# HIT in Australian Hospitals - Evidence of benefits in a systematic review


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## Published

2013

## Conference Title

Proceedings of the 24th Australasian Conference on Information Systems (ACIS)

# HIT in Australian Hospitals - Evidence of benefits in a systematic review

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**Abstract**

*A systematic review of journal articles on Health Information Technology (HIT) adoption in Australian Hospitals was performed to identify the types of technology and benefits reported. 25 articles were analysed and systematically classified. The review was followed by grounded research with a focus group to interpret the concepts of HIT and benefits. Limited evidence for systematic benefits of HIT in hospitals and a lack of agreed taxonomies and frameworks was found, making systematic evaluation of HIT difficult. This highlights the urgent need to study HIT as a phenomenon in an Australian health systems context and the lack of systematic reviews of this to date. Also identified in current research are methodological limitations in terms of purely quantitative approaches to investigating information systems.*

**Keywords**

Medical Informatics, Health Information Technology, Australia, Hospitals, Benefits, Performance

## INTRODUCTION

In 2003 Sanzogni et al. (2006) investigated the adoption of Wireless and Mobile Technology across a range of organisational contexts, including in a major hospital, with a view of developing a model of the benefits of this type of communications technology and their effect on organisational performance. Sanzogni et al. (2006) reported that complex organisational factors in a hospital such as competing motivations and corporate IT policies may block adoption and realisation of potential organisational performance benefits[1]. It was conjectured during this process that the hospital context may present what could be described as a wicked problem, combining organisational, human factor, legislative, and political factors that may affect adoption and the translation of benefits to improved organisational performance.

Health care and its increased share of national budgets is progressively becoming a central concern of policy makers around the World (Mullen 1998) and Australia (ProductivityCommision 2009). Increasingly there is a focus on using performance measurement to manage health care, with the adoption of the adage that "what counts is what counts" (Goddard et al. 2000). Because of its implementation complexity and the increasing importance of extracting efficiency from the health system it was felt that Health Information Technology (HIT) in Hospitals was worthy of additional examination.

HIT is predicted to be a significant enabler of sound, cost effective health care for Australia; this claim is supported by the albeit scant studies conducted locally and reinforced by similar studies conducted abroad. A recent survey by Accenture of doctors in seven countries including Australia (Knickrehm et al. 2013) identified reduction in medical errors, better access to clinical data for medical research, improved cross-organisational working processes, improved quality of treatment decisions, and improved diagnostic decisions as frequently-reported benefits of electronic medical record (EMR) systems. Some researchers have identified possible economic benefits to Australia of health data exchange (a type of HIT) to be in the order of billions of dollars

[1] Some of these barriers to wireless adoption in Health have been confirmed by others as in Heslop, L., Weeding, S., Dawson, L., Fisher, J., and Howard, A. 2010. "Implementation Issues for Mobile-Wireless Infrastructure and Mobile Health Care Computing Devices for a Hospital Ward Setting," *Journal of Medical Systems* (34:4), pp 509-518..

(Sprivulis et al. 2007). Also in Australia, the State of Victoria's Department of Health conducted a literature review of HIT adoption from around the world (Health 2012) and identified significant benefits associated with the adoption of EMR and concluded "*the literature reinforces the argument that EMR systems will be pivotal in enabling the efficient collection of meaningful, accurate and complete data that supports active clinical decision support and the development, implementation and optimisation of clinical pathways.*" In a study of remote communities in Western Australia, Cripps et al. (2011) found that an EMR system did help with providing continuity of care and reduced the administrative burden on staff in clinics.

As a nation Australia would justifiably expect that investment in HIT is well grounded in proven clinical evidence duly reported in academic journals and systematics reviews. While HIT as a culturally-influenced phenomena may be different from the experience of other health systems and hence the relevance of looking for domestic case studies, it is still of great interest to review international literature for the evidence of HIT benefits.

Internationally there have been a significant number of studies of HIT adoption and a number of systematic reviews and sectoral studies of HIT benefits. Many of these have found a positive impact on performance. In a study of Florida hospitals, Bhattacherjee et al. (2007) found a strong and statistically significant positive relationship between adoption of clinical HIT and operational performance. In another study of Florida hospitals, Menachemi et al. (2007) found a positive relationship between HIT adoption and patient safety. Brand et al. (2012) found, in a systematic review of international peer-reviewed literature on hospital performance from 1996 to 2000, that the *"strongest evidence for an association with overall performance was identified for computerized physician order entry systems"*. Buntin et al. (2011) in their systematic review of articles, found mainly positive evidence for EMR but found levels of dissatisfaction in some providers and noted that there are difficulties in adoption that need to be investigated. Devaraj et al. (2000) conducted a longitudinal study of a US hospital network (over 4000 beds in total) and found a positive relationship between IT investment, and both hospital profitability and clinical care indicators. Jamal et al. (2009) found, from a systematic review of research on HIT and quality of care, that compliance with clinical guidelines was improved by HIT but there was insufficient evidence to link this to patient outcomes. Parente et al. (2009) found, in a national study, a small positive effect of HIT on patient safety.

