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INFORMATION SYSTEMS AND HOSPITAL WORK: A STRUCTURALIST INVESTIGATION

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Abstract

This study aims to examine the way routine organisational work processes are transformed through the introduction of a new information system in an emergency department. By conducting a 9-month longitudinal case study in one of the major Australian emergency and trauma centres, we investigate the process of organisational work routine transformation in detail. A structuralist investigation perspective based on Structuration theory and the concept of IT duality is adopted to enable a detailed examination of the dynamic interplay between work routine and IS throughout the transformation process. We propose a three-phased development model which facilitates better understanding of the consequences of IS implementation and management by highlighting different transformational focii at different stages of evolution. This three phase perspective is a unique and novel way of analysing the impact of the introduction of an information system in an organisational setting. These findings help introduce a sense of order and actionability into the usually abstract nature of structuralist investigations to produce a detailed picture of how the introduction of an information system can trigger changes in work routines, and in turn, changes in the IS.

Keywords: Work Routines, Transformation Process, Structuration Theory, Longitudinal Case Study

1 INTRODUCTION

To combat the rapidly rising demand for healthcare services, healthcare reforms are currently underway in numerous countries around the world, including the United States, Great Britain and Australia. Hospital Emergency Departments (ED) as the main providers of emergency and trauma care are on the top of most reform agenda. Due to the highly dynamic work environment of the ED and its information intensive nature (Lapointe & Rivard 2005; Currie & Guah 2007), Information Systems (IS) are considered to have a significant potential role in improving ED operations. It is expected that by introducing large scale IS to assist ED operations, significant benefits can be gained in the form of improved operational efficiency, more effective decision making and better quality of patient care. However, a failure rate as high as 91% (Maxfield 2007) is reported for IS introductions in ED. As a result, investigating IS introduction and its impact on the ED has immediate relevance.

Studies have shown that the same technology can induce contradictory consequences such as empowering or deskilling; restricting or liberalising; and power distance reduction or enlargement among staff in even very similar organisations. Consequently, recent studies highlight the need to acknowledge the ability of an information system's introduction to both drive social changes and be shaped by user manipulation (Markus & Robey 1988; Sahay & Robey 1996; Orlikowski 1993; Orlikowski 1996; Ignatiadis & Nandhakumar 2007) which Orlikowski has called sociomateriality (Orlikowski & Scott 2008). The existence of this reciprocal relationship between an IS and its user has made predicting IS impacts challenging (Barrett et al. 2006; Markus & Robey 1988; Sahay & Robey 1996). In order to facilitate better management of Organisational IS projects and achieve more accurate alignment between anticipated and actual IS consequences, a better understanding of the reciprocal transformational influences between the organisation and the IS is essential to any modern industry.

The most fundamental components of any organisation are its work routines (Karsten & Jones 2008). The daily enactment of work routine allows organisations to be built and rebuilt through time, changing and adapting to the environment (Feldman 2003; Ranson et al. 1980; Cohen et al. 1996; Feldman & Rafaeli 2002; Manning 1982; Hutchins 1991). Consequently, studying organisational work routine is essential in generating in-depth insights about the workings of an organisation. Feldman and Pentland (2003), conceptualise work routine as consisting of two main aspects: the *ostensive institutional structure* and the *performative aspect.* The *ostensive institutional structure* is regarded as the collection of deeply embedded organisational knowledge accumulated through organisational history. Ostensive structure guides every aspect of organisational daily practices and unites different organisational actors by providing a set of commonly shared working guidelines. It is seen as the main source of organisational inertia. The *Performative aspect* on the other hand focuses on the daily enactment of organisational practices by different actors. Guided by ostensive structure, but at the same time in reflection of work task environment and users' own knowledge, work actions are performed by the users. It is through this continuous learning and reflection that organisational transformations occur. Hence, work routines are multi-dimensional phenomena, which are dynamic in their enactment by organisational actors in response to past experiences and the current task environment, and at the same time, guided and restricted by a deeper level ostensive structure that can be relatively stable once the routine is established.

This study aims to examine the way organisational work routines are transformed by IS introduction and the flow-on impacts on the nature of the IS. The research question addressed is: **How does the organisational work routine change over time after the introduction of new Information Systems?** For the purpose of this study, we conducted a 9-month longitudinal case study in a major Australian emergency and trauma centre to investigate the impact on organisational work routine following the introduction of an advanced IS. Continuous in-depth observations and interviews were conducted to collect study data and facilitate triangulation of the data. We adopt a structuralist investigation perspective based on Structuration theory and the concept of IT duality to enable detailed examination of the dynamic interplay between work routine and IS throughout the

transformation process. Our findings point out that after IS implementation, organizational work routine transformation starts with a concept identified in structuration theory known as power action triggered by the introduction of new resources. Then as users' IS knowledge grows, users start to adapt through experimentation and moral sanction. The last stage of transformation is focused on the change in the users' interpretive scheme, which is more deeply imbedded in users' mind and is more difficult to change. Once the new interpretive schemes are integrated in users' minds, the deep structural properties of the work routine can start to change and in turn, establish a new permanent work routine. These findings are unique in introducing a sense of order and actionability into the usually abstract nature of structuralist investigations. They produce a detailed picture of an IS triggered organisational work routine transformation process. The three-phased development model we propose facilitates better understanding of the consequences and management of IS by highlighting different transformational focii at different stages of evolution.

