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Theoretical Framework for Mapping Information of Social-Technical Processes: A Case of Operating Theatre Waiting List Management Process

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ABSTRACT

This paper develops a theoretical framework for mapping the social-technical process and in specific the Operating Theatre Waiting List process. It uses the technique IDEF0 and employs coordination theory and Sociotechnical systems theory. It concludes that the developed theoretical framework is useful for redesigning social-technical processes particularly those of the Operating Theatre Waiting List's.

The motivation for this research is to find an effective information mapping tool that can provide a valid platform for evaluating different OTWL scenarios to enable the most applicable design to be selected. It is hoped that with better design of information flow that allows effective coordination of activities of the OTWL process, the quality of healthcare will improve.

INTRODUCTION

A process can be described as a series of interdependent actions or activities embedded in a structure (Biazzo 2002). There are two aspects to a process; the social aspect and the technical aspect. The principle that a process is based on a combination of two aspects gives rise to the sociotechnical concept. (Biazzo 2000; Fernandez et al 2001). The sociotechnical system (STS) is a systems based approach for process analysis and redesign (Fernandez et al 2001). The technical subsystem comprises of the structures, tools and knowledge necessary to perform the work which produces the products (Fox 1995). The social system includes attitudes and beliefs, contracts between employers and employees, reaction to work arrangements and the relationships between individual and among groups (Pasmore & Sherwood 1988). The Operating Theatre Waiting List (OTWL) process is a constructive example that fits the conception of STS in the sense that it is not just a group of activities but is multi-dimensional and better conceptualized as a set of interacting issues (Foote, North & Houston 2004).

The previous studies of OTWL mainly examined the technical aspects of the process with a few mentioning but not taking into account social factors or vice versa. An example would be the project that NSW Health had employed KPMG Consulting to obtain processes and practice information on managing operation theatre (NSW Health 2002). They have only managed to identify and come up with a very general framework detailing the process involved in the OTWL process, and the problems are not resolved. Therefore, a sociotechnical approach will be a more comprehensive and ample portrayal of the actual system.

To understand what goes on behind the OTWL process, there is a need to map its physical activities besides information flow. Process mapping is a technique used to detail business process's activities by focusing on the important elements that influence the process activities (Soliman 1998). It is used to re-engineer or improve a system. To successfully map a process, we need to go beyond the detailing of each activity in the process. What is required is that we should comprehend what constitutes an activity: the elements of an activity as well as seeing it from a sociotechnical viewpoint.

The importance of such mapping stems from the fact that it allows the interaction and interdependencies between these elements to be mapped and hence provides a better understanding of the dynamics of OTWL process.

OTWL as a Sociotechnical System

The process mapping of the OTWL system should show the relationships between the activities, people, data and objects (patients) involved in the production of a specified output. However, as already mentioned, the previous process mapping studies mainly examined the technical aspects of the situation with a few mentioning but not taking into account social factors. The reason why OTWL is an ideal example of a STS can be seen in some of the issues highlighted that showcase the social aspect of OTWL process:

- The behaviour of the object (patient) is not predictable and it varies: this has been found from the case study with a hospital. An example would be patient's cancellation of surgery at the last minute are very common, resulting in much waste of resources and have to reschedule the patient thus causing further delay.
- Surgeon effectiveness variability: It is hard to measure how effective surgeons perform each and every surgery because every surgeon differs in terms of skills and expertise. Effectiveness is using a skill in a way that raises the probability of success. Effectiveness here could be measured in terms of success.
- Variability of the degree of success of the operation: The success of the operation is hard to determine before the operation because of reasons like variations in patient's condition which cannot be fully assessed until a surgical procedure is under way.
- Variability of surgical time: the resultant unpredictability of surgical time renders difficult any attempt at precision scheduling of theatre lists.

Therefore, the OTWL process is a constructive example of a sociotechinical system.

As part of sociotechnical systems, each activity of OTWL process has additional elements other then input and output. These additional elements are the resources including information necessary to perform the activities and the rules that govern the activity's implementation.

