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KNOWLEDGE MANAGEMENT FOR A SPECIAL CLASS OF PROFESSIONAL PRACTICES – LEARNING FROM *e*HEALTH

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DEDICATIONS

This dissertation is dedicated to my late father and the late Professor John A. Henry (of St Mary's and Imperial College, University of London), who was named Mr. E by the media.

My research interest in Benevolent Physician is due to my late father – an individual who could learn almost anything effortlessly, but had not been fortunate enough to receive much formal education. He educated himself to be a qualified Chinese doctor, acted as if he were the patient, and always offered charity treatment to the needy.

I was fortunate to benefit from fruitful and open discussions with the late Professor Henry on medical decision-making and related matters. The effort of research will be repaid if this work furthers his spirit of contributing to wide and judicious use of medicine.

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CURRICULUM VITAE

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______. 2008b. Medical Decisions: A Two Stage Decision Model with Information Updating. In Wai-Mun, Chia and Hui-Ying Sng, eds., *Singapore and Asia in a Globalized World: Contemporary Issues and Policies*. Singapore: World Scientific.

ABSTRACT

Knowledge Management for a Special Class of Professional Practices – Learning from *e*Health

Sandro Kwei-fun Tsang

This work postulates that an eHealth initiative is comparable in many respects to a technology-facilitated Knowledge Management (KM) initiative. eHealth experience provides rich evidence to explore KM policy-making for leveraging professional intellect.

Implementing eHealth implies caring for patients with codified knowledge to some extent. With appropriate application of KM strategy, technology can accommodate wiser use of professional intellect to deliver medicine more effectively and efficiently. A simple and quantifiable model has been derived to help determine the optimal KM strategy. This policy device may be tested in further research. A more imperative task is to achieve that ideal state of adopting technology into medical practice. An assessment model has been developed to help in achieving this goal through identifying the causal factors.

Methodological triangulation is applied to formulate, operationalise and test a seven-dimensional Computerised Clinical Decision Support System (CDSS) Use model. It involves (i) a multi-stage literature review of different disciplines and (ii) applications of R programming skills and various statistical/psychometric techniques including bootstrapping. VBA programmes have been developed to quicken the sampling process that requires compiling incomplete information from various sources.

A multi-stage Factor Analysis process has validated the CDSS Use model. It includes testing the dimensions that have been under-studied or not yet operationalised. The results suggest that Knowledge Quality of a system and medical decision factors are crucial to judiciously adopting HIT into medical practice. They also support integrating the contexts of a profession and the type of system under study into system assessment.

This work shows a convincing approach to formulation of a KM model even if the KM process cannot be modelled directly. It offers an objective base to better understand medical/clinical decision-making. This will help govern medical practice to deliver better care under the eHealth (or soon to be KM) climate.

GLOSSARY

Acronym/Terminology	Definition/Explanation
Capitalised words	Refer to a discipline or terminology such as Knowledge, Knowledge Management, Management, Information, Ontology, etc. Dicta are kept in the original forms and should be interpreted in accordance with the content.
CATI	Computer-Assisted Telephone Interview
CDSS	"Computerised Clinical Decision Support Systems are information systems designed to improve clinical decision making" (Garg *et al*., 2005, p.1223).
CEO	Chief Executive Officer
CIO	Chief Information Officer
CKO	Chief Knowledge Officer
Clinical Reasoning	A synonym for Clinical Decision-making and Clinical Problem-solving (Stempsey, 2009)
Coded Knowledge	Knowledge in articulated form
CoP	Community of Practice
EbM	Evidence-based Medicine
eHealth	"eHealth can be defined as encompassing information and communications technologies (ICT)-enabled solutions providing benefits to health, be it at the individual or at the societal level" (European Communities, 2007, p.8).
EHR	Electronic Health Record (System)
EMR	Electronic Medical Record (System)
GP	General Practitioner
HIT	Health Information Technology
IC	Intellectual Capital
ICT	Information and Communication Technology
IS	Information System
IT	Information Technology
KBO	Knowledge-Based Organisation

Acronym/Terminology	Definition/Explanation
KM	Knowledge Management
KMS	Knowledge Management System
knowledge	Human knowledge
Latent Variable	An indirectly measurable or unobservable variable. It may refer to a construct, factor or subfactor interchangeably.
management	Those in charge of running a business (WordNet English Dictionary, http://wordnet.princeton.edu/)
Manifest Variable	An observable/measurable variable. It may refer to an item or indicator interchangeably.
MIS	Management Information Systems
OL	Organisational Learning
OM	Organisational Memory
PSF	Professional Service Firm

CHAPTER I

INTRODUCTION

The World Health Statistics (World Health Organization (WHO), 2010) show that expenditure on health was 9.7% of the overall GDP of all the 193 WHO member states in 2007 and 9.2% in 2000. On average, 59.6% of this was publicly financed in 2007 and 57.9% in 2000. This accounted for 15.4% of the overall government expenditure in 2007 and 14.5% in 2000. The size of this sector suggests that even a slight change can impact the rest of the economy noticeably. In reality, the efficiency of health sectors is always of concern. The frequency of reform is a telling sign of this.

In recent decades, health system reform has been an important public issue in some countries. For example, in 1983, the US reformed its health system from a fee-for-services system (an example of a Full-cost Reimbursement System) to a more incentive-based health system similar to a Prospective Payment System (Ellis & McGuire, 1986). Similar reforms happened in the UK in 1990 (Silcock & Ratcliffe, 1996), in Canada during the 1990s (Evans, 1997), and in many other countries.

Reforms of a different nature are also underway. Since the early 1990s, eHealth initiatives have been launched in Europe, the US and other countries worldwide (Bates *et al.*, 2003; eHealth Initiative, 2006; European Communities (EC), 2007; fraserhealth, 2007). The British National Health Service (NHS) has already implemented a programme of knowledge codification (Wyatt, 2001). WHO has been acting on the 10-year KM Global Operational Plan (WHO, 2006). These eHealth initiatives appear to be just a predecessor of the next wave of reforms − Knowledge Management (KM) implementations. To derive KM policies for the healthcare sectors is an imperative task.

Currently, KM implementation is not the motivation of all eHealth initiatives (see EC, 2007, for example). From a technological lens, eHealth refers to the application of Information and Communication Technologies (ICTs) across the whole range of functions that affect the health sector (EC, 2004). ICT systems have fulfilled the characteristics of an ideal Knowledge Management System (KMS) to a certain extent (Maier & Hädrich, 2006). If the capabilities of ICTs are properly utilised, the impacts of implementing eHealth are comparable to implementing technology-facilitated KM.

Also note that health is "knowledge-driven and technology-enabled" (WHO, 2006, p.6). Medical decision-making involves "a knowledge gathering process, knowledge storage, knowledge retrieval, and information processing" (Raghavan, 2009, p.279).[1] Knowledge, in the form of skilled care, is the product (Arrow, 1963). Medical decision-making, by definition, is a KM process (see Alavi & Leidner, 2001; Subsection 2.3.3 for definitions of KM process). In theory, eHealth could result in increasing returns to professional intellect through technology if it is sufficiently and judiciously adopted into medical/professional practice. In practice, it requires certain conditions to be simultaneously in place in order to implement this ideal state. This work aims to develop an approach to identify those working conditions.

1.1. BACKGROUND OF THE STUDY

Various parties appear to be optimistic about the impacts of Health Information Technology (HIT) on healthcare delivery (see EC, 2007; Garets & Davis, 2006; Hillestad *et al.*, 2005; Taylor & Leitman, 2002; WHO, 2006, for example). Taylor and Leitman (2002) note that, on average, 80% of the General Practitioners (GPs) in the EU and 94% of the US primary care physicians use computers in their practices. However, the adoption of HIT for consultation appears to be less appealing. Only six out of these 16 countries reveal that a majority of their physicians use Electronic Medical Records (EMRs). On average only 29% of the GPs in the EU use EMRs and 17% in the US. In recent years, the issue has been mitigated slightly, but remains severe (see Hsiao *et al.*, 2008, EC, 2008).

The severe under-use issue suggests that the effects of HIT on improving healthcare are likely to be limited. On the other hand, further massive investment in HIT is underway (see EC, 2007; eHealth Initiative, 2006, for example). The under-use issue causes concerns that eHealth will never be fully deployed and/or lead to increasing returns to medical professional intellect. Identification of the underlying causes is a precondition for mitigating or resolving it.

Reluctance appears to be a popular explanation (Orlikowski, 2000; Raghavan, 2009). Indeed, a review of the issue from the perspective of medical practice reveals that

[1] Clinical decision-making may be a more appropriate term as CDSS/HIT use for consultation is the focus of this work. However, medical decision-making is also the term used by certain authors. The two terms are, therefore, used interchangeably.

it may reflect physicians' intent to judiciously use HIT to care for patients. KM policies appear to have a role in implementing a desirable outcome.

Evidence-based Medicine (EbM) has increasingly been emphasised by healthcare institutes (Sood *et al.*, 2009; Taylor, 2006; ter Meulen, 2005). The original proposal of EbM practice is to "integrate the best evidence with clinical expertise and patients' choice" (Sackett *et al.*, 1996) to deliver medicine proven to be effective (ter Meulen, 2005). However, "the best evidence" appears to be increasingly chosen from Random Clinical Trials − whose practice environments are ideal and often deviate from the clinical realities (*ibid.*). The medical community is concerned that the enforcement of EbM guidelines will result in delivering "cookbook medicine" (ter Meulen, 2005) – homogenised (cost-saving) procedures. However, ethical indoctrination drives physicians to treat individual patients with the truly EbM principle that requires applications of their "clinical expertise" (tacit knowledge) (*ibid.*) – cost-augmented procedures. A "divide" between management (and/or policy-makers) and physicians can be expected. Such a "divide" can impede the delivery of healthcare (Edwards, 2005).

Implementing eHealth involves knowledge codification. It encourages treating patients with codified knowledge to some extent. If EbM practice can potentially lead to practising "cookbook medicine," then overly applying codified knowledge to patient care may result in practising digitalised "cookbook medicine." Homogeneous treatment is an anticipated consequence. In the worst scenario, it is a matter not just of individual patient welfare, but also of public health. For example, homogeneity in antibiotic prescriptions is a contributing factor to the heightened chance of antimicrobial resistance (Laxminarayan & Weitzman, 2002). Widening the "divide" can be expected from introducing eHealth to enforce EbM practice unless physicians are permitted to judiciously apply HIT and EbM to care for patients. Otherwise, ethical indoctrination may have to be separated from medical practice.

Wyatt (2001) portrays the issue more optimistically. The author (*op. cit.*) opines that not all medical decisions deserve creative solutions that require assessing the uncertainties involved. Codification does not necessarily lead to "one therapy for each disease" (*ibid.*). Empirical evidence shows that wise use of HIT could help (i) achieve better informed-choice decisions (Einbinder *et al.*, 1997) and (ii) encourage specialists to exchange and accumulate tacit knowledge (O'Brien & Cambouropoulos, 2000). Wyatt (2001) proposes careful application of KM strategies to healthcare – codification strategy for common/routine cases and personalisation strategy for cases that deserve creative solutions. This proposal appears to be convincing. However, identifying the right mixed strategy is not easy. A seemingly common/routine medical case can be a complicated case. For a trivial example, at the time of the SARS epidemic, physicians might have dealt with an obvious common cold complaint as if it were a SARS complaint (Lane & Tsang, 2008a). From a KM lens, KM strategy is still in an ongoing research agenda (Koenig, 2004).

Recall that Taylor (2006) considers clinical contextual information to be crucial to clinical decision-making. The author (*op. cit.*) recommends that systems should be designed to allow recording such information in accordance with each clinical context. Similarly, KM strategies may be derived to accord with each clinical context. For example, one may consider assessing the impacts of applying HIT by clinical categories. The methods may include assessing the physician performance and improvement in patient health (see Garg *et al*., 2005).

Wyatt's (2001) proposal of applying KM strategy to healthcare appears to be practicable. However, its credibility is undermined by a lack of a quantifiable model to determine the optimal KM strategy. A simple model has been formulated to address this issue (see Section 2.4). An imperative policy-making task is to identify the conditions that can contribute to judicious adoption of HIT so that medical professional intellect can be leveraged to "much higher levels."

1.2. PURPOSE OF THE STUDY

Resolving or mitigating the under-use issue can heighten the chance of leveraging medical professional intellect through eHealth initiatives. Accordingly, a focus of this study is to formulate, operationalise and test a model that can explain the use decisions.

So far, HIT adoption for medical practice is inferred from the EMR use rates. EMR is an application environment composed of the clinical data repository and various technologies/systems (Garets & Davis, 2006). Its infrastructure includes CDSS (*ibid.*). CDSS assists physicians in communicating with patients about their medical issues, diagnosis or prescribing (EC, 2008). Stempsey (2009) suggests that clinical decision-making (or clinical reasoning) includes thinking about diagnosis, prognosis, treatment selection, and physician-patient communication. A better measure of HIT adoption for medical practice is actually the extent to which CDSS is used.

The existing literature has demonstrated mixed empirical results in the benefits of using CDSS (Chaudhry *et al.*, 2006; Garg *et al.*, 2005). However, CDSS seems to improve physician performance most of the time (Garg *et al.*, 2005). In theory, the use of CDSS is in the physicians' interests. A survey indicates that CDSSs have been used in only less than 5% of all healthcare facilities in the US (Wong *et al.*, 2000). On average, 50% of the GPs in the EU use CDSSs (EC, 2008). That is, deployment of CDSS is also potentially hindered by the under-use issue. Indeed, a systematic review indicates that the majority of available CDSSs are not yet ready for mainstream use (Garg *et al.*, 2005). Clearly, the under-use issue may reflect judicious use rather than physician reluctance. To be precise, a focus of this study is to formulate, operationalise and test a model that can explain the CDSS use decisions.

A reasonable understanding of CDSS is crucial to understanding the under-use issue. Raghavan (2009) poses that, to understand a CDSS, it is important to analyse the medical decision-making process. Note that a consultation is a human encounter; medical decision-making is not purely something done by a physician or aided by a computer (Stempsey, 2009). This and the definition of clinical reasoning (see *ibid.*, p.173) fundamentally suggest that CDSS use should be seen from an integrative perspective of people, process, technology and professional intellect. Some of these elements are subsumed in the Jennex and Olfman (2006) KM System (KMS) Success (J&O) model. However, a reformulation is required in order to introduce the contexts of medical practice and CDSS related technologies into the model. The resulting model can then be empirically tested and applied.

1.3. THEORETICAL FRAMEWORK

CDSSs have been of particular research interest since they demonstrate the potential in facilitating EbM practice (Chaudhry, 2007). This subsection outlines (i) an approach to internalise the context of medical decision-making into a model and (ii) the theoretical model − the CDSS Use model − to be tested empirically.

The medical care industry has its special features (Arrow, 1963).[2] Uncertainty is the cause (*ibid.*). "When there is uncertainty, information or knowledge becomes a commodity" (*ibid.*, p.946). Uncertainty is shown in the production process. "[A] given medical encounter may start as one model of interaction [between physician and patient], but evolve into something else as the encounter unfolds" (Charles *et al.*, 1997, p.688). Medical decision-making is so complex that it cannot be conceptualised by one single model (Gafni *et al.*, 1998) or some algorithms (Stempsey, 2009). Clinical decision-making may never be fully understood (Stempsey, 2009). However, "[i]n organisations, [knowledge] often becomes embedded not only in the documents or repositories but also in organisational routines, processes, practices, and norms" (Davenport & Prusak, 1998, p.5). Knowledge *per se* is the product of medical care (Arrow, 1963). The product and the production activity are identical (*ibid.*). So, a complementary study of the operations of healthcare institutes can help us to understand medical decision-making.

The medical profession exhibits the overlapping features of organisations where professional intellect is the key asset. For example, it meets the following features of Knowledge-based Organisations (KBO):

1. An organisation staffed by a high proportion of highly qualified staff who trade in knowledge itself (Alvesson, 1993a; Starbuck, 1992, 1993).
2. Projects are the typical way of working in most KBOs (Dingsøyr, 2006).

Licensing and tertiary education are the entry restrictions for medical professions (Arrow, 1963). Physicians are sometimes trained in multi-professional teams (Wyatt, 2001) and make decisions jointly (Charles *et al.*, 1997). A health complaint is, therefore, a project. For Professional Service Firms (PSFs), work is also performed by small teams and is project-based (Alvesson, 1993b). These arrangements tie them in a network of Communities of Practice (CoPs) (see Stein, 2007, for a discussion of CoP's definition). A literature search indicates that medical practice does share more features of a PSF than a KBO. Table 1 summarises those overlapping features (see Subsection 2.5.2 for an elaboration).

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[2] "The causal factors in health are many, and the provision of medical care is only one" (Arrow, 1963, p.941). In this work, most stylised facts about medical practice are generalised from the perspective of medical decision-making (precisely, clinical decision-making). Ideally, "medical care" should be uniformly used to reflect Arrow's (1963) opinion about its relation with health. Medical care and healthcare are used interchangeably for the latter term may be more familiar to many.

Table 1: The Overlapping Features of Professional Service and Medical Care

Professional Service Firm	Physician-Patient Relationship Literature
Knowledge is a capacity to act and to serve the client (Fink & Disterer, 2006).	Arrow (1963); ter Meulen (2005)
Work is usually performed by small teams and is project-based (Alvesson, 1993b).	Charles *et al*. (1997); Wyatt (2001)
The professional knowledge hierarchy (Quinn *et al*., 1996): • "Cognitive knowledge" (know-what), • "Advanced skills" (know-how), • "Systems understanding" (know-why), and • "Self-motivated creativity" (care-why).	Arrow (1963); Wyatt (2001)
The nature of PSF service (Evans & Volery, 2000): • "Intelligence", "Consulting", "Counselling", and "Relationship networking."	Butler *et al*. (2001); Charles *et al*. (1997, 1999); Wyatt (2001)
Fink and Disterer (2006) add that • The production and consumption of services occur simultaneously, and • Professional knowledge services are heterogeneous.	Arrow (1963); Butler *et al*. (2001); Charles *et al*. (1997, 1999); ter Meulen (2005); Wyatt (2001)

For other professions, the quality of services is monitored by the clients. For medical care, "the patient cannot check to see if the actions of [the] physician are as diligent as they could be" (Arrow, 1986, p.1184). It is not completely monitored by healthcare institutes either. Medical practice is governed by guidelines (Butler *et al*., 2001; ter Meulen, 2005). However, the institutes have to accept physicians' codes of ethics and allow medical societies to adjudicate some issues (Starbuck, 1992). The "ethically understood restrictions on the activities of a physician are much more severe" than on other professions (Arrow, 1963, p.949). Professional standards and autonomy are enforced by collegiality (Starbuck, 1992). Also, physicians are both vertically and horizontally monitored by colleagues at similar and senior levels (Fama, 1980).

Ethic indoctrination, in the form of altruism, is hinted at by Scott's (2001) econometric work. The author (*op. cit.*) notes that physicians showed willingness to trade off their income against quality of care. The work also reveals that physicians appeared to be willing to trade off their income to work in practices with guidelines that are likely to reduce their clinical autonomy. This finding is surprising given that autonomy is considered to be the hallmark of physician professionalism (Holsinger & Beaton, 2006). Scott (2001) infers that this may be due to physicians' concerns about quality of care and/or litigation avoidance. This may imply that, by giving physicians the right incentive (not necessarily in pecuniary terms), autonomy can be compromised.

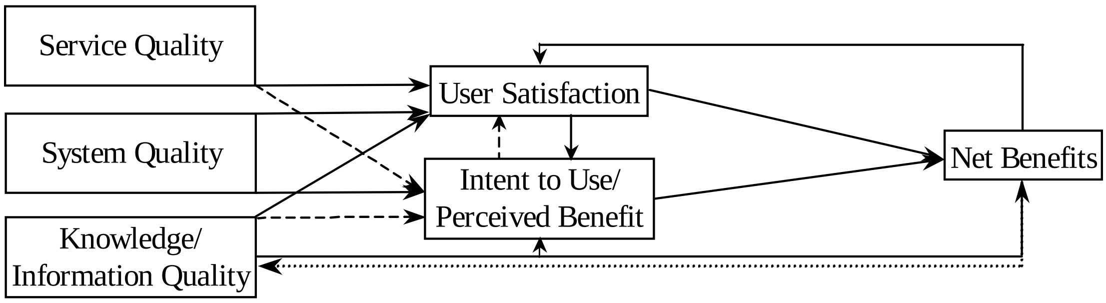
Recently, Agostini *et al.* (2007) have conducted a study into the perceptions of the benefits and limitations of a decision support system – a computerised reminder system. The physicians had both positive and negative perceptions about the reminder. Their perceptions were: (i) technology-specific (positive perception of integrating computers into clinical care); (ii) user interface-related (time needed to read reminders); (iii) professional (threats to physician autonomy); and (iv) health sciences-related (educational value/information content) (*ibid.*). Perhaps the under-use issue may suggest that the benefits of using these technologies do not outweigh the time cost and the cost of a possible loss of autonomy.

The above discussion shows that a complementary study of the operations of healthcare institutes helps us to understand the nature of medical practices. The resulting stylised facts have been internalised into the Jennex and Olfman (2006) KMS Success model to formulate a CDSS Use model (see Subsection 3.4.2 for details).

The DeLone and McLean (2003) IS Success (D&M) model is the baseline model of the J&O model (Jennex, 2006a; Jennex & Olfman, 2006). As at the year 2007, at least 90 empirical studies have examined the D&M model in different contexts and with different systems (Petter, DeLone and McLean, 2008). The sound foundation of this research line can be seen. Its "both complete and parsimonious" properties are unbeatable by other IS Success models. Loosely speaking, the J&O model can be seen as a derivation of the D&M model applicable to assess a specific application (see Petter *et al.*, 2008) − KMS (see Subsection 2.3.5 for KMS definition). EMR is built on KM enabling technologies (see Subsection 3.4.1). CDSS and KMS rely on artificial intelligence technology and were evolved from expert systems (Liebowitz & Beckman, 1998; Raghavan, 2009; Sieloff, 1999, Taylor, 2006). The J&O model appears to be the preferred baseline model for formulating a CDSS Use model.

In fact, the J&O model deviates from the D&M model considerably. To be concise, it introduces more human elements and knowledge quality into the D&M (2003) model. It consists of six dimensions: (i) System Quality, (ii) Knowledge/Information Quality, (iii) Service Quality, (iv) Intent to Use/Perceived Benefit, (v) User Satisfaction and (vi) Net Benefits. Detailed explanations about the J&O model can be found in Subsection 2.3.7. A simplified expression of the modified model is found in Figure 1. It incorporates the results of Petter *et al.*'s (2008) literature review on empirical studies of D&M (2003) at an individual level of analysis. This is also a basis for structuring the theoretical CDSS Use model.

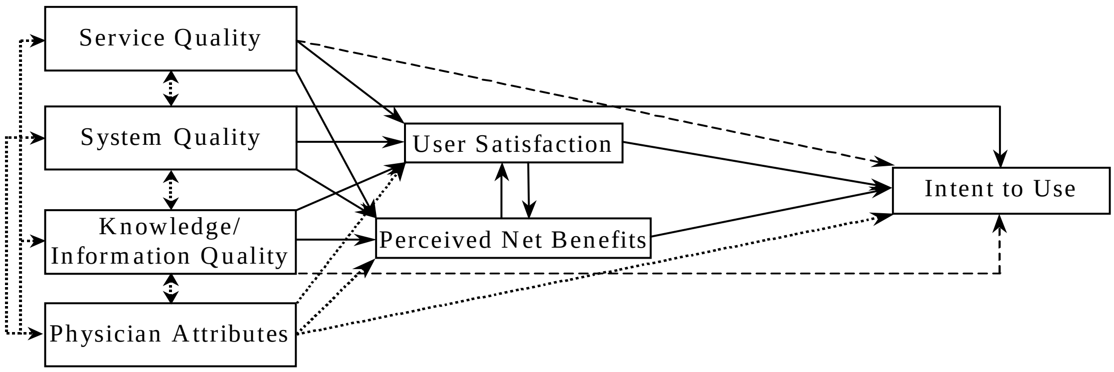
Figure 1: A Re-expression of the Jennex and Olfman (2006) KMS Success Model (Incorporated with the Results of Petter *et al.*'s (2008) Review)



The dashed paths of Figure 1 represent the relationships that are not sufficiently supported by empirical evidence (see Petter *et al.*, 2008). A causal path from the Net Benefits to Knowledge/Information Quality is not posited in the D&M (2003) model. So, it was not reviewed by Petter *et al*. (2008). This is denoted by a dotted path. Although the authors' (*op. cit.*) review is a reliable reference, the findings should not be interpreted in a strict sense. As different IS Success researchers define the constructs and measures differently, these studies are not precisely comparable (see *ibid.*; Gable *et al*., 2008).

To form a CDSS Use model, a Physician Attributes construct has been introduced into the modified J&O model (see Figure 2). This new construct represents physicians' major concerns: (i) altruism towards patients, (ii) autonomy and (iii) litigation avoidance. The other constructs are defined (or redefined) based on (i) other generalised stylised facts of medical practice and CDSS related technologies, and/or (ii) the theories and findings about IS Success (see Section 3.4 for details).

Figure 2: The *a priori* Computerised Clinical Support System Use (CDSS Use) Model



Detailed explanations about this CDSS Use model can be found in Subsection **3.4.2**. In short, it has reversed the causal relationship between Net Perceived Benefits and Intent to Use. This setting is consistent with Davis' (1989) Technology Acceptance Model (TAM) and the classical economic theory of consumer choice. Seddon (1997) has adapted this setting to re-specify the D&M (1992) model. The model has been empirically validated by Rai *et al.* (2002). Substantial evidence also supports that Net Benefits determine Intent to Use (Petter *et al.*, 2008). The dotted paths represent that (i) the under-use issue is a confluence of people, process, technology and professional intellect issues (see Subsection 2.5 for an elaboration) and (ii) Physician Attributes are associated with Net Perceived Benefit and User Satisfaction (Subsection 3.4.2). This model would be validated by self-reported data. So, only Intent to Use could be estimated. Similarly, the results could only reveal physicians' self-assessed impacts of a system on individuals' performance. So, only the Net "Perceived" Benefits could be estimated.