This paper first presents a literature review to discuss the relationship between IS and the organisation and highlights the current gaps in the literature that need to be addressed in this study. Key theories, concepts and the research model are then outlined, followed by a discussion of the research methodology, the case description and the findings. Finally we conclude the paper by outlining some implications and contributions to both theory and practice, particularly, some novel insights into how Structuration Theory can be used to understand the rich interplay that occurs between an organisation and a newly introduced information system.

2 LITERATURE REVIEW

A review of the literature identified two main streams of IS-Organisational relationship research. The first stream adopts a deterministic view towards IS-Organisational relationship and regards an IS as a physical object (Poon et al. 2004; Ignatiadis & Nandhakumar 2007; Nowinski et al. 2007; Coombs et al. 1992). These studies usually regard the newly introduced IS as the main driving force for organisational change and the technical functionalities of the system as the main cause of transformation.

In recent years, the second stream of research highlighting the dynamic and reciprocal nature of the IS-Organisational relationship has gained momentum. The second stream of studies stresses the ability for IS to impact the organisational operation while at the same time is itself implicated in the process (Orlikowski 1991; Burn 1989). This stream of studies found that IS's impact on organisation is no longer unidirectional and deterministic. Instead, the relationship between the IS and the organisation is characterised as a reciprocal interplay between the IS, organisational environment and organisational agents (Sahay & Robey 1996; Robey & Boudreau 1999; Pozzebon & Pinsonneault 2005; Crowston et al. 2001; Lapointe & Rivard 2005; Greenhalgh & Stones 2010). By closely investigating the impact of IS across different cases and organisational settings, studies have found that the use of the IS can have local as well as environmental consequences depending on a user's interpretation of the technology (Orlikowski 1992). These findings further confirm the value of the dynamic approach over the determinist approach. Comparing with the determinist studies, acknowledgement of a dynamic IS-Organisational relationship allows researchers to study IS in its entirety, addressing both the technological as well as the informational aspect of the technology. However, due to the complexity involved in empirically investigating the reciprocal IS-Organisational relationship, the existing research is so far mainly concentrated on the exploration and confirmation of the nature of the IS-Organisation relationship. To date, there has been limited understanding about the processes of interaction between IS and the organisation. Two areas in particular have been identified where the literature is very limited:

Firstly the current literature identifies but does not fully explain the dynamic development of the reciprocal relationship between the IS and the organisation . The majority of the existing studies are conducted in a static manner, taking a snapshot of the phenomenon under investigation at one point in time. Such analysis is inadequate in accurately reflecting the causal agency involved in this complex process of mutual adaptation (Robey & Boudreau 1999; Brooks 1997; Dobson 2001). Analysing a

temporal process through a static lens can significantly reduce the reliability of the conclusions reached. As a result, this research uses a longitudinal study to provide a more complete picture of interaction between IS and the organisation. Second, there is a lack of cross-level investigation of IS's organisational impact. Due to the social interpretation of IT, the IS assimilation process is also an event that occurs across all levels of organisations. Consequently this research uses a method that enables us to investigate the phenomenon of interest through an integrated multi-levelled view within the organization.

3 DEVELOPING THE RESEARCH MODEL

We propose a new model in order to effectively study the reciprocal interaction between IS and work routine in a longitudinal manner. Structuration theory is selected to guide the development of our research model. Below we explain how Structuration theory can serve as a useful theoretical lens to understand the formation of organisational work routine and the reciprocal influence between IS introduction and the transformation of work routine.

3.1 Structuration Theory

Structuration Theory was originally developed to explain the constitution of social life by Giddens in 1984. It adopts an interpretivist view of the world and sees social reality as a product of structuration by social actors that does not exist outside of the human mind (Barrett and Walsham 1999). As a result, all social interactions can be analysed in terms of the following structural properties, the structure of signification, domination and legitimation (Giddens 1984; Orlikowski and Robey 1991).

The study of structuring is the investigation of how "action" and "structure" reciprocally configures each other . The concepts of structural duality, actor knowledgability/reflexivity and time and space highlight the dynamic, emergent and reciprocal influences between the "structure" and "action" as shown in Figure 1. Recognition of the interplay between these concepts can help explain the unpredictability of the IS-Organisation relationship, and the possible relevance of Structuration Theory in explaining these relationships.

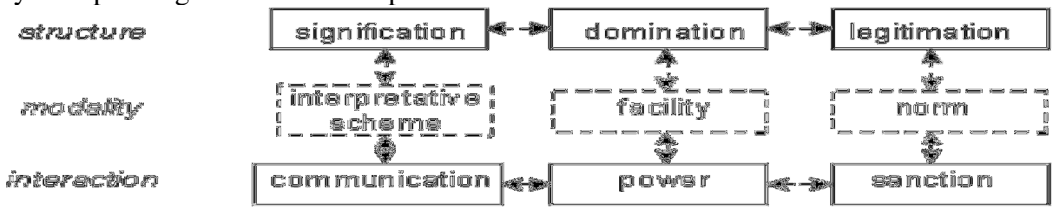

Figure 1. Dimensions of Structuration, Giddens 1994

Existing IS studies use Structuration Theory as a way to escape the determinist tradition and view the relationship between IS and the host organisation from a new angle. Structuration theory offers high level guidance to IS researchers by providing a more clearly defined scope of research. Most importantly it facilitates easier visualisation of the relationship between observable human actions and the abstract deep level structure (Karsten & Jones 2008; Currie & Galliers 1999). It offers an avenue through which IS researchers can start approaching the issue of IS enabled organisational transformation. In addition, the temporal nature of Structuration Theory has also allowed some researchers to explain changes in organisational consequences observed over a research period (Edmondson et al. 2001; Karsten & Jones 2008).