The next sections cover the discussion of the Operating Theatre Waiting List, the research question as well as the theoretical background.

OPERATING THEATRE WAITING LIST

Waiting times and waiting lists are important issues for health care. They are used by politicians as the measure of success or otherwise of government action on the health services. Specifically, Operating Theatre Waiting Lists (OTWL) are of great concern in society nowadays because of their societal and political priority, their potential link to the quality of individual patient's life, relation to the economic management of operating theatres and management of patient flow through the hospital and distribution of scarce medical resources (Al-Hakim & Fitzgerald 2003).

Long waiting times are a problem for patients not only because of uncertainty but also because the state of the patient may deteriorate if not treated early enough. Short waiting times generally indicate that there are fewer problems in accessing care (Council of Europe 2005).

The operation theatre waiting list management process involves scheduling patients waiting for surgery conducted in hospital theatres (Buchanan & Wilson 1996). Generally decisions about theatre lists are entered in multiple patient records, by a number of staff and officers who do not always communicate their independent actions. This is not helped by the fact that there is difficulty in arranging meetings with all the specialists who are very busy people with over crowded schedules (McAleer et al, 1995)

Once the list has been drawn up, it is still vulnerable to multiple alterations and modifications for reasons like:

- Accommodating emergency cases which are given priority
- Unanticipated variation in the patient's condition only known during the surgery
- Unpredictability of procedure's length of time (Buchanan & Wilson 1996).
- Unanticipated variations in the time of patients stay in the recovery ward (Healthcare commission 2005).
- Cancellation of operations on the day of intended surgery. (Schofield et al 2005)

Typically, OTWL can be classified into two categories; elective and non-elective. Under elective surgery, there is day surgery and more than one day surgery. Day surgery takes place when a patient is admitted to hospital, has surgery and is discharged on the same day, without having to stay overnight. There is a wide range of non-emergency surgical operations that can be carried out as day surgery and this has considerable advantages for patients as well as the hospital (Health care commission 2005). The British Department of Health's NHS Plan (2000) set a target that 75% of elective admissions should be day cases (Healthcare commission 2005). There is no such target in Australia but it is recommended that more surgeries can be set as day surgery.

With so much importance being placed on the operation theatre waiting list, efforts have been made to try to map out the processes in order to facilitate the development of optimal practices for improvement, redesigning the process and benchmarking (NSW Health 2002). However, this research finds that most of the previous studies employ traditional mapping process tools do not adequately map information flow as well as the interdependencies between elements of OTWL process's activities; therefore, they are not suitable enough for mapping information and hence for the redesign or effective improvement of the process. This research aims to employ a suitable process mapping technique for OTWL management process and investigate the flow of information and the interdependencies across the activities of the Operating Theatre Waiting List (OTWL) management process.

RESEARCH QUESTION

The paper aims to answer the following research question: 'How can the flow of information and the interdependencies between the elements of the activities of the OTWL process be identified and mapped for the purpose of process reengineering?'

From the research question, the following sub-problems are drawn:

- What are the elements of each activity of OTWL?
- What are the relationships and interdependencies between the elements of the OTWL process's activities?
- How can the information flow between OTWL activities and their elements be mapped and structured?

The motivation for this research is to find an effective information mapping tool that can provide a valid platform for evaluating different OTWL scenarios to enable the most applicable design to be selected. It is hoped that with a better design to coordinate the activities of the OTWL process, the quality of healthcare will improve.

THEORETICAL BACKGROUND

There are two ways to improve OTWL process; one is through incremental changes and the other way is through breakthroughs (Evans & Lindsay 2005). Incremental changes are small and gradual improvements in specific sections in OTWL. Breakthroughs are large or rapid improvements. Breakthroughs require redesigning the OTWL process; this is a reference to Business process re-engineering (BPR) (Al-Mashari & Zairi 1999).

So far, most of the studies deal with the gradual change and improvement to the system (Audit Commission 2001; NSW Health 2002; Lismore et al 1995). There are limitations in the studies that deal with the re-engineering of emergency and OTWL process (Levary 1997). Therefore this implies that there might be a need for the complete redesign of the OTWL process.

