. Secondly, when the timetabling function had been run the resulting timetable had so many problems most of which had to be rectified manually is a rush of overtime at the last minute.

## **RESEARCH METHOD AND DATA COLLECTION**

The research approach was a field study, in which a variety of data would be collected through various methods with no preconceived research questions or hypotheses. Using a grounded theory approach has been shown to be suitable for this type of research (Glaser and Strauss 1967; Glaser 1998; Martin and Turner 1986; Strauss and Corbin 1998). It enables the revelation of details within complex phenomena in an organisation when a substantial new system is implemented. It allows concepts to emerge from the data, which are then organised by the researcher into core categories, which are then investigated further through literature searches and, possibly, additional data collection.

The research plan was to collect data through interviews, observations, and relevant documentation. This process for collecting data lasted over a year from mid 2002 until end of year 2003, covering the preparation of both the 2003 and the 2004 timetables. Key stakeholders interviewed were the senior manager responsible for the project, the registrar, the external consultant, the institution's timetabling officer, school timetabling officers, IT system support staff, teaching staff, and students. The majority of the interviews were with the school timetabling officers who were considered as the main direct users of the new system. Relevant documentation was collected from the start of the implementation and included system documentation, user training manuals, instructions to staff and a comparative evaluation of resource utilisation before and after the introduction of this

new system. The researchers conducted the grounded theory analysis by summary, inspection and interpretation of the data.

The study was started shortly after the initial implementation stage of the project when it was recognised that severe problems were being encountered by several sets of key stakeholders. As mentioned previously, the research was planned to collect data through vary methods from mid 2002 to end of year 2003 covering the period of preparing the 2003 timetable to the completion of the 2004 timetable. The data collection was conducted in 4 phases as follows:

- Phase 1: Data collection began with a study of relevant documents and initial interviews with the registrar, the institutional timetabling officer and an external consultant.
- Phase 2: Interviews with school timetabling officers and observations of their work.
- Phase 3: Interviews with senior management, the institutional timetabling officer, academic teaching staff and students. This phase also included the usability tests.
- Phase 4: Follow up interviews with school timetabling officers.

## RESEARCH DATA SUMMARY

This section of the paper, therefore, contains a summary of the case emerging from the collected data, concentrating mainly on the interviews and usability tests with the school timetabling officers attempting to use the new timetabling computer-based system in support of the complex timetabling task.

Despite a small trial with two of the smaller schools in the institution, there seems to have been little awareness of potential problems by those managing the project when they decide to change completely to the new system in 2002 for the 2003 timetable. To begin general use of the new timetabling system, a brief introduction was provided to school timetabling officers in only one session (of about 30 minutes) by the external consultant and the institution's timetabling officer. No actual training was provided to the timetabling officers; instead they provided a manual and list of instructions about the system to the officers, most of whom had no idea about the system when they were interviewed by the researcher.

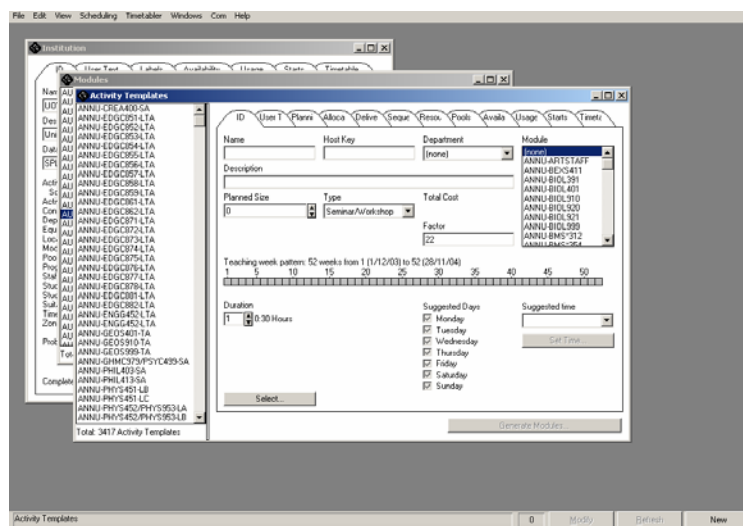


Figure 1: A typical screen of the new timetabling system. Usability tests confirmed that even experienced timetabling officers were confused and could not find desired functions or successfully complete required tasks.