Not all the research supports the premise that HIT delivers health performance improvements or that there is a convincing business case for HIT; some of the studies find that HIT has a neutral, mixed or negative effect on indicators that could be considered indicators of organisational or health system performance (either in terms of quality or efficiency). Agha (2011) completed an econometric analysis of HIT adoption in 3900 US hospitals and found that HIT investment was not associated with efficiency or quality of hospital care. Black et al. (2011) found in their systematic survey of the clinical trials literature that there was little evidence to support the claims of eHealth technologies and their positive impact on quality and safety. Chaudhry et al. (2006) published a systematic review of journal articles from 1995 to 2004 and found that in relation to quality metrics, the main areas of reported improvement were increased adherence to guideline-based care, enhanced surveillance and monitoring, and decreased medication errors. They found however, that in terms of efficiency the results were mixed and empirical data limited.

HIT are complex interventions occurring in complex organisations (hospitals). There are certainly examples where the implementation of HIT has not been successful and has not translated to benefits e.g. the Victorian Governments HeathSmart initiative (LeMay 2012). To understand performance we must seek to understand the antecedents of performance. A prerequisite for benefits being derived from a technology, is that it must first be adopted. For this reason, a significant amount of the research literature is focused on identifying the barriers to adoption (Gagnon et al. 2012; Granlien et al. 2012; Miller et al. 2004; Poon et al. 2004; Szydlowski et al. 2009).

Culture plays a role in adoption, for example the medical and nursing sub-cultures in a hospital affect adoption behaviour (Callen et al. 2009). England et al. (2007) investigated the role of executive leadership in adoption of HIT and found their doubts about the value of HIT has a significant inhibiting effect – they were not convinced of the business case for HIT in their hospital and this doubt impaired adoption.

A broader question in information systems (IS) research is how individuals and organisation make the decision to adopt a technology. There are a number of models that have been developed to explain technology adoption (the decision and act of adopting a particular technology) and these have been applied to health care. The main models are: Diffusion of Innovation (Rogers 1962), Technology Acceptance Model (Davis 1989) and Unified Theory of Acceptance and Use of Technology (Venkatesh et al. 2003). Holden et al. (2010) have shown that in general terms the Technology Acceptance Model predicts HIT adoption. This model proposes that external variables influence Perceived Usefulness and Perceived Ease of Use. These interact and determine the Attitude to Using, the Behavioural Intention of using and ultimately Actual Use.

While barriers to use and the factors effecting adoption are important areas for research, it is also of value to consider the potential for performance improvement (be that in terms of organisational efficiency, financial performance or clinical care quality) through the introduction of information technology (IT) - once the

challenges of adoption are addressed. Our observation from an initial review of Australian and overseas literature is that most HIT research is focused on the benefits of a particular technology in an immediate clinical situation, often looking at only simple unitary metrics. To develop a comprehensive understanding of benefits, researchers should first identify the beneficiaries and in what way they benefit. Hospitals contain multiple stakeholder groups with differing agendas and motivation. This has the potential to disconnect an initial benefit, for example saving time by automation, from improving the overall performance of the organisation. Instead, the nature of the relationship between identified benefits to what constitutes benefits to the patient, organisation or society should be considered.

Melville et al. (2004) performed a systematic literature review of articles relating to IT and organisational performance. From their analysis of these articles they developed a model of IT adoption and organisational performance based on a resourced-base view of the firm to explain how IT impacts organisational performance.

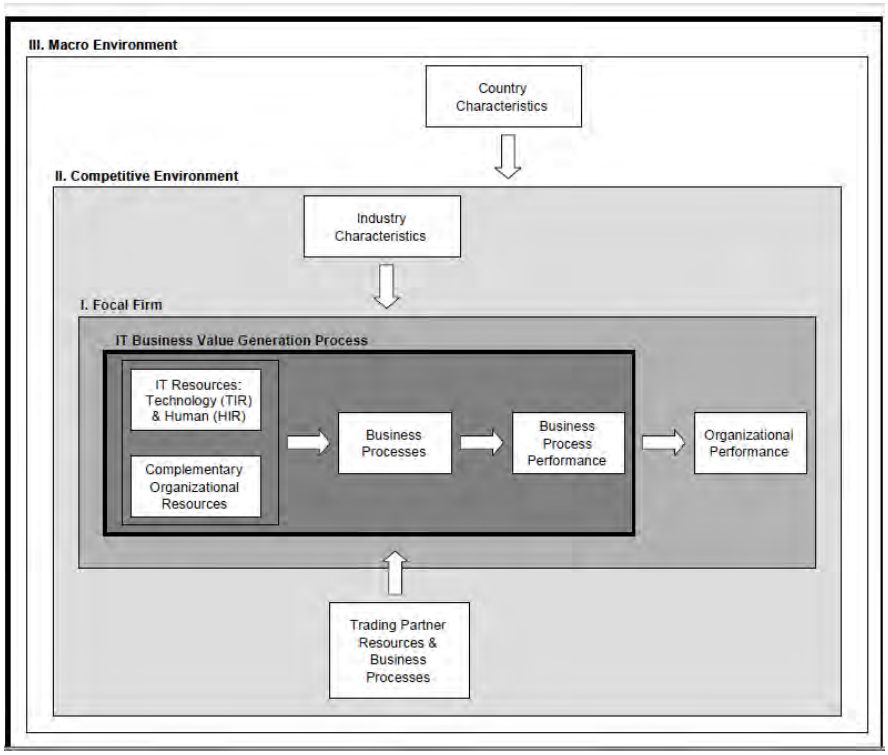


**Figure 1: Melville et al (2004) IT and organisational Performance**

At the firm level their model proposes that physical IT assets combine with people with IT skills to create IT capabilities. These are intertwined with complementary organisational resources (e.g. knowledge, policies, and organisational structures) to impact on business processes. The process performance can then create the potential for organisation performance; however this is mediated by trading parties and their processes, characteristics of the industry they operate in (e.g. ability of competitors to imitate) and the macroeconomic environment (e.g. the regulatory environment the firm operates in). Lee et al. (2011) applied this model to explain how knowledge management technology and cultural competencies translate into organisational performance in a study of 128 hospitals in Taiwan.