To redesign the whole OTWL, the identification of interdependencies between the elements of activities as well as the coordinating the elements of the interdependencies is essential. To do so, the use of the software IDEF0 has been employed. IDEF0 is chosen over competing methods because it uses a hierarchical top-down approach and focuses the discussion on the conceptual basis for a process rather than on the detailed sequence of specific micro-level activities required to deliver the end result (Fulscher & Powell 1999), therefore it suits the multi-criteria objective of the operation theatre waiting list management process. This can be seen in Figure 1. The primary hierarchical relationship is between a parent box and the child diagram that details it.

The use of IDEF0 as an effective process mapping technique forms the first step towards OTWL business process re-engineering. IDEF0 iden-

***Figure 1**. Example of hierarchical top-down model (Adopted from KPSI 1993)*

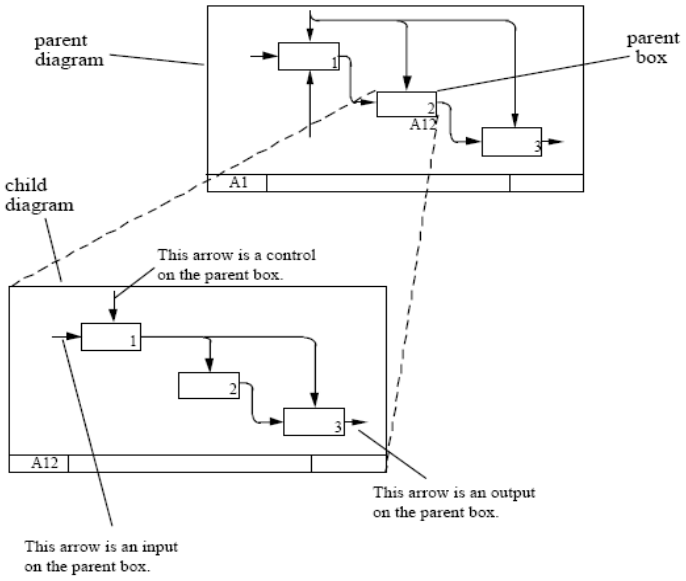
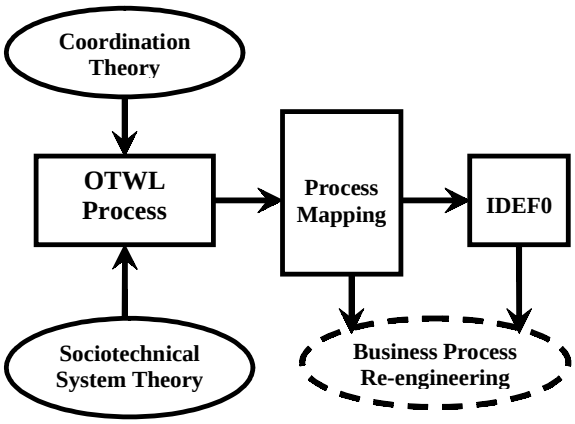


Figure 2. Proposal theoretical framework



tifies elements of OTWL activities as well as the interdependencies between them.

The result of applying IDEF0 is a model that consists of diagrams, text and glossary, cross-referenced to each other. The box and arrow meanings are used to relate several sub-functions on a diagram comprising a more general function.

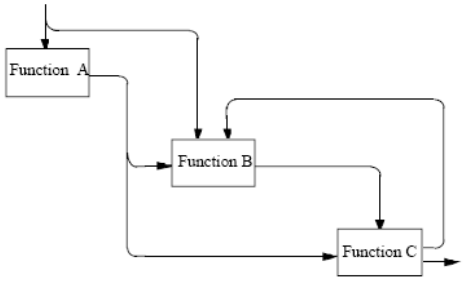
Inputs are data or objects that are consumed or transformed by an activity. Outputs are data or objects that are the direct results of an activity. In this research, the OTWL processes are described as a set of linked activities, each with inputs and outputs. External or internal factors control each activity. Controls are data or objects that specify conditions which must exist for and activity to produce correct outputs. It can also be said that the controls of an activity refer to the actions, policies or regulations that direct the activity.