1.4. RESEARCH QUESTIONS

This study aims to answer the following questions:

(i) Does triangulating people, process and technology impact the use of CDSS or HIT for consultation?

(ii) What are the user- and non-user specific reasons for (not) using HIT for medical practice?

1.5. EXPECTED IMPACTS

The expected impacts of this work are not limited to providing insights into adoption of HIT for medical practice − a natural but insufficiently acknowledged KM issue. It can contribute to (i) research in leveraging professional intellect through technology-facilitated KM and (ii) other research areas such as KM and Organisational Studies, IS Success and governing medical practice.

The medical care industry has certain special features that are favourable for implementing desirable KM outcomes. For example, physicians are altruistic and in a permanent CoP network (Section 1.3). These properties are drivers for knowledge sharing (see Brown & Duguid, 2001; Constant *et al.*, 1994, for example). eHealth reforms provide rich evidence for deriving a role model of technology-facilitated KM. The results are going to be of reference value for organisations that rely on "expert economics" and intent to implement KM.

The CDSS Use model integrated the contexts of medical practice and CDSS related technologies into a popular IS Success theory − the D&M model. This approach requires a proper understanding of medical decision-making. However, medical decision-making is so complex that it may never be fully understood (see Stempsey, 2009). To address this issue, the stylised facts of the medical decision-making are complemented with that of the operations of the healthcare institutes. This approach may be applied to other situations where the KM processes can hardly be captured. Gupta *et al.*'s (2004) paradox of expertise is another example of these situations (see Subsection 2.3.8 for details).

IS Success research has been established for more than three decades (Gable *et al.*, 2008). There is still little consensus on what is the appropriate measure (*ibid.*). Over the last decade, few IS Success studies have worked on formulating models or measures to portray a holistic view (Petter *et al.*, 2008). Very little work has been done to formulate models to evaluate Health Information Systems (Turunen, 2009). This work has proposed, operationalised and validated an integrated CDSS Use model − a profession-specific assessment/evaluation model.

As an EC (2007) report notes, eHealth brings not only new opportunities, but also new risks. The work provides insights into reducing the risks. For example, eHealth reform can impose a risk of intensifying the conflicts between management and physicians. The medical community has been concerned that the enforcement of EbM guidelines will result in delivering "cookbook medicine" (ter Meulen, 2005). CDSS demonstrates the potential in facilitating EbM practice (Chaudhry, 2007). eHealth reforms are going to further enforce EbM practice. This work poses that eHealth based EbM does not necessarily lead to conflicts. As discussed in Chapter II, altruism towards patients, autonomy, litigation avoidance are the major concerns of physicians (Arrow, 1963, 1986; Butler *et al.*, 2001; McGuire, 2000; ter Meulen, 2005; Scott, 2001). This work preliminarily suggests that to find the right balance among these elements can encourage the use of CDSS or HIT for consultation. This research direction can help deploy eHealth to enable practising truly EbM with minimal "divide" between management and physicians. It shows an approach to understanding medical practice on an objective basis. This can help achieve the goal, as the "divide", in some sense, originates from a lack of understanding about medical practice (see Edwards, 2005). A "divide" free healthcare institute can generally help produce better healthcare outcomes (*ibid.*).

1.6. LIMITATIONS

Survey research has been chosen for an empirical study. It is one of the most common methods for evaluating IS impacts (Kraemer, 1991).

Every research method has its respective strengths and weaknesses. Survey is a less costly and time-consuming approach to collect primary data in comparison with census (Bethlehem, 2009) and qualitative methods. Under certain conditions, it can produce generalised results (*ibid.*; Peachey *et al.*, 2007). The collected primary data are more likely to be representative and replicable in comparison with those collected by qualitative data. However, survey data may not reflect the in-depth meaning of interviewees as reliably as a qualitative method may. For example, a survey instrument cannot record the facial expression of an interviewee. What is not recorded can be crucial. The weaknesses of the survey method may be mitigated by a careful application of methodological triangulation (see McGrath, 1982). Quantitative methods may also be more precise than qualitative methods as results are derived from numbers.

In this work, qualitative secondary data have been employed to compensate for certain weaknesses in the survey method and a major criticism against factor analysis (i.e., its non-uniqueness procedure may lead to subjective interpretation (Härdle & Léopold, 2007)). For example, the CDSS Use model was operationalised by (i) combining standardised measures with established reliability and validity − a method that is used by many researchers (Aydin, 2005); and (ii) developing items based on the stylised facts of the relevant IS systems (Petter *et al.*, 2008). The effects may be comparable to internalised evidence from secondary qualitative data. Also the statistical results were interpreted in accordance with the theories and results drawn from studies of different research scopes and methods. For example, the reading includes: Agostini *et al.* (2007) (qualitative analysis of a cohort study), DesRoches *et al.* (2008) (expert consensus and survey), Garg *et al.* (2005) (systematic review), Petter *et al.* (2008) (qualitative literature review of empirical studies), etc.

Recall that to understand a CDSS, it is important to analyse the medical decision-making process (Raghavan, 2009). A consultation is a human encounter (Stempsey, 2009). In this work, the respondents are physicians. In further work, patients' opinions may be included and interpretative analysis be employed. However, this work remains a robust anecdotal study for finding out if it is worth conducting costly in-depth research in certain areas.

1.7. ORGANISATION OF THE DISSERTATION

This chapter shows that an eHealth initiative is comparable in many respects to a KM initiative − an opportunity for leveraging Professional Intellect. Particularly, implementing eHealth usually involves an implementation of HIT, hence codification. With application of appropriate policies such as KM strategy, codification can be optimally implemented to accommodate wiser use of medical professional intellect to deliver medicine more effectively and efficiently. However, this ideal state can hardly be achieved if HIT is not sufficiently and judiciously integrated into the medical care process.

This chapter also outlines a possible method for answering two research questions − (i) Does triangulating people, process and technology impact the use of CDSS or HIT for consultation? and (ii) What are the user- and non-user specific reasons for (not) using

HIT for medical practice? The results may contribute to policy-making in implementing judicious use of HIT for practising EbM and other research areas.

A literature review is given in Chapter II. It poses that KM is an integrative discipline of people, process and technology. Accordingly, KM policy-making should aim to addressing these three elements simultaneously and be complemented with other corporate policies. It also presents a KM policy-making device to help optimise KM strategy in a simple and quantifiable approach. Chapter III discusses the methodology and research design to answer research questions (i) and (ii) identified by the extensive literature review. Chapter IV presents the statistical procedures and results. A conclusion, some implications and contributions can be found in Chapter V.

CHAPTER II

LITERATURE REVIEW

2.1. INTRODUCTION

"Knowledge Management" (KM) literally means the act of managing knowledge. Its fuzzy nature is suggested by the fact that there is no universal definition of KM nor Knowledge (Beckman, 1999). There is absolutely no agreement on what constitutes KM either (Wilson, 2002). However, KM appears to be an unavoidable pursuit in today's Knowledge Economy era. Knowledge and information is now being produced as if it were cars and steel produced in the industrial economies (Stiglitz, 1999a). "The capacity to manage human intellect… is fast becoming the critical executive skill of the age… [T]here has been a flurry of interest in intellectual capital…, but surprisingly little attention has been given to managing professional intellect" (Quinn *et al.*, 1996, p.71).

Quinn *et al.* (1996) are convinced that "new technologies and management approaches" is the avenue "to leverage professional intellect to much higher levels" (p.74). The current eHealth reforms open up rich evidence to study this issue at both macro and micro levels.

Implementing eHealth involves an implementation of Health Information Technology (HIT) and thus knowledge codification. It causes concerns that physicians will be driven to practise digitalised "cookbook medicine" that treats patients efficiently, but with "one therapy for each disease". It could also lead to wiser use of professional intellect to deliver better medicine. Wyatt (2001) is convinced that, with careful application of KM strategies, more effective and efficient healthcare can be achieved. For example, the widely-agreed and carefully-validated common/routine cases can be treated with codified knowledge and cases that deserve creative solutions with tacit knowledge (*ibid.*). This idea is consistent with (i) Hansen *et al.*'s (1999) proposal for choosing KM strategy to reflect an organisation's competitive strategy and (ii) Grant's (1996a) proposal for integrating specialised knowledge through optimal use of rules, routines and group problem-solving (see Munkvold, 2006; Subsection 2.3.3). Wyatt's (2001) proposal appears to be credible for leveraging medical professional intellect. To act on this proposal, it requires addressing two immediate issues.

First, KM processes potentially touch upon all the procedures and operations in an organisation (Brooking, 1996; O'Dell & Grayson, 1998a). Apparently, KM strategy needs continual refinements. However, it appears that there is a lack of a simple model to help in deriving KM strategy on an objective basis. Second, significant evidence suggests that HIT has been far from being routinely used for consultation (European Communities (EC), 2008, Taylor & Leitman, 2002). To be able to understand these causal factors is the prerequisite for mitigating (or resolving) it in order to fully deploy eHealth. The under-use issue does not appear to have been sufficiently studied (see Subsection 2.5.2).

Accordingly, a simple and quantifiable KM strategy model is proposed in Section 2.4. Section 2.5 explores the possible research directions to study the under-use issue. Section 2.3 demonstrates KM's essence in general. It supports Bali *et al.*'s (2009) idea that any potential KM solution should come from combining these three elements. A concluding section is found in Section 2.6. This literature review starts with a discussion of the incentives for studying KM in Section 2.2.

2.2. THE INCENTIVES FOR STUDYING KNOWLEDGE MANAGEMENT

The *Nobel Prize Laureate* F.A. Hayek (1945) conceptualises managing knowledge in an organisational setting. However, KM research has only been active since the mid-1990s (see Peachey *et al.*, 2007). Its full potentials still await exploration. Accordingly, this section mainly discusses the evidence available fairly recently.

2.2.1 An Academic Perspective

KM is recognised as being a sub-discipline of Information Systems (IS) or Organisational Behaviour (Jennex & Croasdell, 2007). Significant evidence suggests that KM is not only an established, but also a fast growing discipline. Its research potentials cannot be taken lightly.

To Be a Pioneer Researcher of a Young but Established Discipline

There are diverse opinions about KM's identity as a discipline. For example, Spiegler (2000) sees it as a new name for an old IS concept. Birkinshaw (2001) opines that KM has matured into a discipline. Jennex and Croasdell (2007) show that substantial evidence demonstrates that KM has met Kuhn's (1996) criteria for being an established discipline. The authors (*op. cit.*) also remark that KM is an established, but still a young discipline.

Peachey *et al.* (2007) notice that the maturity of KM could have been understated. The authors (*op. cit.*) examined the KM papers published between 2001 and 2005 based on certain criteria and the modified McGrath (1982) methodological triangulation model.[3] The result shows that the methodological triangulation of KM research is similar to some more mature disciplines (*ibid.*). It further confirms that KM is not another "fad and fashion syndrome" in Management research (Alvesson & Kärreman, 2001).

A Fast Growing Literature with the Potential of Spanning across Disciplines

Burden's (2000) KM bibliography cites over 900 books and 8,000 articles devoted to KM that encompass both research and industry/trade publications (*ibid*.). Rollett's (2003) bibliography cites over 1,000 academic research articles on KM (*ibid*.). Gu's (2004) bibliometric analysis shows that 2,727 authors have contributed 1,407 KM publications since 1975 (Nonaka & Peltokorpi, 2006).

Peachey *et al*. (2007) performed an ABI/Inform search using the keywords − knowledge management. It returned 43 articles published for the period 1990–1995, over 700 articles for the period 1995–2000 and over 2,000 articles for the period 2000–2005. The result shows that that KM research has been proliferating since the mid-1990s. The 18 KM dedicated journals alone produce over 500 articles annually (Schwartz, 2006a).

Various authors, including Laurence Prusak (2006) (a co-author of a KM seminal paper), have listed the disciplines involved in KM. The extent of KM's multi-disciplinary nature can be inferred from some statistics from the *Encyclopaedia of Knowledge Management*. The *Encyclopaedia* has been contributed by 249 authors affiliated with 29 distinct disciplines (Schwartz, 2007). The top four affiliation categories make up the vast majority (71.08%) – Information Systems (44.58%), Computer Science (15.66%), Information and Library Science (6.02%) and Management (4.82%). It is noted that 82.3% of contributors are affiliated with the traditional Information and Management-

[3] The minimal requirement for triangulation is to use more than one research strategy or approach. The modified McGrath (1982) model is a spiral methodological process of (i) theory formulation, (ii) field data collection, (iii) precision maximisation, and (iv) generalisation maximisation. (see Peachey *et al.*, 2007, for details).

related fields (*ibid.*; see Table 2 for details).

Table 2: The Distribution of the Affiliated Departments of the Authors of the *Encyclopaedia of Knowledge Management* (Schwartz, 2007; Reprinted by Permission of the Publisher)

Traditional Information and Management-Related Fields		Nontraditional Fields	
Information Systems	44.6%	Economics	2.4%
Computer Science	15.7%	Marketing	2.4%
Information Science	6.0%	Cognitive Science	2.0%
Management	4.8%	Philosophy	2.0%
Communications	2.4%	Social Psychology	1.6%
Management Science	2.0%	Sociology	1.2%
Engineering Management	1.6%	Education	0.8%
Information Management	1.2%	Engineering	0.8%
Organizational Science	1.2%	Finance	0.8%
Human Resource Management	0.8%	Innovation Studies	0.8%
Media Management	0.8%	Mathematics	0.8%
Technology Management	0.8%	Banking	0.4%
Business Administration	0.4%	Cultural Studies	0.4%
		Real Estate	0.4%
		Science andTechnology	0.4%
		Statistics	0.4%
Total	82.3%	Total	17.7%

Schwartz (2007) comments that KM is a fragmented field with multiple (often conflicting) terminologies and goals. Teece (1998) called for addressing this issue through formulating a unified KM theory to integrate different standalone fields a decade beforehand. Schwartz (2007) queries if a common profile in KM is desirable given that a similar situation persists in the over 40-year IS research. Conversely, Peachey *et al.* (2007) notice that KM research has already appeared in a wide variety of disciplines. Given time, KM would be an important perspective in many disciplines.

2.2.2 A Practitioner's Perspective

A Promise for Improving Competitiveness

"In an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge" (Nonaka, 1991, p.96).

The knowledge-based view posits that knowledge is a key strategic resource that can enable competitive advantage for an organisation (Conner & Prahalad, 1996; Grant, 1996a; Spender, 1996). In the resource-based view, knowledge is a strategic asset with the potential to be a source of sustainable competitive advantage for an organisation

(Barney, 1991a; Conner, 1991; Peteraf, 1993; Prahalad & Hamel, 1990; Wernerfelt, 1984). By Prahalad and Hamel's (1990) core competency philosophy, knowledge is suitable for application in many different markets, is difficult for competitors to imitate and creates a significant contribution to customer value. In an Economist's terminology, knowledge is a source of monopolistic power – an opportunity for supernormal profit. It exhibits the property of increasing returns to scale (Stiglitz, 1999a).

Perhaps the temptations of practising KM also stem from the success of giant organisations' turning into Knowledge-Based Organisations. Examples include Accenture, Buckman Laboratories, Ford Motor Company, KPMG Peat Marwick, Nucor Steel and the World Bank (Rubenstein-Montano, 2004; Stiglitz, 1999a).

Business Opportunities

It was estimated that worldwide spending on KM services would grow from US$776 million in 1998 to more than US$8 billion by 2003 and US$12.7 billion in 2005 (Gupta & Sharma, 2004). A report estimated that the total KM software market would reach US$5.4 billon by 2004 (Duffy, 2000).

In fact, KM activities may have been under-invested. For example, a comprehensive HIT network has not been implemented in the US – the world's largest healthcare industry (Hillestad *et al.*, 2005). Most medical records are still in paper form (*ibid.*). It is a well-documented fact that the healthcare industry spends a lower percentage of its revenue on IT than other industries, which might suggest that investment is too low (Bower, 2005). This is just the situation of one sector in one country. As discussed in Chapter I, eHealth initiatives are likely to be progressed into KM initiatives ubiquitously. An under-investment in KM is evident.

Also note that the spending on KM activities may have been unreported. Walsham (2001, 2002) notes that many organisations have been leveraging knowledge through Information and Communication Technologies (ICTs). ICTs have already been developed into KM enabling technologies to some extent (Becerra-Fernandez & Sabherwal, 2006; Maier & Hädrich, 2006). An empirical study finds that many organisations in the German-speaking countries have only implemented knowledge management systems (KMSs) partially or KMSs that have not reached a comprehensive level (Maier, 2004). These are just a few examples. Huge KM related business opportunities are on the way.

An Unavoidable Pursuit to Stay in Business

Jennex (2007) summarises a workshop discussion at the 2006 Hawaii International Conference on System Sciences (HICSS) conference regarding the confluence of trends that drove KM to be prominent in the late 1990s (HICSS is a reputable IS conference (Kankanhalli *et al*. (2007)):

1. Organisations realised that they lost key knowledge over the early 1990's Business Process Reengineering fad by changing processes and reducing staff.
2. KM implementation was a consequence of fully utilising the progressively advanced technological capabilities. The Year 2000 (Y2K) date problem drove many organisations to replace older computers with new models that came with KM enabling capabilities.
3. Gaining back managerial control from information overload and a loss of control of information flow due to the rapid growth of the Internet, intranets, data warehouses and databases.
4. Switching to a service-based economy that required sustaining capabilities by retaining high-value staff. Codifying knowledge was a possible solution.

The Theory of Innovation suggests that "smart buyer[s]" have a role in driving organisations' innovation directions (see Rogers, 1995). Walsham (2001) poses that ICTs have become an essential component of contemporary lives. While ICTs are part of consumers' lives, organisations can no longer satisfy the smarter consumers with business processes, products and services that are built on old technologies. While new ITs are needed to please the smarter consumers, KM practice becomes a logical consequence of deploying the complementary KM enabling capabilities.

In conclusion, KM offers an avenue for (i) publications and academic positions, and (ii) exploiting the huge business opportunities. KM appears to be essential for many organisations, if not all.

2.3. KNOWLEDGE MANAGEMENT IN GENERAL

Alvesson and Kärreman (2001) notice a usual, but not the only, approach in Knowledge Management research as follows:

> *"[W]e don't know very much about 'knowledge', but we know how to manage it!"* (p.1014)

This approach may suit a "fad and fashion" research area, but KM is an established discipline (see Subsection 2.2.1). Accordingly, the definitions of Knowledge are chosen to be an integral part of a literature review of KM rather than a separate section.

2.3.1 What Do We Intend to Manage?

Knowledge. However, "everyone defines knowledge differently" (Starbuck, 1992, p.736).

The nature of Knowledge has been intriguing philosophers, as far as we know, since the time of Socrates, Plato and Aristotle (Wickramasinghe, 2006).[4] This branch of Philosophy appears to be at the root of much KM thinking. A thorough review is desirable but unachievable. Substantial evidence suggests that a discussion of the widely accepted definitions is sufficient for understanding KM's essence.

Epistemology Origin

Epistemology can be defined as the Theory of Knowledge (Aarons, 2006). The formal definition of Knowledge has been a subject of open-ended debates in Epistemology (*ibid.*; Schwartz, 2006b). However, the idea that Knowledge is an individual's "true justified belief" appears to be the building block of most analytic philosophers' work (*ibid.*; Johnson, 2007).[5] This is derived from Descartes' (1640) "scepticism" approach and knowledge proposition "*cogito ergo sum*" – literally "I think, therefore I exist" (*ibid.*).

Accordingly, Knowledge is considered as a personal item that can be expressed in a sentence, and can be evaluated for truth or falsehood (or scepticism in Descartes'

---

[4] See Wickramasinghe (2006) for a summary of the different perspectives of Knowledge.

[5] This definition is sometimes referred to as the Neo-Platonic definition of Knowledge (Butler, 2006; Johnson, 2007).

terminology) (*ibid.*). Descartes (1640) considers that this approach puts the "I exist" proposition beyond doubt (*ibid.*). The Cartesian paradigm remains the foundation of much philosophical work (*ibid.*). KM research generally refers to Knowledge as beliefs, values and experience (Land *et al.*, 2006). This can, at least, be seen from the four KM seminal publications identified by Jennex and Croasdell (2007) as follows:

- The first ranked publication – Nonaka and Takeuchi (1995) opine that "Knowledge, unlike information, is about justified true beliefs and commitment."
- The third ranked publication – Nonaka (1994) poses "Unlike information, knowledge is about beliefs, commitment, perspectives, intention and action."
- The fourth ranked publication – Alavi and Leidner (2001), adapting from Nonaka's (1994) work, restate "Knowledge is usually defined as a justified belief that increases an individual's capacity to take effective action."

The second ranked publication's definition of Knowledge is often quoted and is possibly the most self-explanatory one among the four seminal works. Davenport and Prusak (1998) pose:

> *"Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in the documents or repositories but also in organisational routines, processes, practices, and norms."* (p.5)

These definitions consistently suggest that knowledge is personal, true and justified belief. Knowledge refers also to a practical tool for framing experiences, sharing insights and assisting with practical tasks (Aarons, 2006). It is the "practical tool" and the potentially "collective" qualities that differentiate KM from traditional philosophical works that only address the production of "personal" knowledge. KM emphasises knowledge manipulation in a collaborative context (*ibid.*).

The influence of this line of thinking can be inferred from some other evidence.

Jennex and Croasdell (2007) notice that approximately 70% of the 204 KM-related HICSS papers cited the works where Ikujiro Nonaka is an author. Nonaka's (1994) paper is one of the 20 most frequently cited KM articles in the peer-reviewed leading Management journals (Nonaka & Peltokorpi, 2006). Nonaka and Takeuchi's (1995) work is the most widely read KM reference (Gupta *et al.*, 2004). It is identified as the most cited and influential KM work in Ponzi's (2004) extensive bibliometric analysis. Davenport and Prusak's (1998) work was regarded as the one that popularised KM by many participants of a workshop at the 2006 HICSS conference (Jennex, 2007). Jennex and Croasdell (2005) comment that Davenport and Prusak (1998) and Alavi and Leidner (2001) are two of the most cited publications in KM. The influence of those definitions in KM is evident.

These definitions also lead us to consider that (i) if knowledge is about belief, then it is a religion (Butler, 2006). Practising KM is a rite; and (ii) knowledge is value-added behaviours and activities (Pfeffer & Sutton, 2000). "Knowledge, however, is intangible, boundaryless, and dynamic, and if it is not used at a specific time in a specific place, it is of no value" (Nonaka & Konno, 1998, p.41). Apparently, managing knowledge involves risks or uncertainty. Indeed, knowledge is "elusive" as a commodity (Arrow, 1963).

This subsection shows that the precise definition of Knowledge is controversial and an open-ended pursuit. However, Knowledge has a widely accepted definition – a belief. Another dominating perspective is outlined in the next subsection.

Knowledge vis-à-vis Information and Data (KID/DIK)

There are inter-relationships between Data, Information and Knowledge. Nonaka and Peltokorpi (2006) suggest that authors have largely unified perspectives of data and information in comparison with knowledge. Indeed, the definitions are also debatable. Let us discuss the following two examples:

> *"Data are raw stimuli with little organization or ready utility (Alavi & Leidner, 2001). Data become information when they are processed and organized in a systematic way. Information becomes knowledge when it is ready to be used to orient action. In Davenport, Long, and Beers' terms, 'Knowledge is a high value form of information that is ready to apply to decisions and actions'*

> *(Davenport et al., 1998, p.43).”*[6]
>
> Nelson and Hsu (2006, p.827)

> *“Data can be classified as raw numbers, images, words, and sounds derived from observation or measurement. Information represents data arranged in a meaningful pattern.”*
>
> Nonaka and Peltokorpi (2006, p.75)

The first quotation is self-explanatory. The definition of Knowledge is consistent with the four seminal papers’ definitions. In a relatively new terminology – “Knowledge… can be characterised as unstructured or semi-structured, whereas information and data are fully structured” (Tauber & Schwartz, 2006, p.260). This definition is perfectly consistent with the idea that “data become information when they are processed and organised in a systematic way.”

The second quotation is a typical explanation often cited in the literature. If we were to accept “meaningful pattern” easily, the definition of Knowledge – “true justified belief” would not have been subject to refinements by philosophers and scientists for millennia. KM research and practice would not have been difficult, nor, perhaps, interesting. Some insights may be found from Tuomi’s (1999) reversed relationship of Data-Information-Knowledge (DIK).

Tuomi (1999) considers that knowledge must have existed before information can be formulated and/or before data can be measured to form information. This view emphasises that knowledge does not exist outside a knower − it is indelibly shaped by one’s needs as well as one’s initial stock of knowledge (Fahey & Prusak, 1998; Tuomi, 1999). Alavi and Leidner (2001) add that information is converted to knowledge once it is processed in the minds of individuals. Knowledge becomes information once it is articulated and presented in any symbolic forms such as text, words, graphs, etc. (*ibid.*). A shared (human) knowledge base is the pre-requisite of shared understanding for the same pieces of data, information or knowledge (*ibid.*).

Neither an Epistemological view nor KID/DIK suggests that knowledge in articulated form is a perfect substitute for human knowledge.

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[6] In the KM literature, data and information in electronic forms are sometimes referred to as (coded) knowledge (see Davenport and Prusak, 1998, p.68, for example). Knowledge is referred to as human knowledge and data/information as codified knowledge in this work.

Beyond the Dominating Schools of Thought

The dominating schools of thought about knowledge in KM have been outlined in the two preceding subsections. Alavi and Leidner (2001) note that there are different non-philosophical perspectives about Knowledge. A concise summary is as follows:

1. Knowledge *vis-à-vis* information and data (see the preceding subsection)
    - Data are facts, raw numbers. Information is processed (or interpreted) data. Knowledge is personalised information.
2. State of mind
    - Knowledge is the state of knowing and understanding.
3. Object
    - Knowledge is an object to be stored and manipulated.
4. Process
    - Knowledge is a process of applying expertise (knowing and acting simultaneously).
5. Access to information (an extension of the "Object" view)
    - Knowledge is a condition of access to information.
6. Capability
    - Knowledge is the potential to influence action.