Overlaying any discussion about technology adoption and hospital performance and benefits is the question regarding measurement of benefits and performance. Although there has been significant work in developing methods for evaluating the performance of the health system (NHPC 2001; WHO 2000), Aggelidis et al. (2008) have pointed out that we have lacked comprehensive measures for the pluralistic evaluation of hospital information systems. From their review, they identify that user satisfaction, usage, and economic evaluation are the main ways we measure HIT. They propose that user satisfaction is the prime means that should be used to evaluate HIT success, which seems at least partially aligned with the model of DeLone and McLean (DeLone et al. 2003), which has become widely accepted within the IS research community. There have also been proposals to use an evaluation framework to assess HIT projects (Nykänen et al. 2012; Rein et al. 2012). There has been significant research on economic methods for assessing hospital efficiency (Cesconetto et al. 2008; Goddard et al. 2000; Guerra et al. 2012; Hollingsworth 2008; Macinati 2008; Nayar et al. 2013) typically using data envelopment analysis (DEA) however, it is rare that these are applied systematically to measuring the impact of HIT on that efficiency. At least one researcher (Fareed et al. 2012) has and found limited benefit of HIT. There

has even been a proposal to use balanced score card to assess hospital performance (Yuen et al. 2012) that could potentially be extended to measure HIT and activity-based costing has been used to evaluate HIT (Muto et al. 2011).

If considering HIT benefits it is essential consider how these are measured. Current approaches to measuring benefits most frequently adopt quantitative research models (e.g. before and after studies, randomized trials) but some take a qualitative approach. Some researchers has identified limitations with a simple unitary methodology: in Australia, Georgiou et al. (2012) have proposed using measurement of organisational communication as a means of evaluating HIT effectiveness while Westbrook et al. (2007) explored a mixed-methods (qualitative combined with quantitative) approach to evaluating HIT.

There have been a number of systematic studies of specific HIT technology by Australian researchers e.g. Georgiou et al. (2007). The question therefore is why it would be valuable to study the Australian experience specifically, rather than to look at the problem by technology or by type of institution in general. We know that levels of HIT adoption differ between countries (Aarts et al. 2009; Anderson et al. 2006). We also know that the concerns of IT managers are different between countries (Watson et al. 1997) and we know that the health systems perform differently at a national level (Schoen et al. 2005). In a general context, there is evidence that organizational culture varies between Australia and the United States (Lok et al. 2004). Considering the number of systematic studies focussing on the United States and if we accept that success and benefits are as much socially as technologically determined, it is more appropriate to ask why we should consider that results from overseas can be applied here without qualification. After all, Australia may represent a health system that influences the use of HIT through unique characteristics. It is for this reason that we believe Australian HIT is worthy of study. Being interested in the relationship between adoption and organisational performance we have selected the "hospital setting" as the focus of study. Other contexts are equally valuable (for example the use of EMR by primary care physicians) however, we do not feel it possible to effectively measure health in a generic way across a sector, so we have selected hospitals because they present to some degree, a closed system that can be studied.

The research method adopted was:

1. A systematic literature review of published articles and conference papers, which were then analysed and codified in terms of technologies, benefits, disadvantage, barriers to and enablers of adoption.
2. A focus group of HIT experts who were asked to interpret the relationships between the various terms used in HIT from the literature review, so as to allow the development of a conceptual model of technologies, benefits and barrier to adoption based on the Australian experience.

## LITERATURE REVIEW

### Method

The first step was to identify a pool of relevant journal articles and conference papers. A keyword search using Proquest health and information systems databases for "Health Information Technology" and "hospitals" and "Australia" was performed. The following synonyms were also used for Health Information Technology: HIT, eHealth, Health Informatics, Medical informatics, Electronic Medical Records (EMR), Clinical Provider Order Entry (CPOE), Clinical Decision Support Systems (CDS or DSS), Picture Archive and Communication Systems (PACS), ePharmacy, Nurse Information Systems, Clinical Information Systems, and Patient Administration System. These were restricted to academic journals published over the last ten years. This search yielded 46 articles. A keyword search was then performed for "Australia" in conjunction with the names of leading HIT technology vendors[2] (Allscripts OR Cerner OR iSOFT OR Cerner OR InterSystems OR Trakcare OR Meditech OR i.s.h.med OR Soarian) in the same period and this yielded an additional 11 articles. Next Medline was searched, also restricted to the past ten years, for the MeSH subjects "Medical Informatics" and "Australia" and this produced a list of 135 articles. The abstracts of these articles were scanned for relevance to HIT in hospitals. Finally the contents of proceedings and journals of Australian Health Review, Medical Journal of Australia, HISA conferences, Health Information Management and ACIS Conferences - HIT Track were scanned for papers that were related to HIT in Australian hospitals. Full papers that were peer reviewed were added. Three conference articles were excluded because they could not be sourced as they were published in book form and not available in Australia.