Each activity requires one or more mechanisms and/or resources. They support the successful completion of an activity but are not changed in any way by it. It is assumed that each activity may have several inputs, outputs and may be embraced by a number of controls and may require several mechanisms (Al-Hakim 2006, Fulscher & Powell 1999).

Theoretical Framework

This research uses coordination theory to coordinate the interdependencies (Crowston 1997). Given that this research define OTWL process from the perspective of sociotechnical theory, the theoretical background of process mapping for the purpose of reengineering the OTWL process therefore relies on two theories; sociotechnical and coordination theory as shown in Figure 2.

Figure 3. Interdependencies between activities (Source: KBSI 1993)



Business Process Re-engineering (BPR)

Business Process re-engineering can be defined as the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed (Horna 1995; Al-Mashari & Zairi 1999). Re-engineering perspectives have been widely applied in hospital settings in recent years in particular to address the operating theatres problem (Buchanan 1998). Hospital re-engineering has reputed success in America and Sweden and became popular in the UK during the second half of the 1990s.

It has been noted that during their stay patients normally will come into contact with a range of professional staff in the hospital each with their own management structure and hierarchies. This can result in a fragmented approach to care delivery which fails to put the patient at the centre of the process; disempowering the patient and providing less than effective care delivery (Buchanan & Wilson 1996). Process re-engineering brings a holistic perspective to the hospital work system based on the analysis of the relevant activities across the hospital, ignoring the functional boundaries and adopting a fresh start or a 'blank sheet' approach to process redesign.

Coordination Theory

Coordination theory will provide the theoretical background to this research as it provides a way to the study of processes and its intent is to analyse organizations in a way that facilitates redesign (Crowston 1997). Coordination theory offers a framework for understanding and characterizing different types of dependencies and identifies the processes that can be used to manage these dependencies (Lewis & Talalayevsky 2004). The aim of this theory therefore is to define processes and attempt to improve performance. It is said that coordination problems arise from dependencies that constrain how tasks can be performed (Crowston 1997).

A key claim of coordination theory is that dependencies and the mechanisms for managing them are general; that is, a particular dependency and a mechanism to manage it will be found in a variety of organizational settings, thus this theory suggests identifying and studying common dependencies and their related coordination mechanisms in a case cane be applied across a wide variety of organizational settings. This helps in the external validity of this research as only one or two case studies will be used. The next claim of coordination theory is that there are often several coordination mechanism that could be used to manage a dependency, thus this theory suggests that these mechanisms may be useful in a wide variety of organisational settings as well (Crowston 1997; Lewis & Talalayevsky 2004).

Identification of Interdependencies

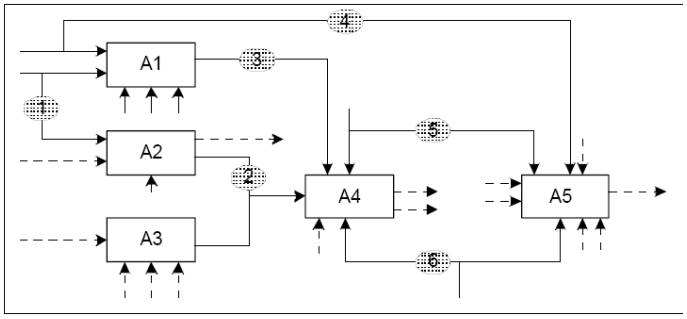
The interactions between activities are not only in the form of inputs and outputs; in many cases the output of an activity may control another activity. As seen in Figure 3, the output of Function A forms an input into both Function B and C while the output of Function B controls Function C (KBSI 1993).

The output of and activity may even form a feedback that requires the reworking of a prior activity is a distinguishing feature of IDEF0. Assuming that Function B is an operating theatre and Function C is a recovery room, an example can be given on how this work. The recovery ward does have a limited capacity and if it is full, it may cause patients to stay in the operating room for longer den necessary. Thus, this is how function C and control function B.