Alavi and Leidner (2001) note that each perspective suggests a different strategy for managing the knowledge and view on the role of IT in KM. For example, perspectives 3 and 5 tend to consider that human knowledge can be validly embedded in an IS.

Economic Theories Survive in a Knowledge Economy Era

The *Nobel Prize Laureate* Joseph E. Stiglitz (1999a,b) is one of the economists who works on Knowledge Economy research. A literature search may give an impression that economists have drawn much more attention to Information than Knowledge.

It may be interesting to re-examine Roberts' (2000) proposition – Microeconomic analysis has treated knowledge as information since the work of another *Nobel Prize Laureate* Kenneth J. Arrow (1962) until quite recently. This challenges the reliability of the KM research that is founded on the earlier economic works and the authority of many

Economic theories.

Roberts' (2000) proposition appears to be convincing if words are taken literally. For example, Arrow (1963) notes:

> *"When there is uncertainty, information or knowledge becomes a commodity…"* (p.946)

Note that market or institutional conditions are often part of the specifications of economic models. This meets Davenport and Prusak's (1998) definition – knowledge is contextual, experiential and actionable information. Let us take Economics of Information as an example. Suillvan (2000) states "[t]he economics of information applies to any idea, expression of an idea, or fact that is known by one person and is potentially of value to another" (p.271) (Ariely, 2006). This quotation implies that the Economics of Information applies to not only knowledge (any justified belief; see pp.21–23), but also Intellectual Capital. (Sullivan (2000) defines Intellectual Capital (IC) as "knowledge that can be converted into profit" (p.192)). It highlights that it requires special care in order to introduce Economic theories into KM work. It is necessary to identify the dimensions of knowledge that are analogous to perfect information, complete information, imperfect information, incomplete information and so on. These assumptions crucially determine the decision structures of economic models.

Readers should soon notice that the terms Knowledge and Information are often used interchangeably in the KM literature. The terms *per se* only suggest the literal meaning. The in-depth meaning is embedded in the context. It is the latter that matters. Similarly, a KM initiative should be defined by the context of a campaign not its name.

Taxonomy of Knowledge and Its Implications for Knowledge Management

Hitherto, Knowledge has been considered as a single entity or a composite of data/information. Knowledge is complex. It has different dimensions.

Various knowledge taxonomies exist (Jennex, 2007). A thorough discussion of different dimensions is not intended. Only the tacit and explicit dimensions are elaborated due to their importance in the KM literature. Another focus is on a less discussed aspect of Taxonomy – its functions.

The most commonly used taxonomy is Polyani's (1958, 1966a) and Nonaka's (1994) tacit-explicit knowledge (Alavi & Leidner, 2001; Jennex & Croasdell, 2005). Jennex and Croasdell (2007) notice that tacit-explicit taxonomy seems to be the only common ontology among the 173 KM papers presented at HICSS during 1998 to 2006.[7] If KM scholars rarely agree with each other, this is the area where they can find their consensus. Tacit knowledge and explicit knowledge are sometimes referred to Ryle's (1949) "know-how" and "know-that" respectively (Brown & Duguid, 2001). Nonaka's (1994) work certainly has popularised Michael Polanyi's tacit-explicit taxonomy (Walsham, 2001). Some authors assume that Ikujiro Nonaka and Michael Polanyi have identical opinions about tacit and explicit knowledge (*ibid.*). Walsham (2001) points out that there are differences.

Tacit Knowledge in Polanyi's (1966a) opinion is what "we can know more than we can tell" (p.136). It is hidden, personal, context-specific, difficult to express in verbal, symbolic and written form, and therefore hard to formalize and communicate (*ibid.*). The contrary applies to explicit knowledge. Polanyi (1966b) adds that "[w]hile tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is either tacit or rooted in tacit knowledge. A wholly explicit knowledge is unthinkable" (p.7). Polanyi (1958, 1966a,b) considers knowledge essentially resides in humans' minds. Knowledge has different degrees of tacit qualities (*ibid.*). Applying his proposition into a KM context, knowledge embedded in an IS *per se* is just some sort of information or code.

Ikujiro Nonaka's opinion about tacit knowledge is captured by his (1994) spiral knowledge-creation model. This model suggests that tacit knowledge can be explicated and expands through a spiral process of:

1. Socialisation – a tacit-tacit transformation via apprenticeship,
2. Externalisation – a tacit-explicit transformation via an articulation of nuances,
3. Combination – an explicit-explicit transformation via formal learning of

[7] There are numerous definitions of ontology (Berztiss, 2006; Holsapple & Joshi, 2006). Definitions that help understand this work are: (i) Kalfoglou's (2002) definition − "[a]n ontology is an explicit representation of a shared understanding of the important concepts in some domain of interest" (Berztiss, 2006); and (ii) Gruber's (1995) definition − "simplified and explicit specification of a phenomenon" (Holsapple & Joshi, 2006).

facts, and

4. Internalisation – an explicit-tacit transformation occurs when new explicit knowledge from different sources is internalised (or synthesised).

This SECI model postulates that knowledge is dynamic and can be transformed (i) from tacit to explicit dimension and (ii) from individual to social knowledge then embedded in a collective setting. Note that Polanyi (1958, 1966a,b) regards tacit knowledge as a personal item "hidden" in humans' minds. All knowledge has tacit quality (Polanyi, 1966b). The idea that tacit knowledge is something to be externalised and embedded in a collective setting does not appear to have invariably captured Polanyi's (1958, 1966a,b) original ideas. However, the authors (*op. cit.*) also note that tacit-explicit knowledge transformation is difficult, if not impossible, despite advances in research in communications technology. Apparently, Ikujiro Nonaka denies that IT can fully capture tacit knowledge.

In the literature, tacit knowledge is often considered to be equivalent to implicit knowledge. A similar situation applies to explicit knowledge and codified knowledge. Indeed, they are different in nature and have different implications for KM.

Organisations can only rent tacit knowledge; they cannot own it outright (Brooking, 1996). However, implicit knowledge is hidden in the operations procedures, methods and even the organisational culture (*ibid.*). That is, implicit knowledge is an organisation's invisible asset. The major challenge in managing it is to identify it and optimise its usage. It appears that the most we can do with tacit knowledge is to motivate knowers to input it into the business processes. Unfortunately, "capturing" tacit knowledge is often presented as central to KM (Wilson, 2002). If this is proven to be true, practising KM may lead to allocating resources to non-yielding activities.

Explicit knowledge is well organised in the mind of an individual, and may also be articulated (Brooking, 1996). Davenport and Prusak (1998) define Codified Knowledge (or Coded Knowledge) as knowledge that is converted into "accessible and applicable formats." Therefore, it is an output of explicit knowledge (or an input from a DIK perspective) (see Subsection 2.3.1). In other words, explicit knowledge is not necessarily codified, but codified knowledge is explicit. Codified knowledge is, therefore, a proper subset of explicit knowledge. Johnson (2007) suggests that "codified knowledge is best thought of as information or 'potential' knowledge" (p.135).

It is beyond the scope of this research to exhaustively discuss other taxonomies. Perhaps it is of reference value to recall Alavi and Leidner's (2001) well-known summary of Knowledge taxonomies as shown in Table 3. The functions of Taxonomy have drawn relatively little attention comparing with Taxonomy *per se*. The publications of Ein-Dor (2006) and Schwartz (2006b) show the values of understanding knowledge taxonomy.

Table 3: Knowledge Taxonomies and Examples

(Alavi & Leidner, 2001; Reprinted by Permission of the Publisher)

Knowledge Type	Definition	Example
Tacit	Knowledge is rooted in actions, experience, and involvement in specific context	Best means of dealing with specific customer
Cognitive tacit:	Mental models	Individual's belief on cause-effect relationships
Technical tacit:	Know-how applicable to specific work	Surgery skills
Explicit	Articulated, generalized knowledge	Knowledge of major customers in a region
Individual	Created by and inherent in the individual	Insights gained from completed project
Social	Created by and inherent in collective actions of a group	Norms for inter-group communication
Declarative	Know-about	What drug is appropriate for an illness
Procedural	Know-how	How to administer a particular drug
Causal	Know-why	Understanding why the drug works
Conditional	Know-when	Understanding when to prescribe the drug
Relational	Know-with	Understanding how the drug interacts with other drugs
Pragmatic	Useful knowledge for an organisation	Best practices, business frameworks, project experiences, engineering drawings, market reports

Taxonomy facilitates description and analysis (Ein-Dor, 2006). Aristotle (384-322 B.C.) poses that the function of categorising knowledge objects is to make them accessible to thought (*ibid*.). A mundane example is the Dewey library classification system. Taxonomy is also a component of Ontology (Buchholz, 2006; Holsapple & Joshi, 2006). Ontology often has an important role in Knowledge Management Information Technology (Buchholz, 2006). Taxonomy helps understand the nature of a knowledge item (Ein-Dor, 2006). Accordingly, modes for representing knowledge in efficient and effective computational solutions can be chosen, and knowledge can be elicited and embedded in an IS (*ibid.*). Schwartz (2006b) shows that taxonomical approach helps identify the role of IT in different KM processes.

Ein-Dor (2006) considers that a knowledge item can have overlapping dimensions. For example, a data item embedded in an IS of an organisation is generally explicit, declarative, social and organisational (*ibid.*). The author (*op. cit.*) shows that, with application of taxonomy, the extent to which ITs can (or cannot) be applied to a knowledge item can be identified. For example, ITs can assist witnesses to describe physiognomies of the suspects that cannot easily be described verbally (*ibid.*). This is a situation where ITs can help elucidate what "we can know more than we can tell" (Polanyi, 1966a, p.136) and "we cannot tell" to a certain extent. For another example, the potentials of expert systems have not been realised since eliciting expert knowledge is extremely difficult. Even if expert knowledge is elicited, it may be difficult to represent it in digital form (*ibid.*).

The work of Ein-Dor (2006) highlights that the nature of a knowledge item determines the computation solutions that are required for each KM task when ITs are applicable. Taxonomy helps identify how a knowledge item can be handled by IT effectively and efficiently and to what extent. It also helps appropriately choose trade-offs between ITs and human resources (a proxy of human knowledge).

Schwartz (2006b) maps Aristotle's five intellectual virtues of thought into a knowledge hierarchy. The order is (i) Epistémé – Factual or scientific knowledge; (ii) Téchné – Skill-based technical and action-oriented knowledge; (iii) Phrónésis – Experiential self-knowledge or practical wisdom based on experience; (iv) Noûs – Intuition; and (v) Sophía – Theoretical knowledge of universal truths or first principle. Each virtue is then mapped into different KM processes. The mapping is illustrated in Table 4.

Scientific discovery, augmentation and proof of theorems are all in the realm of Sophía (Schwartz, 2006b). The author (*op. cit.*) considers that it is beyond the scope of KM to manage Sophía.[8] Noûs has tacit elements of Téchné and Phrónésis and is about

[8] Perhaps Sophía may be what Spiegler (2000) refers to as wisdom – beyond knowledge.

manner. It cannot be acquired by a KM enabling IS. It is suggested that Noûs can be discovered, modelled and classified through the use of social network-mapping tools (tools for enabling a personalisation KM approach; see Subsection 2.3.8 for Personalisation). Téchné and Phrónésis cannot be created through KM processes, but can be discovered, gathered for storage by presentational systems, organised and distributed.[9] It also has indirect impacts on enhancing Noûs. Epistémé can be created through various IT techniques such as data mining, text mining, neural networks, information resource discovery and other advanced pattern-recognition techniques. Schwartz (2006b) shows that taxonomy can help identify (i) which KM processes must be strengthened and (ii) on what occasions and to which extent ITs can be applied in order to meet the KM needs of an organisation.

Table 4: Mapping Aristotle's Knowledge Virtues to KM Processes by the KM Definition of Schwartz *et al.* (2000) (Schwartz, 2006b; Reprinted by Permission of the Publisher)

Process	Noûs	Epistémé	Téchné	Phrónésis	Sophía
Acquisition					
creation	no	yes	no	no	n/a
discovery	yes	yes	yes	yes	n/a
gathering	no	yes	yes	yes	n/a
validation	no	yes	yes	yes	n/a
Organization					
modeling	yes	yes	yes	yes	n/a
classification	yes	yes	yes	yes	n/a
calibration	yes	yes	yes	yes	n/a
integration	yes	yes	yes	yes	n/a
Distribution					
sharing	yes	yes	yes	yes	n/a
reuse	no	yes	yes	yes	n/a
maintenance	no	yes	yes	yes	n/a
dissemination	yes	yes	yes	yes	n/a

To conclude, understanding the nature of a knowledge item helps us to decide (i) which KM processes should be strengthened and (ii) how each KM task can be effectively and efficiently proceeded by ITs and/or humans. That is, it helps better allocate human and IT resources. Taxonomy certainly has a role in this.

What Does "Manage" Mean?

To define Knowledge is not sufficient to answer: What do we intend to manage?

[9] Téchné and Phrónésis are essential for carrying out knowledge work (see Butler & Murphy, 2006; Subsection 2.3.6). Managing knowledge workers (or expertise) has been an important research area in recent years (see Blackler, 1995).

So far, the discussion shows that the definitions of Knowledge are controversial. Knowledge is not definitive, perhaps “elusive” in Kenneth J Arrow’s (1963) term. It is, indeed, shaped by the management mode. Alvesson and Kärreman (2001) suggest that broadly speaking managerial intervention can be on a coordination or control mode.

If management insist on being in a strict control mode, then possibly codified knowledge is what they can manage. As discussed, codified knowledge is the only knowledge dimension that is outside the mind and, therefore, can be centralised. However, knowledge required for an entire economic process is initially dispersed among many people (Hayek, 1945). Also, “the critical executive skill of the age” is “the capacity to manage human intellect” so as “to convert it into useful products and services” (Quinn *et al.*, 1996, p.71). This cannot be possibly done without “many intermediaries” and “communication” to integrate the knowledge and act on it (Hayek, 1945). These fundamentally suggest that management have to adopt a coordination mode if they mean to manage different knowledge dimensions.

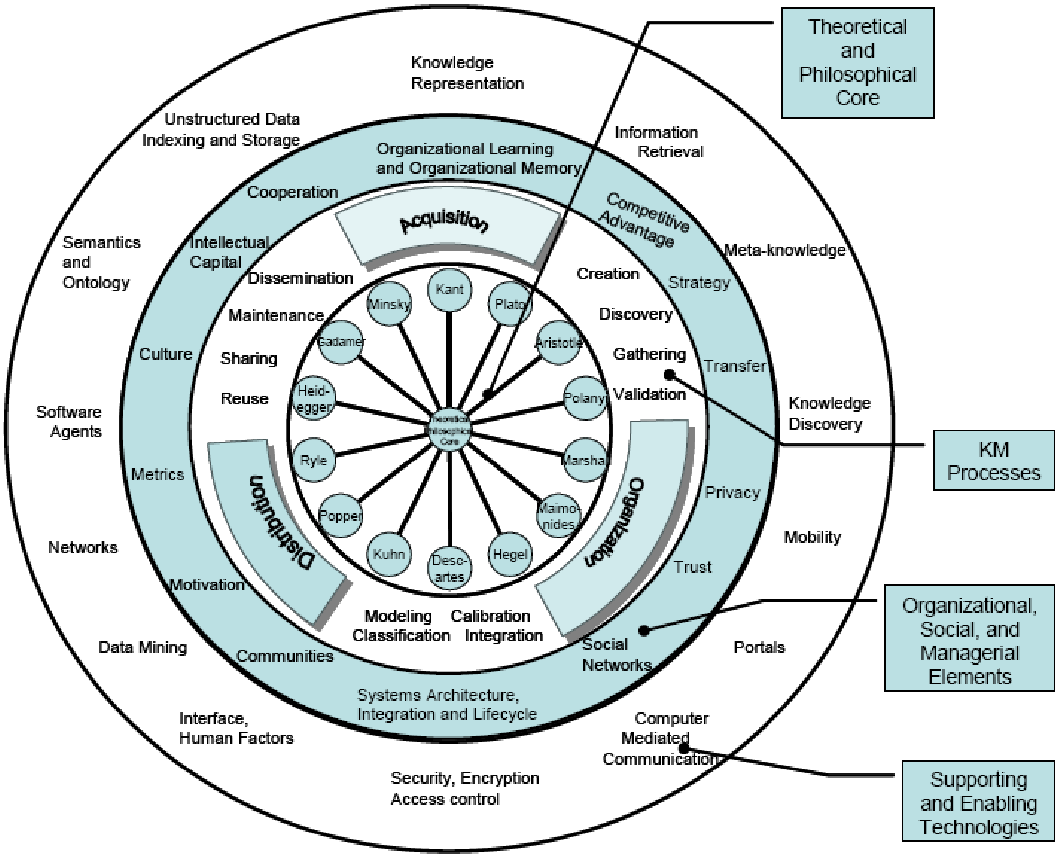
To conclude, what is intended to be managed is crucially determined by the management mode to be pursued.

2.3.2 Definitions of Knowledge Management

Jennex (2007) notes that, in a 5-page short article (Corral *et al.*, 2005), three KM experts define KM in three different ways. This indicates the controversial nature of KM and its diversity in definitions. Rubenstein-Montano *et al.* (2001) have identified 26 KM frameworks in a literature review. Peachey *et al.* (2007) identify 17 KM frameworks from the 12 peer-reviewed IS journals. The complexity of KM can be inferred from Schwartz’s (2006b, 2007) layered KM approach diagram (see Figure 3).

In general, “[KM] is largely regarded as a process involving various activities” (Alavi & Leidner, 2001, p.114). This may be seen from the KM definitions of the four seminal papers and those derived for different contexts.

Figure 3: Layer upon Layer of Knowledge Management: Formulated on the Basis of Schwartz *et al.* (2000) and the Articles in the *Encyclopedia of Knowledge Management* (Schwartz, 2007; Reprinted by Permission of the Publisher)



Nonaka and Takeuchi (1994, 1995) define KM as the processes of creating, transferring and (re-)using knowledge. The other two seminal publications pose consistent definitions. Alavi and Leidner (2001) consider KM, at a minimum, involves the processes of knowledge creation, knowledge storage and retrieval, knowledge transfer and knowledge application. Davenport and Prusak (1998) define KM as a process of knowledge generation, knowledge codification and coordination, knowledge transfer, and knowledge roles and skills.

The latter two definitions have overlapping processes. Davenport and Prusak's (1998) knowledge transfer subsumes knowledge application (Peachey *et al.*, 2007). Davenport and Prusak (1998) consider a knowledge transfer process as incomplete until the knowledge is both internalised and used – "knowing is not doing" (p.102). The "knowledge roles and skills" process establishes it as a socio-technical oriented definition

(Peachey *et al.*, 2007). Surprisingly, this process is not considered to be necessary to the success of a KM initiative by any of the 26 KM frameworks identified by Rubenstein-Montano *et al*. (2001) (*ibid.*). Peachey *et al.*'s (2007) literature survey suggests that this process is the least studied one in comparison with knowledge creation, storage and retrieval, transfer and application.

Examples of IT-oriented definitions are found in Correl *et al*. (2005). One author suggests that the purpose of KM is to disseminate knowledge quickly and KMSs are essentially document management systems. Another suggests that KM is the process of handling unstructured knowledge. Murray Jennex considers KM combines technical and organisational initiatives to manage structured and unstructured knowledge in order to help the organisation improve its effectiveness through improved retention and reuse of knowledge (Jennex, 2007).[10]

As discussed in Subsection 2.3.1, with the application of taxonomy, it is possible to identify which KM process or task can be strengthened by ITs. That is, KM can switch to Organisational Learning (OL) or Organisational Memory (OM). It involves lengthy illustrations to formally define OL or OM. Only generic definitions of OL and OM are given to keep our focus on KM. Concisely, KM is more about techniques for applying and accumulating knowledge, while OL is more about learning (Bennet & Tomblin, 2006). OM is the mechanism to bring knowledge from the past for present and future use; and KM emphasises knowledge in current use (Jasimuddin *et al*., 2006). OM is considered to be a subset of KM (*ibid.*). Jennex (2007) considers knowledge to be a subset of OM and the processes of KM a subset of OM processes. OL uses OM as its knowledge base (*ibid.*). Based on the inter-relationship between KM, OL and OM, Jennex (2007) suggests the working definition of KM is:

> *"KM is the practice of selectively applying knowledge from previous experiences of decision making to current and future decision-making activities with the express purpose of improving the organization's effectiveness. (Jennex, 2005)"*
>
> (Jennex, 2007, p.6)

This definition corresponds to Taylor's (2006, p.13) opinion about Evidence-based medicine (EbM) in an eHealth context (see Subsection 2.5.2).

[10] See Subsection 2.3.1 for an explanation of structured and unstructured knowledge.

A credible KM practitioner's definition may be:

> *"Knowledge management includes activities related to the creation, capture, organization, maintenance, retrieval, and use of organizational knowledge to promote improved decision-making and performance."*
>
> (The website of KMG Philadelphia, Stein (2007, p.150))

Knowledge Management Group (KMG) of Philadelphia is a community of KM practice that comprises over 240 members; approximately 94% of them are KM practitioners (Stein, 2007).

The World Health Organization's (2006) definition is:

> *"Knowledge Management is a process of surveying and associating items of information or knowledge, preferably visually, in such a way that the mapping itself creates additional knowledge by determining, for example, where knowledge assets and gaps are located and how knowledge flows in the system."* (p.1)

This could potentially be the future definition of KM for health systems worldwide.

Before closing this subsection, let us explore a definition that could potentially be a dominating general KM definition in the future. The term ontology is rarely used in KM circles (Buchholz, 2006). However, after some extensive literature survey, Mika and Akkermans (2004) conclude that ontologies are the "future KM technologies" (*ibid.*). Holsapple and Joshi (2006) quote an ontological KM definition:

> *"Knowledge Management [is] an entity's (such as an individual, group, organization, community, nation) deliberate and organized efforts to expand, cultivate, and apply available knowledge in ways that add value to the entity, in the sense of positive results in accomplishing its objectives or fulfilling its purpose (Holsapple & Joshi, 2004)."* (p.397)

It appears that there is a consensus that KM is about knowledge manipulation in a collective setting. However, KM mechanisms are argumentative. This is to be expected given that knowledge is contextual. There are many other KM definitions to be considered. I leave the interested readers to explore the relevant ones.

2.3.3 Knowledge Management Processes

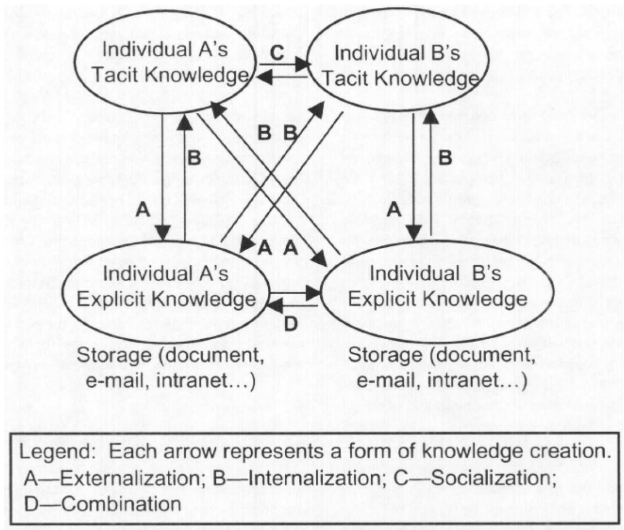
There are as many as 30 KM processes (Schwartz, 2007) and 26 KM frameworks (Rubenstein-Montano *et al.*, 2001). A starting point of a discussion appears to be those processes mentioned in the four KM seminal publications and Grant's (1996a) integrating specialised knowledge framework.

Knowledge Creation/Generation

One may immediately recall the SECI model in Nonaka and Takeuchi (1994, 1995) – the spiral knowledge-creation process (see Subsection 2.3.1). It is reckoned to be the cornerstone of knowledge creation research (Wickramasinghe, 2006). It may be necessary to add that, in this model, new and more complex explicit knowledge is discovered and created through combinations of new explicit knowledge from different sources of explicit knowledge, data or information. The creation of tacit knowledge takes place through the integration of multiple streams of tacit knowledge and the mechanism of socialisation – a synthesis of tacit knowledge from different individuals. Nonaka (1991) emphasises conscious overlapping of organisational information, business activities and managerial responsibilities. Despite its overwhelming popularity, the SECI model does face criticism. For example, Garvin (1993) notes that Ikujiro Nonaka's "recommendations are far too abstract, and too many questions remain unanswered" (p.79).

An apparent question is whether a series of tacit-explicit-tacit transformations could just be a recycling of knowledge. Alavi and Leidner (2001) note that "[t]he four knowledge creation modes are not pure, but highly interdependent and intertwined" (p.116) (as depicted in Figure 4). Nonaka and Takeuchi (1995) did note that tacit knowledge and explicit knowledge are complementary; they interact and interchange in the knowledge creation processes. That is, knowledge creation does not only involve a unidirectional spiral process of knowledge transformations, but also bilateral between-transformation processes and bilateral transformations among all processes. This suggests that individuals' knowledge bases grow in the process of knowledge creation at least in the short-run. Knowledge that has been hidden becomes accessible.

Figure 4: The SECI Knowledge-Creation Model
(Alavi & Leidner, 2001; Reprinted by Permission of the Publisher)



However, it remains hard to judge the validity of the SECI model. There are still few frameworks available for exploring how to actualise the spiral process (Alavi & Leidner, 2001; Schultze & Leidner, 2002). Instead, some authors consider Grant's (1996a) integrating specialised knowledge framework to be a promising framework of knowledge creation (Munkvold, 2006; see the Knowledge Application subsection).