However, Structuration Theory is also widely considered to be a quite challenging theory to use in the field of IS. The reasons are threefold. First, the role of technology is never addressed in Structuration Theory. The lack of acknowledgement of technology in Structuration Theory has prevented researchers from effectively addressing the IS construct during investigation (Riley 1983; Pozzebon & Pinsonneault 2005; Karsten & Jones 2008). Second, Structuration Theory as a meta-theory does not offer any solid propositions and explanations of any specific phenomenon. The abstractness of this theory presents challenges to its adopters in its operationalization in empirical studies (Karsten &

Jones 2008; Orlikowski 1991; Currie & Galliers 1999; Avgerou 2001). Third, conducting studies using Structuration Theory requires extensive resources. The temporal nature of Structuration Theory requires studies to be carried out over an extended period of time to investigate the mutual interaction between action and structure. Such demands are sometimes not practical for researchers to undertake (Pozzebon & Pinsonneault 2005) but have been feasible and appropriate in this study.

3.2 The Transformation of Work Routine

Work routines can be conceptualised as consisting of an institutional structure and an associated action. Consequently, Structuration Theory and its key concepts are found to be useful tools in conceptualising work routine. In line with Structuration theory, the ostensive structure of organisational work routine can be regarded as a part of the organisational structure and consequently analysed through its structural properties. The performative aspect of work routine can be represented by the system of action.

The interaction between the ostensive and performative aspects of work routine allows the investigation of the way work routines are transformed. As shown in Figure 2, this interaction will form a part of the research model guiding the measurement of work routine and its analysis. Due to the fact that the modalities of change represent the rules and means of change, it is depicted in dashed boxes in Figure 2 to highlight their role as the conditions of the relationship between structure and performance. This model highlights the emergent nature of a changing work routine and offers a systematic scheme for studying work routine. This model addresses both the stable and dynamic nature of work routine change on a temporal base.

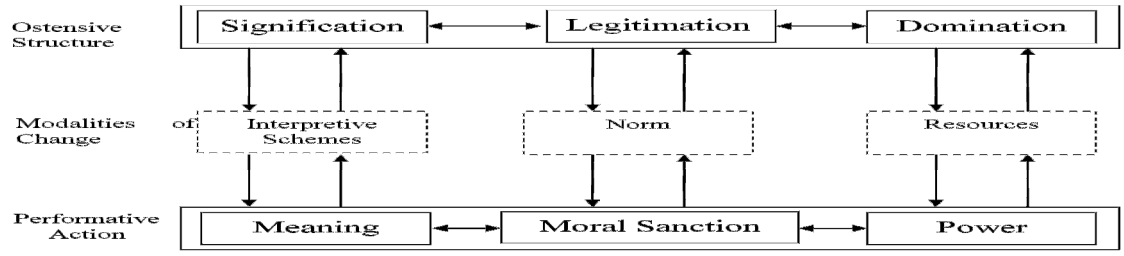

Figure 2. The Transformation of Work Routine.

3.3 The Research Model

IT duality refers to the dynamic interactions between IT and the organisation (Orlikowski 1992) and hence is employed in this study to link the IS construct with the work routine construct to enable an integrated investigation of the IS-work routine relationship as one single event. Combining the theories and concepts discussed above, IS can be examined through the modality of structuration in the investigation of the reciprocal relationship between IS and the work routine. Building on the transformation of work routine as illustrated in figure 2 and the concept of IT duality, the research model is shown in figure 3. This research model is constructed by combining the concept of IT duality and the transformation of work routine. The introduction of IS is represented by linking the new IS construct with modalities of structuration to represent its interaction with organisational work routine.

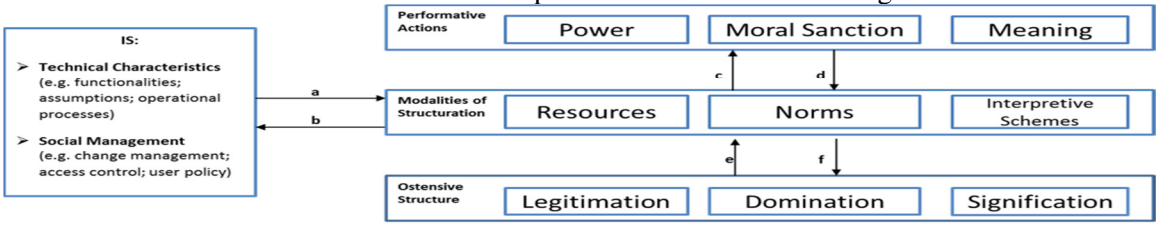

Figure 3. The Research Model Developed by Combining the Concept of IT Dualtiy and the Transformation of Work Routine Model

The model in Figure 3 shows us that in general, IS's influence on the structuring process of an organisation stems from its technical characteristics as well as its social management within the organisation. In terms of technical characteristics, IS can alter modalities of structuration through its functionalities, assumptions and operational processes embedded in its technology by the developers as represented by arrow a. Through its different functionalities, embedded assumptions and operational processes, IS has been found to have the potential to provide a new system of reality representation (Barley 1986; Madon 1992; Robey and Azevedo 1994; Walsham 2002), act as a new set of resources for redistributing or reaffirming power relationships (Barley 1986; Robey and Azevedo 1994; Walsham 2002) and control the behaviours of the actor to solidify or modify the existing system of legitimation (Barley 1986; Coombs et al. 1992; Madon 1992; Robey and Azevedo 1994; Doherty and Perry 2001; Walsham 2002; Doherty and Doig 2003) .