Ultimately, 29 articles that were analysed in detail out of which 25 were included in the final analysis on the basis of relevance to benefits realised in a hospital setting and a focus on benefits and/or adoption. A terms list was

[2] These vendor names were sourced from an analysis of the global EMR market by Gartner http://www.gartner.com/technology/reprints.do?id=1-1CQHORB&ct=121107&st=sg accessed on 15 July 2013

developed during the first scan where papers that were not specifically relevant to Australian Hospitals, HIT and Benefits were also eliminated. Synonyms were eliminated and then a categorisation of the dimension of effect (positive / negative) was done on a second scan.

For each paper the type of study (e.g. case study), the technology studied (see the Glossary for HIT terms), reported benefits and negative benefits (disadvantages), identified success factors and barriers to adoption, were codified and the hospital context (public/private, type and location) described.

**Results**

The codified analysis of the papers is found in Appendix 1. The first observation is that no examples of research that systematically measured the overall benefits to the hospital, patients, doctors, nurses or the community were found – no study was able to point to a hospital-wide benefit and few of the studies looked at hospital-wide HIT adoption in a systematic manner.

The papers used a variety of research approaches: Quantitative before-and-after studies (14), Surveys (4) and Qualitative/Interpretive (8). The quantitative studies measured performance indicators related to the process they were automating (for example radiology functional performance for PACS). The indicators were of the following types: time saving, error reduction and protocol compliance.

The themes of the papers were captured in Table 1. The themes relate to benefit, disadvantage and barrier or enablers of adoption. Care was taken as to not interpret the data, only consolidating counts where there are syntactic differences in concepts.

Table 1 – Themes from the papers

| | Technology Type | TOT | Electronic Handover System | CPOE | EMR | PACS | Digital Pen | IDS+EMR+PAS | PAS | Electronic Discharge Summaries | LIMS | e-prescribing | Electronic Chart | Automated Anaesthetic Record Keeping System (AARK) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benefits | Ease of access to information | 5 | | 1 | 2 | 1 | | 1 | | | | | | |
| | Faster provision of information to clinicians | 4 | | 2 | 1 | | | | | 1 | | | | |
| | Time Saving | 3 | 1 | | | | | | | | | 1 | | 1 |
| | Quality of information | 3 | 1 | | | | | | | 1 | | 1 | | |
| | Information transfer between facilities / organisations | 2 | | | | 1 | | 1 | | | | | | |
| | Better Clinical Decisions | 2 | | | 1 | | | | | | | | 1 | |
| | Better staff to staff relationships | 2 | | 1 | | | | 1 | | | | | | |
| | Improved patient care | 1 | | | 1 | | | | | | | | | |
| | Ability for nurses to challenge doctors decisions | 1 | | | 1 | | | | | | | | | |
| | Reduced time to find information | 1 | | | | 1 | | | | | | | | |
| | Time available for patient treatment (less time in non-patient time) | 1 | | | | 1 | | | | | | | | |
| | Faster clinical decisions | 1 | | | | 1 | | | | | | | | |
| | Reduced Length of Stay (LOS) | 1 | | | | | 1 | | | | | | | |
| | Reduced Post-operative complications | 1 | | | | | 1 | | | | | | | |
| | Maximise knowledge | 1 | | | | | | 1 | | | | | | |
| | Better in-service education | 1 | | | | | | 1 | | | | | | |
| | User Satisfaction | 1 | 1 | | | | | | | | | | | |
| | Reduce duplication of services | 1 | | | | | | 1 | | | | | | |
| | Improved delivery rate of information | 1 | | | | | | | | 1 | | | | |
| | Better audit trails of treatment | 1 | | 1 | | | | | | | | | | |
| | Better compliance with treatment protocols | 1 | | | | | | | | | | 1 | | |
| | Better collections of statistical information | 1 | | | | | | | | | | 1 | | |
| | Notification of patient movements | 1 | | | | | | 1 | | | | | | |
| | Better bed management | 1 | | | | | | 1 | | | | | | |
| | Ease of use | 1 | | | | | | | | | | | | 1 |
| | Decreased wait time for treatment | 1 | | | | | | 1 | | | | | | |
| Disadvantages | Clinical Errors, not otherwise classified | 2 | | | | 1 | | | | 1 | | | | |
| | Time spend in data entry | 1 | | | 1 | | | | | | | | | |
| | Nurses role as 'information holder' reinforced | 1 | | | | | | | 1 | | | | | |
| | New system missing features of previous process | 1 | | | | | | | | | 1 | | | |