Davenport and Prusak (1998) focus on the conscious and intentional generation of knowledge (Peachey *et al.*, 2007). The authors (*op. cit.*) have identified five forms of knowledge creation among many: (i) acquiring an organisation with the desired knowledge – Nonaka and Takeuchi (1995) note that there is no guarantee that the desired knowledge will stay after the acquisition; (ii) hiring people who possess the same knowledge; (iii) "renting" knowledge though hiring outside consultants; (iv) supporting R&D (research and development) activities of universities and research centres; and (v) supporting activities of "in-house" research centres.

Storage and Retrieval of Knowledge/Codification and Coordination

Storing, organising and retrieving organisational knowledge is critical to the organisation's ability to learn and make informed decisions (Peachey *et al.*, 2007). Examples of technologies involve Data Mining, Learning Tools and Collaborative Systems (*ibid.*).

Codification is intended to turn organisational knowledge into an articulated form organised in an accessible, explicit and easily understandable manner for those who need it (Davenport & Prusak, 1998). Mapping knowledge is an important part of a codification process that organises and classifies knowledge within the organisation (*ibid.*). Note that knowledge is always in a process of extending beyond itself (Fransman, 1998). Without constant collaborations, the current knowledge can hardly be identified and mapped. This again suggests that there is no pure codification approach.

Knowledge Transfer

Knowledge transfer can occur at different levels – individual, group or organisational levels (Alavi & Leidner, 2001). Davenport and Prusak (1998) consider knowledge application as an inseparable part of knowledge transfer. Alavi and Leidner (2001) consider them as two different processes. From a cost appropriation point of view, this approach may be more relevant. From the perspective of management or policy-makers, Davenport and Prusak's (1998) approach may be more relevant. This is because any investor would expect payoff from KM efforts and investment.

Knowledge Application

This process can be explained by Grant's (1996a) integrating specialised knowledge framework – a popular framework in knowledge integrating research (Munkvold, 2006).

Grant (1996a) has identified four mechanisms for integrating knowledge application: (i) rules and directives; (ii) sequencing; (iii) routines; and (iv) group problem solving and decision-making. The latter has been recognised as fundamental for knowledge creation by some authors (Munkvold, 2006).

Grant (1996a) emphasises maximal use of rules and routines to reduce communication and knowledge transfer, and group problem-solving is limited to the most extreme, important and unusual tasks. The source of competitive advantage resides in the application of the knowledge rather than in possession of knowledge (Grant, 1996a) or in the knowledge *per se* (Alavi & Leidner, 2001). Davenport and Prusak (1998) regard improving an organisation's capabilities as the goal of knowledge transfer (application is subsumed). Holsapple *et al.* (2007) posit that the best knowledge resources and best knowledge manipulation skills are of no use if they are not applied effectively during the conduct of KM.

Knowledge Roles and Skills

Davenport and Prusak (1998) pose that knowledge roles and skills are crucial to capturing, distributing and using knowledge. Knowledge roles and skills, along with technology, are enablers of KM (*ibid.*). There are four levels of knowledge management roles: (i) line workers, who must manage knowledge within their own jobs, (ii) knowledge management workers, (iii) knowledge project managers and (iv) senior knowledge executives along with differing skills required for each position (*ibid.*).

This subsection mainly covers the KM processes mentioned in Grant (1996a) and the four KM seminal publications. There are more processes to be discussed. They depend on which KM model is to be employed (Schwartz, 2007).

2.3.4 An Alternative Framework – Knowledge Management Activities as Episodes

"[KM] is largely regarded as a process involving various activities" (Alavi & Leidner, 2001, p.114). It would be interesting to briefly discuss an alternative approach – an episodic framework formulated on the basis of ontology (Holsapple & Jones, 2006). Ontology is considered as the "future KM technolog[y]" (Mika & Akkermans, 2004). The framework has been validated by an empirical study (Holsapple *et al.*, 2007).

Knowledge Chain Model

This framework portrays knowledge manipulations as KM episodes rather than a process (Holsapple & Jones, 2006). It identifies activities of particular interest to persons formulating KM strategy (*ibid.*). This model defines competitiveness as the organisational performance, and is achieved by nine activities through (i) Productivity; (ii) Agility; (iii) Innovation; and (iv) Reputation approaches (PAIR) (Holsapple *et al.*, 2007).

The model was formulated on the basis of a KM ontology developed via a Delphi study (Holsapple *et al.*, 2007). The Delphi panel consisted of 31 leading international KM academics and practitioners (Holsapple & Joshi, 2006). The ontology went through four phases of research (preparatory, anchoring, collaborative and application phases) and two Delphi rounds (*ibid.*). This process identified 61 types of activities (Holsapple *et al.*, 2007). They were classified into five primary KM activities (knowledge manipulations) and four secondary KM activities (managerial influences) (*ibid.*). The model poses that the secondary activities support and guide the performance of the primary activities (Holsapple & Jones, 2006). Table 5 explains each activity.

Table 5: KM Activity Classes in the Knowledge Chain Model (Holsapple & Jones, 2006; Reprinted by Permission of the Publisher)

Category	Activity Class	Description
Primary	Knowledge Acquisition	Acquiring knowledge from external sources and making it suitable for subsequent use
Primary	Knowledge Selection	Selecting needed knowledge from internal sources and making it suitable for subsequent use
Primary	Knowledge Generation	Producing knowledge by either discovery or derivation from existing knowledge
Primary	Knowledge Assimilation	Altering the state of an organization's knowledge resources by distributing and storing acquired, selected, or generated knowledge
Primary	Knowledge Emission	Embedding knowledge into organizational outputs for release into the environment
Secondary	Knowledge Measurement	Assessing values of knowledge resources, knowledge processors, and their deployment
Secondary	Knowledge Control	Ensuring that needed knowledge processors and resources are available in sufficient quality and quantity, subject to security requirements
Secondary	Knowledge Coordination	Managing dependencies among KM activities to ensure that proper processes and resources are brought to bear adequately at appropriate times
Secondary	Knowledge Leadership	Establishing conditions that enable and facilitate fruitful conduct of KM

The explanations of PAIR are summarised as follows (Holsapple *et al.*, 2007):

1. Productivity
   - It is the rate at which goods and services are produced per unit cost.
   - Delio (2000) adds that it can be defined in terms of labour and/or seen as the value people contribute to business processes.
2. Agility
   - Various definitions can be chosen. Holsapple *et al.* (2007) note that various KM academics and practitioners consider that today's business climate (Knowledge Economy) is unpredictable in comparison with the past. It is also a driver

of KM implementation. A definition that is related to Flexibility is, therefore, presented here.

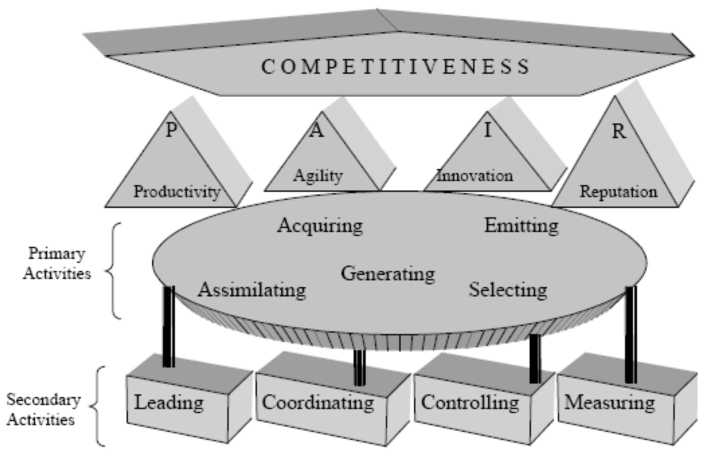
- Fliedner and Vokurka (1997) regard flexibility as the capability of changing rapidly from one task to another when changing conditions are defined ahead of time [a predictable environment] (*ibid.*).
- Fliedner and Vokurka (1997) regard agility as the ability to respond quickly to unanticipated marketplace changes (*ibid.*).

3. Innovation
   - The definition that fits the flow of our discussion the best is – "By triggering insights and new approaches and by leveraging experiences and hard-earned lessons, knowledge management is all about the pursuit of that most valuable of capabilities in today's frenetic business world: innovation" (*ibid.*, p.58).
4. Reputation
   - It is the public opinion about an organisation's conduct (*ibid.*).

The relation between the nine activities and PAIR is depicted in Figure 5.

Figure 5: The Knowledge Chain Model

(Holsapple & Jones, 2006; Reprinted by Permission of the Publisher)



Empirical Evidence

A pilot test was conducted with two KM academics and two experienced KM practitioners (Holsapple *et al*., 2007). Amendments of the drafted survey instrument were made in accordance with their comments. A brute-force strategy was chosen to collect contact information of potential candidates due to the lack of a readily available contact list. The response rate of the questionnaire was 31.4% (out of 102 candidates who performed a CKO role).

The details of the respondents' backgrounds are given in Holsapple *et al.* (2007). An interesting observation is that 66% of the participants reported that they took a technical KM approach. The original seven-point Likert items were rescaled into Weak (1-3), Moderate (4) and Strong Contributions (5-7) for analysis. The response rate of "Strong Contribution" is the highest for each PAIR-primary activity. In all cases, the 25% threshold is surpassed (50%, in fact). The results are not so clear for the secondary activities. "Strong Contribution" is the largest category only for PAIR-Leadership and AI-Coordination. "Weak Contribution" is the largest category for other secondary activities. Each secondary activity obtains a "Strong Contribution" of over 40% for at least one of the PAIR approaches (*ibid.*). The 25% threshold is surpassed (*ibid.*). ANOVA results show that there is no statistical significance ($\alpha \leq 0.10$) for each primary activity. ANOVA results are mixed for the secondary activities. However, it is (statistically) prudent to assume that each PAIR-secondary activity is valid. The results validate the Knowledge Chain Model overall. The authors (*op. cit.*) acknowledge the need for improvement.

Note that a self-administrated survey was conducted (Holsapple *et al.*, 2007). The results may only report the perceptions about KM activities and PAIR (vehicles for competitiveness/performance) rather than their actual relations. However, the model was derived through a rigorous development process and consistent with the anecdotal evidence (*ibid.*). This suggests that the results are of good reference value. Nevertheless, it offers an alternative framework (episodic not sequential) to understand (i) knowledge manipulations and (ii) the relations between competitiveness and KM activities, and to help (iii) identify appropriate KM policies.

2.3.5 What Technologies Do We Need?

Knowledge is not only a public good – once it is shared the marginal cost of using it is zero – but indeed a global public good (Stiglitz, 1999a,b). In a similar vein, Knowledge Management should be practicable for all sizes of organisations. The focus of this subsection is to explore the practicality of this proposal from a technological perspective.

Choice Criteria

Alavi and Leidner (2001) suggest that not all KM initiatives involve an implementation of IT. There is no single role of IT in KM (*ibid.*). McDermott (1999) notes "while the knowledge revolution is inspired by new information systems, it takes human systems to realise it" (p.116). Technology should be considered as an enabler of KM rather than as an essential component (Alavi & Leidner, 2001; Davenport & Prusak, 1998; Rubenstein-Montano *et al.*, 2001). Efficient operations require codifying knowledge to a certain extent (Denning, 1998). It implies that effective KM involves an appropriate trade-off between human knowledge and codified knowledge through IT.

Maier (2002) defines a KMS as an ICT system that supports KM. Maier (2004) puts forward that KMS is the technological part of a KM initiative/strategy targeted at improving the productivity of knowledge work (Maier & Hädrich, 2006). This implies that the choices of technologies are dependent on the chosen KM approach – a technology-oriented approach or a human-oriented approach.[11]

Maier and Hädrich (2006) notice that the term KMS has often been used ambiguously and labelled in various terminologies in the literature. An authoritative definition of KMS is:

> *"KMS [is] a class of information systems applied to managing organizational knowledge… developed to support and enhance the organisational processes of knowledge creation, storage/retrieval, transfer and application."*
>
> (Alavi & Leidner, 2001, p.114)

KMS performs functions that are beyond the capabilities of traditional ITs – "storage and retrieval of coded knowledge" (Alavi & Leidner, 2001). In theory, human knowledge

[11] See Subsection 2.3.8 for details about the two broad KM strategies.

becomes increasingly substitutable by ITs.

Maier and Hädrich (2006) derive a set of characteristics that differentiates KMS from traditional IS. Accordingly, the authors (*op. cit.*) conclude that:

> *"[A] KMS is defined as a comprehensive ICT platform for collaboration and knowledge sharing with advanced knowledge services built on top that are contextualized and integrated on the basis of a shared ontology, and personalized for participants networked in communities. KMSs foster the implementation of KM instruments in support of knowledge processes targeted at increasing organizational effectiveness."* (p.444)

The authors (*op. cit.*) also identify two ideal types of KMS architectures – (i) centralistic client-server solution and (ii) peer-to-peer (p2p) metaphor. The former better suits a technology-oriented KM approach (codification) and the latter a human-oriented KM approach (personalisation) through facilitating collaborations. Table 6 illustrates the relationship between KMS types and KM approaches. Although there are still some issues to be solved such as connectivity, security and privacy, p2p KMSs appear to be promising in resolving some of the shortcomings of centralised KMSs (*ibid.*). The observed progressive technological development suggests that p2p systems will soon become true KMSs.

Table 6: KMS Types and KM Approaches

(Maier & Hädrich, 2006; Reprinted by Permission of the Publisher)

Characteristics	**Centralized KMS**	**p2p-KMS**
Strategy	Codification	Personalization
Organizational Design	Central	Decentralized
Content	Primarily lessons learned, (approved) knowledge products, and secured knowledge, but also ideas, experiences, and individual contents	Individual contents, ideas, and results of group sessions and experiences
Organizational Culture	Both types of culture (restrictive or loose user privileges)	Open, trustful culture

Digging a Mine with Irrelevant Tools

Knowledge Management Software is one of the synonyms of KMS (Maier & Hädrich, 2006). Baroni de Carvalho and Ferreira (2006) categorise 21 KM software products into 10 types and relate them to each transformation process of the SECI model (Nonaka, 1994; Nonaka & Takeuchi, 1995). It is shown that only knowledge portal products, a relatively new technology, enable all SECI processes. A comparable solution to a basic knowledge portal requires the integration of at least four KM systems: (i) the intranet, (ii) content management system (CMS), (iii) groupware and (iv) business intelligence (BI) (*ibid.*).[12,13] However, integration is not a recommended solution as it can be a cumbersome task (*ibid.*).

The authors (*op. cit.*) notice that the actual utilisation of those products stresses mainly their support of information access and retrieval, while their communication and collaboration dimensions are yet to be discovered. By Alavi and Leidner's (2001) definition, the capabilities of these products are not far different from those of traditional ITs. KM requires strong collaborations – at least the prominent KM scholar Ikujiro Nonaka and colleagues (1991, 1994, 1995, 1998) would agree with this. It again suggests that KM's potentials cannot be deployed solely by implementing ITs.

Tauber and Schwartz (2006) note that the first generation of KMSs have been developed as add-on or parallel systems of management information systems (MISs). Empirical evidence suggests that semi-structured or unstructured information account for about 80% of the information volume within organisations (*ibid.*). MISs that aid organisational processes can only address 20% of the information management needs. This implies a need for a fusion of MIS and KMS (*ibid.*). However, the existing systems analysis tools have been derived for MIS not KMS (*ibid.*). It further suggests that technology *per se* is not a KM enabler.

Unpacking the Full Potentials of Existing Organisational Resources

A KM expert opines that KM enabling technologies are not necessary those labelled as KM products (Dash, 1998). In practice, Walsham (2001) notes that ICTs have been central to many KM initiatives. McDermott (1999) notes that organisations have found that leveraging knowledge through ICTs is often hard to achieve. Walsham (2001,

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[12] Choo *et al.* (2000) suggest that a portal's primary function is to provide a transparent directory of information already available elsewhere. Portal is not meant to act as a separate source of information *per se* (Baroni de Carvalho & Ferreira, 2006).

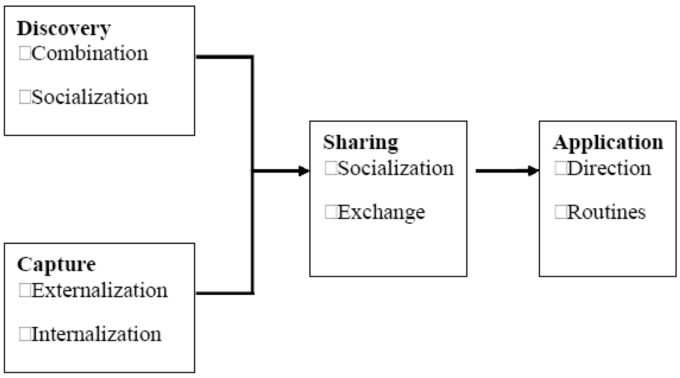
[13] Baroni de Carvalho and Ferreira (2006) note that an intranet is a tool for systematising and adding the explicit knowledge dispersed across departments/locations. Communications via intranet are usually passive because users have to pull the information. Both CMS and BI support the combination process and can perform documents retrieval functions. CMS deals with unstructured knowledge that is in a wide range of formats. BI handles information with specific attributes and in standardised formats. Groupware is a synonym of Computer-Supported Cooperative Work (CSCW) (*ibid.*) – this name well explains its functions.

2002) remains optimistic about ICTs' potentials for enabling KM if human meaning is properly incorporated into the KM processes. Recently, Maier and Hädrich (2006) comment that ICT systems fulfil the characteristics of an ideal KMS to a certain extent. It is worth exploring the practicality of facilitating KM through ICTs.

Becerra-Fernandez and Sabherwal (2006) observe that ICTs have been significantly advanced recently. The authors (*op. cit.*) show that ICTs have merely become KM enabling technologies by a taxonomical approach.

The authors (*op. cit.*) pose that there are four broad KM processes and each process can be subdivided into subprocesses as depicted in Figure 6. The discovery and capture processes correspond to Nonaka's (1994) SECI knowledge-creation model (see Subsections 2.3.1 and 2.3.3). The application process comprises two constructs of Grant's (1996a) integrating specialised knowledge framework (see Subsection 2.3.3). The exchange subprocess represents communication and transfer of explicit knowledge between individuals, groups and organisations (Grant, 1996b).

Figure 6: The Four Broad Knowledge Management Processes
(Becerra-Fernandez & Sabherwal, 2006; Reprinted by Permission of the Publisher)



Accordingly, the authors (*op. cit.*) classify KMSs into four corresponding types. The explanations are as follows:

1. Knowledge-discovery systems support developing new tacit or explicit knowledge from data and information or from the synthesis of prior knowledge.
2. Knowledge-capture systems support retrieving either explicit or tacit

knowledge that resides within people, artefacts, or organisational entities and sometimes resides outside organisational boundaries (e.g., consultants, competitors, consumers, suppliers and prior employers of new employees).

3. Knowledge-sharing systems support group communications.
4. Knowledge-application systems support rational (or economising) tacit-knowledge transfer.

The mechanisms and technologies that support the respective subprocesses are illustrated in Table 7. The authors (*op. cit.*) note that ICTs have already been developed into technologies that can facilitate KM through the data processing, storage, communication technologies and systems, and expert locator functions. That is, ICTs support both codification and collaborative functions required for the two broad KM initiatives/strategies. KM processes do not need to be supported by KM products, but by ICTs. ICTs are the technologies originally developed to support an organisation's information-processing needs (*ibid.*).

Table 7: Knowledge Management Systems, Sub-processes, Mechanisms and Technologies (Becerra-Fernandez & Sabherwal, 2006; Reprinted by Permission of the Publisher)

KM Processes	KM Systems	KM Sub-Processes	Illustrative KM Mechanisms	Illustrative KM Technologies
Knowledge Discovery	Knowledge Discovery Systems	Combination	Meetings, telephone conversations, and documents, collaborative creation of documents	Databases, web-based access to data, data mining, repositories of information, Web portals, best practices and lessons learned
		Socialization	Employee rotation across departments, conferences, brainstorming retreats, cooperative projects, initiation	Video-conferencing, electronic discussion groups, e-mail
Knowledge Capture	Knowledge Capture Systems	Externalization	Models, prototypes, best practices, lessons learned	Expert systems, chat groups, best practices, and lessons learned databases
		Internalization	Learning by doing, on-the-job training, learning by observation, and face-to-face meetings	Computer-based communication, AI-based knowledge acquisition, computer-based simulations
Knowledge Sharing	Knowledge Sharing Systems	Socialization	See above	See above
		Exchange	Memos, manuals, letters, presentations	Team collaboration tools, web-based access to data, databases, and repositories of information, best practices databases, lessons learned systems, and expertise locator systems
Knowledge Application	Knowledge Application Systems	Direction	Traditional hierarchical relationships in organizations, help desks, and support centres	Capture and transfer of experts' knowledge, troubleshooting systems, and case-based reasoning systems; decision support systems
		Routines	Organizational policies, work practices, and standards	Expert systems, enterprise resource planning systems, management information systems

The authors (*op. cit.*) also find that ICTs demonstrate the IT infrastructures that meet the capabilities proposed by various authors, as follows:

- Reach – a measure of access and connection, and the efficiency of such access.
    - Examples are the Internet, XML (extensible makeup language) [a context-based correspondence of HTML], etc.
- Depth – a measure of the detail and amount of information that can be effectively communicated over a medium.
    - Bandwidth (and more recently channel bandwidth) is a corresponding measure.
- Richness of a medium measured by:
    - Multiple cues simultaneously – e.g, body language, facial expression, tone of voice, etc.;
    - Quick feedback;
    - Personalised message; and
    - Use of natural language to convey subtleties.
    - ICTs use lean communication medium but significant improvement in richness is observed.
- Aggregation – a measure of the ability to store and process information quickly.
    - e.g., the intranet appears to be offering this ability.

The authors (*op. cit.*) are aware of the existence of sophisticated systems for eliciting and cataloguing expert knowledge. However, these systems are generally not recommended as they involve very costly knowledge-engineering effort.

ICTs have not yet fully fulfilled the capability standard (*ibid.*). The observed progressive development in ITs suggests that the richness issue will soon be overcome. ICTs do meet the definitions of KMS that are proposed by Alavi and Leidner (2001) and Maier and Hädrich (2006). This is an expected conclusion given that (i) Maier and Hädrich (2006) find that ICT systems fulfil the characteristics of an ideal KMS to a certain extent, and (ii) Maier (2002) proposes that KMS is an ICT system that supports KM. “Knowledge Management for all sizes of organisations” appears to be a pragmatic proposal from a technological lens.

2.3.6 People Aspects

Wilson (2002) suggests that there is absolutely no agreement on what constitutes KM. However, there is a consensus that KM involves people, process and technology (Dash, 1998; Peachey *et al.*, 2007; Ruggles, 1998; Wickramasinghe, 2006). Most experts believe that technology comprises the smallest part of a KM initiative (Dash, 1998). Ruggles (1998) poses that the right balance among people, process and technology is 50/25/25.

The technology aspect has been covered in Subsection 2.3.5. Business/organisational process is industry- or organisation- specific, and to be discussed in Section 2.5. KM processes potentially touch upon all the procedures and operations in an organisation (Brooking, 1996; O'Dell & Grayson, 1998a). An exhaustive discussion of the dynamism is impossible. Only some people aspects are explored to demonstrate that the present economic climate is different from what has been witnessed.

Organisational Structures

Stiglitz (1999a) notes that the shift towards a Knowledge Economy involves a shift in organisations away from top-down hierarchical structures to flatter structures such as networks of semi-autonomous teams.[14,15] Tayloristic vertical structures were designed to enforce and coordinate certain physical behaviours (*ibid.*). A Knowledge-Based Organisation involves greater recognition of the autonomy and self-direction of the mind (*ibid.*).

Quinn *et al.* (1996) pose an extreme view – "No organisational form is a panacea." (p.80). Perhaps the only definite organisational structure is knowledge workers, who make up the biggest part of the workforce (Drucker, 2000).

A Power Game – Gaining or Losing Power?

Land *et al.* (2006) point out that the underlying notions of KM are purpose and control. Facilitating knowledge sharing may be to improve the productivity of the group, but also to control the way the group works (*ibid.*). Similarly, providing knowledge for

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[14] Drucker (1998) also poses flattened organisation structures.

[15] Network structure corresponds to what Hedlund (1994) labels as the "N-form organisation" ("N" for "new"). Perhaps it is also similar to the temporary "spider's web" form (Quinn *et al.*, 1996). Network structure is considered as effective to facilitate knowledge sharing.

consumers may be to enable informed choices, but also to mislead the consumers and control consumer behaviours (*ibid.*).

However, there may be an opposing force. The foundation of the 21st century organisation is no longer money or capital or even technology; it is knowledge (Drucker, 2000). Boisot and Griffiths (1999) suggest that knowledge workers are the owners of the means of production – knowledge and intellectual capital. Streatfield and Wilson (1999) note that knowledge cannot be managed directly (Ariely, 2006). Only the knowers can decide to share it or not. It is hard to tell who are going to take control.

Similarly, consumers may be misled. They may also learn to be "smart buyer[s]" They can drive an industry to higher efficiency (see Rogers, 1995). Not meeting their demand can also drive an organisation to losing their monopolistic power (see Subsection 2.2.2). According to Classical Economic theories, the outcome depends on an organisation's ability to differentiate their products or services from its competitors. This idea is similar to Barney's (1991b) proposal for establishing rarity (contrary to competition), imitability and substitutability.

Blurry Management Roles

Central management change to a supportive role and only intervene in extreme emergencies (Quinn *et al.*, 1996). Mangers may act as consultants rather than giving orders (*ibid.*). Some supervision roles of management are delegated to the services staff and mid-to-low level managers for they are the people who actually have specialised skills and expertise to oversee the business processes (Drucker, 1998).

Johnson (2007) notes that knowledge workers are their own managers – "management from without." Management cannot directly monitor them due to a knowledge gap, but can direct them to an area where their skills should be applied (*ibid.*).

Butler and Murphy (2006) define knowledge workers as those who apply experiential self-knowledge (Phrónésis) and/or skills-based technical knowledge (Téchné) in organisational settings. The authors (*op. cit.*) also note that if knowledge is considered to be dispersed and collective then all staff in an organisation are knowledge workers. This implies that management lose their authority.