The institution determined a particularly short time frame for the school timetabling officers to input data into the system (see Figure 1) in this introductory year. Consequently, most of the officers could not finish on time because they had problems with the usability of the new system. Most reported that they had attempted to learn to use the system by themselves. There was only one person, the institutional timetabling officer that they could ask to help them to fix the problems. He was the one expert on using the system in the institution, and had to

help more than 20 timetabling officers as well as do his own job. He was not trained to deal with this task and so it was impossible to fix problems for all of them at the same time. However it was due to his long hours of manual effort that the timetable was eventually created.

There were many problems with the first draft of the 2003 timetable produced by the system. As a result, much of the actual timetabling ended up being done by the old the manual process. The need for the institutional timetabling officer to do most of the data entry caused the 2003 timetable to be delayed and some teaching staff could not get the correct information for their subjects in time for the start of session. Many complaints and requests for changes from academic staff were received and school timetabling officers were not able to respond to them promptly. This caused widespread discontent among administrative and teaching staff alike.

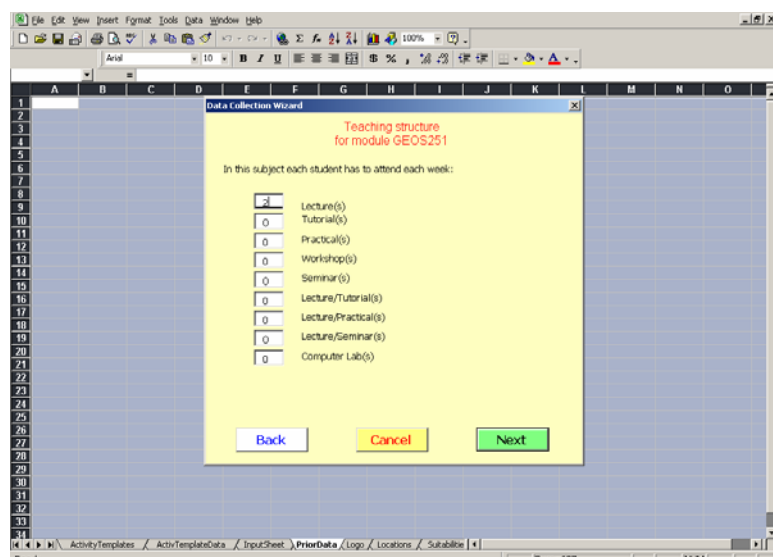


Figure 2: A screen of the simplified software module. Usability testing indicated that users were frustrated that it would not allow them to do anything but enter very routine details of subjects.

The development team, consisting of the external consultant and the institutional timetabling officer had formed a user group to gather information from school timetabling officers' problems and their suggestions. After receiving many comments from the user group, the development team spent unintended time to created a simplified software module (see Figure 2) on top of the system to enable the school timetabling officers enter the data easily. This module provides a step-by-step process for entering data. It occurred to us that other institutions using the system must have also encountered this problem but the knowledge was not transferred to our case.

The timetabling process for the 2004 timetable was somewhat better, because school timetabling officers were becoming more familiar with the job, the process, and the system. They were provided with more training, and given better written instructions, both in the use of the new module that helped them to enter data more easily, and also in some functions of the timetabling system itself. However, there were still problems with the new simplified interface module for data entry and the whole institutional timetabling system. The data entry process is not as straightforward as the step-by-step process would suggest. There is such variety in the way different subjects run and the single simplified interface does not allow users to enter specialised information or other requests for less straight-forward classes. Therefore, the timetabling officers had to provide this sort of information in a separate Word document form. The timetabling system itself does not take into account many special conditions or information, for example, the varied reasons for repeat lectures. The system was programmed on the assumption that lectures were repeated because the class was too large for any available room whereas often the repeat lecture catered for different groups of students, such as, part-time working students or to fit in with off-campus classes. This caused the officers to recheck the timetable drafts many times, greatly increasing their workload.

The main concerns of school timetable officers, who are the main end-users, are that they cannot get their job done on time because of a lack of knowledge and understanding of the new system itself and the whole timetabling process that seems to have changed to meet the constraints of the new system. The change of the process using the new timetabling system has increased their workload while the old process was already working, well from their perspective. Much of the complexity of the timetabling process may still be best

handled by people and indeed are still done by system workarounds. It is generally believed that the system attempts to automate too much of the process that is not as stable and specifiable as the system demands.