In addition, the social management of IS within the organisation can also have a direct impact on how IS interacts with organisational work routine and practices (arrow a). For example, an organisation's change management practices can directly impact how the IS is perceived by its users (Au and Enderwick 2000; Boddy et al. 2009); the access control and user policies put in place can also shape the distribution of IT as resources and the norms regarding the use of IS (Sahay 1997; Kreuser 2007; Uzoka, Shemi and Seleka 2007). On the other hand, changes/persistence of the modalities of structuration also influence the IS's technical characteristics and management (arrow b). The deep-seated organisational norms and interpretative schemes have been found to transform the usage and management of new IS in a way that is not anticipated by the adopters (Volkoff, Chan and Newson 1999; Walsham and Sahay 1999). By impacting the modalities of structuration, IS can consequently exert influence on human actions (arrow d) as well as work routine structure (arrow e). Meanwhile, Ostensive structure and performative action's influence on the modalities of structuration (arrows f and c), can indirectly impact IS's technical characteristics and management (arrow b). This research model will be used to understand the findings in the case study which follows.

4 RESEARCH METHODOLOGY

This study is exploratory in nature. A longitudinal single case study approach is adopted to answer the proposed research question. Through a series of semi-structured interviews, casual interviews, observations and documentations, qualitative data was collected to help triangulate the study findings and improve study rigor. This study was carried out over a period of 9 months, in one of the major emergency and trauma centre in Australia which will be referred to as ED-A in this paper. This case study tracks the introduction of an advanced emergency department information system (EDIS) in ED-A and its impact on work routine and explores the findings through the lens of structuration theory. As one of the first hospital departments in Australia to attempt to go completely paperless through EDIS, this study site offers revelatory insights and is an ideal environment for the investigation of interaction between the new system and the organisational work routine. The case study was structured into 4 main phases, starting April, 2010 and finishing December, 2010. The field study was scheduled to enable in-depth investigation of the work routine change through time by overlapping the main investigating phases. The concurrent occurrence of the observation, interview and validation phase enabled iterative adjustment of the research strategy on an ongoing basis.

After analysing the department's operation and the nature of the IS project, three main work roles were selected as the research focus. As the backbone of the ED, the Duty Consultant (DC), Resuscitation Consultants (RC) and the Floor Coordinators (FC) are chosen to be observed and interviewed throughout the investigation period. They were randomly assigned pseudonyms Dr A- Dr. M and Nurse A – Nurse G. The main reason behind the selection of these three work roles lies in their central importance to the operation of the ED. As senior consultants and nurses, they are a small group of medical staff who are permanently based in the ED, while the majority of other junior medical staff is usually rotated out every three months. Their permanent position within the department means they are the main carrier of organisational routine, structure and culture. Their action and belief has significant long term organisational consequences. These senior consultants and nurses are directly involved in the education of the new staff, and their behaviour is commonly used

as key reference points by the new staff while adapting to the ED work. In total, all senior consultants (17) and floor coordinators (10) were observed during the 9 month period. All full time senior consultants (13) and the majority of frequently observed senior nurses (7) were interviewed.

Two different kinds of interview techniques were used to gather direct feedback from the medical staff and validate the interpretations and study findings. During the interview phase, semi-structured interviews were carried out to directly gauge staff opinions. Overall 20 interviews were conducted to cover all full-time senior consultants and the majority of FCs. Each interview lasted from 20 minutes – 1 hour in length. The interview protocol was used as a guide to ensure the coverage of the main research constructs. The actual interview questions were tailored to each interviewee according to their role, background and work preferences that the researcher was able to learn during months' of shadowing. Findings generated during the observation also inform the development of interview questions to explore issues that were not anticipated in the research model. All these interviews were recorded and transcribed by the researcher for further analysis.

5 CASE DESCRIPTION

As a major public emergency and trauma centre, our study site provides medical care to the highest acuity emergency patients in its residing state and is currently treating more than 55,000 patients annually. The recent years have seen a very heavy rise in emergency care demand which put the ED-A under heavy performance pressure. It is estimated that by 2015, ED-A will have to provide treatment to more than 64,000 patients annually. In order to cope with the ever growing service demand, an advanced suite of EDIS was introduced to the department in an attempt to digitalise the ED operation and build a more efficient, accurate and safer emergency department.

This suite of EDIS incorporates a wide range of functionalities covering virtually all aspects of ED operation. When fully assimilated, this suite of IS will enable the realisation of a fully computerised, paper-less department. The entire EDIS introduction project includes a complete revamp of the computer hardware infrastructure within the department as well as the rollout of a series of software systems. In terms of software, 4 main system modules are included in the EDIS suite. At its heart is an electronic medical record (EMR) system that supports clinical, administrative and clerical operations in the ED by enabling information collection and accessing at the point of care. Its main functionalities include patient administration, triage and tracking; clinical documentation and nursing notes; electronic ordering and prescribing; decision support and conditional data collection and electronic discharge summary and patient advice letters. In addition to the EMR system, a hospital administration system, results tracking system and picture archiving and communication system are also working concurrently with the EMR to facilitate the operation of the department.