Alternatively, management may also apply codification as a strategy to manage behaviours through IT (Alvesson & Kärreman, 2001). Codification empowers those less qualified to perform duties that were previously beyond their capacities (*ibid.*). Eventually, those more qualified become more replaceable. Knowledge workers have to be competent in IT to empower their expertise. In other words, they lose their autonomy over IT to some extent. Endless debates are expected.

New Accounting and Recruitment Approaches

Various accounting practices exist to measure Intellectual Capital in order to estimate organisational knowledge (Ariely, 2006). They have emerged to address the obvious gap between an organisation's actual market value and its "book value" (Petty & Guthrie, 2000).[16] Those relatively new accounting practices have not yet reached statutory recognition (Ariely, 2006). It would not be surprising to see them being developed into some standard practices to attract stakeholders or to boost the value of an organisation at the capital markets. In fact, Organisation for Economic Co-operation and Development (OECD) (2004) notes that corporation stock market valuation is increasingly dependent on intangible asset value.

Human resources departments may not have the knowledge to screen out the right persons to meet the organisations' needs. Some of the recruitment duties are likely to be delegated to the knowledge workers as they know their business better.

A New Position and New Roles

In a Knowledge Economy, the newest member of executive team emerged – Chief Knowledge Officer (CKO) (Liebowitz, 1999). This person is cognizant of corporate strategy and works with the Chief Information Officer (CIO) to oversee organisation-wide KM efforts (Dash, 1998). CKO may assign "knowledge champions" to manage the content of knowledge their group produces and revise the knowledge base and motivate their team members to do the same (*ibid.*).

Angus (1998) suggests that it is necessary to appoint a specific person or a team to take primary responsibility for knowledge dissemination in an organisation. From

[16] Book Value only records the historical value of a transaction. Suppose a premise at Hampstead in London was bought in 1918 at £20. Its value would remain £20 in the Balance Sheet of Year 2007.

Nonaka's (1991) perspective, middle managers perform crucial roles in KM success. These managers are considered to be the actual "knowledge engineers" [not the IT professionals] (*ibid.*). They synthesise the tacit knowledge of both the frontline staff and senior executives, explicate it, and incorporate it into new technologies and products (*ibid.*).

New IT Practices

As noted in Subsection 2.3.5, Tauber and Schwartz (2006) point out that there is a need to have a fusion system that integrates a MIS and KMS. To maintain it requires constant cooperations between (i) users and IS systems analysts, and (ii) IS systems analysts, KM analysts and CKO. In the KM era, IT professionals have to cope with unstructured or semi-structured information (80% of many organisations) (Tauber & Schwartz, 2006) rather than purely fully-structured data or information as in the past.

McDermott (1999) notes that "[t]he great trap in knowledge management is using information management tools and concepts to design knowledge management systems" (p.104). All these point to the conclusion that IT professionals have to revise their practices and specialities (in IS or KMS). Also note that the existing ITs are increasingly integrated with KM enabling technologies to some extent (Becerra-Fernandez & Sabherwal, 2006; Jennex, 2007; Maier & Hädrich, 2006). Soon, all IT professionals have to be trans-experts in both IS and KMS.

There are many other aspects to be discussed. The discussion here shows that, in the KM era, the key to success is "stronger collaboration 'and' agility." An exhaustive discussion may be done in further research.

2.3.7 What Measures Do We Have?

Measures are essential from both academic and practitioner perspectives (Kankanhalli *et al.*, 2007). Boudreau *et al.* (2001) suggest that, for academics, reliable and valid measures help in (i) developing finer and consistent new research, and (ii) avoiding redundant efforts in redeveloping instruments (*ibid.*). Kankanhalli *et al.* (2007) add that, for practitioners, they are indicators of what works and what does not work. More importantly, "we hardly recognize a subject as scientific if measurement is not one of its tools" (Boring, 1929, p.286).

The focus of this section is to show that there exist measures in different aspects of KM.

Knowledge Management Evaluation – An Accounting Approach

The terms assessment and evaluation are often used interchangeably (Neville & Powell, 2004). However, they refer to different levels of investigation; evaluation involves deeper levels of investigation (*ibid.*).

If KM is considered to be a source of competitive advantage, then the relevant measure should be the improvement of an organisation's performance. Measuring performance is in the realm of Management Accounting (Kankanhalli *et al*., 2007).

This approach assumes that KM initiatives have impacts on an organisation's Intellectual Capital (IC) [IC is defined in Subsection 2.3.1, p.25] (*ibid.*). Kankanhalli *et al*. (2007) discuss three general approaches (points 1 to 3) and three specific approaches (points 4 to 6). These approaches are summarised respectively as follows:

1. House of Quality (Quality Function Deployment) (see Hauser & Clausing, 1988) – It involves the following elements:
    - The desired outcome of KM initiatives (left wall);
    - Performance metrics (roof);
    - Weights of importance of outcomes (right wall); and
    - Targets, priorities and benchmark values (base).[17]
    - KM areas to be focused can be identified from the correlations of the above elements (of a house/matrix).
    - QFD designer is one of the available software tools.
2. Balance Scorecard Technique (see Kaplan & Norton, 1996)
    - It is a comparison of consumer perspective, financial perspective, internal business perspective, and learning and growing perspective.
    - Each perspective involves goals, metrics, targets and initiatives.

[17] Benchmark involves a process of identifying, sharing, and using and practising the knowledge (O'Dell & Grayson, 1998b).

- This method assesses the current state of KM and evaluates the impact of initiatives.
- Software tools are also available.

3. American Productivity Quality Centre Approach (see APQC, 2006)
   - It is a process classification framework (PCF).
   - It is a detailed taxonomy of business processes.
   - It can be employed for benchmarking and assessing impact on business processes.
4. Skandia Navigator (see Edvinsson & Malone, 1997) – It consists of:
   - 112 types of IC; and
   - Traditional metrics (some metrics are overlapping) in five areas of focus – financial, consumer, process, renewal and development, and human.
   - It is similar to the Balanced Scorecard, but introduces the human focus area.
5. The IC Index (see Roos *et al.*, 1998)
   - It is an extension of the Skandia IC Metric.
   - It is a composite index.
   - Analysis is drawn from the correlation between the resulting index and the changes in the market (IC stock and IC flow are also included).
6. Intangible Assets Monitor (see Sveiby, 1997a)
   - It is the measure of the discrepancy between book values and values of tangible assets and visible debt.
   - Intangible assets are categorised into (i) external structure, (ii) internal structure and (iii) individual competence.
   - For each intangible asset component, it includes three indicators that focus on growth and renewal, efficiency, and stability of that component.

The efficacy of each technique depends on the competence of management in applying the technique (Kankanhalli *et al.*, 2007). The applications of these techniques involve subjective judgements; e.g., the weights of indicators (*ibid.*). IC accounting is not legally required for this reason (Ariely, 2006). Bontis (2001) notes that similar measures are often inconsistently termed (Kankanhalli *et al.*, 2007).

Kankanhalli *et al.* (2007) conduct a literature review on KM and KMS evaluations based on the articles from reputed IS and Management journals and established IS conferences. The results show that most of the evidence on KM assessment is on a case-by-case basis. That is, there is a lack of generalised results in KM evaluation.

Knowledge Management System Evaluation

Various KMS measures are available (Kankanhalli *et al.*, 2007). There are two broad classes of KMSs − (i) the repository model and (ii) the network model. The former is associated with the codification KM approach and the latter the personalisation KM approach.

A repository model can be evaluated by system-level measures for Electronic Knowledge Repositories (EKR) – tools for coding and sharing best practices. That is, to measure number of downloads, dwell time, usability surveys, number of users, and number of contributions and seeks. A network model can be evaluated in terms of enabling knowledge transfer through expert locator or electronic/virtual communities of practice (CoPs). Measures for electronic CoP include number of contributions and seeks, frequency of update, number of members, and ratio of number of members to the number of contributors (*ibid.*). Alternative measures for electronic CoP are discussed in Rubenstein-Montano (2004).

The literature review of Kankanhalli *et al.* (2007) notes that there is a lack of generalised measurable techniques in KMS evaluation.

A Knowledge Management System Success Model – A Comprehensive Assessment Tool

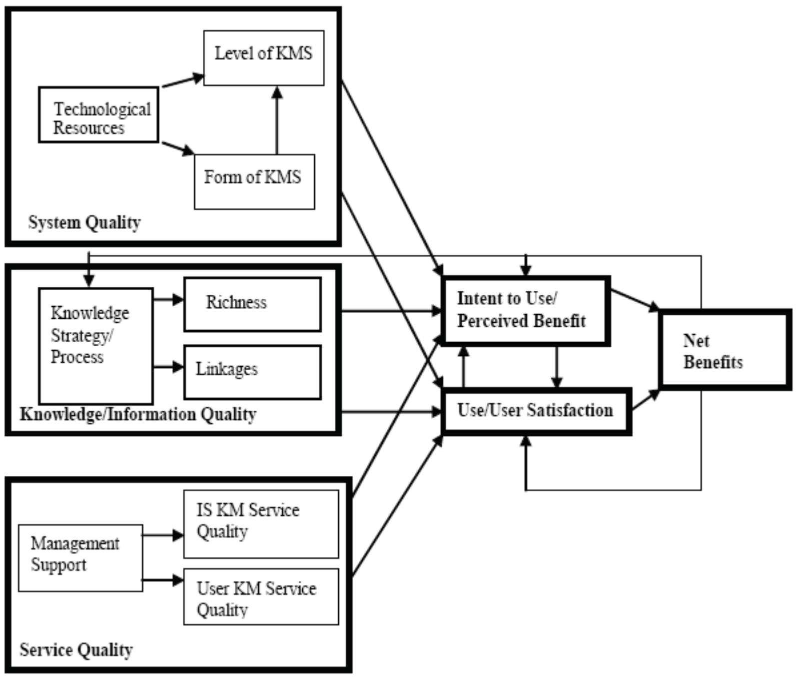
There are different reasons to determine the success of a KMS (Jennex, 2006a). The author (*op. cit.*) summarises the three reasons that are given by Turban and Aronson (2001):

- To provide a basis for the valuation of an organisation;
- To stimulate management to focus on what is important; and
- To justify investments in KM activities.

These reasons are in an organisational perspective. Jennex (2006a) adds that, from the perspectives of KM academics and practitioners, the measurement of KMS success is crucial for understanding how these systems should be built and implemented.

There exists, a range of KMS success models (see Jennex, 2006a; Jennex & Olfman, 2007). To be highly selective, Jennex and Olfman's (2006) KMS model is chosen for a discussion for (i) its sound foundation and historical root – DeLone and McLean's (2003) IS success model and (ii) the fact that it has been empirically validated to some extent (see Halawi *et al.*, 2007, for example). The model is illustrated in Figure 7.

Figure 7: The Jennex and Olfman (2006) KM/KMS Success Model (Jennex & Olfman, 2007; Reprinted by Permission of the Publisher)



DeLone and McLean's (1992) model has been seen as a comprehensive IS assessment model (Myers *et al.*, 1997; Seddon, 1997). Its root traces back to the Shannon and Weaver (1949) transmission model of communication (this model is regarded as fundamental to most research on knowledge transfer by Szulanski (2003) – a prominent figure in knowledge transfer research). In addition, it also incorporates the stylised facts of 180 research studies that used some IS Success factors as the dependent variable (DeLone & McLean, 1992). The authors (2003) modify their model in response to various authors' suggestions for validation and further development. Recently, Petter, DeLone and McLean (2008) have conducted a qualitative review of IS Success academic papers published for the period of 1992–2007. Out of the 180 identified papers, 90 are empirical studies that examined the DeLone and McLean (1992; 2003) model to different extents (*ibid.*). These studies generally validate the model (*ibid.*).

Jennex and Olfman (2006) extend this model into a KMS success model. The authors (*op. cit.*) regard KM Success as the impacts from use of knowledge (from the KMS) that leads to an improvement in organisational effectiveness (Jennex, 2006a, 2008; Jennex & Olfman, 2007). Each construct is explained as follows:

1. System Quality
    - It measures how well the KMS performs the functions of knowledge creation, storage/retrieval, transfer and application,
    - how much of the knowledge is codified, and
    - how the KMS is supported by the IS staff and infrastructure.
2. Knowledge/Information Quality
    - It ensures that the right knowledge with sufficient context is captured and available for the right users at the right time.
3. Service Quality
    - It measures management support, KM governance, and organisational support of KM.
4. Use and User Satisfaction
    - It measures the extent to which the KMS has been used.
    - User satisfaction measures the satisfaction of the users with their use of the KMS.
5. Perceived Benefit (and/or Intent to Use)
    - It measures perceptions of the benefits and impacts of the KMS by users and is based on the Thompson *et al.* (1991) Perceived Benefit model.
    - It is useful for predicting that the KMS will be used when appropriate.
6. Net Benefits (or Net Impact)
    - An individual's use of a KMS will produce an impact on that

person's performance in the workplace.

- Each individual impact will in turn have an effect on the performance of the whole organisation.
- The association between individual and organisational impacts is often difficult to draw. Accordingly, all impacts are combined into a single dimension.
- The net impact is positive (negative) when the use of knowledge generates benefits (negative benefits).
- This model also allows for feedback from these benefits to drive the organisation to either use more knowledge or to forget specific knowledge.

Recently, Halawi *et al.* (2007) have empirically tested a similar model. The authors (*op. cit.*) assume away (i) the causal paths from KMS Success (Net Benefits) to Intention to Use and User Satisfaction and (ii) the path between KMS Success and Knowledge Quality. The evidence validates the model except the positive relationship between Service Quality and Intention to Use (*ibid.*).

Knowledge Management and Knowledge Management System Success Factors

Jennex (2006b) points out that determining KMS success factors can help determine KM initiative success factors. There is no consensus on what KM/KMS success is, but two broad concepts can be identified (*ibid.*). Both concepts consistently pose that KM/KMS success factors are "factors that encourage or help users to use the KMS to effectively perform KM functions" (*ibid.*, p.436).

The author (*op. cit.*) suggests that, from the IT practitioner perspective, the differences between KM and OM are (i) KM serves end users, and (ii) IS personnel tend to be concerned with OM. A thorough literature review on KM success factors should include KM, KMS, OM, OMS and OMIS (Organisational Memory Information Systems) (*ibid.*). Having identified the success factors from the success factor studies, the author (*op. cit.*) reviewed and paraphrased them into a set of ranked success factors. The rankings of the success factors are given in Table 8.

Success factors SF1 to SF4 are considered to be key success factors – that are mentioned by a majority of the success factor studies. The author (*op. cit.*) acknowledges that the results are generated by a bibliographical analysis. There is a need to develop an integrated and quantifiable KMS success factor model (*ibid.*).

Table 8: KMS Success Factor Summary

(Jennex, 2006b; Reprinted by Permission of the Publisher)

ID (Rank)	Success Factor	Source
SF1	An integrated technical infrastructure including networks, databases/repositories, computers, software, KMS experts	Alavi and Leidner (1999), Barna (2002), Cross and Baird (2000), Davenport *et al.* (1998), Ginsberg and Kambil (1999), Jennex and Olfman (2000), Mandviwalla *et al.* (1998), Sage and Rouse (1999), Yu *et al.* (2004)
SF2	A knowledge strategy that identifies users, user experience-level needs, sources, processes, storage strategies, knowledge, and links to knowledge for the KMS	Barna (2002), Ginsberg and Kambil (1999), Holsapple and Joshi (2000), Jennex *et al.* (2003), Koskinen (2001), Mandviwalla *et al.* (1998), Sage and Rouse (1999), Yu *et al.* (2004)
SF3	A common enterprise-wide knowledge structure that is clearly articulated and easily understood	Barna (2002), Cross and Baird (2000), Davenport *et al.* (1998), Ginsberg and Kambil (1999), Jennex and Olfman (2000), Mandviwalla *et al.* (1998), Sage and Rouse (1999)
SF4	Motivation and commitment of users including incentives and training	Alavi and Leidner (1999), Barna (2002), Cross and Baird (2000), Davenport *et al.* (1998), Ginsberg and Kambil (1999), Jennex and Olfman (2000), Malhotra and Galletta (2003), Yu *et al.* (2004)
SF5	An organizational culture that supports learning and the sharing and use of knowledge	Alavi and Leidner (1999), Barna (2002), Davenport *et al.* (1998), Jennex and Olfman (2000), Sage and Rouse (1999), Yu *et al.* (2004)
SF6	Senior management support including the allocation of resources, leadership, and providing training	Barna (2002), Davenport *et al.* (1998), Holsapple and Joshi (2000), Jennex and Olfman (2000), Yu *et al.* (2004)
SF7	Measures established to assess the impacts of the KMS and the use of knowledge, as well as to verify that the right knowledge is being captured	Alavi and Leidner (1999), Davenport *et al.* (1998), Jennex and Olfman (2000), Sage and Rouse (1999)
SF8	A clear goal and purpose for the KMS	Ackerman (1994), Barna (2002), Cross and Baird (2000), Davenport *et al.* (1998)
SF9	A learning organization	Barna (2002), Cross and Baird (2000), Sage and Rouse (1999), Yu *et al.* (2004)
SF10	Easy knowledge use supported by the search, retrieval, and visualization functions of the KMS	Alavi and Leidner (1999), Ginsberg and Kambil (1999), Mandviwalla *et al.* (1998)
SF11	Work processes designed to incorporate knowledge capture and use	Barna (2002), Cross and Baird (2000), Jennex and Olfman (2000)
SF12	The security/protection of knowledge	Jennex and Olfman (2000), Sage and Rouse (1999)

N.B. see Jennex (2006b) for citations

Knowledge Management Maturity

Prat (2006) observes that the existing KM models are characterised by three major limitations as follows:

1. They often do not present a holistic view nor give a multidisciplinary account to reflect KM's multidisciplinary nature.
2. They are inappropriate for either navigating from abstract levels to detailed levels of KM topics or vice versa.
3. There is no quantifiable framework for assessing KM effort.

The author (*op. cit.*) notes that the existing KM models are all in the semantic class – descriptive frameworks for defining KM concepts and representing the complexity of their relations explicitly. Accordingly, an analytic KM model is formulated to integrate the features of the existing KM models with Saaty's (1980) analytic hierarchy process. In Prat's (2006) model, there are three major components: (i) Knowledge Types, (ii) KM Processes and (iii) KM Context.

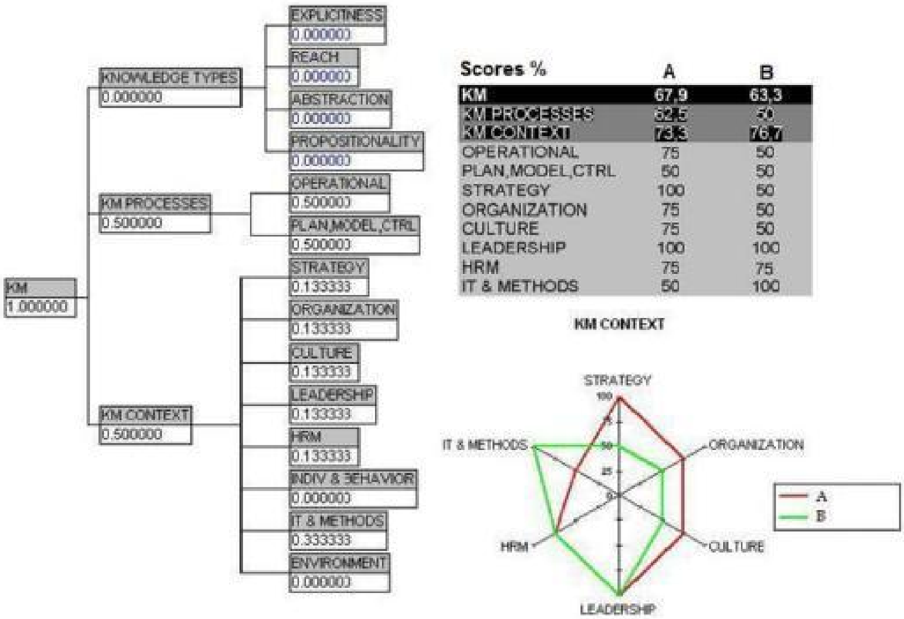
The Knowledge Types component is a composite of different knowledge dimensions. A knowledge item may be multi-dimensional, but not be overlapping (*cf.* Ein-Dor, 2006). The KM Processes component includes: (i) operational processes (knowledge manipulation activities), and (ii) planning, modelling and control processes. The latter elements are related to management roles in KM. The KM Context component includes factors that influence the conduct of KM. These factors are strategy, culture, leadership, choices of technologies, the roles of a CKO, and the rest of an organisation's operations.

These three components form three main nodes (see Figure 8). The descendant nodes are determined by the semantic and practical considerations. The levels of decomposition are determined by the measurability of each element. The decomposition process halts if no additional meaning can be gathered. An organisation can choose (i) the extent and levels of decomposition for each component and (ii) the weight of each element to fit its assessment preferences. The complete theoretical model can be found in Prat (2006).

Prat (2006) proposes that the hierarchical model can be used to assess the KM maturity of an organisation with the application of auditing tools. The author (*op. cit.*) generates a working example with the application of some secondary data of two organisations and an auditing programme that supports analytic hierarchy processing.

The tree diagram in Figure 8 shows that it is a two-level analysis. A zero score in the Knowledge Types component indicates that the organisation may not consider knowledge dimension to be important for KM success. Similar explanation applies to any component or element that scores a zero. The weights of the three components are obtained after entering the weights of all sub-hierarchy nodes. The KM scores indicate the overall KM maturity of Organisations A and B (67.9% and 63.3% respectively). Organisation A may be in a more mature KM state.

Figure 8: Applying the KM Hierarchical Model
with Actual Organisation Names Being Replaced by A and B
(Prat, 2006; Reprinted by Permission of the Publisher)



Prat (2006) suggests that this hierarchical model is a complement of semantic KM models. The two classes of models have different strengths and weaknesses (*ibid.*). Although this model is still at an experimental stage, it shows potential for being developed into a simple and quantifiable, but comprehensive model.

Some of the works mentioned in this subsection are still at an experimental stage. However, the discussion shows that measures of different aspects of KM do exist.

2.3.8 Policy-Making

So far, the discussion shows that each aspect of KM *per se* involves clustered issues. Recall a crux in Economics that has not yet been disproved – Tinbergen's (1952) rule. The author (*op. cit.*) poses that the number of policy objectives requires the same number of policy instruments. It is unlikely that an array of efficient KM policies could be identified. Implementing effective KM outcomes is a more pragmatic regime.

A full coverage of KM policy instruments is impossible. Some instruments are discussed to show the dilemma in KM policy-making.

The Right Split of Initiatives/Strategies

KM strategy has been briefly mentioned, particularly in Subsection 2.3.5. This subsection will outline the dilemma in choosing or mixing KM strategies.

There are interactive relationships among choice of strategies, technologies, knowledge context and an organisation's financial resources (see Hansen *et al.*, 1999). Technologies have been progressively advanced at decreasing cost (Becerra-Fernandez & Sabherwal, 2006). Knowledge context appears to be relatively paramount.

KM strategies can broadly be classified into (i) Codification and (ii) Personalisation (Hansen *et al.*, 1999). In the earlier phase of the KM era, codifying tacit knowledge into explicit knowledge has been the primary KM objective, at least in Western firms (Balconi, 2002; Nonaka & Takeuchi, 1995; Schulz & Jobe, 2001). Fahey and Prusak (1998) claim that a widespread managerial error is attempting to substitute technological contact for human interface. Hansen *et al.* (1999) suggest that effective organisations excel by primarily emphasising one strategy and using the other in a supporting role. The authors (*op. cit.*) posit that organisations trying to excel at both strategies risk failing at both. A 20-80 split between codification and personalisation is proposed (*ibid.*). This proposal leads to much discussion in the literature (Koenig, 2004).

Codification refers to a technology-oriented initiative ("people-to-documents") (Hansen *et al.*, 1999). It is also called an "integrative" (Zack, 1999) or "product-centred" approach (Mentzas *et al.*, 2001). The KMS model designed for this strategy is referred to as a Repository model (Kankanhalli *et al.*, 2003, 2007). As Davenport and Prusak (1998) state:

> *"The aim of codification is to put organizational knowledge into a form that makes it accessible to those who need it. It literally turns knowledge into a code (though not necessarily a computer code) to make it as organized, explicit, portable, and easy to understand as possible."* (p.68)

This strategy may be more relevant to organisations with their activities mainly focused on standardised products (or mature products) and explicit knowledge (Ribière & Román, 2006). Denning (1998) notes that there are two modes of sharing knowledge: (i) collecting dimension and (ii) connecting dimension. The former is the capturing and disseminating of know-how that can be facilitated by ICTs (*ibid.*). That is, ICTs and codification strategy can have a role in sharing tacit knowledge up to a certain extent.

Personalisation refers to a human-oriented initiative ("person-to-person") (Hansen *et al.*, 1999). It can be considered as the counter analogue of the codification strategy. It is also called an "interactive" (Zack, 1999) or "process-centred" approach (Mentzas *et al.*, 2001). The KMS model developed for this strategy is referred to as a Network model (Kankanhalli *et al.*, 2003, 2007). There are two approaches to this: providing (i) pointers to locations of experts, e.g., expert locator systems and (ii) tools to link people who are interested in similar topics, e.g., CoP (*ibid.*; see Community of Practice in this subsection).

This strategy may be more applicable when:

> *"Knowledge that has not been codified – and probably couldn't be – is transferred in brainstorming sessions and one-on-one conversations."*
>
> (Hansen *et al.*, 1999, p.108)

It mainly focuses on customised and innovative projects (Ribière & Román, 2006). It emphasises collaborations. This approach facilitates the connecting dimension of knowledge sharing (Denning, 1998) where in-person contact is a must.