## DATA ANALYSIS

Following the data collection, some of which was summarised in the preceding section, the results were subject to a grounded theory process of coding, identification of themes and reduction into main categories. At the end of this process three main contextual factors emerged that appeared to hinder users from using the system effectively to do the timetable work in the organisation.

Grounded theory analysis in this case revealed three inter-related categories that summarise the main aspects of the problem: 'Knowledge Transfer', 'System Capability', and 'Organisational Context'. These three categories advance into the theme 'Influencing capability and thereby organisational performance' (see Figure 3) which is proposed core category in this research. The breadth of these findings is attributed to the use of grounded theory methods in the research which enabled themes to emerge from the data that were not anticipated at the outset. Although a different case or a different analysis of this case may yield different themes, the review key literature confirms that those identified are significant and may be of application to academics and practitioners in the field.

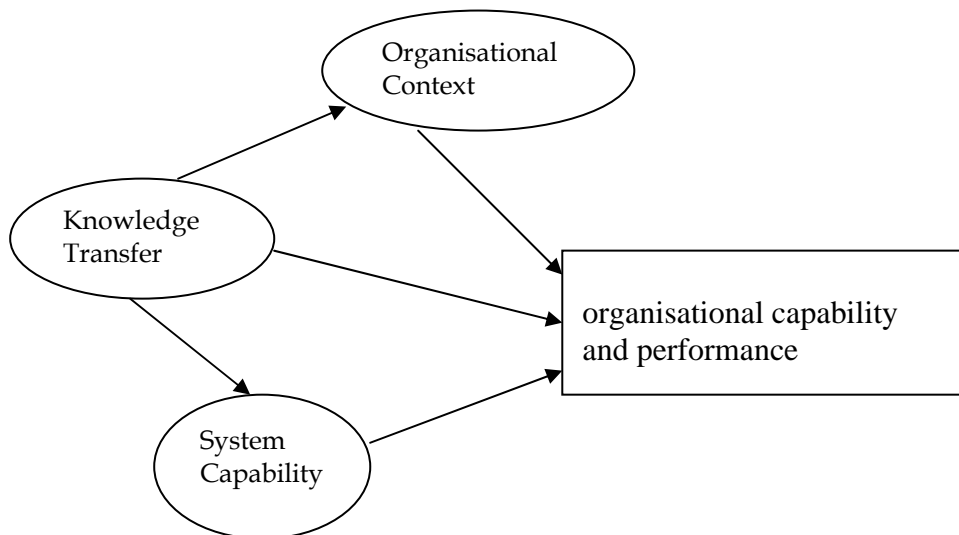


Figure 3: The relationships between t critical contextual factors emerging from the study

These concepts appear to be the critical contextual factors to consider when implementing complex IT-based systems in an organisation. The problems within each aspect will be discussed.

Knowledge Transfer's problems are as follows:

- The lack of knowledge transfer between organisations is a critical issue demonstrated in this case. When one organisation decides to purchase a software application which already well established in other organisations similar to itself, it is not uncommon for those responsible for the project to consult current users for their opinion. Such communication may occur at management level but rarely happens with the end users of the system. It does not mean that the system will transfer easily and implement successfully even with such knowledge. Less of a consideration by management is whether the context of use in the receiving organisations is similar to those where the system is currently being used so that systems transfer can take place with ease.
- The lack of knowledge that transfers between different system stakeholders within the organisation is exacerbated by the lack of communication or even awareness of the need for such communication. If stakeholders' had a better understanding of each others perspectives, a better knowledge of the new system, the purpose of implementing the new system, and the benefits they would receive from the new system, it would decrease their resistance to the new system.

System Capability's problems are:

- The usability of the application software of the new system that being employed to support the job is considered important especially for end users. Users prefer to use software that does not complicate their work and provides a user-friendly interface.
- The system itself should be able to provide a significant benefit to users (both directly and indirectly). Of most concern to users of the new system is the degree of increase in their workload and its potential to make their work more complicated.
- The nature of the task that supported by the new system need to be considered. Management underestimate the difficult of automating the actual task and do not appreciate the complexity of the timetabling system.