In order to facilitate easy system access for the ED staff, a new computer infrastructure was also introduced. Computer terminals were installed in every cubicle, while the trauma bays were equipped with 2-3 computer work stations to enable concurrent access to multiple systems. In addition, work bays with multiple computer terminals were also strategically placed along the corridor and in the ED control areas. The distribution of the computer infrastructure is made to enable near ubiquitous access of the EDIS anywhere in the ED. Given the new system's aim to computerise the entire ED operations, ensuring timely access to computer terminals is critical to the ED work flow.

The system was implemented through a phased approach. The computer infrastructure was implemented by the end of September 2009 and the software modules started to be rolled out around November 2009. The users were offered training sessions before system rollout, and ongoing on the floor support and training were provided during the first week of system implementation. On the go-live day, all users were required to conduct their work using the new system implemented and the old manual system were kept as a backup system in case of EDIS failure. The initial rollout had the biggest impact on the doctor's work processes as they were required to switch away from manual note taking, test ordering and patient management activities they were used to doing for decades and start to complete these tasks electronically. The resulting confusion and dissatisfaction caused significant

drop in ED-A's operational efficiency, which lasted for a few months. The nursing modules were introduced several months later to avoid overwhelming the department and allowing better management of system assimilation.

6 STUDY FINDINGS

Our longitudinal case study of the interaction between the newly implemented IS and the work routines in ED-A yielded some interesting findings and effectively highlighted the dynamic relationship between IS and the organisation. By continuously tracking changes in the EDIS and the work routines over a 9 month period, we collected and analysed our data guided by the research model. Comparing the data across the entire investigation period, we find that we can use the lens of Structuration Theory to categorise the work routine change process into three main phases with different structuration activity focii. We term the three phases resource evaluation phase, experimental adaptation phase and structural realignment phase.

The growth in users' IS knowledge and capability drives the progress of IS-work routine structuration. The first Resource Evaluation stage is triggered by initial resource redistribution. It forges users' attitude toward the new system as the users evaluate the new resource set against their original domination structure and personal preferences. Given they have little understanding of the new system, user reactions are largely exercised through the extent of their system utilisation. Complex adaptation behaviours were not observed in this phase.

As users' system knowledge accumulates, they gather enough confidence to actively manipulate the system's functionality and forge new work processes. This signals the arrival of the experimental adaptation phase. The experimental adaptation phase focuses on the development of new work norms through mutual adaptation between the IS and the user. In this phase, users experiment with different approaches to working with the new system and slowly develop a set of acceptable norms shared within a work group. However, in this stage, the limited integration of interpretive schema is still a major source of adaptation volatility.

Finally, as the users' experience with the new system builds up, their interpretive schemes start to adjust and converge in response of the new working environment. The transformation of users' interpretive schemes signals the arrival of the structural realignment stage. In this phase, the development of organisational wide interpretive schemes facilitates the realignment of deeply embedded work routine structure. It in turn solidifies IS's integration into daily work practices. The following section discusses each of these phases in detail. The arrows depicted in each phase are labled in reflection of the Research Model.

6.1 Resource Evaluation

The resource evaluation phase is the first stage of the IS enabled work routine transformation process. Our observation and interview data suggest that it can be characterised as resource driven, dominated by power actions and individually oriented. The structuration process between work routine and IS is depicted in figure 4.

During the early stage of investigation in ED-A, observations of frustration and dissatisfaction triggered by the absence of old resources are the most visible consequences of EDIS introduction. Due to the installation of work stations, introduction of new work processes and altered information distribution, the most direct impact on the organisation of the EDIS is through resource redistribution (arrow a). Unlike new norms that are embedded in the EDIS which is largely flexible and hidden, resource redistribution explicitly signals the coming change and leaves little room for interpretation by users. Consequently, the newly installed resource conflicts with the old domination structure embedded in the ostensive structure of the work routine (arrow f). For example, as observed in the first month of investigation, the consultants frequently attempted to access old paper forms and department overview maps that have been replaced by the new EDIS to conduct their work. The

removal of these old resources have physically prevented them from retreating to old work routines and enforced changes introduced by the EDIS. This redistribution breaks the balance in the work routine structuration process and triggers work routine transformation to achieve a new equilibrium (arrow d).

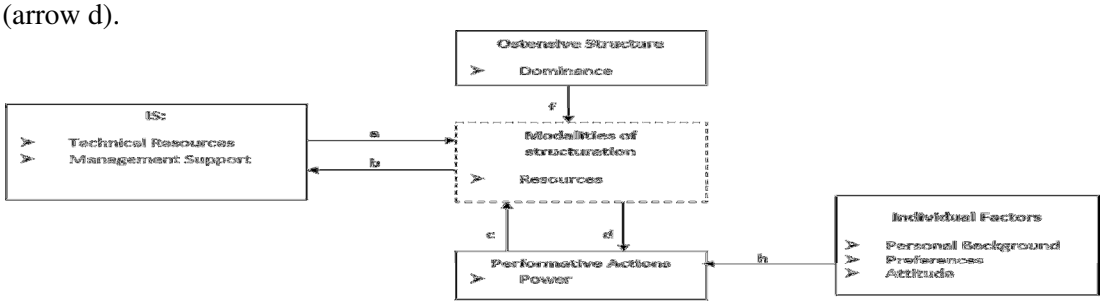

Figure 4. Transformational Process of the Resource Evaluation Phase

Faced with this conflict between the old and new, power actions such as resistance, acceptance or active learning were widely used by the ED-A medical staff in response to the change (arrow c). However, it is interesting to note these responses are individualised and vary widely. Depending on individual user's background, preferences and attitude toward the new EDIS, different ED-A medical staff reacted differently (arrow h).