| | Technology Type | TOT | Electronic Handover System | CPOE | EMR | PACS | Digital Pen | IDS+EMR+PAS | PAS | Electronic Discharge Summaries | LIMS | e-prescribing | Electronic Chart | Automated Anaesthetic Record Keeping System (AARK) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Increase patient wait times | 1 | | | 1 | | | | | | | | | |
| | Increase treatment times | 1 | | | 1 | | | | | | | | | |
| | Increased discharge processing times | 1 | | | 1 | | | | | | | | | |
| | Increases DNW percentage (no treatment provided) | 1 | | | 1 | | | | | | | | | |
| | System not able to record important information | 1 | | | 1 | | | | | | | | | |
| | Worse Clinical Decisions | 1 | | | | | | | | | | | 1 | |
| | Impaired communication of information | 1 | | | | 1 | | | | | | | | |
| | System induced errors | 1 | | | | | | | | | | 1 | | |
| Barriers Enablers | Lack of integration with other systems | 4 | | | 2 | 1 | | | 1 | | | | | |
| | Lack of suitable IT equipment in ward | 2 | | 1 | 1 | | | | | | | | | |
| | System does not support information model required | 2 | | | 2 | | | | | | | | | |
| | System hard to use, Poor HCI design | 2 | | | 1 | | | | | | | | 1 | |
| | Legacy IT Systems | 1 | | 1 | | | | | | | | | | |
| | Lack of confidence in data quality | 1 | | 1 | | | | | | | | | | |
| | Concerns relating to user's ability to adopt | 1 | | 1 | | | | | | | | | | |
| | Internal ICT Services | 1 | | | | | | 1 | | | | | | |
| | Lack of strategic coordination & governance | 1 | | | | | | 1 | | | | | | |
| | Concerns for patient safety | 1 | | | | | | | | | 1 | | | |
| | Lack of training | 1 | | | | | | | | 1 | | | | |
| | Lack of functionality | 1 | | | | | | | 1 | | | | | |
| | Not enough time to use | 1 | | | | | | | 1 | | | | | |
| | Lack of security access | 1 | | | | | | | 1 | | | | | |
| | Usability of IT equipment in ward | 1 | | | 1 | | | | | | | | | |
| | Lack of business process redesign | 1 | | | 1 | | | | | | | | | |
| | Good project management | 1 | | | 1 | | | | | | | | | |
| | Good management of change | 1 | | | 1 | | | | | | | | | |

The values in the table represent the number of times the factors were identified in the reviewed papers. It is important to note that these values are just indicators of frequency. As any of the papers may report multiple benefits, barriers, and enablers the total counts in this table may differ from the number of papers reviewed.

Technologies that consistently report only positive benefits include:

- Electronic handover systems (single study)
- CPOE
- DS+EMR+PAS (single study)
- Digital Pen (single study)
- Automated Anaesthetic Record Keeping System (AARK) (single study)

EMR results are contradictory; and the following technologies have at least one reported disadvantage:

- PAS
- Electronic Discharge Summaries
- E-prescribing
- LIMS
- Electronic Chart

Disadvantages did not appear to be focused in any one area with no factor being identified by multiple researchers. Disadvantages included:

- Time taken in data entry

- Negative effects on operational efficiency
- System-induced errors
- Missing information or features in new system
- Cultural re-enforcement of roles

In terms of benefits, the most cited were:

1. Ease of access to information
2. Faster provision of information to clinicians
3. Time Saving
4. Quality of information
5. Information transfer between facilities / organisations
6. Better Clinical Decisions
7. Better staff to staff relationships

The top barriers to HIT adoption were:

1. Lack of integration with other systems
2. Lack of suitable IT equipment in ward
3. System does not support information model required
4. System hard to use, Poor HCI design

The top enablers of HIT adoption were:

- Good project management
- Good management of change

There was limited investigation of the total performance impact on hospitals of HIT, as opposed to localised benefits at the ward or unit: The exceptions were:

- Derhy et al. (2009) reported reduction in Length of Stay (LOS) and post-operative complications
- Poulos et al. (2007) reported reduction in waiting and transfer times
- Massy-Westropp et al. (2005) found better client satisfaction in referring GPs
- Mohan et al. (2013) reported negative impact on treatment and waiting times

## FOCUS GROUP

The completion of the review of the literature yielded a list of health information technology terms. It was apparent from descriptions in the articles that seemingly related technologies were given different labels. Similarly the distinctiveness of the terms used to describe benefits and barriers to adoption were not convincing. These observations lead to the conclusion that ambiguities between the concept and the label need to be removed. A web search for a taxonomic reference model for eHealth was not successful so the decision was made to conduct an explorative study to identify if such a model existed and how these issues of classification were addressed in Industry.

A grounded theory approach (Locke 2001) was used to investigate these terms. A focus group was formed led by one of the researchers consisting of two HIT consultants[3] from a consultancy firm that specialises in HIT. The

[3] Consultant A has 25 years in Medical Informatics primarily in preventative health, has a Masters in Population Health and has completed a systematic review of a territory health systems information systems architecture and a state health departments requirements for LIMS. Consultant B has 10 years' experience in health informatics including a key architecture role in the PCEHR programme, has a Bachelor of Engineering and has been the lead consultant in an ICT strategy review of two government health department ICT strategies.

terms identified from the review were used as sensitizing concepts and the group was asked to ladder[4] the technologies by asking 'in what ways are these concepts the same and what ways are the different' to produce a taxonomy (see figure 2) by rearranging post-it notes containing the terms on a whiteboard.