In reality, Foley (2001) reports that, on average, only 42% of knowledge assets and intellectual property data were captured by Information Week 500 firms in 2001 and 38% in 2000. An average of only 33% of employees at these firms accessed the data stored in these systems in 2001 and 29% in 2000. For another example, only 20% of the knowledge of National Semiconductor that needed to be transferred was in codified forms (O'Dell & Grayson, 1998b).

Recall Polanyi's (1966b) proposition that all knowledge has tacit qualities – personal elements (see Subsection 2.3.1). This implies that knowledge can hardly be 100% efficiently transmitted from one person to another. Transmission of knowledge through IT involves a double transformation process from knowledge to information and then to data and vice versa (Bolisani & Scarso, 1999). A pure codification strategy is just a double knowledge drainage process. It is a worse state than knowledge leakage (see Brown & Duguid, 2001, for definition of knowledge leakage). If knowledge leaks to competitors and becomes desirable to consumers, it will improve social welfare (a wider choice range of goods or services). For drainage, knowledge is treated as sewage. It signifies the myopic nature of implementing a pure codification strategy.

These confirm that a mix of strategies is a must in theory and in practice in order to fully deploy the knowledge capacity of an organisation. The question is how to establish the state that is mentioned by Davenport and Prusak (1998) – knowledge roles and skills, along with technology, are enablers of KM.

As mentioned earlier, what split is the optimal one has been an argumentative topic (Koenig, 2004). In short, the opinions are divergent. For example, Denning (1998) suggests that codification is essential for efficient operations. It is generally believed that technology should stay under one third of the total effort of a KM project (Davenport & Prusak, 1998; Smith & Farquhar, 2000). These imply that an effective KM accommodating split should be starting from 33-67, but not reaching 0-100 nor 100-0. According to Hansen *et al*. (1999), a 50-50 split is an avenue for KM failure. There exists, a need to have a simple and quantifiable model to provide an objective judgement (see Section 2.4).

Ribière and Román (2006) suggest that the intensity of tacit knowledge is a crucial split decision factor. It is also noticed that recent research in this area highlights the critical role of organisational culture and interpersonal trust (*ibid.*). Trust is crucial to Agency Problem and Community of Practice (see subsequent content).

Technology

As mentioned in Subsection 2.3.5, the choices of technologies are conditional on the chosen KM strategy (see Maier & Hädrich, 2006). KM strategy should be chosen to reflect an organisation's competitive strategy − expert economics or reuse economics (Hansen *et al.*, 1999). Schwartz (2007) points out that KM processes should be founded on theory and other aspects, including technologies, should be founded on practice. Obviously, the knowledge context of an organisation crucially determines the choices of technologies directly and indirectly (via KM strategies and practice).

Jennex (2008) suggests that the organisations which can benefit from KM technology are those apply it. Applying Jennex's (2006b) idea about KM Success factor, technologies should be chosen to encourage or help users to use them to effectively perform KM functions (see Subsection 2.3.7). A user-friendly system should have a crucial role. Specific user factors are likely to be situational.

Agency Problem – Moral Hazard and Bilateral Uncertainty in Knowledgeability

In theory, applying the right codification-personalisation split guarantees a full coverage of knowledge context.

However, moral hazard problems persist regardless whichever strategy is to be pursued. Knowledge is invisible. Although knowledge is shown in the actions of a knower – knowledge is actionable and contextual (Davenport & Prusak, 1998), to have the shared (human) knowledge base is the prerequisite for understanding knowledge (Alavi & Leidner, 2001).

For a codification strategy, it requires the knowers to explicate the knowledge in order to embed it into the system. For example, O'Dell and Grayson (1998b) report that Jerry Baker says 80% of the knowledge of National Semiconductor that needs to be transferred is in the noncodifiable arena. Jerry Baker puts it this way:

> *"It may be that somebody held their tongue just right as they pulled the wafers out of the oven, and that's what made things work."*
>
> (O'Dell & Grayson, 1998b, p.157)

Even if knowledge is embedded in an information system, there is no guarantee that it will be used and applied. Similarly, there is no reason to believe that knowers will transfer more knowledge to others through personal contact. Incentive scheme is a candidate to resolve this moral hazard problem.

Jennex's (2006b) bibliographical analysis suggests that incentive is the fourth most important KM/KMS success factor. Incentive (or motivation) generally has a positive effect on knowledge transfer (King, 2006). Incentives can be classified into intrinsic and extrinsic incentives (see Ekbia & Hara, 2006; King, 2006). Intrinsic incentives exist when activity is valued for its own sake and appears to be self-sustained (King, 2006). Extrinsic incentives involve monetary rewards, recognition and promotion (Ekbia & Hara, 2006) – i.e., economic incentive schemes.

Ekbia and Hara (2006) notice that (i) in a survey with a group of knowledge workers, 58% of the respondents perceive that there is a discrepancy between merit increase and performance rating (Smith & Rupp, 2003); (ii) economic incentive schemes are not derived upon employee responsibility (Austin, 1996); and (iii) there is mismatching between economic incentives and performance measurement (Barth, 2000). The authors (*op. cit.*), therefore, perceive that economic incentives fail to address non-pecuniary issues that are attached to KM such as commitment, job satisfaction, etc.

Indeed economists have introduced intrinsic aspects into the discussion of incentives. For example, trust has long been recognised as crucial in any exchange (Fehr & Rockenbach, 2003). Arrow (1963) notes that "the ethically understood restrictions on the activities of a physician are much more severe" than on those of other professions (p.949). Arrow (1986) puts forward that "there is a whole world of rewards and penalties in social rather than monetary form" (p.1194). The author (*op. cit.*) also proposes introducing ethical indoctrination and reputation into principal-agent modelling. In fact, altruistic (or benevolent) agency modelling has gained its popularity in the healthcare reimbursement scheme literature (Ellis & McGuire, 1990). For example, Ellis and McGuire's (1986) benevolent physician model has subsequently been extended by the authors and others. Scott's (2001) econometric work evidences that physicians are benevolent as they show willingness to trade off their income against quality of care.

Recently, Lane and Tsang (2008a,b) extend Ellis and McGuire's (1986) model to discuss a form of Physician-Patient relationship that can give insights into KM incentive design. The authors (*op. cit.*) notice that bilateral uncertainty in aetiology and diagnosis often exist in medical decisions. In their model, the benevolent Physician's diagnostic effort can improve the diagnostic quality. Nevertheless, the aetiology and diagnostic result remain uncertain to both Physician and Patient in the whole decision process. The results show that none of the three broad reimbursement schemes appears to be efficient (Arrow (1963) suggests that reimbursement schemes can broadly be classified into (i) full-cost payment, (ii) prospective payment and (iii) cost-sharing payment). It is proposed that the altruism parameter can be treated as a decision variable or a response function in further research on physician-patient modelling (*ibid.*).

In Lane and Tsang's (2008a,b) papers, Patient and the healthcare institute are passive. Physician is a paternalistic and altruistic common agent (*ibid.*). Altruism is a driver of knowledge sharing behaviours (Constant *et al.*, 1994). In reality, both management and knowers are usually active and self-interested. They can game each other. Lane and Tsang's (2008a,b) proposal for deriving an extrinsic-intrinsic scheme appears to be applicable to mitigate this moral hazard problem. However, like the Physican's decision problem (*ibid.*), the bilateral uncertainty problem can never be eliminated.

Bilateral uncertainty in knowledgeability can be seen from the paradox of expertise (see Gupta *et al.*, 2004). A good explanation is that "[experts] know more than [they] can tell" – a re-expression of Polanyi's (1966a, p.4) often quoted dictum. The knowers are not consciously aware of how much they know nor of what the organisation does. That is, "[t]he value of information [or knowledge] is frequently not known in any meaningful sense to the buyer; if, indeed, he knew enough to measure the value of information, he would know the information itself" (Arrow, 1963, p.946).

Economic (extrinsic) incentive schemes are effective. It is just that incentive schemes have not been applied in the appropriate conditions. Intrinsic and extrinsic incentives are not mutually exclusive. Altruistic agency models that incorporate work processes into the decision structures such as Lane and Tsang's (2008a,b) works can be considered as a basis for deriving KM incentive schemes in further research. However, accommodating corporate policies are also needed.

Community of Practice (CoP)

"[I]f people issues do not arise, the effort underway is probably not knowledge management" (Ruggles, 1998, p.88). Not surprisingly, researchers often relate organisational culture to KM (Alvesson & Kärreman, 2001). However, culture should not be over-emphasised (*ibid.*). For example, Kroeber and Kluckhohn (1952) have compiled over 150 definitions of culture. Identifying a relevant and working definition appears to be a research question *per se*.

Instead, existing empirical studies suggest that CoPs do work in a way to hold and share knowledge collectively for their shared practice (Brown & Duguid, 2001). This suggests that a desirable KM outcome can be expected from establishing an environment that encourages the emergence of CoPs.

CoP as a constructive social form has been in existence for centuries (Stein, 2007). It is the concept of CoP in the workplace that is relatively new (*ibid.*). For example, CoP has been defined as a "community of knowing" in organisational studies literature (see Boland & Tenkasi, 1995). According to Brown and Duguid (1998), the early modern formulation of the concept CoP is due to Lave and Wenger (1991). There are various attempts to define CoP. An authoritative one is possibly:

> *"[C]ollective practice leads to forms of collective knowledge, shared sensemaking, and distributed understanding that doesn't reduce to the content of individual heads. A group across which such know-how and sensemaking are shared… has been called a 'community of practice'."*
>
> (Brown & Duguid, 1998, p.96)

Stein (2007) summarises the opinions of various authors and notes five distinct aspects of CoP as follows:

1. A knowledge domain of interest;
2. A set of interested and interconnected participants;
3. Opportunities for ongoing processes of sense-making, knowledge sharing and discovery within the domain of interest;
4. A set of resources related to the domain of interest, including methods, tools, theories, practices, etc., that are acquired, retained and accessible

by the community; and

5. Processes by which the community maintains and refreshes its membership.

These characteristics, especially sense-making, crucially distinguish CoP from other similar settings in an organisational framework such as community of interest, community of learners and learning community (*ibid.*).

Not much is known about how CoP is evolved and what activities contribute to its longevity and success (Coakes & Clarke, 2006; Stein, 2007). McDermott (1999) suggests four challenges for building CoP "to design human and information systems that not only make information available, but help community members":

1. "think together" (p.116) (originally proposed by Boland and Tenkasi (1995)),
2. develop communities so that they will share their knowledge,
3. create an organisational environment that values shared knowledge, and
4. encourage an atmosphere of openness and willingness to share knowledge.

Within a CoP environment, knowledge is leaky (Brown & Duguid, 2001). The authors (1998) note that (i) when communities do not overlap, translators are needed to act as media to convert or translate knowledge; (ii) when they do overlap, the common members (across communities) are in a position to act as knowledge brokers; and (iii) the knowledge items that are of interest to more than one community are boundary objects.

Points (i) and (ii) raise concerns that there will be a loss in translation or brokerage. Perhaps knowledge is leaky within a CoP, but not equally distributed. It appears that recruiting the persons who already have the shared knowledge is prerequisite for an organisation to benefit from the positive impacts of CoP on KM. This is a form of knowledge creation identified by Davenport and Prusak (1998) (see Subsection 2.3.3).

In recent years, research attention has been drawn to Virtual CoP (Kankanhalli *et al.*, 2007; Rubenstein-Montano, 2004). This appears to be a costless setting to encourage knowledge sharing. However, Virtual CoPs do have their limitations. Rubenstein-Montano (2004) suggests that (i) their knowledge sharing is heavily restricted by technology; (ii) tacit-knowledge can be shared only up to a certain extent, and (iii) explicit-knowledge sharing appears to be their major function. The possibility of setting up a virtual CoP in an organisational setting is largely conditional on the staff's degree of trust in the management (*ibid.*). In a web environment, it is relatively difficult to trace back the user identities. In an institutional environment, no matter how big an organisation is, the users can always be identified. Virtual CoP could become an add-on means for management to control their staff. Also, there appears to be a lack of evaluation studies on virtual CoP (Kankanhalli *et al.*). That is, their net effects on KM are uncertain.

Coakes and Clarke (2006) point out that CoPs are often voluntary in nature – they are susceptible to outside control and can be ceased easily. Stein (2007) identifies a CoP that went through an organisational life cycle and renewed itself. However, that CoP is not operated within an institutional setting. A reasonable amount of evidence suggests that a CoP is more likely to sustain if it is left self-organising (Coakes & Clarke, 2006; Stein, 2007) and self-managing (Coakes & Clarke, 2006). Although informal networks often exist in organisations (Willem & Buelens, 2007), management may feel uncomfortable to formalise an informal setting not directly controlled by any rule or routine. Particularly, Brown and Duguid (2001) note that CoP can span across organisations. There exists a possibility of knowledge leakage. Liebeskind (1996) sees leaking knowledge to competitors as harmful to an organisation's competitive advantage. Management may consider CoP as a threat rather than a KM facilitator.

In conclusion, CoP can be a desirable KM facilitator under certain conditions. However, the impacts of CoP are likely to be limited and short-lived due to lack of authority.

This subsection is not intended to discuss KM policy instruments exhaustively. However, it highlights the need to include KM policies into a prioritised corporate strategic plan.

2.3.9 What is New to Management?

It has been shown that KM involves choosing the right combination of ITs to leverage the knowledge that resides in human resources.

The rapid advancement in IT research may convince us that in time this situation will change. Indeed, the underlying assumption of the application of expert systems is that "the superior storage and processing capacities of a computer [or an IS] will allow it to perform as well as an expert" (Taylor, 2006, p.59). Note that knowledge is always in a process of extending beyond itself (Fransman, 1998). Knowledge is recursive and reflexive in nature – a process that generates new data and information as well as new knowledge (Spiegler, 2000). Information systems are closed – they cannot ever capture all aspects of a business problem domain (Butler, 2006). One may argue that this can be resolved though frequent updating of coded knowledge. It may be so. However, this argument ignores the fact that what come with knowledge are intellectual capabilities.

Cattell (1963) suggests that human intellectual capabilities can broadly be classified into Fluid and Crystallised Intelligence. Fluid intelligence is the ability to quickly process a potentially large amount of information to solve issues that are not of one's prior knowledge (*ibid.*). Crystallised intelligence is the ability to retrieve knowledge (*ibid.*). One may build an IS that has higher capabilities in storing and retrieving information than an average human does. However, only the most gifted individuals are well endowed with fluid intellect (it cannot be learnt). One cannot expect that an expert (a learned and gifted individual) can be replaced by some pieces of microchips at a low cost.

Also note that "the traditional economics of managing professional intellect" is changed by "new technologies and management approaches" (Quinn *et al*. 1996, p.74). As posed in Subsection 2.3.6, in the KM era, the key to success is "stronger collaboration 'and' agility." Management have to prepare to (i) allow knowledge "intermediaries" and "communication" to take place; and (ii) accept the outcome of transforming an "elusive" commodity − knowledge − into potentially rewarding "products and services."

To conclude, the new tenet of Management is to coordinate with knowledge workers and support them with the right information/knowledge resources.

2.4. A Policy-Making Device – A Codification-Personalisation Split Meter

Bali *et al.* (2009) opine that any potential KM solution should come from combining people, process and technology. Most KM experts believe that, of these three elements, technology comprises the smallest part of a KM initiative (Dash, 1998). However, authors seem to have different opinions about the right balance among these three elements (Davenport & Prusak, 1998; Ruggles, 1998; Smith & Farquhar, 2000).

This evidences the need to derive a quantifiable model to determine the right levels and types of ITs to be implemented from an integrative perspective of people, process and technology. Hansen *et al.*'s (1999) oft-cited KM Strategy paper has laid a foundation for formulating such a model.

2.4.1 The Baseline Model

Hansen *et al.* (1999) propose that an efficient organisation can excel by appropriately complementing codification strategy ("people-to-documents") with personalisation strategy ("person-to-person") to reflect its competitive strategy. An organisation that relies on "reuse economics" may choose a codification strategy and "expert economics" a personalisation strategy (*ibid.*). The authors (*op. cit.*) recommend a 20-80 split between codification strategy and personalisation strategy. IT infrastructure and staff structure may be determined in accordance with the chosen KM strategy (*ibid.*).

This proposal has taken people, process and technology into consideration for making split decisions. However, organisations have different IT infrastructure and staff structure (knowledge requirements). The proposed 20-80 spilt is arbitrary. Also, IT infrastructure and staff structure may not be adjusted easily. It may be more plausible to consider that IT infrastructure and staff structure determine the split. The complicated KM strategy decisions can be explained by a simple and quantifiable model.

A Graphical Representation

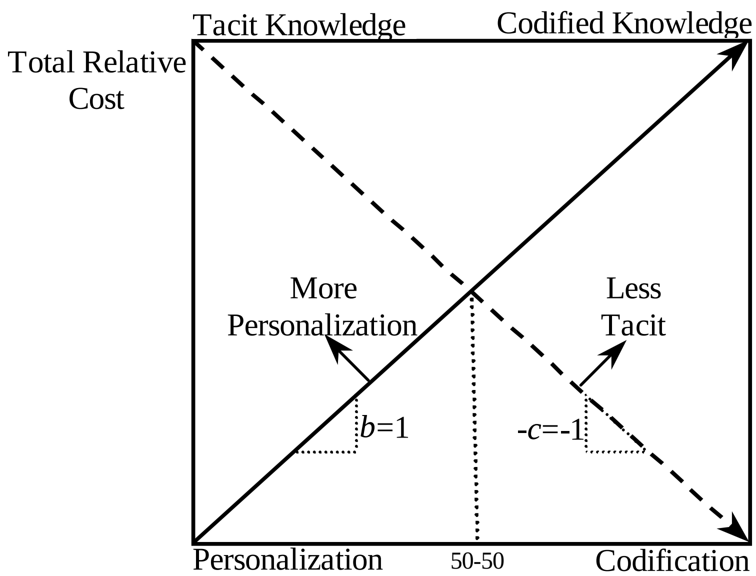
The upper horizontal line of Figure 9 represents a Knowledge Context Spectrum of tacit and codified knowledge. It is normalised to 100. Tacit knowledge is the normalisation base. Tacit Knowledge is defined as what "we can know more than we can tell" (Polanyi, 1966a, p.136). All human knowledge has tacit qualities (Polanyi, 1966b).

Codified Knowledge refers to knowledge that is converted into "accessible and applicable formats" (Davenport and Prusak, 1998); i.e., information or data. The structure/ratio of (non-IT) operations staff types is a proxy of an organisation's knowledge context. The upper horizontal line represents a Knowledge Context Spectrum. The lower horizontal line represents an IT Spectrum. It is scaled in proportion to the Knowledge Context Spectrum.

KM strategy is determined by the intersection point of the two arrows. The dashed arrow and solid arrow represent Competitive (or Knowledge) Strategy and IT Strategy respectively. Following the tradition of representing split, 0-100 (100-0) represents a pure KM personalisation (codification) strategy.

The solid arrow is the total relative cost schedule of codification ITs. The magnitude of its slope, *b*, represents the relative unit cost between codification and personalisation ITs. The more costly codification ITs are, the steeper the arrow is – more personalisation ITs will be employed. When only codification (personalisation) ITs are employed, the arrow coincides with the lower horizontal (left vertical) line.

Figure 9: A Codification-Personalisation Split Meter



Let the relative unit cost between codified and tacit knowledge be *c*. Suppose the maximum the organisation is willing to pay for one unit of tacit knowledge is normalised to 1. The budget for employing knowledge (or IT) is 100. Employing one extra unit of codification ITs facilitates the use of codified knowledge, but crowds out the use of tacit knowledge. Consequently, the productivity of codified knowledge also decreases due to the decrease in the use of the complementary tacit knowledge. Therefore, the dashed line represents the total benefit schedule of employing codification ITs. The more costly codified knowledge is, the steeper the dashed arrow is – less codified knowledge is going to be employed. When only codified (tacit) knowledge is employed, the arrow coincides with the upper horizontal (left vertical) line.

The intersection point of the two arrows is where no extra unit of codification (personalisation) ITs can be employed without forgoing one unit of codified (tacit) knowledge or vice versa − an implication of the Pareto optimality. In Figure 9, a 50-50 split between codification and personalisation strategies is the optimum.

The Quantifiable Approach

Simplicity only partially reflects the beauty of this model. Figure 9 can efficiently explain the dilemmas involved in a KM strategy decision. In general, it requires a quantifiable approach in order to compute the KM strategy precisely and the optimal spending on ITs or knowledge. To do so, it only requires an application of elementary algebra.

The general form of any linear function is:

$$y_i = A + Bx_i$$

where A is the y-intercept, B (=b,−c) is the slope, and i=1,2. Arrow (1963) notes that knowledge has a cost of production and a cost of transmission. So, the absolute value of B represents the unit relative cost between two (production) factors and is assumed to be positive. Its magnitude is exogenously determined. That is, no organisation has the monopsony power to affect the factor prices. A split is represented by the weights of codification and personalisation strategies, $x - (100 - x)$. x_i, where i=1,2, ranges in value from 0 to 100 units.

Accordingly, the IT Strategy (the solid arrow) is represented by:

$$y_1 = bx_1 \tag{1}$$

where $b > 0$ is the relative unit cost between codification and personalisation ITs. It may include the relative unit cost of substituting IT staff who specialise in IS for those who specialise in KMS.

The Competitive (or Knowledge) Strategy (the dashed arrow) is represented by:

$$y_2 = 100 - cx_2 \tag{2}$$

where $c > 0$ is the relative unit cost between codified and tacit knowledge. It may be considered as the relative unit cost of substituting the general operations staff for those knowledgeable ones.

Substitute (1) into (2), and rearrange the terms to obtain:

$$x^* = \frac{100}{b+c} \qquad (3).$$

x^* is the optimal codification weight and $(100-x^*)$ the optimal personalisation weight. As shown in Figure 9, when $b = 1$ and $c = 1$, by (3) the split x^*-$(100 - x^*)$ is 50-50.

To be explicit, the split index is represented by:

$$\frac{x^*}{100 - x^*} = \frac{1}{b + c - 1} \qquad (4).$$

The reciprocal of (4), $(b + c - 1)$, is the optimal relative unit cost between codification and personalisation. Neither (3) nor (4) permits $x^*=0$ as the numerators can never be zero. The positive relative unit cost assumption ($b>0$ and $c>0$) guarantees that the denominator of (3) is positive $(b + c > 0)$. Therefore, (3) will not become undefined. Similarly, $b + c = 1$ is not permitted, as (4) will become undefined. So, x^* cannot be 100 nor $(100-x^*)$ be 0. Neither a pure personalisation nor pure codification strategy can be an optimal strategy. The condition $0 < x_i < 100$, where i=1,2, rules out $(100 - x^*) < 0$ and $b + c < 1$. So, (4) cannot be negative. The condition for applying (3) and/or (4) must be $b+c>1$. The resulting optimal KM strategy must be characterised by $0<x^*<100$ and $0<(100-x^*)<100$.

So, (3) and (4) support the proposition of Hansen *et al.* (1999) that effective organisations excel by applying mixed KM strategies. A 50-50 split is an optimal KM strategy only if $b+c=2$ (the situation depicted in Figure 9). So, it generally supports Hansen *et al.* (1999) that a 50-50 is a suboptimal strategy. It also does not dispute Koenig's (2004) empirical study with the pharmaceutical industry.

2.4.2 Alternative Decision Rules

What can we do if the two functions never intersect? In this case, the $b+c>1$ condition does not hold. An application of (3) and (4) cannot conclude an optimal KM strategy. An apparent option is to apply decision rule (1) or (2) in accordance with an organisation's major objective − containing IT cost or incorporating the right knowledge context into its business processes.

Recall that B is a relative unit cost. Should only one decision rule be applied, the split index is determined by its reciprocal as follows:

$$\frac{x_i}{100-x_i}=\frac{1}{B} \qquad (5).$$

where $i=1,2$ and $B=b$ $(=-c)$ when $i=1$ (=2). The codification weight is, therefore, determined by:

$$x_i=\frac{100}{B+1} \qquad (6).$$

This is a special case of (3) where one of the relative costs equals one. For example, (3) degenerates to $x^*=100/(b+1)$ when $c=1$ and (4) degenerates to $\frac{x^*}{100-x^*}=\frac{1}{b}=\frac{1}{B}$ as expected. So, either applying the IT Strategy (1) or Competitive Strategy (2) to the situation in Figure 9 will conclude an optimal split 50-50. That is, a dominating decision rule is generally a suboptimal strategy unless $b = 1$ and/or $c = 1$.

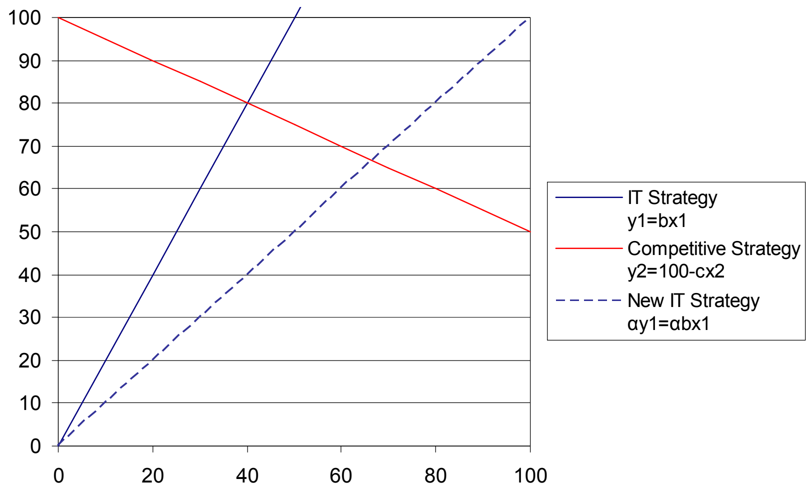
A preferred remedy will be to introduce a weighting factor, $\alpha > 0$, to allow rescaling the costs. For example, the organisation may rescale the cost of codification ITs to αb by $\alpha < 1$ ($\alpha > 1$) if it perceives the cost is over- (under-) priced. Accordingly, (3) and (4) become $x^* = \dfrac{100}{\alpha b + c}$ and $\dfrac{x^*}{100 - x^*} = \dfrac{100}{\alpha b + c - 1}$ respectively. The interpretation of (3) and (4) in the preceding subsection still holds, but with b being replaced by αb. In this case, the optimal KM strategy is determined by the factor market and also the organisation's subjective assessment.

