



# Information Mapping: A Case of Operating Theatre List Management Process

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## ABSTRACT

This paper considers an important dimension of information quality that is information flow and proposes a procedure for mapping the operating theatre waiting list (OTWL) process. The paper discusses the issues that make information mapping of the OTWL a challenging task and explains the difficulties associated with traditional process mapping techniques in determining the interdependencies of various elements of the OTWL process activities. The proposed procedure integrates a structured process mapping technique known as IDEF0 with another structured technique referred to as dependency structured matrix (DSM) to map the OTWL process. The paper indicates that it is possible to reduce feedbacks from other activities that affect the stability of the waiting list by administratively controlling the information flow through certain activities of OTWL process.

## INTRODUCTION

Information becomes a critical component of business operations (Sen, 2001). Today's technology allows business to collect and analyse "enormous volumes of information and manipulate it in different way to bring out otherwise unforeseen areas of knowledge" (Abbott, 2001). Managers make decisions based on information available to them, and misinformed people tend to make poor decisions (Fisher and Kingma, 2001). Type and timing of information flow plays a major role in decision-making process. Information mapping depicts information flow between various entities of a process. Several studies (Bosset, 1991; Evans and Lindsay, 2002; Fadlalla and Wickramasinghe, 2004) stress the importance of process mapping and emphasise the role information flow in improving the decision-making process. This paper deals with information mapping of the waiting list process in hospitals. It considers information flow as a component of two dimensions of information quality; contextual dimension and accessibility dimension.

## Information Quality and Information Mapping

Customers view quality in relation to differing criteria based on their individual roles in the production-marketing chain (Evans and Lindsay, 2002). Thus it is important to understand the various perspectives from which information quality (IQ) is viewed. Wang (1998) finds an analogy between quality issues in product manufacturing and those in information, and further asserts that information manufacturing can be viewed as processing system acting on raw data to produce information products. Wang urges organisations to manage information as they manage products if they want to increase productivity. Based on the analogy of Wang, information quality can be viewed by information consumers from various perspectives: as "fitness for intended use," or as "meeting or exceeding customer expectations".

Just like quality management of physical products, IQ has multiple dimensions. IQ dimensions refer to issues that are important to information consumers. However, there are no uniform lists for the IQ dimensions as illustrated in Table 1. The choice of these dimensions is primarily based on intuitive understanding, industrial experience, or

literature review (Hung et. al, 2001) and depends on the actual use of information. Good information for a specific user in one case may not be sufficient in another case. Strong et al. (1997) group the IQ dimensions into four categories. These categories are contextual, intrinsic, accessibility and representation. These categories are widely acceptable in the literature (Li et. al (2003) and can implies others dimensions as shown in Table 1.

Good information mapping allows information system's users to receive correct amount of information (completeness), only relevant information (relevancy), updated information (timeliness) at the required time (currency) and with adequate level of accessibility (accessibility). Accordingly, information mapping is directly related to two categories of IQ dimensions; contextual and accessibility.

## Operating Theatre Waiting List

There are commonly two kinds of waiting lists in hospitals: outpatients and surgery (Gonzalez-Busto and Garcia, 1999). The first type of waiting list includes patients waiting for consultation in certain sections, including the Accident and Emergency Departments. The second type of waiting list is a reference to the operating theatre schedule. Patients on this list are awaiting a surgical intervention to be conducted in an operating theatre of the hospital. This research deals with the operating theatre waiting list "OTWL" and concentrates on the information mapping of the OTWL process. OTWLs are critical for many reasons: their societal and political impact, their potential link to the patients' life; their relationship to the economic management of operating theatres and the allocation of scarce resources such as surgeons, specialists, nurses and equipment (Al-Hakim, 2006).

Consulting surgeons historically determine the urgency of patients' conditions, the nature of the required surgery and the timing of the operation. They make clinical decisions based on their opinion of the physical status and medical needs of their patients (McAleer, et al., 1995). Decisions regarding the physical status of a patient include assigning the patient to a certain category of emergency. Once drawn up, the composition of a waiting list is unprotected in that it is subject to multiple alterations and modifications, without prior notice or agreement with patients already in the list. Unanticipated changes affect the quality of patient care and may escalate costs considerably. Patients who have their consultation or procedure time altered can suffer prolonged anxiety, pain and discomfort, frustration, anger and stress (Buchanan and Wilson, 1996). For the organisation, delayed or cancelled procedures usually result in activity targets not being achieved.