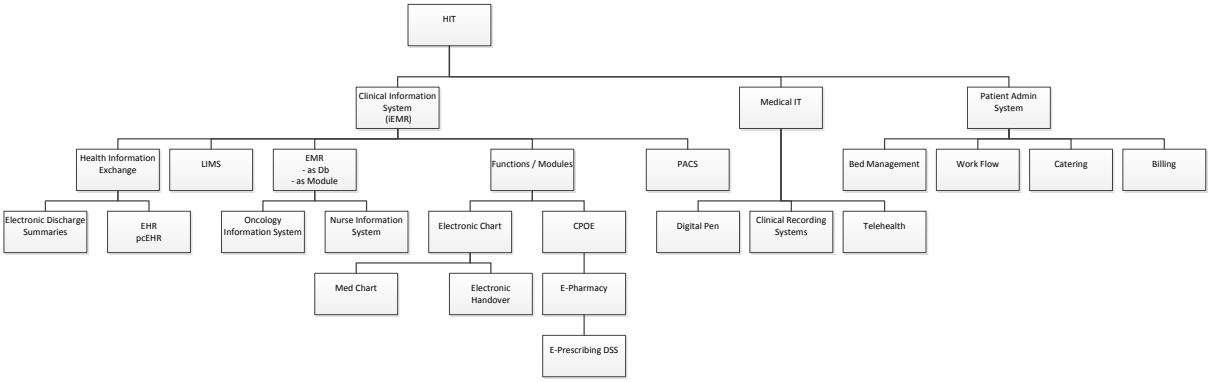


**Figure 2: HIT Taxonomy**

The group was not aware of a pre-existing clinical information technology taxonomy but commented "that there was general agreement on what some of the terms meant." They saw value in a taxonomy being established. They observed that the technology could be broadly grouped around EMR as "the database" and the functional systems that were specialised to a particular area e.g. PACS. They made a distinction between EMR, being the internal medical records created and maintained in the hospital and Electronic Health Records (EHR) which is the data set shared between organisations. They also differentiated devices and data capture and recording systems as a separate category of technologies.

The group was also asked to consider benefits and how hospital performance should be measured using a similar methodology. This appeared to be a more difficult task, with the consultants struggling to find a common ontological framework to progress the discussion. One of the consultants introduced the National Health Performance Framework (NHPC 2001) and this seemed to provide a means of classifying benefits of HIT. The domains under which benefits were classified where:

- Efficiency
- Quality or Effectiveness
    - Safety
- Access
- Continuity of Care or Communication
- Health outcomes

It was difficult for the participants to classify benefits into a strict taxonomy in the time available with items being moved around from one area to another. We can see from the result that there is not a distinct classification. The discussion of benefits lead to the observation that in HIT it is about "pay-if-forwards" – That a benefit is created but the creator does not directly benefit and that benefit diffuse through-out the system. There was an observation that the benefits mainly translate into quality/effectiveness benefits, rather than efficiency benefits. One of the participants made the comment that "when time is saved it usually results in better clinical treatment rather than more throughput."

[4] Laddering refers to the process of differentiation in a taxonomy e.g. if presented with two concepts asking how they are similar and different to establish criteria.

## DISCUSSION

### Types of HIT

A barrier to the effective study of HIT is the variety of terms used to describe the technologies. Within the literature review analysis only a few distinct classes of system surfaced but were invariably labelled in an idiosyncratic and task specific manner e.g. a nurse information system rather than an Electronic Medical Record. The focus group found that different terms did not mean substantively different technologies. Further, the literature review and the focus group did not reveal a comprehensive functional taxonomy of HIT. In other sectors of management information systems, such as ERP, there are reference models for the technology that allow for meaningful comparison. The "work in progress" taxonomy developed in this research from the focus group could be extended, improved and validated to serve this purpose. If there was agreement on such taxonomy the research into the adoption and benefits would be more meaningful.

### Benefits

In assessing the HIT interventions in hospitals the perspective adopted by most researchers was that of HIT as an intervention that could be judged in terms of success or failure. DeLone et al. (2003) have developed a model of IT success that has been well accepted by the IS research community, which categorises success into six dimensions: systems quality, information quality, usage, user satisfaction, individual impact, and organisational impact. Van Der Meijden et al. (2003) used DeLone et al.'s model to examine hospital adoption of HIT and found it possible to classify benefits on this basis. This paper's literature review of Australian HIT appears to support the possibility of classification on this basis as well however, it is noted that measures of individual and organisational impact were frequently neglected in the studies.

In the current research an overall health system performance framework was suggested as being applicable by expert informants. This framework deconstructs benefits, not so much to direct users of the technology but to the patient, the organisation and the community and does so in terms of: Efficiency, Quality, Access, Continuity of Care, and Health outcomes. What can be concluded is that today there seems to be relatively little agreement on what is the best way to classify benefits within the Australian research literature.

The observation in the focus group that benefits are appropriated is important. Most will acknowledge that there is a degree of competition for appropriation of benefits in HIT – that a win for one interest group may be a loss for another. This has been supported by research in the USA (Agha 2011). That there is relatively little research on how this effects adoption in Australia is a limitation to understanding HIT and hospital performance in this country. Mapping competing claims by stakeholder groups may promote better understanding of how the localised benefits of a technology may translate into performance of the organisation and system as a whole. If we consider doctors, nurses, other health professionals, patients, referring doctors, hospital managers, IT, health funders and shareholders of the hospital (either public or private) as potential beneficiaries and map the benefits of a technology in this way we will move the discussion of HIT's impact of performance forward. The DeLone et al. model may provide a basis for this analysis. A grounded research approach in a hospital context is needed to further this line of investigation.

### Exploring the relationship between HIT use and benefits

Leaving aside the question of whether a technology's reported benefits translate into hospital performance differences between the main classes of technology were found. In our study we saw that technologies such as CPOE more frequently delivered benefits compared to other technologies such as EMR. Why is this so? CPOE improves the velocity and reduces the cost of information distribution however the same could be claimed for EMR. Some researchers have pointed to communication processes (Georgiou et al. 2005; Georgiou et al. 2012) as being the issue and this is no doubt part of the picture. From our previous research (Sanzogni et al. 2006) we believe that the manner that organisational resources are mobilized via a technology may the at the heart of the elusive performance benefit from certain HIT technologies e.g. EMR. If this is the case then Melville et al. (2004)'s model of IT and performance will form a good theoretical basis for further inquiry.