On power action, resistance is usually demonstrated through doing the bare minimum and consequently compromising the information accuracy, as well as reducing work performance in order to trigger another redistribution of resources in their favour. As one of the interviewees heatedly declared during interview:
"…I'm happy to do it in terms of accuracy and transparency. But don't expect us to perform at our current level…The whole system has to change…"

Acceptance is another main form of power action, which is performed by submitting to the power of change. Despite being senior consultants within ED-A, a number of study targets expressed their feeling of powerlessness in the face of EDIS introduction. Comments like *"you just do it"* and *"we were never given an option"* were frequently uttered during interviews. Active learning on the other hand was observed from some young and tech-savvy doctors who proactively studied the new system and promoted EDIS assimilation within the department. They believe that *"it is the right way forward"* and *"change is a part of our work"*.

In response to the power action displayed by ED-A staff, the management team of EDIS also exercised their own power to stabilise the situation (arrow b). Meetings were carried out to firmly convey the message that EDIS is here to stay and hospital executives' support was frequently quoted to highlight the strong political backing of EDIS introduction. Under these combined efforts, resistance actions were not able to effect any significant changes on EDIS (arrow c) in this stage.
In the Resource Evaluation stage, the ED-A staff evaluate the new system and formulate their response individually based on the impact of the EDIS has on their work. Few sophisticated adaptation behaviours were observed as few users have enough knowledge about the new system to facilitate user adaptation. Power actions however have the potential to derail the project if enough users take on the resistance stance and overpower the support of the project. In ED-A's case, the resistance is isolated to a very small group of medical staff and the EDIS was accepted in general. As the Resource Evaluation stage progresses through time and the users' individual understanding about the system starts to accumulate and they converge as a group, the work routine change process moves to the next phase, experimental adaptation.

6.2 Experimental Adaptation

Experimental adaptation is termed to highlight the dynamic mutual adaptations and transformations that happen during this structuration phase. As shown in figure 5, this phase is centred on the conflict

and integration of the original work norms and the new norms embedded in the IS (arrow a). With increased understanding of the new system and norms, ED-A's medical staff were observed to experiment with different approaches to adapt to the changed environment from the third months of our investigation. The old norms of work routine were still strongly supported by the legitimation scheme deeply embedded in the traditional work routine structure (arrow f), while the new routine were facilitated and enforced by the EDIS introduction team and hospital administration through policies, support and training (arrow a). Unlike resources, the new norms cannot be physically implanted into the peoples' mind, hence, it is up to the users as knowledgeable agents to learn and adapt according to their own schedule. This results in the co-existence of two sets of norms that simultaneously influence the moral sanctions enacted and received by different organisational agents (arrow d). Meanwhile, we also found that moral sanctions at this stage are under the influence of group and individual characteristics such as personal capability and group attitude (arrow h), especially at the early stages of the structuration phase.

This phase of work routine structuration is driven by the users' continuous efforts in *"making the best of the situation"* and *"make the system work for you"*. In the process of this adaptive structuration, boundaries were pushed regarding the EDIS's flexibility and the management's tolerance (arrow b). EDIS's functionality and work processes were modified several times during observation following negative consequences resulting from unexpected misuse of the system. Meanwhile, some cases of user adaptation were also reprimanded by the management to maintain the new work norm. Throughout the investigation period, loopholes in the EDIS were continuously explored to develop shortcuts and workarounds as illustrated by consultants' adoption of documentation shortcuts. Some of the resulting new work processes spread among the medical staff and formed new work norms that were implicitly accepted by the management. This set of transformational process discussed above can be clearly illustrated through an event observed in ED-A, which can be called the "Admission Data Error Incident".

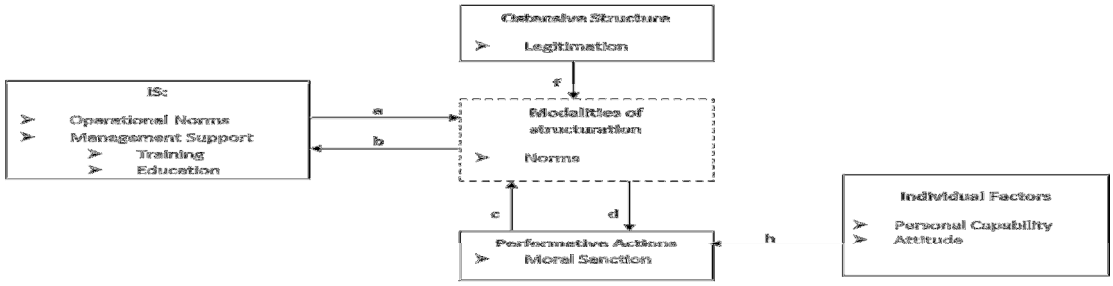

Figure 5. Transformational Process of the Experimental Adaptation Phase

6.2.1 Admission Data Error Incident

At the beginning of the experimental adaptation phase, the senior consultants reluctantly accepted EDIS under heavy management pressure. They frequently expressed their feelings of powerlessness through comments like *"you just do it"* and *"we were never given an option"* during interviews.