Several studies (District Commission, 2002; New Health, 2002; Schofield, 2005) stress the importance of process mapping and emphasise the role of information flow in improving or redesigning the OTWL process. This paper deals with process mapping of OTWL and provides a conceptual procedure for mapping the information flow throughout the activities of the OTWL process.

The procedure is applied for mapping the OTWL process within an Australian Hospital. Information presented is only at a macro level and

Table 1. Categories and dimensions of IQ

Category	Implication / Definition#	IQ Dimensions from Selected Literature				
		Delone and McLean (1992)*	Goodhue (1995)	Wang and Strong (1996)	Strong et al (1997)	Jarke and Vassiliou (1997)#
Intrinsic	Information has quality in its own right.	Accuracy, precision, reliability, freedom from bias.	Accuracy, reliability.	Accuracy, believability, reputation, objectivity.	Accuracy, objectivity, believability, reputation.	Believability, accuracy, credibility, consistency, completeness.
Contextual	IQ must be considered within the context of the task.	Importance, relevance, usefulness, content, completeness, currency, sufficiency.	Currency, level of detail.	Value-added, relevance, completeness, timeliness, appropriate amount.	Relevancy, value added, timeliness, completeness, and amount of data.	Relevance, usage, timeliness, source, currency, data warehouse currency, non-volatility.
Accessibility	Information is interpretable, easy to understand and manipulate.	Useableness, quantitiveness, convenience of access.	Accessibility, assistance, ease of use, location.	Accessibility, ease of operations, security.	Accuracy and access security.	Accessibility, system availability, transaction availability, privileges.
Representation	Information is represented concisely and consistently.	Understandability, readability, clarity, format, appearance, conciseness, uniqueness, comparability.	Compatibility, meaning, presentation, lack of confusion	Understandability, interpretability, concise representation, consistent representation, arrangement, readable, reasonable.	Interpretability, ease of understanding, concise representation, consistent representation.	Interpretability, syntax, version control, semantics, aliases, origin.

\* Adopted from Lee et al (2002)  
# Adopted from Turban and Aronson (2001).

more detailed information at the micro level may be required for justification of the results.

The next section of the paper explains issues that make information mapping OTWL a challenging task. The paper explains the difficulties associated with current process mapping techniques and proposes a procedure to overcome these difficulties. The procedure integrates a structural process mapping technique known as IDEF0 with a process design mapping technique referred to as dependency structured matrix (DSM).

**CHALLENGES FACING OTWL**

The OTWL process has a multiple-criteria objective of:

1. compliance with all due dates and times of the scheduled consultations and operations; and
2. ensuring a quick and convincing response to unanticipated changes to the waiting list.

These criteria may conflict with each other in that the waiting list requires changes in response to unanticipated clinical needs rather than order of arrivals, as well as logistical factors, such as readily available resources (Al-Hakim, 2006). The difficulty of compromising the two conflicting criteria of OTWL objective arises mainly from the process complexity.

**Process Complexity**

Giddens (Giddens, 1984) - in Biazzo, 2002) describes a process as a series of interdependent actions or activities embedded in a structure. Giddens views a structure as a set of rules and resources which can both constrain and enable social actions. OTWL process is a constructive example that fits Giddens' concept and, accordingly, the OTWL process can be considered as not just a group of activities. Rather, it is a 'sociotechnical' system (Keating, et al., 2001) in which each activity has additional elements other than that activity's 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 complexity of the OTWL process arises from two aspects:

- a. the process mapping aspect which relates to the interdependencies between the elements of various activities of the OTWL process and;
- b. the sociotechnical aspect which requires designing work such that a balance can be struck between the technology and the people using the technology. This is known as joint optimisation.

There are four variables that make both defining interdependencies between the elements of the various activities of the OTWL process and achieving joint optimisation extremely important:

- Object behaviour. The behaviour of the object (patient) is not predictable and could vary considerably. Significant disruption could result from patient behaviour eg cancellation of surgery by a patient. This makes every patient a unique object in the system.
- Surgeon effectiveness. Surgeons differ in skill and expertise. It is hard to measure the effectiveness of a surgeon in dealing with various complexities during surgery.
- Surgery success. Because of the level of complexity and variability it is hard to predict the degree of success of a surgery.
- Surgical time. Though the time required for surgery can be partly predicted, complexities during surgery may considerably affect the surgery time. The high probability of the unpredictability of time required for surgery renders difficult any attempt to precisely schedule OTWL.