Organisational Context's problems are:

- Change in the organisation due to the new system affects the whole organisation but is especially evident at the level of the work unit where the new system is being implemented. The stakeholders would accept change that is driven by the new system if they understood the benefits from this change and if it does not complicate their job or increase their workload.
- The organisation is accustomed to using a command and control approach to management that provides little discretion to other stakeholders, especially the lower level. The staff must accept the decision of the management and are not encouraged to comment. There is little sharing of opinions or information between the management and the staff. This leads to the resistance of the staff or negative attitude towards management resulting in many unauthorised work-practices that employees adopt to get the work done. It is likely that a less autocratic managerial approach would enable more flexible for staff to adjust their work to the new system.

## RESEARCH DISCUSSION

Discussion on these three aspects and their relationships is now presented based on the study together with a selection of relevant critical literature.

The failure of the flow of knowledge together with the highly structured design of the system and the complex and dynamic nature of organisational work were identified as significant issues that resulted in the failure of the new system to improve capability throughout the organisation and hence organisational performance. The data collected and analysed in this case demonstrate this relationship.

The case analysis by means of grounded theory reveals that the core category involving the influence of a new information system on organisational capability and performance is related to three important aspects: Knowledge Transfer, System Capability, and Organisational Context. When an organisation wants to increase performance through improved efficiency and transform itself to be competitive in the business and improve the organisational performance, one of the first alternatives to consider is to implement a new computer-based system into the organisation. Management often assumes that the introduction of a sophisticated new computer-based system used in other similar environments will be a straightforward event and result in noticeable improvements to the performance of the organisation and be highly valued by the organisation.

Organisational performance is commonly evaluated by financial measures such as profit, revenue growth, return of investment, or market share (O'Regan 2002). According to Gautreau and Kleiner (2001), broader measures of organisational performance can be based on the concepts of a balanced scorecard (Kaplan and Norton 1992) and benchmarking which is now widespread as an instrument of managerial practice (Drew 1997; Lee and Choi 2003).

However in the study case, there is no attempt by the institution to set in place any procedure to determine how organisation performance was affected by the introduction of the new system. They put a great deal of effort into the implementation and to push the new timetabling system to become operational without considering the outcome or evaluating the resulting change to the performance of the institution. They assumed that the system would bring improvements but made little attempt to determine whether or not the new timetabling system made it more efficient to produce the timetable and subsequently provide a more efficient timetable.

As mentioned above, there are three main areas where there were deficiencies in the case that appeared to be detrimental to the core category concerning improved performance of the organisation. Lessons from the case in these areas are as follows:

- Knowledge does not transfer easily between organisations especially from one where an application package was apparently already implemented successfully to the organisation in the process of introducing it to support a new system. This case would have benefited from improving the communication between organisations at the managerial level and at lower levels where direct and indirect users of the new software could gain an understanding of the whole system and the problems that encountered by others who had implemented systems using the same software.
- Knowledge transfer within the organisation often does not occur nearly as well as it should. In this case progress could have been improved if there had been better communication between all stakeholders in the organisation so that management and other key stakeholders of the new system were able to exchange knowledge. This would lead to greater understanding between stakeholders during the planning, implementation and ongoing use of the new system.
- The holistic nature of a system is rarely appreciated. It should be consistent with the complexity of the task that is supported by the system. Management in the case did not understand how all aspects of the system inter-relate and interact before implementing the new system and proceed accordingly
- Traditional management tend to employ a 'command and control' approach to managing their organisation. This is no longer applicable as changeable organisational contexts become unstable and unpredictable which affect and are affected by their environment. Modern organisations are too complex for management to believe that they can control situation and everything that happens in the organisation. This situation can be explained by complexity theory and one of its main principles 'self organisation'. Accordingly management needs to consider allowing all stakeholders in the organisation to share ideas and be part of the decision-making on how the system works and have input to improve the performance of the organisation.

The problems observed in this case and categorised by the analysis has been recognised as common issues even in the twenty-first century as explained by Ciborra (2004, p. 17): "When dealing with the deployment and management of complex information and communications infrastructures, managers at the turn of the twenty-first century seem to lack the words to describe, let alone capture, the multiplicity of unexpected consequences, serendipitous occurrences, and emergent, disappointing features of the new technological systems they are busy installing."