### Need for further research

This review did not find any evidence that HIT improves overall Australian hospital performance in any meaningful and measurable manner. This is not the same as saying that HIT does not – it simply means that there is not the research to support or disprove this claim. Considering the considerable sums invested by hospital systems in HIT and the uniqueness of the Australian hospital system this is a puzzling situation; business case development seems to have been largely uninformed by academic study in Australia. It is in our view an urgent research priority in an environment where money spent on HIT comes from a broader health budget.

As IS researchers entering health informatics, we were surprised by the lack of qualitative studies in an environment which, for the most part lies at the socio-technical domain. It may well be possible to do quantitative research or to use quantitative research as part of a mixed-methodology but the risks and limitations of this approach need to be addressed. As Blumer (1954) elegantly pointed out in his seminal article on the subject the limitation of using quantitative metrics is that in dealing with complex social phenomena we can't be confident we have selected valid or appropriate metrics. There is the real possibility that the desire to measure shapes the choice of what social phenomenon is important to study. It may be that CPOE results in a faster delivery time but how did faster delivery time become rarefied into the singularly important factor to measure - could it be that this is a convenient metric readily extracted from database record timestamps or is it the result of a thorough and situated assessment of what is important to the health system. This could not be determined from the studies as published. What can be said is that measurement convenience should not drive importance of factor, and from the review it is not obvious for many of the studies how these decisions (of what to measure) were made. The research community needs to be more systematic in how it selects variables to measure if they intend to continue to rely on quantitative approaches. A grounded theory research approach is perhaps better suited to determine the variables to study.

From this initial review it can be concluded that there is a need to undertake more systematic studies of HIT adoption and health system performance in an Australian context. The current research is valuable but insufficient to draw generalised conclusions about the usefulness of HIT as an intervention in hospitals. In the absence of this research, business cases for HIT investment may be accused of triumphalism and excessive optimism. Such vulnerability to criticism makes it difficult for hospital CIOs to defend technology investment when other investments may offer great potential to improve health outcomes.

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## ACKNOWLEDGEMENTS

We would like to acknowledge of the assistance of: Griffith University librarians, Naomi Doessel and Katrina Henderson, for their assistance in the literature review; Business Aspect for providing access to their consultants for the focus group; and Associate Professor Fabrizio Carmignani (Griffith Business School) and Dr. Thomas Mandeville (University of Queensland) for their participation in our research syndicate and their contribution to developing concepts of performance and health economics that have been incorporated in this paper.

## APPENDIX 1 –REVIEW OF PAPERS

This appendix contains the analysis of papers.

Table 2 - Table of Studies

| Reference | Type of study | HIT studied | Quantitative / Qualitative | + Benefits,<br>- disadvantages | + Success factors, - Barriers to adoption | Hospital context |
|---|---|---|---|---|---|---|
| (Barnes et al. 2011) | Case Study | Electronic handover system – Sub-type of EMR | Qualitative. Nominal Survey – pre and post introduction | + Medical staff satisfaction<br>+ Quality of information<br>+ time saving | | Tertiary Hospital, Victoria |
| (Bomba et al. 2006) | Case Study | Electronic Prescribing Decision Support Systems aka<br>CPOE | Qualitative: Exploratory case study to assess feasibility of implementation | N/A | - Legacy systems<br>- low availability of IT in wards<br>- Lack of confidence in electronic information<br>- Concern over user population's ability to adopt | Public hospital, NSW |
| (Callen et al. 2008) | Case Study | Electronic discharge summaries | Quantitative, expert analysis of data errors | - Increased errors and omissions over hand written | - insufficient training | Hospital, Sydney |
| (Creswick et al. 2010) | Case Study | EMR, Electronics charts | Qualitative study using interviews and focus groups | + perceived improvement in patient care<br>- Increased time in data entry<br>+ Improved power of nurses to challenge doctors<br>+ Ease of access to patient information | | Metropolitan public hospital emergency department, NSW |
| (Crowe et al. 2004) | Case Study | PACS | Qualitative – structured interviews | + Availability of images & reports<br>+ Reduced time search for Xrays – some dep up to 1 hr per day<br>+ Easier transfer of patients from other facilities<br>+ Time taken on patient management improved<br>+ Faster clinical decision – in particular neurosurgery | - Need to integrate to clinical information systems (CIS) to allow quality audit and follow up studies ordered by clinicians | Public General Hospital, QLD |
| (Darbyshire 2004) | Focus groups | Clinical Information Systems | Qualitative – semi-structured interviews | - Reduced ability to record tacit / soft activities<br>- No change to management practices – targeting wrong KPI | - Limitations in ability to query systems<br>- Poor integration<br>- Difficult to use | 52 Nurses working in Hospitals from across country |
| (Derhy et al. 2009) | Case Study of pilot | Digital Pen & Paper,<br>Clinical Pathway Variance capture | Quantitative | + reduced LOS<br>+ reduced post-op complications | | Orthopaedic surgery in Queensland Hospital |