2.4.3 A Numerical Example

A numerical example is simulated by a spreadsheet application to show that the application of this model only requires some basic numerical skills (see Figure 10). Suppose $b = 2$ and $c = 0.5$, $b + c = 2.5 > 1$, so the condition for applying (3) and/or (4) holds. Both the highlighted data and (3) and (4) consistently suggest that the optimal KM strategy x^*–$(100 - x^*)$ is 40-60. The optimal total cost of codification is 80 ($= 2 \times 40$) and that of personalisation is 20 ($= 100 - 80$).

If the split is determined by the IT Strategy (Competitive Strategy) alone, the recommended split is 33.33-66.67 (66.67-33.33). The results are consistent with the split indexes $1/b = 0.5$ and $1/c = 2$. In this example, neither b nor c equals 1. So, no application of single strategy determines a KM strategy that coincides with the optimal one. The orders of the relative costs are $b > b + c - 1 = 1.5 > c$, so $x_1 < x^* < x_2$ and $100 - x_1 > 100 - x^* > 100 - x_2$ as shown by the data. So, the IT Strategy (Competitive Strategy) recommends an overly personalisation- (codification-) oriented KM strategy. Suppose the organisation rescales the codification IT cost by 50% $(\alpha = 0.5)$. The original upward sloping schedule rotates clockwise. The new IT Strategy is denoted by the dashed and upward sloping schedule. In this case, $\alpha b + c = 1.5 > 1$, an application of (3) and (4) will conclude a 66.67-33.33 split. That is, its subjective optimal KM strategy deviates from the one concluded from the market factor prices.

Figure 10: Algebraic Approach of KM Strategy Determination



x	IT Strategy $y_1=bx_1$	Competitive Strategy $y_2=100-cx_2$	New IT Strategy $\alpha y_1=\alpha bx_1$	$b=2$	$c=0.5$	α	Checking	Split
0	0	100	0	2	0.5	0.5	***Two Decision Rules***	
10	20	95	10	2	0.5	0.5	Codification: $x^*=100/(b+c)$	40
20	40	90	20	2	0.5	0.5	Personalisation: $100-x^*$	60
30	60	85	30	2	0.5	0.5	Split Index: $x^*/(100-x^*)=1/(b+c-1)$	2/3
40	**80**	**80**	40	2	0.5	0.5		
50	100	75	50	2	0.5	0.5	***IT Strategy***	
60	120	70	60	2	0.5	0.5	Codification: $x_1=100/(b+1)$	33.33
70	140	65	70	2	0.5	0.5	Personalisation: $100-x_1$	66.67
80	160	60	80	2	0.5	0.5	***Competitive Strategy***	
90	180	55	90	2	0.5	0.5	Codified: $x_2=100/(c+1)$	66.67
100	200	50	100	2	0.5	0.5	Tacit: $100-x_2$	33.33

This simple and quantifiable model offers a tool to determine optimal KM Strategy from an integrative perspective of people, process and technology. However, there is no pretence that determining the right KM strategy is an easy task. It requires constant collaborations among different parties to gather sufficient knowledge in order to revise the decisions. For example, the knowledgeable staff have a better knowledge about which functions of the systems suit their duties. No major system implementation is allowed without the consent of the CEO. The CKO knows the costs better than others do in fact know them.

This model poses that, at the optimal KM strategy, the levels and types of ITs are also optimally determined for a given combination of IT infrastructure and staff structure. Note that this model assumes that IT is fully adopted into practice. Unfortunately, significant evidence suggests that IT adoption has been an issue in different industries. In further research, IT adoption may be introduced into the model as a decision variable.

2.5. KNOWLEDGE MANAGEMENT AND LEVERAGING PROFESSIONAL INTELLECT

So far, KM has been discussed in a general framework. The focus of this section is to outline the background of the specific research questions – leveraging professional intellect through judiciously adopting IT into (medical) professional practices and identifying the required conditions.

2.5.1 Introduction

Since the early 1990s, eHealth initiatives have been launched in Europe, the US and other countries worldwide (Bates *et al.*, 2003; EC, 2007; eHealth Initiative, 2006; fraserhealth, 2007). WHO has been acting on the 10-year KM Global Operational Plan (WHO, 2006). eHealth reforms appear to be just a predecessor of implementing KM in the health sectors worldwide.

This subsection will show that eHealth initiative is an intent to leverage professional intellect in a special class of professional practices through IT. Managing professional intellect is an under-studied area (Quinn *et al.*, 1996). Leveraging professional intellect through technology-enabled KM has drawn much attention from Professional Service Firms (PSFs) (Fink & Disterer, 2006). PSF is considered to be an ideal organisational setting to conduct KM research (Blackler *et al.*, 1993). Hitherto, the full potentials of these KM initiatives are yet to be optimised in PSFs (Fink & Disterer, 2006). The current eHealth reforms offer an ideal opportunity to understand this imperative KM issue. The implications are likely to be applicable to organisations which rely on "expert economics" and intend to implement technology-facilitated KM.

2.5.2 Why a Medical Care Industry?

A study in a healthcare setting can enlighten many research areas, not just healthcare and its related disciplines.

Uncertainty Perhaps Unpredictability – Knowledge Economy

In a Knowledge Economy era, knowledge and information is being produced as if it were cars and steel produced in industrial economies (Stiglitz, 1999a). "The capacity to manage human intellect… is fast becoming the critical executive skill of the age" (Quinn *et al.*, 1996, p.71).

These phenomena may be implied by the prevalence of uncertainty, perhaps unpredictability. Arrow (1963) notes:

> *"When there is uncertainty, information or knowledge becomes a commodity… [I]nformation, in the form of skilled care, is precisely what is being bought from most physicians, and, indeed, from most professionals. The elusive character of information as a commodity suggests that it departs considerably from the usual marketability assumptions about commodities.*
>
> *The risk and uncertainty are, in fact, significant elements in medical care hardly needs argument. I will hold that virtually all the special features of this industry, in fact, stem from the prevalence of uncertainty."* (p.946)

This situation is not unique to the medical care industry. Nonaka (1991) consistently notes that "[i]n an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge" (p.96).

Some authors put forward that today's economy is characterised by unpredictability and/or a rapid rate of changes (Fliedner & Vokurka, 1997; Holsapple *et al.*, 2007; Hsu & Mykytyn, 2006). For example, Smith and Reinertsen (1998) note that over the past 10 years, product/technology development time has been reduced by one half, from 24 to 36 months to 12 to 18 months, amid competitive pressure and the drive to obtain first-mover advantage (Amesse & Cohendet, 2001).

Medical decision-making involves applications of agility to implement a desirable outcome. Charles *et al*. (1997) opine that consultations are characterised by a continuum of models ranging from the paternalistic model through the shared decision-making model to the informed choice model. "[A] given medical encounter may start as one model of interaction, but evolve into something else as the encounter unfolds" (Charles *et al*., 1997, p.688). Charles *et al.* (1999) add that the decision-making approach can change within one physician-patient interaction and in the next interaction. The preferences of both physicians and patients can vary widely and change over time (Charles *et al*., 1997). Medical decision-making is so complex that it cannot be conceptualised by one single model (Gafni *et al*., 1998) or some algorithms (Stempsey, 2009).

This situation may explain the fact that physicians hardly perceive patient (or parental) expectation for antibiotic prescriptions correctly (Butler *et al.*, 2001; Mangione-Smith *et al.*, 1999, 2003). The degree of agreement between physician perception and patient expectation is not much better than a chance event ($p<0.05$; $\kappa=0.14$) (Mangione-Smith *et al.*, 1999, 2003). Physician perception has been identified as the only significant predictor of prescribing antibiotics for presumed viral aetiology (Butler *et al.*, 2001). The adverse impacts of uncertainty or unpredictability can be seen.

Unpredictability is, in fact, a driver of KM implementation (Holsapple *et al.*, 2007). Research on medical decision-making can offer insights into developing agility to excel in today's Knowledge Economy.

Overlapping Features of the Medical Care Industry with Other Organisations of the Age

"The capacity to manage human intellect − and to convert it into useful products and services − is fast becoming the critical executive skill of the age" (Quinn *et al.*, 1996, p.71). So, the organisations of the age are those that can prosper from managing human intellect.

Arrow (1963) notes that the medical care industry has its special features. It deserves a formulation of a specific KM framework. Unfortunately, these KM models scarcely exist, and those which do emphasise physicians as learners (de Lusignan *et al.* (2002; Orzano *et al.*, 2008). Learning is an important process, but only part of a medical decision-making process (a form of KM process). Perhaps a pragmatic approach is to identify a close equivalent organisation framework from the organisational studies related literature.

Metaxiotis (2006) suggests that healthcare institutes are Knowledge-Based Organisations (KBOs) "which process massive amounts of data, such as electronic medical records, clinical trial data, hospitals records, administrative reports and generate knowledge" (p.204). Judging from the quotation from Quinn *et al.* (1996, p.71), if healthcare institutes are to be defined as KBOs, then it must be that knowledge is the product (Arrow, 1963). The product and the activity of production are identical (*ibid.*). So, physicians are their own executives of the age as their knowledge is converted into "the form of skilled care" (Arrow, 1963, p.946).

Davenport and Holsapple (2006) consider that comparing various frameworks helps understand the nature of KBO. The authors (*op. cit.*) review three KBO frameworks that represent a spectrum of current points of view about the nature of KBOs. These three frameworks emphasise knowledge as a key organisational asset that enables action (*ibid.*). Sveiby's (1997a) framework may be applied to describe the staff structures of the medical care industry. None of those three frameworks represents a knowledge manipulation framework that can capture the unpredictable nature of medicine decision-making processes (see Charles *et al.*, 1997, 1999; Gafni *et al.*, 1998; also Subsection 2.5.1).

Alternatively, a search has been performed based on Davenport and Holsapple's (2006) recommended synonyms of KBO. The following descriptions or features of KBOs are found:

1. Knowledge Organisation is characterised by weak hierarchies, dense lateral connections, low departmental walls and openness to the environment (Achrol & Philip, 1999).
2. For Knowledge-Based Organisations, competitive advantage and profits are generated through the successful management of intangible assets such as reputation (Sveiby, 1997b).
3. Knowledge-Centric Organisation is a Navy initiative wherein personnel organise virtually around knowledge needs such that the virtual organisation becomes an overlay to existing command structures (Millward, 2000).
4. A Knowledge-Intensive Firm is an organisation staffed by a high proportion of highly qualified staff who trade in knowledge itself (Alvesson, 1993a; Starbuck, 1992, 1993).
5. Projects are the typical way of working in most Knowledge-Intensive Organisations (Dingsøyr, 2006).

It requires further research in order to confirm or disconfirm points 1, 2 and 3. Points 4 and 5 are trivial features of the medical care industry. The quotation from Arrow (1963) clearly suggests that healthcare institutes trade in knowledge. Licensing and tertiary education are the entry restrictions for the medical profession (*ibid.*). Point 5 is suggested by the fact that each health complaint can be considered as a project.

In fact, healthcare institutes exhibit unique organisational structures. Physicians are not completely monitored by their affiliated institutes, but highly regulated. The institutes have to accept physicians' codes of ethics and allow medical societies to adjudicate some issues (Starbuck, 1992). Medical practice is governed by guidelines (Butler *et al*., 2001; ter Meulen, 2005). "[T]he ethically understood restrictions on the activities of a physician are much more severe" than on other professions (Arrow, 1963, p.949). Professional standards and autonomy are enforced by collegiality (Starbuck, 1992). The author (*op. cit.*) considers healthcare institutes to be Professional Firms. However, they cannot be Autonomous Professional Firms. Physicians are both vertically and horizontally monitored by colleagues at similar and senior levels (Fama, 1980). Informality and flexible structure is not a valid description of this industry − a feature of Autonomous Professional Firms (see Starbuck, 1992). In fact, physicians are in a "network of semi-autonomous teams" (see Stiglitz, 1999a; Subsection 2.3.6, p.49). Note that medical decisions are sometimes made by medical teams (Charles *et al*., 1997). Physicians are sometimes trained in multi-professional teams (Wyatt, 2001). Without "sense-making" (Brown & Duguid, 1998) – the defining feature of CoP (Stein, 2007) – these activities can hardly take place. The medical profession is, naturally, a network of permanent CoPs.

Medical practice also shares some features of a Professional Service Firm (PSF) − a close equivalent of KBO (DeTore & Balliet-Milholland, 2003). For PSFs, work is usually performed by small teams and is project-based (see Alvesson, 1993b), and knowledge is a capacity to act and to serve the client (Fink & Disterer, 2006).

The nature of medical knowledge appears to be also in a form of professional intellect hierarchy proposed by Quinn *et al*. (1996) as follows:

1. "Cognitive knowledge" (know-what) is the basic mastery of a discipline that professionals achieve via education and training.
2. "Advanced skills" (know-how) is the ability to apply cognitive knowledge into effective execution to real world problems.
3. "Systems understanding" (know-why) is a deep knowledge the web of cause-and-effect relationships underlying a discipline, expressed as highly trained intuition.

4. "Self-motivated creativity" (care-why) consists of the will, motivation, and adaptability for success that enable renewal of knowledge in the face of today's rapid changes.

Point 1 is similar to the fourth feature of KBOs. Other aspects can be seen from the fact that physicians are trained to invent solutions by being taught basic sciences and encouraged to do research (Wyatt, 2001).

The nature of services of PSFs is defined by Evans and Volery (2000) as follows:

1. "Intelligence" is the provision of quality information to sharpen, improve, or support the cleverness of clients in situations such as decision-making. Professional knowledge is applied to structure and present the information to optimise the utility of its usage for clients.
2. "Consulting" is the customisation of information to satisfy the particular circumstances of a client. Consulting involves the ability to apply and transfer a high level of professional knowledge to the client.
3. "Counselling" involves acting as a mentor to the client: the service provider works with the client to structure, identify, and recommend appropriate approaches to the client's problems. High levels of professional experience, knowledge, and motivation are required. This provides an example of a 'care-why' knowledge type.
4. "Relationship networking" is the ability of the service provider to bring clients into contact with other clients or parties that may have the potential to provide them with business benefits. At these meetings, trades take place in the form of information, ideas, experiences, etc.

"Intelligence" and "consulting" can easily be found in any medical consultation. A credible example is seen from Charles *et al.*'s (1999) explanation about information exchange:

- "*Types of information that the physician might communicate to the patient include: the natural history of the disease, the benefits and risks (side effects) of various treatment alternatives, a description of the* *treatment procedure(s) to be used and community resources and information that the patient could access about her disease."* (p.654)

- *"Information that the patient might reveal to the physician include: aspects of the patient's health history, her lifestyle, her social context (e.g. work and family responsibilities and relationships), her beliefs and fears about her disease and her knowledge of various treatment options obtained from lay networks and/or other information sources."* (p.654)

The quotations capture a feature of the shared decision-making model in the continuum of consultation models (Charles *et al*., 1997) – "a meeting between experts" in diagnosis and clinical evidence, and in their own body and life style (Butler *et al.*, 2001). Medical practice involves "counselling" since one-to-one clinical mentoring is a commonly used clinical strategy (Wyatt, 2001). Referral to another physician is an example of "relationship networking".

Alexander and Hordes (2003) compare and summarise the nature of professional services and products (see Table 9).

Table 9: The Nature of Products and Professional Services

(Fink & Disterer, 2006; Reprinted by Permission of the Publisher)

Dimension	Product	Service
Production	Built	Performed
Production Costs	Uniformity	Uniqueness
Involvement	Rarely	Usually
Quality Control	Compare output to specification	Compare expectation to experience
Poor Quality Procedure	Recall	Apologise and atone
Moral and Skill Level	Important	Vital

These dimensions of professional services appear to be vaguely applicable to medical care. However, "the patient cannot check to see if the actions of [the] physician are as diligent as they could be" (Arrow, 1986, p.1184). The quality of care is largely monitored by physicians' ethical indoctrination and other non-pecuniary mechanisms.

Arrow (1986) notes that "[p]rofessional responsibility is clearly enforced in good measure by systems of ethics, internalised during the education process and enforced in some measure… more broadly by reputations" (p.1194). Indeed, "the ethically understood restrictions on the activities of a physician are much more severe" than on other professions (Arrow, 1963, p.949). Also, physicians are horizontally and vertically monitored by themselves (Fama, 1980). This helps enforce the reputation mechanism. Arrow (1986) also notes that little evidence indicates that liability for malpractice is associated with physician remuneration. Empirical evidence suggests that litigation campaigns hardly ever succeed, due to lack of professional witnesses; however, physicians tend to be excessively concerned about them (McGuire, 2000). In Scott's (2001) econometric analysis, physicians are willing to trade off their income to work in practices with guidelines that are likely to reduce their clinical autonomy. This may be due to physicians' concerns about quality of care and/or litigation avoidance (*ibid.*).

Fink and Disterer (2006) add that (i) the production and consumption of services occur simultaneously (the co-presence of service provider and client is required) and (ii) professional knowledge services are heterogeneous. Point (i) is inarguably true. Point (ii) is implied by the empirical evidence that physician procedures for the same disease often varied considerably (Charles *et al*., 1999).

Conclusively, medical care industry has features that overlap with those of KBOs and more so with those of PSFs. It also has its unique features. Medical practice is governed by ethical indoctrination (Arrow, 1963, 1986), physicians themselves (Fama, 1980), clinical procedures, diagnostic categories, prescription guidelines, etc. (Butler *et al.*, 2001; ter Meulen, 2005). Medical practice is conducted under time pressure (Butler *et al.*, 2001; Charles *et al*., 1997; Taylor, 2006). Medical decision-making is not only a KM process, but also a professional intellect application process where professional ethics are an essential feature. KM appears to suit this industry exceptionally well due to some of its special features. For example, physicians are: (i) altruistic, (ii) naturally in a permanent CoP network and (iii) possibly more closely monitored than other professions – by their predominant ethical indoctrination, their colleagues, the governing bodies, guidelines and the threats of litigation. Properties (i) and (ii) are drivers for knowledge sharing (see Brown & Duguid, 2001; Constant *et al.*, 1994, for example). Together with property (iii), physicians have every incentive to coordinate with each other. Desirable KM outcomes can be expected from this industry.

This subsection highlights that medical practice is an ideal control observation for conducting research in expertise or professional intellect. The results are expected to be of valuable reference for organisations that rely on “expert economics”.

A Preview of HIT Adoption into Medical Practice and Towards a Better Measure

Significant evidence suggests that eHealth reforms are likely to continue and be progressed into KM initiatives (see Subsection 2.5.1). This implies that further massive investment in technology is on the way.

Jennex (2008) poses that organisations that have prospered are not the organisations that implemented KM technology, but those organisations that applied it. The nature of the medical profession suggests that healthcare institutes can only prosper from eHealth initiative if HIT can be “judiciously” integrated with medical practice.

Taylor and Leitman (2002) compare the result of a survey study conducted in the US with that of a EU report. The result indicates that medical practices in the EU and US demonstrate different degrees of HIT adoption (*ibid.*). Table 10 illustrates that, except Portugal, a majority of the US primary care physicians and the general practitioners (GPs) of those 15 European countries use computers in their practices (overall, 80% in the EU on average and 94% in the US). The variations appear to be more divergent in terms of using the Internet or General Practitioner Networks (61% in the EU on average and 79% in the US) – the facilities that allow GPs to communicate with other physicians and potentially to use Electronic Medical Records (EMRs). The result suggests that EMRs have been far from being universally used (17% in the US and 29% in the EU on average). Only six countries reveal that a majority of their physicians use EMRs.

More recent studies show that the under-use issue remains unsolved (see Hsiao *et al.*, 2008, EC, 2008). This is an anticipated conclusion. Note that under-use of ITs (KMSs) is also evidenced in PSFs (see Kautz & Mahnke, 2003) − the earliest and most successful adopters of KM (Simmons, 2004; Skyrme, 1999; Terrett, 1998) and advanced ITs (Hansen *et al.*, 1999; Orlikowski & Gash, 1994). In contrast, the deployment of ICTs in health sectors is considered to be lagging behind other sectors in Europe (EC, 2007). In the US, the healthcare industry spends a lower percentage of its revenue on ITs than other industries (Bates *et al.*, 2003; Bower, 2005). One might expect that physicians could do better in adopting technology into their routines.

Table 10: General Practitioners' Use of Information Technology (Taylor & Leitman, 2002)

	Use in Computer Practice (%)	Use Internet or GP Network (%)	Use Electronic Medical Records (%)
Finland	100	100	56
Netherlands	100	100	88
Sweden	98	93	90
Germany	95	53	48
United Kingdom	95	87	58
France	89	80	6
Austria	82	64	55
Ireland	72	48	28
Spain	71	43	9
Denmark	70	62	62
Luxembourg	68	46	30
Italy	66	48	37
Belgium	66	51	42
Greece	52	27	17
Portugal	37	19	5
European Union Average	**80**	**61**	**29**
U.S.A.	**94***	**79***	**17****

* January/February 2001
**June 2000
Sources: European Union EuroBarometer June, July 2001 (numbers repercentaged by Harris Interactive) and Harris Interactive Surveys for U.S.A. in June 2001 and January/February 2001.

Kautz and Mahnke's (2003) survey study with a large global consulting firm reveals that KMS is not the consultants' primary source of knowledge. Its repository is used mostly for general information search (*ibid.*). Only half of the users are participating in (electronic) knowledge networks (*ibid.*). The evidence suggests that KM enabling capabilities of KMS are not being deployed. One explanation is that consultants are reluctant to contribute knowledge (Fink & Disterer, 2006). Knowledge sharing appears to be inconsistent with the individualistic and competitive nature of the organisations (Quinn *et al*., 1996). This nature is perceived as incompatible with the collaborative nature of the technology (Orlikowski, 2000). This proposition appears to be detached from reality. Kautz and Mahnke (2003) notice that consultants' colleagues are their primary knowledge source. The idea of not sharing knowledge is emphasised in medical education (Wyatt, 2001). Table 10 shows that, on average, physicians appear to be less reluctant in adopting collaborative technologies than those consultants in Kautz and Mahnke's (2003) study.

Self-interest cannot be the one and only explanation for the under-use of EMR. EMR is widely believed to be an important tool for reducing medical errors and improving healthcare quality and/or efficiency (Garets & Davis, 2006; Hillestad *et al.*, 2005; Taylor & Leitman, 2002). In theory, EMR relieves physicians from concerns about patient welfare and litigation avoidance (see Arrow, 1963, Scott, 2001; ter Meulen, 2005). The substantial under-use of EMR appears to be a peculiar phenomenon. In fact, the use of HIT for medical practice is a complicated decision.

Let us take computerised clinical decision support system (CDSS) as an example (Garets and Davis (2006) suggest that CDSS is part of the infrastructure of an EMR). The existing literature has demonstrated mixed empirical results in the benefits of using those systems (Chaudhry *et al.*, 2006; Garg *et al.*, 2005). However, CDSS seems to improve physician performance most of the time (Garg *et al.*, 2005). Recently, Agostini *et al.* (2007) have conducted a study into the perceptions of the benefits and limitations of a decision support system – a computerised reminder system. The physicians had both positive and negative perceptions about the reminder. The perceptions included: (i) technology-specific (positive perception of integrating computers into clinical care); (ii) user interface-related (time needed to read reminder); (iii) professional (threats to physician autonomy); and (iv) health sciences-related (educational value/information content). Inferring from points (ii) and (iii), not using HIT is a perfectly rational behaviour. Recall that medical practice is conducted under time pressure (Butler *et al.*, 2001; Charles *et al.*, 1997; Taylor, 2006). Autonomy is the hallmark of physician professionalism (Holsinger & Beaton, 2006). It appears that the under-use issue is implied by the fact that the benefits of using these technologies do not outweigh the time cost and the cost of a possible loss of autonomy. Points (i), (ii) and (iv) are consistent with the proposition of a popular IS Success framework − the DeLone and McLean (1992, 2003) IS Success model.

According to that framework, system use is (i) determined by information (and/or knowledge) quality, system quality and service quality, and (ii) associates with user satisfaction; system use and user satisfaction impact the net benefits of using a system (see DeLone & McLean, 1992, 2003; Jennex & Olfman, 2006; see Subsection 2.3.7). However, to properly understand a CDSS, it is important to analyse the medical decision-making process (Raghavan, 2009). These studies suggest that medical decision-making factors and the context of a system should be introduced into the HIT use measure.

Research predicts that the major gains from HIT will come from its potential to effectively exchange healthcare information across systems (Chaudhry, 2005). This capability is referred to as interoperability (*ibid*.; Garets & Davis, 2006). An effective interoperable system across the US does not yet exist (Garets & Davis, 2006). Of the 32 European countries, only the Czech Republic has a fully implemented interoperable system with a national-wide scope (EC, 2007). Also, Taylor (2006) suggests that clinical contextual information is a crucial decision-making factor. However, such information is unlikely to be completely embedded in any EMR due to various technical, intellectual and organisational issues (*ibid.*, p.15). These systems *per se* only allow physicians to make decisions mostly based on incompletely codified patient histories. Also, codified medical knowledge *per se* is just information (*ibid.*) – it requires physicians to excise their experiential knowledge and tacit knowing to convert it into actionable knowledge. Indeed, a systematic review indicates that the majority of available CDSSs are not yet ready for mainstream use (Garg *et al*., 2005). These imply that CDSS can only be used as a complementary tool. However, medical practice is conducted under time pressure (Butler *et al*., 2001; Charles *et al*., 1997; Taylor, 2006). Unless these systems can "quickly provide accurate information to busy people working in chaotic places" (Taylor, 2006, p.51), the benefits of using them are unlikely to outweigh the attached time cost. It seems that 100% usage is not a valid indicator of full HIT adoption. Instead, judicious use of HIT for medical practice appears to be a better measure of HIT adoption.