With this reluctant attitude, the consultants set out to work in the new environment to their best abilities. One of the key challenges they had to deal with was the increased documentation work that was originally completed by the clerical staff in the department. Under EDIS it is now the responsibility of the consultants to classify each patient case into different government-specified condition categories. Despite them being senior medical doctors, they were not familiar with the formal government classification scheme. As a result of the reluctant attitude developed earlier, instead of going into detail and finding the most appropriate category to assign each case to, consultants were observed to choose the one that is the most broadly applicable. At this stage, the consultants still regard data collection as a trivial task. The quality of clerical data collected was not given much thought. Such adaptations received no negative feedback. The lack of negative feedback reinforced this set of work practices in ED-A which promoted the further spread of the behaviour.

Consequently, over time this shortcut adaptation spread among the consultants and became a commonly accepted practice. Due to consultants' supervisory and educational role in the department, this practice was then picked up by the junior doctors. The attitude of "*just tick the easiest box*" became a widely accepted workaround when faced with unfamiliar documentation tasks introduced by EDIS.

One of the unfamiliar documentation tasks junior doctors encountered is the classification of admission status for each patient case. Due to the complexity involved in the classification criteria, only a number of senior consultants fully understood the process. In addition, with admission classification being a key piece of data determining the amount of funding received by ED-A, consultants were responsible of classifying all cases in the pre-EDIS era. However, in the post-EDIS department, the responsibility of classifying the admission status of patient cases was distributed to all ED-A medical staff members including the junior doctors. By ticking a simple yes or no tickbox at the bottom of the patient discharge screen, the computerised process directly lodges the data without requiring any input from the consultants.

The lack of sufficient admission classification knowledge prevented the junior doctors from accurately assessing the status of each patient case. As a result, in the beginning, non-admitted cases were often classified as admitted. However since all admitted cases have to be double checked by the medical records department, all mistakes were picked out and complaints were made against the junior doctors. In response of this negative feedback, the junior doctors adopted the "*just tick the easiest box*" attitude. As recounted by one of the consultants during the interview about this incident:

"Very few people understand the DHS government admission criteria. In the old system, although we have the computerised system, at the end of the day before the history went down, it still relies on the consultant to manfully check the histories to ensure that the patient will fulfil admission criteria or not. We require manually check because the information is hard to know. We've now moved away from the manual check, it's now completely automated, so if the doctors don't understand or don't care about the admission criteria, they just hit no." (Dr. M)

Such practice went on for months and it was only picked up through a random audit eight months after EDIS introduction. As a result of this workaround, ED-A's admission data became seriously corrupted. The audit showed that over 10% of the data were inaccurate as compare to the error rate of about 1% in the pre-EDIS era. It was estimated that over 6 million dollars in funding were lost due to the miss-classification. In order to rectify the issue and recuperate some of the lost revenue, ED-A applied for data resubmission and was granted 14 days to resubmit two months' worth of data. In order to meet the deadline, over time were paid to all senior medical staff members to reclassify over 6000 patient records; the normal activities of the department were consequently disrupted. Despite their efforts, only 1 million in revenue was recovered.

As demonstrated by the Admission Data Error Incident, the experimental adaptation phase is found to sit between the individual and group level. Initially, most of the adaptations are individually based, resulting in increased confusion, frustration, reduced work efficiency and increased work load. Overtime, some adaptations spread onto the group level to form a collective norm as experiences were exchanged within the work groups. In this stage, IS management plays a very significant part in the formation of appropriate work norms. Without effective supervision, some users' unsolicited adaptations can develop into common practices and have severe consequences as highlighted in the admission data error incident.

Furthermore, in the experimental adaptation phase, the integration of the interpretive schemes is still lagging behind. As observed, the majority of the adaptation behaviours are based on the old interpretive scheme, which consequently results in actions that are in conflict with the new working conditions and requirements. In fact, the lack of integration in interpretive schemes is one of the main causes for inappropriate adaptation. In the case of the "Admission Data Error Incident", the doctors' inability to change their interpretive schemes about their work triggered a series of adaptations that lead to a multi-million dollar loss. Their old legitimation scheme regarding the importance of clerical work drove them to develop the "*just tick the easiest box*" shortcut when faced with increased

documentation load. This event highlighted the difficulty in changing the interpretive schemes of the organisational actors.

6.3 Structural Realignment

The structural realignment stage is the phase where new work routine gets institutionalized into the organizational structure through realigning the ostensive structure of the work routine as depicted in figure 6. In this stage, with continuous learning and experimental adaptation, the new set of interpretive schemes is finally able to gradually replace the old interpretive scheme (arrow a) to reflect the changed work practices. In ED-A, during the first 5 months of investigation, confusion was observed frequently caused by the medical staffs' different interpretations of various symbols, signals and events. The introduction of EDIS and the consequent adaptation has given rise to a new set of acronyms, jargon and signals that were brought in by the system and further developed by users to cope with changes in work routine. These new systems of interpretive schemes were initially shared within small work groups such as the triage nurse group, ED assistant group and consultant group etc. as highlighted in this quote by a senior nurse.
"I cheat, I use shorten(sic) form. Hopefully the organisation will accept the abbreviations."