| | | | | | | |
|---|---|---|---|---|---|---|
| (Dunn et al. 2004) | Exploratory case study of anticipated benefits and barriers | Nurse information system / EMR,<br>Integrated delivery systems (IDS) | Qualitative: semi-structured interviews, site visits, lit reviews, focus group | Predicted only – no actuals<br>+ Maximise knowledge<br>+ Broader in-service education<br>+ Enhance collegial relationships<br>+ Eliminate duplication of services | Predicted only – no actuals<br>- IT Help desk design<br>- Lack of agreement on priorities<br>- Independent develop at each site | Regional hospital network – 3 sites, SA |
| (Firth et al. 2008) | Case Study | PAS | Qualitative: Interviews | - Nurses remain providers of tactic patient information to clinicians<br>? Cost reduction | - Lack of strategic alignment of administration and clinicians | Public hospital, Victoria |
| (Forsythe et al. 2009) | Case Study | Electronic discharge summaries | Quantitative | + Discharge summaries received by GPs by 44%<br>+ Improved rating for quality by GPs<br>+ Improved speed to send to GPs | | Two public hospitals, Queensland |
| (Georgiou et al. 2005) | Case Study | CPOE | Qualitative | + Saves time<br>+ Access to information<br>+ Communication | - Poor coordination of implementation | Hospital, NSW |
| (Georgiou et al. 2011) | Case study | CPOE,<br>LIMS | Quantitative | + CPOE system greatly improved the monitoring process within the department by providing an audit trail of each of the important steps in the Blood Bank process<br>- New LIMS systems did not replicate critical function of previous middleware | - Concerns about the safety of the system | a major metropolitan<br>hospital pathology service - NSW |
| (Grayson et al. 2004) | Case Study | Clinical DSS, e-prescribing | Quantitative – review and coding of case records | + Reduction in time spend on phone-based approvals<br>+ More compliance with drug use standards<br>+ better collection of statistical drug use | | Private Tertiary hospital, Melbourne, VIC |

| | | | | | | |
|---|---|---|---|---|---|---|
| (Li et al. 2012) | Case Study | EMR | Qualitative – structured interviews based on a grounded-theory approach | + Access to patient's chart in a more timely fashion from other departments<br>+ Access to path and rad results sooner<br>+ Improved clinical decision making | - Inability to store full treatment info led some NPs to use paper records as well<br>- Physical access to computer<br>- Utility of end-devices (CoWs)<br>- islands of data | Nurse practitioners, Emergency department, 3 hospitals, NSW |
| (Mawilmada et al. 2012) | Case Study | PAS | Qualitative - Survey | - Did not assist in clinical decision making | - Lack of Data integration<br>- Lack of time<br>- Lack of reporting tool<br>- Limited access | Cardiac Care in Queensland public hospital |
| (Massy-Westropp et al. 2005) | Case Study | Data Linking of EMR between aged care and hospital | Qualitative - survey | + Notification of admission and discharge<br>+ Better information for aged care physicians<br>+ improved inter-organisational communication | | Hospital in South Australia |
| (McLellan et al. 2009) | Case study | Automated Anaesthetic Record Keeping System (AARK) | Quantitative – time logging and Qualitative - Survey | + Reduced recording effort<br>+ Ease of use | | 2 Hospitals, Queensland |
| (Miller et al. 2009) | Case Study | Electronic Chart, sub-type of EMR | Quantitative - experiments | + Agreement in interpretation for simple variable decisions<br>- Reduced agreement on cognitively complex decisions versus equivalent paper version | | Hospital in Victoria |
| (Mohan et al. 2013) | Case Study | EMR | Quantitative – measurement of KPI | - increases patient wait time<br>- increased treatment time<br>- increased discharge time<br>- increase DNW rate | | ED in NSW Hospital |
| (Poulos et al. 2007) | Case Study | Patient Administration systems (PAS),<br>Bed management, EMR | Quantitative – measurement of KPI | + Decrease in wait time for consultation<br>+ Decrease in wait time for transfer | + Clinical leadership and participation in system implementation<br>+ Close liaison with IT department<br>+ Supported clinical workflows<br>+ Real time data capture | Area health service, NSW |

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|---|---|---|---|---|---|---|
| (Stewart et al. 2012) | Case study | PACS | Quantitative – analysis of adverse incident causes | - Clinical errors<br>- Communication breakdown | | Hospital, NSW |
| (Westbrook et al. 2006) | Case Study | CPOE, LIMS | Quantitative – Analysis of turn-around times pre and post implementation | + Improved time to process test | | Hospital, NSW, Pathology dept. |
| (Westbrook et al. 2008) | Time and motion study of doctors time | N/A | Quantitative – self reporting time using a PDA | N/A<br>Doctors spend 32.6% of time processing data in any form. 8.8% of time using a computer. | N/A | Teaching hospital in Sydney |
| (Westbrook et al. 2012) | Case study | CPOE<br>e-Prescribing | Quantitative – systematic review of scripts for errors | + reduction in errors versus handwritten scripts<br>- System induced errors | | 2 teaching hospitals in Sydney |
| (Yu et al. 2010) | Case Study, Comparison of two projects | Oncology Information System (OIS),<br>EMR | Qualitative – Semi-structured interviews, | + Access to information<br>+ Improved communication | + Mandatory use – no use of paper<br>+ Clinical leadership<br>- Continued use of paper<br>+ Project management<br>+ Redesign of workflow | 2 hospitals in Sydney |