An example could be seen in how the output of function C control section B.

Al-Hakim (2005) identified six basic forms of interdependencies between the elements of activities representing the flow of information mapping. Each type of dependency corresponds to the same number as seen in the diagram in Figure 4.

Figure 4. *Six form of interdependencies representing the flow of information mapping*



1. Input/input dependency
2. Input/output dependency
3. Output/control dependency
4. Input/control dependency
5. Control/control dependency
6. Resource/resource dependency

CONCLUSION

This research develops a theoretical framework for mapping information of the Operating Theatre Waiting List (OTWL) management process from a sociotechnical viewpoint. It investigates the flow of information and the interdependencies across the activities of OTWL management process. The motivation for this research is to find an effective process mapping tool that can provide a valid platform for evaluating different OTWL scenarios to enable the most applicable design to be selected. The research finds that a structured technique known as IDEF0 achieves the research motivation. It is hoped that with a better design of information flow between the activities of the OTWL process, the quality of healthcare will improve.

The theoretical framework of this research is deemed appropriate for the topics of mapping the sociotechnical system of the OTWL process because of the following issues:

1. It takes into account the Social and Technical aspects of a process
2. It identifies and maps the four elements (Input, output, resource, control),
3. as well as the interdependencies of the activities/elements and the flow of information between the elements
4. It is easy to identify the flow of information and interdependencies from the graphic description of the systems in IDEF0
5. There is also the allowance for an activity to form a feedback that requires the reworking of a prior activity.
6. Coordination theory allows us to see if the elements are linked effectively, giving us the opportunity to change the relationship of the elements and to create new interdependencies thus the process can be redesigned.

As a result, this theoretical framework is useful for redesigning a process

REFERENCES

AMA Queensland, 2005, 'Waiting List Crisis More Urgent Than Ever', viewed 13 June 2005, <http://www.amaq.com.au/index.php?action=view&view=2742&pid= >

Al-Hakim, L. 2006, 'Web-based hospital information system for managing operating theatre waiting list', *International Journal of Healthcare Technology and Management*, Vol. 7, No.3/4, pp.266-282.

Al-Hakim, L & Fitzgerald, A. 2003, 'Web-Mobile-Based technologies: a fuzzy logics approach to decision-making about queues in operating theatre suites', *Proceedings of the 4th International Web conference 2003*, Perth, Australia.

Al-Mashari, M. & Zairi, M. 1999, 'BPR Implementation process: an analysis of key success and failure factors', *Business Process Management Journal*, Vol. 5 No. 1, pp. 87-112.

Audit Commission, 2002, Operating Theatres: A bulletin for health bodies.

Audit Commission, 2003, Operating Theatres: Review of national findings.

Biazzo, Stefano, 2000, 'Approaches to business process analysis: A review', *Business Process Management*, Vol. 6, No. 2, pp. 99-113.

Buchanan, D. 1998, 'Representing process: the contribution of an engineering framework', *International Journal of Operations and Production Management*, vol 18, no. 12, pp.1163 – 1188

Buchanan, D. & Wilson, B. 1996, 'Re-engineering operating theatres: the perspective assessed', *Journal of Management in Medicine*, Vol. 10, No. 4, pp. 57 – 74.

Council of Europe, 2005, 'Social Cohesion and quality of life: Criteria for the management of waiting lists and waiting times in health care', viewed 20 July 2005, <http://www.coe.int/T/E/Social_Cohesion/Health/Documentation/Waiting%20lists%20report%20&%20%20rec%20PUB%20English.asp>

Crowston, K., 1997, 'A coordination theory approach to organizational process design', *Organization Science*, Vol. 8, No. 2

Fernandez, A.A., Jacobs, D.A., Kauffman, P. & Keating, C.B., 2001, 'A methodology for analysis of complex sociotechnical processes', *Business Process Management Journal*, Vol. 7, No., pp. 33-49.