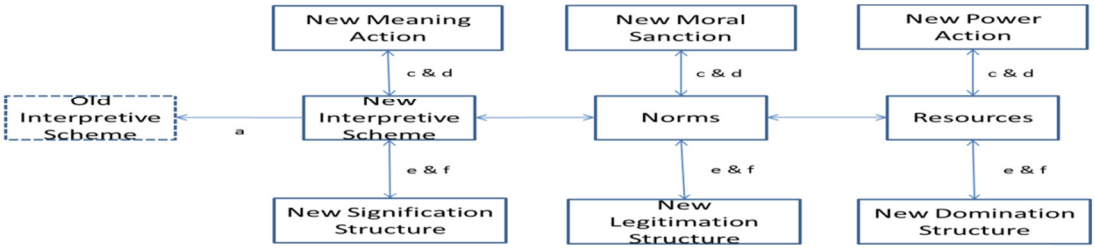

Figure 6. Transformational Process of the Structural Realignment Phase

Such fragmentation in interpretive schemes leads to inter-group miscommunication in an environment where communications are heavily dependent on jargon and acronyms for quick information delivery and processing. Through time with continuous communication and knowledge exchange within ED-A, these fragmented interpretive schemes were found to gradually converge on the organisational level and a unified interpretive scheme was developed. As a result, occurrences of miscommunication were observed to decrease as time goes on. As another nurse put it:
"…the information I need is still there… maybe they just become more efficient at writing chest clear and abdomen soft… And I think they may be become more succinct in what they do..."

As the user's standard of interpretation develop and change overtime, an increased alignment and equilibrium can be achieved between the new set of actions and modalities (arrow c & d). As a result, the deeper level changes in the ostensive aspect of work routine can occur (arrow e & f). Changes in work perception, work practices, as well as the organizational hierarchy will become embedded in the organizational structure and have long lasting impact in the operation of the organization. In ED-A, the introduction of EDIS caused a significant long term shift in the medical staff's work perception. The data driven nature of EDIS and the new norms of operation changed the ED-A medical staff's work focus from face-to-face patient care to patient throughput and data collection. As exemplified in the following quotes by a nurse:
"I have become more robotic, become more conscious of your statistics, and your throughput more than ever."

Meanwhile, the EDIS introduction also shifted the domination structure of the ED-A. EDIS enabled real-time access to work progress by senior medical staff and department administrators and so increased the power of the managers. The feeling of constantly being under scrutiny was common among the medical staff:

"…now that the information is available in real-time that does mean when I'm in charge, someone like x can also see what I'm seeing. And there is an increased level of scrutiny if you start falling behind a bit…"

7 IMPLICATION AND CONCLUSION

Overall, our findings have confirmed that the organisational consequences of introducing a new IS are inherently unpredictable. In the case of ED-A, the introduction of the Emergency Department Information System (EDIS) caused several unexpected negative organisational consequences such as decreased operational efficiency, higher work load and decreased clinical time. The functionality and operational protocols of the EDIS itself were also altered in response to user influences. Such unpredictability highlighted the importance of understanding and controlling the development process of IS and appreciating the broader consequences. By tracking the evolution of work routine and EDIS via a structuralist perspective, we discovered that the interplay between IS and organisational work routine evolves over time through resource evaluation, experimental adaptation and structural realignment. Each structuration phase focuses on different structuration activities across different levels of the organisation. This three phase perspective is a unique and novel way of analysing the impact of the introduction of an information system in an organisational setting.

These finding provide implications for practitioners and researchers in the future:
From the practitioners' perspective, IS projects need to be managed from three key angles instead of seeing an IS as an objective entity, disconnected from users. To control IS's influence on the adopting organisation, the introduction of new resources, the implementation of new work processes and development of new interpretive schemes need to be carefully managed as they are the main entry points through which organisational changes are triggered. When managing the physical implementation of the system hardware and software, care has to be taken to ensure the resulting resource reflects the dominant structure the organisation is aiming to achieve.

The work norms that are embedded in IS also need to be scrutinised to identify any misfit between the new work process, user capability and user work preferences. Processes and tasks that require significant learning by the user will drive the development of shortcuts and workarounds, sometimes to the detriment of work quality. As a result, training and support need to focus on the most challenging aspects of the new process to facilitate the integration of new work processes. Finally, the embedded system of interpretation that is required to support the new operation also needs to be carefully examined. The development of an isolated group level interpretive scheme is found to be commonplace during user adaptation, but management need to consciously monitor the development of different interpretations and communication standards in the organisation to avoid confusion and errors. In order to effectively control the organisational consequences of introducing a new IS, these three aspects of IS introduction need to be closely monitored and managed well beyond the conclusion of conventional IS projects. Unexpected changes in work routine can happen months after the initial system introduction as in the case of ED-A.

This study provides both theoretical and practical contributions. In the field of organisational IS studies and health informatics, this study provides insights into the intricate interplay between the organisation and the IS. The phased model of structuration transformation provides a more concrete view of a phenomenon that has so far been studied rather abstractly. Practically speaking, this study highlights the dynamic actions that occurs within the organisation following IS introduction and offers actionable suggestions for improving IS management.

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