While some of the above variables are uncontrollable, their impact on OTWL scheduling can be considerably reduced and effectively managed with (a) correct and real-time flow of information, and (b) coordination of the various interdependencies between elements of the activities involved in the OTWL process. Realising the role of information flow and interdependencies as the main drivers of the OTWL schedule highlights the need for effective process mapping. This is the topic of the next section.

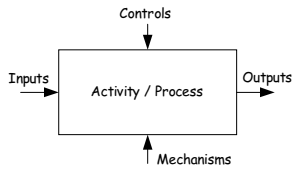
**PROCESS MAPPING**

Process mapping is a technique used to detail business processes by focusing on the important elements that influence their behaviour (Soliman, 1998). Lin, Yang and Pai (2002) argue that process mapping performs two important functions. The first function is to capture existing processes by structurally representing their activities and elements. The second function is to redesign the processes in order to evaluate their performance.

The value of an activity is derived from the coordination of the process's activities, its rules and resources that make the product or service valuable or satisfactory in terms of its price to the customer. The effectiveness of activity coordination is directly related to process complexity. Browning (1998) stresses that process complexity is a function of at least four factors: (1) the number of activities, (2) the individual complexity of each activity (the number of relationships (or interdependencies) between activities, and (4) the individual complexity of each interdependency. Giddens's seeks additional relationships and interdependencies between resources and rules governing the actions. Three additional important factors can be added here: (5) the relationships or interdependencies between activities and the associated resources and rules, (6) the interdependencies between the resources, (7) the interdependencies between the resources and rules, and (8) the complexity of these interdependencies.

An effective process mapping should therefore consider the interrelationships between activities as well as the object involved, the resources needed to perform the process's activities, the rules and policies that govern the implementation of activities and the flow of information between various elements of the activities. Traditional process mapping such as flow and Gantt charts are not robust enough to handle the process complexity. Traditional process mapping techniques focus only on activities or work flow rather than information flow. They deal with the sequence of activities but do not address the required resources. Accordingly these techniques cannot be used to map the interdependencies between the elements of the activities and hence cannot deal with the complexity factors mentioned above. One structured process mapping technique referred to as IDEF0 can be used to map the various elements of activities. The next section discusses its suitability for mapping process complexity.

Figure 1. IDEF0 elements: inputs, outputs, controls, and mechanisms



**IDEF0**

The name IDEF originates from the United States Air Force program for Integrated Computer Manufacturing (Mayer, et al., 1995). IDEF0 is one of the IDEF series of techniques that was originally developed in order to describe, specify and model business processes in a structured graphical form (Lin, et al., 2002; Fulscher and Powell, 1999). IDEF0 describes a business process as a series of linked activities in which each activity is specified by four elements: inputs, controls, outputs and mechanisms. These elements are referred to as ICOMs (Lin, et al., 2002). Figure 1 illustrates generically how IDEF0 is used to depict activities and their associated elements.

The controls of an activity include actions, policies or regulations that control the activity, while mechanisms refer to the resources required to achieve the activities. We assume that each activity may have several inputs and outputs, may be embraced by a number of controls and may require several resources. An activity may represent a stage, a process, or a certain course of action within the process. The IDEF0 representation fits with the Giddens’s concept of a business process as well as the sociotechnical system definition.

IDEF0 allows a hierarchical or top-down decomposition approach to analyse processes at multiple levels of abstraction (Kappes, 1997). The essence of hierarchical decomposition approaches to business process mapping, in which a basic, single-activity description of the process is decomposed step-by-step into its constituent activities to whatever

level of detail, is appropriate for the mapping purposes (Fulscher and Powell, 1999). This hierarchical decomposition of activities helps to organize the development of IDEF0 models and proved critical in abstracting the essence of the process itself from the details of current practice. The top level activity which represents the subject of the model is always given the number A0. The next level of activities are numbered A1 to An where n indicates the number of “child” activities that A0 was broken into. Figure 2 illustrates an overview or macro-map of OTWL process mapping (level A<sub>0</sub> detail) for the case hospital using IDEF0.

**Determining Interdependency**

The elements of an activity do not exist in isolation from elements of other activities in the waiting list management process and the relationships between these elements form the interdependencies between the process’s activities. There are six basic forms of interdependencies between elements of activities representing the flow of information mapping; (1) input/input dependency -as between activities A1 and A2, (2) input/output dependency, (3) output/control dependency, (4) input/control dependency, (5) control/control dependency, and (6) resource/resource dependency (Figure 3).