These are in line with recent statements made by Baskerville and Land (2004, p.263) concerning the "tacit assumption that the construction of IT-based systems supports and benefits the organisation and that the possibility that the application of IT can harm, and even destroy, the organisation has received far less attention." They further observe: "Any introduction of IS that does not take into account the socio-cultural dynamics in the organisation setting in which it is used has the potential to destroy the organisation it was intended to support (ibid)."

Although this statement is extreme the message is clear and aligned with the findings of the research. This indicates the potential general application of the research findings.

One of the critical issues in the implementation of the new system is knowledge transfer between organisations especially knowledge from where the system is already implemented successfully. Even though the organisations have a similar context of use and there was communication at management and IT staffing levels important knowledge at the user level was not transferred in this case. Management rely on the advice of the consultant who only explained the significant aspects of the system in technical terms and ignored the details of the activities, which it should support. Moreover as each organisation has its own unique context knowledge, thus transfer from outside is not enough to ensure good planning for the implementation of the system in a new organisation. The lack of people to assist all stakeholders with the implementation and the lack of understanding the whole nature of the new system inevitably led to problems in the introductory stage of the implementation.

The senior manager with the ultimate responsibility for the implementation of the new timetabling system had no IS background or experience with IS. The motives for his activities were mostly to improve efficiencies and to save on costs. Therefore management did not have enough knowledge of the activities involved in implementing a new system and how its implementation would affect the existing work activities of all stakeholders. The institutional timetabling officer though conscientious did not have the required skills or personality to deal with the problems people were having with the system although he assumed that role by default. The remaining staff especially the direct users of the new system did not receive the right knowledge in the right form needed to understand the benefits of the new system for themselves and the motives for adoption of the new system. Furthermore, the management ignored all issues of the usability of the application software used for the new system. The software was assumed to be unproblematic, as it has already been used in a comparable real world situation. In fact, usability issues cause problems to the activities of both direct and



indirect users. The direct users suffered from the difficulty of using the software without enough support from management. The indirect users suffered from the faulty assumptions that resulted in the software creating bad outcomes in the form of an unworkable timetable that was vital as a tool for the teaching activities.

The educational institution is a traditional and conservative organisation that normally employs a 'command and control' approach to manage the whole organisation. The management prefer the staff to accept management decisions and follow the procedures set out by management. They do not encourage staff to share opinions or organise the work themselves. Lack of understanding from management about the conditions experienced by the staff and complexity of the task led to resistance from staff in accepting the changes caused by the new system. Allowing staff to self-organise would increase their acceptance of the new systems and probably result in better work practices informed by the staff knowledge of their own activities.

The management want to improve the performance of the organisation by implementing the new computer based system assuming the timetabling activity was a simple routine job and would thus make it easier. However the nature and the processes of the job are more complicated than they thought. It is not simple to implement a system to support a job that is inherently complex without allowing staff to use their knowledge of the real conditions.

## CONCLUSION AND FUTURE DIRECTIONS

The case study described unanticipated difficulties encountered when a computer-based system was introduced into an organisation to solve a complex problem. It was assumed that the implementation of the system would proceed smoothly based on supposed successful use of the system in similar organisations. A research regime of data collection followed by a grounded analysis of the data revealed three categories that could be the source of the problem: failures in knowledge transfer, difference in the organisational context and capability of the system.

Some critical research in each of these areas has been briefly described. Knowledge transfer between organisations and among stakeholders in the receiving organisation can be improved through communication and training. The context of any particular organisation is invariably unique and complex and difference need to be anticipated when the transferring a sophisticated system between even apparently similar organisations. This study raises issues of the degree to which a system can automate complex decision-making processes and the ability of even experienced staff to quickly adapt to new ways of doing their job as demanded by a new system. The management need to consider how to measure the effects of anticipated improvement of the organisation when the new system is implemented. This can assist the management to understand problems and improve the organisational performance that is supposed to be supported by the new system.

Future research could be undertaken not only on each of the concepts in the model of Figure 3 but also on the relationships between them which emerge as patterns of use when a workplace adjusts to a new system in the organisation. The degree of the lack of understanding by managers of the IS implementation process or even the recognition that they needed expert advise in this area was surprising. It could be that organisational managers should value education matters of IS research and practice and this could be a matter both for research and management education.

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