Foote, J.L., North, N.H. & Houston, D.J., 2004, 'Towards a systemic understanding of a hospital waiting list', *Journal of Health Organization and Management*, Vol. 18, No. 3, pp. 140-154.

Fox, W.M., 1995, 'Sociotechnical system principles and guidelines: past and present', *Journal of Applied Behavioural Science*, vol. 31, no. 1, pp. 95-105.

Fulscher, J. & Powell, S.G., 1999, 'Anatomy of a process mapping workshop', *Business Process Management Journal*, Vol. 5, No. 3, pp. 208 - 237.

Giaglis, G.M., 2001, *A Taxonomy of Business Process Modelling and Information Systems Modelling Techniques*, viewed 10 August 2005, <www.eltrun.gr/papers/IJFMS_Giaglis_2001.pdf >

Gonzalez-Busto, B. & Garcia, R. 1999,'Waiting lists in Spanish public hospitals: a system dynamics approach', *System Dynamics Review*, Vol. 15, No. 3, pp. 201-224.

Horna, P., 1995, 'Business process re-engineering: Theory and evidence-based practice', *Business Process Reengineering & Management Journal*, vol. 1, no. 3, pp. 10-30.

Johnson, J.A, Jones, W.J. & Siddharthan, K., 1996, ' A priority queuing model to reduce waiting times in emergency care', *International Journal of Health Care Quality Assurance*, Vol. 9, No., 5, pp. 10-16.

KBSI 2003, *Announcing the standard for Integration Definition for Function Modeling (IDEF0)*, Knowledge Based Systems, Inc., viewed 10 August 2005, <http://www.kbsi.com>

Leedy, PD & Ormrod, JE 2005, *Practical research: planning and design*, 8th edn, Prentice Hall, New Jersey.

Levary, R.R., 1997, 'Re-engineering hospital emergency rooms: an information system approach', *International Journal of Health Care Quality Assurance*, Vol. 10, No. 5, pp. 179-191.

Lewis, I. & Talalayevsky, A., 2004, 'Improving the interorganizational supply chain through optimization of information flows', *The Journal of Enterprise Information Management*, Vol. 17, No. 3, pp. 229-237.

Lismore, T.D., McAleer, W.E. & Naqvi, I.A 1995, 'Simulation of a hospital's theatre suite', *Journal of Management in Medicine*, Vol. 9, No. 5, pp. 14-26.

Mayer, R.J., Painter, M.K. & deWitte, P.S., 1992, 'IDEF Family of Methods for Concurrent Engineering and Business Re-engineering Applications. Knowledge Based Systems, Inc, TX, USA.

McAleer, W.E., Turner, J.A., Lismore, D. & Naqvi, I.A., 1995 'Simulation of a hospital theatre suite', *Journal of Management in Medicine*, Vol. 9, No.3, pp. 134 -26

Neuman, WL. 2003, 'Social research methods, qualitative and quantitative approaches', 5th edn, pp. 9-13, cited in *Research Methodology 1 Selected Readings* 2005, Distance Education Centre, USQ, Toowoomba, Australia. Reading 1.3.

New Health, 2002, *Operating Theatre Management Project – Supplementary report on Process Mapping*, NSW: NSW Health Department.

Pasmore, W.A. & Sherwood, J.J., 1988, *Designing Effective Organisations: The Sociotechnical Systems Perspective*, Wiley, New York, NY.

Queensland Health 2005, *Waiting times and definition*, viewed 22 July 2005, <http://www.health.qld.gov.au/surgical_access/html/definitions.asp >

Ramirez-Valdevia, M.T. & Crowe, T.J. (1997) 'Achieving hospital operating objectives in the light of patients', *International Journal of Health Care Quality*, Vol. 10, No. 5, pp.208-212.

Scottish Executive, 2001, 'Waiting times to become litmus test of NHS performance' 30 Aug 2001.

Soliman, F. 1998, 'Optimum level of process mapping and least cost business process re-engineering', *International Journal of Operations and Production Management*, Vol. 18, Nos. 9-10, pp.810-816