The Activity/Concept (A/C) matrix window of IDEF0 displays in matrix format which concepts (elements) are attached to which activities and how they are attached - as inputs, controls, outputs, or mechanisms (Figure 4). The A/C matrix can be used to depict the six types of interdependencies. Figure 4 illustrates that the advice of an anaesthetist is needed during implementing activities pre-assessment, peri-operations, procedure and discharge. However, IDEF0 is not designed precisely to map information feedback needed from other activities before the start of the current one. Accordingly, IDEF0 cannot be actively used to group activities for the purpose of information flow. This research integrates

Figure 2. Macro-map of OTWL process using IDEF0

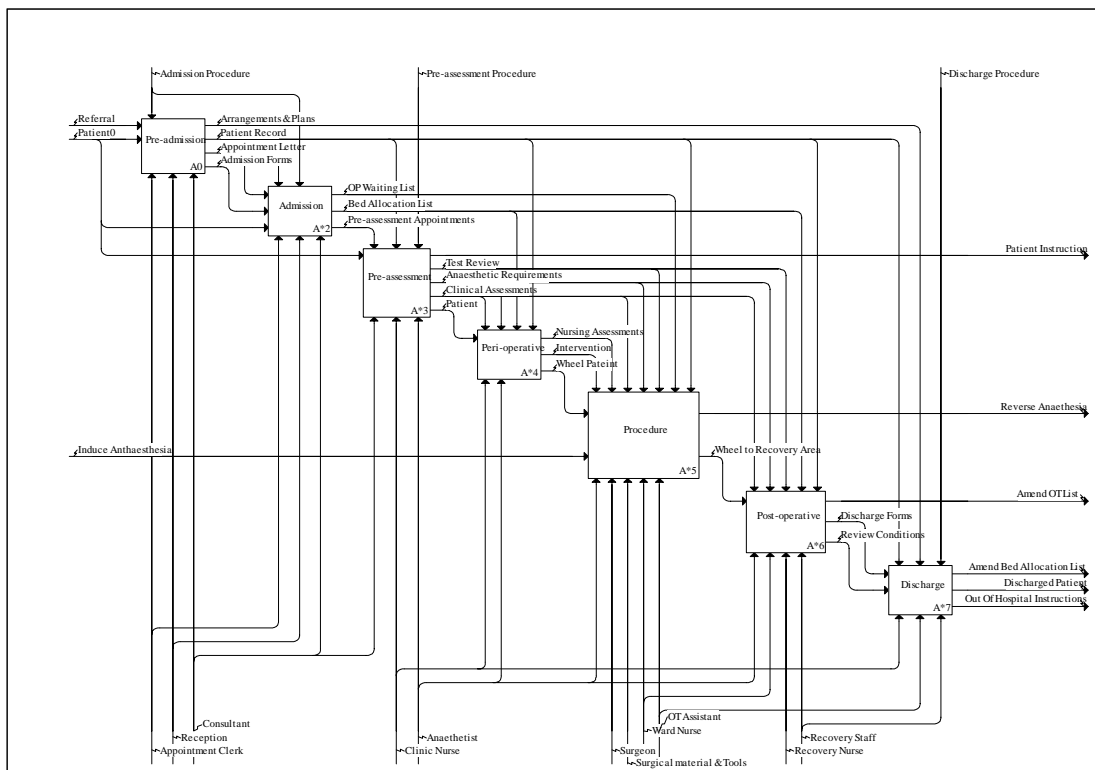




Figure 5. An overview mapping of OTWL process with DSM

Activity	Pre-admission	Admission	Pre-assessment	Peri-Operative	Procedure	Post-operative	Discharge
Pre-admission						•	
Admission	•				•	•	
Pre-assessment		•					
Peri-Operative			•		•	•	
Procedure			•	•		•	
Post-operative					•		
Discharge						•	

a case hospital to present the procedure. The results indicate that it is possible to reduce the amount of feedbacks from other activities that affect the stability of the waiting list by administratively controlling the information flow through certain activities of OTWL process.

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Figure 6. The modified DSM

Activity	Admission	Pre-assessment	Operation	Discharge
Admission			•	
Pre-assessment	•			
Operation		•		
Discharge			•	

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