This subsection has shown that ITs are not only under-used for medical practice, but also other expert/professional practices. It also shows that the measures of appropriate levels of IT use and thus IT adoption should internalise the contexts of a profession and the type of IS under study. This will help in deriving policies to implement judicious use of ITs for expert/professional practices.

2.5.3 Judicious Use of Professional Intellect to Care or Digitalised Cookbook Medicine?

Denning (1998) indicates that organisations that make no or little attempt at codification can be very inefficient. Implementing eHealth implies an HIT implementation. To deploy eHealth unavoidably involves substituting technologies for human resources through codification to some extent. Resistance and human issues are likely to follow.

A research line suggests that clinical autonomy has been under threat due to managerial expansion (Prosser & Walley, 2007). A physician may emphasise quality of care and management may emphasise cost savings (*ibid.*).

A consistent view is that medical practice has been increasingly governed by EbM built on "the best available evidence" (ter Meulen, 2005). However, such evidence appears to be increasingly chosen from Random Clinical Trials − whose practice environments are ideal and often deviate from the clinical realities (*ibid.*). EbM is criticised as statistics-based clinical reasoning that cannot account for clinical experience and tacit knowing (Stempsey, 2009). In fact, the original proposal of EbM practice is to "integrate the best evidence with clinical expertise and patients' choice" (Sackett *et al.*, 1996) to deliver medicine proven to be effective (ter Meulen, 2005). The medical community is concerned that the enforcement of EbM guidelines will result in delivering "cookbook medicine" (ter Meulen, 2005) – homogenised (cost-saving) procedures. However, ethical indoctrination drives physicians to treat individual patients with the truly EbM principle that requires applications of their "clinical expertise" (tacit knowledge) (*ibid.*) – cost-augmented procedures. Widening the "divide" between management (and/or policy-makers) and physicians can be expected. "Divide" can impede the delivery of healthcare (Edwards, 2005).

Adopting HIT into medical practice involves treating patients with codified knowledge to some extent. If codification is overly emphasised, physicians may end up delivering digitalised "cookbook medicine". It will adversely affect patients' welfare – homogenous treatment is an anticipated consequence. In the worst scenario, the adverse impacts on individual patients could develop into negative externalities for the entire population (see Arrow, 1963; Laxminarayan & Weitzman, 2002, for definition of externality). For example, homogeneity in antibiotic prescriptions is a contributing factor to the heightened chance of antimicrobial resistance (Laxminarayan & Weitzman, 2002). Conflicts between management and physicians are likely to be further intensified by introducing eHealth into EbM practice unless physicians are permitted to judiciously apply HIT and EbM to care for patients. Otherwise, altruism may have to be separated from medical practice.

Wyatt (2001) is more optimistic about implementing knowledge codification to patient care. The author (*op. cit.*) opines that not all medical decisions deserve creative solutions that require assessing the involved uncertainties. Codification does not necessarily lead to "one therapy for each disease" (*ibid.*). For example, Dell is able to apply a codification strategy and offers its consumers 40,000 validated alternative products while its competitors typically offer about 100 (Hansen *et al.*, 1999). Wyatt (2001) is convinced that treating common/routine medical cases with widely agreed and carefully validated solutions can result in more effective and efficient healthcare. Encouraging examples include applying information technologies to (i) achieve better informed-choice decisions (Einbinder *et al.*, 1997) and (ii) encourage specialists to exchange and accumulate tacit knowledge (O'Brien & Cambouropoulos, 2000). Wyatt (2001) proposes careful application of KM strategies to healthcare – codification strategy for common/routine cases and personalisation strategy for cases that deserve creative solutions. This proposal appears to be practicable. However, identifying the right mixed strategy is not easy. The decisions cannot be made lightly and may need continual refinements.

Note that a seemingly common/routine medical case can be a complicated case. For a trivial example, at the time of the SARS epidemic, physicians might have dealt with an obvious common cold complaint as if it were a SARS complaint (Lane & Tsang, 2008a). For another example, antibiotic prescription is not purely a technical decision. It involves much uncertainty in writing an antibiotic prescription partially due to various social and institutional reasons (Butler *et al.*, 2001; Mangione-Smith *et al.*, 1999, 2003; Nicolau, 2002). From an IT perspective, identifying the desired mixed KM strategy is still in an ongoing research agenda (Koenig, 2004).

Recall that Taylor (2006) considers clinical contextual information to be crucial to clinical decision-making. The author (*op. cit.*) recommends that systems should be designed to allow recording such information in accordance with each clinical context. Similarly, KM strategies may be derived to accord with each clinical context. For example, one may consider assessing the impacts of applying HIT by clinical categories. The methods may include assessing the physician performance and improvement in patient health (see Garg *et al.*, 2005).

Wyatt's (2001) proposal for applying KM strategy to healthcare is convincing.

However, the outcome is conditional on sufficiently and judiciously adopting HIT into medical practice. Having a framework to identify the causal factors is the first step towards adopting HIT to practise the truly EbM principle so that medical professional intellect can be leveraged to "much higher levels" through eHealth.

2.6. CONCLUSION

Knowledge Management is a relatively new discipline, but fulfils Kuhn's (1996) criteria for being an established discipline (Jennex & Croasdell, 2007). KM research has already appeared in a wide variety of disciplines (Peachey *et al.*, 2007). There exist, measures to assess or evaluate different aspects of KM. KM is "the art of creating value from intangible assets" (Sveiby, 1997a, p.1). It is also perfectly scientific.

Knowledge in an organisational setting is supposed to be a commodity. Interestingly, the theme of KM can be summarised by Joseph E. Stiglitz's (1999b) opinions about knowledge as a global public good (once it is shared) as follows:

> *"Initial knowledge is a key input into the production of further knowledge."* (p.312)
>
> *"As essential as the adaptation and creation of new knowledge within a country [an organisation] is the dissemination of knowledge throughout a country [an organisation]. The movement of ideas within a country [an organisation] is affected by the effectiveness of its communications system."* (pp.317–318)
>
> *"Creating the knowledge infrastructure entails learning how to learn – that is, creating the capacity to close the knowledge gap, an essential part of a successful development strategy."* (p.318)
>
> *"Knowledge enhances the productivity of capital."* (p.319)
>
> *"Knowledge is one of the key to development and that knowledge is complementary to private and public capital."* (p.320)

If further elaboration is needed, then "development" may be interpreted as the improvement in organisational performance.

The properties of knowledge as a commodity are found in Kenneth J. Arrow (1963) as follows:

> *"Like other commodities, it has a cost of production and a cost of transmission, and so it is naturally not spread out over the entire population but concentrated among those who can profit most from it. (These costs may be measured in time or disutility as well as money.)… The value of information [or knowledge] is frequently not known in any meaningful sense to the buyer; if, indeed, he knew enough to measure the value of information, he would know the information itself."* (p.946)

KM involves risks or uncertainty partially due to the absence of a mechanism to validly internalise the costs of production and transmission of knowledge. Overly emphasising codification is a further distortion. KM is presumably a remedy for the managerial mistake that caused losing key knowledge during the early 1990s (Jennex, 2007). It can also be manipulated into another managerial mistake that marginalises knowledge generation opportunities − "substituting technological contact for human interface" (Fahey & Prusak, 1998). However, with applications of suitable policies, KM can leverage professional intellect through technology.

KM policy-making and implementing judicious adoption of IT into medical practice are chosen to be the focuses of this research work. This literature review preliminarily shows that, with appropriate application of KM strategy, medical practice can be appropriately accommodated by the right IT. This can help deliver efficient and effective medicine that fulfils the current EbM standard. eHealth serves as an example to explore the practicality of leveraging professional intellect to "much higher levels" through new technologies. To implement this ideal state, it requires appropriate applications of KM and global policies to create a suitable environment − triangulating people, process and technology − so that knowledge can be used more wisely to improve performance.

CHAPTER III

RESEARCH METHODOLOGY

3.1. INTRODUCTION

This chapter explains the research framework and methodology to be employed. It begins with a review of the purpose of the study that has been identified by the literature survey (see Chapter II). Sections 3.4 and 3.6 outline the process of formulating and operationalising a Computerised Clinical Support System Use (CDSS Use) model based on the modified Jennex and Olfman's (2006) KMS Success model.[18] Section 3.3 restates the research questions. Other subsections include (i) the research hypotheses, (ii) the development of the measurement, and (iii) the administration of the empirical research processes including analysis techniques and facilities.

3.2. A REVIEW OF THE PURPOSE OF THE STUDY

The extensive literature review in Chapter II identifies that an implementation of optimal KM strategy can help realise the potential of eHealth in leveraging professional intellect. However, its efficacy in achieving this goal is subject to adoption of HIT for medical practice. It is also shown that EMRs may have been under-used for medical practice in the EU and US (Taylor & Leitman, 2002; EC, 2008). EMR is widely believed to be an important tool for reducing medical errors and improving healthcare quality and/or efficiency (Garets & Davis, 2006; Hillestad *et al.*, 2005; Taylor & Leitman, 2002). If the under-use issue is not mitigated (or resolved), massive resources are likely to be misallocated and eHealth will never be fully deployed. Understanding the causes of the under-use issue is the prerequisite for resolving it.

In fact, the use of EMR may be an imprecise measure of HIT adoption for medical practice. EMR is an application environment composed of the clinical data repository and various technologies/systems (Garets & Davis, 2006). Its infrastructure includes CDSS (*ibid.*). CDSS assists physicians in communicating with patients about their medical issues, diagnosis or prescribing (EC, 2008). Stempsey (2009) suggests that

[18] Garg and colleagues' (2005) definition of CDSS remains applicable. However, CDSS also refers to any HIT used for consultation hereafter, but the converse does not apply. For example, a recording tool may be used during consultation, but is not a CDSS tool as it does not assist physicians in clinical reasoning.

clinical decision-making (or clinical reasoning) includes thinking about diagnosis, prognosis, treatment selection, and physician-patient communication. A better measure of HIT adoption for medical practice is actually the extent to which CDSS is used during consultation.

The existing literature has demonstrated mixed empirical results in the benefits of using CDSS (Chaudhry *et al.*, 2006; Garg *et al.*, 2005). However, CDSS seems to improve physician performance most of the time (Garg *et al.*, 2005). In theory, the use of CDSS is in the physicians' interests. A survey indicates that CDSSs have been used in only less than 5% of all healthcare facilities in the US (Wong *et al.*, 2000). On average, 50% of the GPs in the EU use CDSSs (EC, 2008). That is, deployment of CDSS is also potentially hindered by the under-use issue. Indeed, a systematic review indicates that the majority of available CDSSs are not yet ready for mainstream use (Garg *et al.*, 2005). Clearly, the under-use issue may reflect judicious use rather than physician reluctance. To be precise, a focus of this study is to formulate, operationalise and test a model that can explain the CDSS use decisions.

A reasonable understanding of CDSS is crucial to understanding the under-use issue. Raghavan (2009) poses that, to understand a CDSS, it is important to analyse the medical decision-making process. Note that a consultation is a human encounter; medical decision-making is not purely something done by a physician or aided by a computer (Stempsey, 2009). This and the definition of clinical reasoning (*ibid.*, p.173) fundamentally suggest that CDSS use should be seen from an integrative perspective of people, process, technology and professional intellect. Some of these elements are subsumed in the Jennex and Olfman (2006) KM System Success (J&O) model.[19] However, a reformulation is required in order to introduce the contexts of medical practice and CDSS related technologies into the model. It can then be empirically tested and applied.

3.3. A RESTATEMENT OF RESEARCH QUESTIONS

According to the discussion in Sections 2.5 and 3.2, the research questions to be answered are as follows:

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[19] To be precise, the J&O model includes knowledge aspect as an element. Knowledge becomes professional intellect when it is applied to accord with ethical indoctrination.

(i) Does triangulating people, process and technology impact the use of CDSS or HIT for consultation?
(ii) What are the user- and non-user specific reasons for (not) using HIT for medical practice?

3.4. RESEARCH METHODOLOGY

The research methodology is composed of two components: (i) qualitative research and (ii) quantitative research.

Secondary data (the existing publications) were gathered by a literature review of KM, Clinical Reasoning, Organisational Studies, etc. The research questions were identified by a preview of the existing evidence about HIT use in the healthcare sectors (see Chapter II). The baseline theoretical model (Jennex & Olfman, 2006) (see Subsection 2.3.7) was modified and operationalised based on (i) the stylised facts of medical practice and CDSS related technologies, and/or (ii) the theories and findings about IS Success (Subsection 3.4.1). People and process aspects were identified by a literature survey of Clinical Reasoning and its related disciplines.

The quantitative research was conducted to test the proposed CDSS Use model (see Subsection 3.4.2). The process involved (i) formulating a survey instrument, (ii) sampling, (iii) collecting primary data, and (iv) statistical/psychometric techniques including bootstrapping (see Section 3.5 and onward).

Survey research was the chosen empirical method. It was one of the most common methods for evaluating IS impacts (Kraemer, 1991). The survey instrument was formulated by combining the items from some standard measures with established reliability and validity. This technique is used by many researchers (Aydin, 2005). Some items were developed from the findings related to the context of CDSS when appropriate instruments could not be found. This technique is employed by some authors to formulate IS/KMS Success measures (see Petter *et al.*, 2008). Visual Basic for Applications (VBA) programmes were developed to help identify potential respondents and quicken the sampling process. Multivariate analyses were conducted to analyse the survey data. The results will be presented in Chapter IV. Contributions to specific disciplines will be discussed in Chapter V.

3.4.1 The Secondary Review − CDSS, People, Process and Professional Intellect

Physician reluctance is considered to be a cause for slow acceptance of CDSS (Raghavan, 2009). Section 3.2 suggests that this issue involves a confluence of people, process, technology and professional intellect issues. This subsection outlines the connections between these elements.

Implementing an interoperable Electronic Health Record (EHR) system that allows effectively exchange healthcare information across the nation/continent is a top prioritised objective for the European and US eHealth reforms (EC, 2007; eHealth Initiative, 2006). EHR is, in fact, a fuzzy term (EC, 2007). Garets and Davis (2006) notice that there has been confusion about the terms EHR and EMR – they are often used interchangeably. "EMR is the legal record created in hospitals and ambulatory environments that is the source of data for the EHR" (*ibid.*, p.2). An EHR is reliant on EMRs being in place (*ibid.*). The authors (*op. cit.*) have identified various distinctions between an EHR and an EMR. An EMR that conforms to certain interoperability standards is an EHR (NAHIT, 2008). An EHR can be a basic or fully functional EMR (DesRoches *et al.*, 2008). So, the foundations of EMR and EHR are based on the common IT infrastructures (see Garets & Davis, 2006). Garets and Davis (2006) note that the foundation of an EMR/EHR is the clinical data repository (CDR) − a real-time transaction-processing database of patient clinical information for practitioners. Workflow and CDSS are tightly coupled with the three ancillaries of an EMR required to improve patient safety and reduce medical errors (see *ibid.*). Workflow allows work items to be tracked (Sharma *et al.*, 2009). It is a collaborative technology. That is, an EMR/EHR needed to benefit from an eHealth initiative is essentially a KMS by Maier and Hädrich's (2006) KMS definition. In other words, an EMR/EHR that can fulfil the objectives of these eHealth reforms is actually a KMS (see EC, 2008, eHealth initiative, 2006; Hillestad *et al.*, 2005). From a technological lens, with appropriate applications of KM policies, implementing eHealth is comparable to implementing KM.

It is impossible to have an exhaustive discussion about the relationships between medical practice and all the technologies embedded in an EMR/EHR. CDSS is chosen as a focus as it has been the current research interest and it potentially has direct impacts on Evidence-based Medicine (EbM) (Chaudhry, 2007). EbM has been an emphasis of current medical practice (Sood *et al.*, 2009; Taylor, 2006; ter Meulen, 2005).

Medical/clinical decision support systems can be paper- or computer- based; the latter is referred to as a CDSS (Raghavan, 2009). Under the eHealth climate, using CDSS for medical practice will eventually become a standard clinical procedure. Raghavan (2009) notes that there is no formal definition of medical/clinical decision support systems. However, different definitions have been proposed (van der Lei & van Bemmel, 2002). The definition from Garg *et al.* (2005) is adopted in this work − "information systems designed to improve clinical decision making" (p.1223). CDSS was evolved from expert system research (Raghavan, 2009; Taylor, 2006).[20] The underlying assumption is that the superior storage and processing capacities of a computer will allow a system to perform as well as an expert (Taylor, 2006).

CDSS makes decisions based on clinical practice guidelines − rule-based knowledge (Raghavan, 2009). Its applications to medical decisions may be controversial. Note that guidelines can be perceived as efforts to restrict the authority of clinicians and to ration care (Elstein & Schwartz, 2002). The common goal of guidelines is to provide cost effective and high quality healthcare services (Field & Lohr, 1992). Førde (1998) notes that clinical knowledge is multidimensional − it is contextual and depends on physician-patient relationship. A consultation is a human encounter; medical decision-making is not purely something done by a physician or aided by a computer (Stempsey, 2009). It may be in physicians' interests to use CDSS to assist delivering a high quality of patient care. However, physicians are not trained to be "financial realists" as the management are (Edwards, 2005). The use of CDSS appears to challenge physicians' autonomy, ethical indoctrination and professional intellect. It also appears to widen the "divide" between physicians and the management. "Divide" can impede the delivery of healthcare (*ibid.*).

Various CDSSs have been used for medical practice (Raghavan, 2009). CDSS is, in theory, a possible means to support the implementation of clinical guidelines (van der Lei & van Bemmel, 2002). A systematic review suggests that guidelines appear to be effective in changing medical practice (Grimshaw *et al.*, 2004). Experience suggests that decision support is not particularly effective in changing the behaviours of physicians (Taylor, 2006). Also, a survey indicates that CDSSs have been used in only less than 5%

[20] There is an argument that KM has been evolved from the applications of expert systems and artificial intelligence (Liebowitz & Beckman, 1998; Sieloff, 1999). Artificial intelligence is a commonly used decision support technique (Raghavan, 2009).

of all healthcare facilities in the US (Wong *et al*., 2000). On average, 50% of the GPs in the EU use CDSSs (EC, 2008). These show that CDSS is not a promising tool to facilitate EbM or guideline-based medicine, partially due to the poor adoption or diffusion.

The above discussion shows that EMR/EHR required to achieve the eHealth objectives is built on KM enabling technologies. It also confirms that CDSS use decisions involve technology, people, process and professional intellect issues. Desirable eHealth outcome can be expected from a simultaneous implementation of KM policies.

3.4.2 Model Formulation

This subsection outlines the formulation process of a CDSS Use model to be operationalised and tested.

The Modified Baseline Model

DeLone and McLean's (2003) IS Success (D&M) model is the baseline model of the J&O model (Jennex, 2006a; Jennex & Olfman, 2006). The D&M model has been extensively studied (Petter *et al*., 2008). This research line provides a sound foundation for deriving a reliable assessment model. Also, its "both complete and parsimonious" properties are unbeatable by other IS Success models.

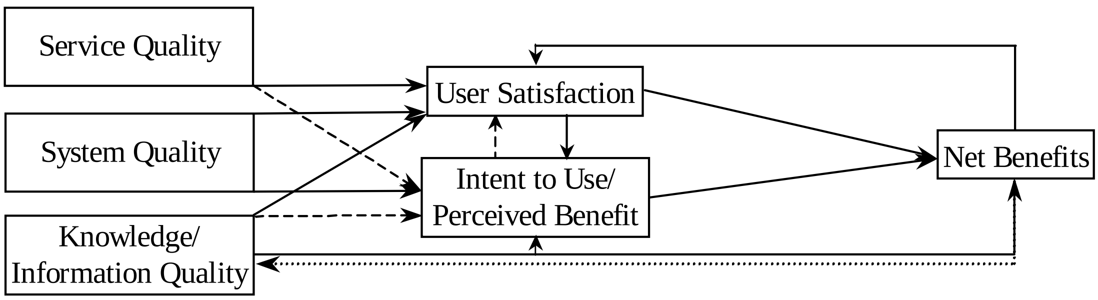
In fact, another derivation of the D&M model can also be an ideal baseline model. Hebert (2001) proposes a telehealth evaluation model built on the D&M (1992) model and Donabedian's (1980) quality of care assessment model. Medical context has been internalised by the Process of Care construct (see *ibid.*). However, Hebert (2001) has not explicitly dealt with the knowledge aspect. As repeatedly mentioned, clinical/medical decision-making is fundamentally a KM process (see Section 2.5). Also, an EMR/EHR needed to benefit from an eHealth initiative is essentially a KMS (see Subsection 3.4.1). The J&O model is apparently the preferred baseline model.

Loosely speaking, the J&O model can be seen as a derivation of the D&M model applicable to assess KMSs. KMS is a specific application (Petter *et al.*, 2008). It deviates from the D&M model considerably. To be concise, it introduces more human elements and knowledge quality into the D&M (2003) model. This is consistent with the goal of studying the CDSS use from an integrative perspective of people, process, technology and professional intellect.

The J&O model consists of six dimensions: (i) System Quality, (ii) Knowledge Quality, (iii) Service Quality, (iv) Intent to Use/Perceived Benefit, (v) User Satisfaction and (vi) Net Benefits. Detailed explanations about the J&O model can be found in Subsection 2.3.7. A simplified expression of the modified J&O model is found in Figure 1 (see p.9 or subsequent content). It incorporates the results of Petter *et al.*'s (2008) literature review on empirical studies of D&M (2003) at an individual level of analysis.

The dashed paths of Figure 1 represent the relationships that are insufficiently supported by empirical evidence (see Petter *et al.*, 2008). A causal path from the Net Benefits to Knowledge/Information Quality is not posited in the D&M (2003) model. So, it was not reviewed by Petter *et al.* (2008). This is denoted by a dotted path.

Figure 1: A Re-expression of the Jennex and Olfman (2006) KMS Success Model (Duplicate)



A Physician Attributes construct is introduced into the model to represent the contexts of medical practice. The other constructs are defined (or redefined) based on (i) other generalised stylised facts of medical practice and CDSS related technologies, and/or (ii) the theories and findings about IS Success.

The details of each construct and the structure of the model are outlined in the following content.

Service Quality

This construct measures management support, governance, and organisational support (Jennex & Olfman, 2006). The following aspects might also be operationalised.

1. Optimal Training
   - Individuals who are less adaptable to change may need more time and support during training and implementation (Counte *et al*., 1987).
   - However, healthcare professionals sometimes express resentment at being required to take time away from patient care to learn to use a computer system (e.g., Aydin and Rice, 1991, 1992).
2. Supportive Management
   - IT adoption may be associated with allowing individuals time to experiment and learn more about it (Taylor & Bowers, 1972) (see Aydin, 2005).

System Quality

This construct measures (i) how well a system performs in all KM processes; (ii) how much of the knowledge is codified; and (iii) how the system is supported by the IS staff and infrastructure (Jennex & Olfman, 2006). A literature search suggests that the following aspects might be included:

1. Adaptability and flexibility to new and changing knowledge/information (Turban & Aronson, 2001)
2. Accessibility of facilities (Raghavan, 2009)
3. Alert level
   - It should not be intrusive – optimal false positive/negative alerts (Raghavan, 2009).
   - It reminds the physician about referrals for preventative services, treatments, and tests during the diagnostic stage or potential adverse events (Office of Technology Assessment (OTA, 1995).
   - It may also remind the physicians about a specific patient's

previous orders, results, frequency rule checks, and schedule of treatment or procedures (OTA, 1995).

4. Comprehensive electronic library
    - Taylor (2006) notices that books and journals are two of the most common sources of knowledge/information. Other reading materials such as patient education materials may also be included into the systems (Sittig, 2009, Figure 1, p.224).
5. Dominating control of the system
    - Physicians/clinicians should be given the autonomy to customise the alert level or the mode of information delivery (pull or push technology) (Sittig, 2009). They should have complete control of the systems (Beatty, 1999; Turban & Aronson, 2001).
    - They should be allowed to choose when the system should intervene in their decisions during consultation (Sittig, 2009).
6. Customisation
    - Allowance for filtering/eradicating unnecessary information (Krall & Sittig, 2002; Sittig, 2009; Taylor, 2006).
    - Complexity of customising knowledge discourages physicians from using the systems (Raghavan, 2009).
7. Ease of use
    - Navigating (Turban & Aronson, 2001) or inputting information without typing (Taylor, 2006)
8. Easy and convenient access to information (Taylor, 2006).
9. Flexibility
    - It should allow decision makers to create simple decision constructs (Turban & Aronson, 2001).
    - It should allow flexibility in recording each patient's data (terminology or vocabulary is not overly standardised) (Taylor, 2006).
10. Reliability (consistency with clinical procedures) (Raghavan, 2009)
    - Overly simple rules force the physicians to refrain from

using the systems (Raghavan, 2009). That is, the rule fails to reflect the complexity of real clinical procedures.

11. System features
    - It includes more timely and reliable methods and tools to support better communications and coordination (Sharma *et al.*, 2009).
    - It includes methods and tools to support faster dissemination of information via the Internet (Sharma *et al.*, 2009).
    - It includes tools that help tap into expert knowledge and explicit knowledge (Sharma *et al.*, 2009) e.g., Expert Locators and traditional knowledge repositories (colleagues are a common source of knowledge/information (Taylor, 2006)).
    - It includes Workflow – a system integrated with Workflow is more likely to improve physicians' compliance with clinical guidelines and outcomes (Raghavan, 2009).
12. Update knowledgebase (Currency) (Raghavan, 2009)
    - A system needs to be easier to access, more updated and complete than paper ones (Sharma *et al.*, 2009).

Knowledge/Information Quality

This construct measures the extent to which the right knowledge with sufficient context is captured and available for the right users at the right time (Jennex & Olfman, 2006). A literature search suggests that the following aspects might be included:

1. Complete guidelines
    - It includes guidelines in diagnostic levels and types, drug dosage (medication formulary), treatments and preventive services (OTA, 1995).
2. Completeness of patient data
    - It should include patient history, clinical context information (Taylor 2006) and the patient narrative (patient's experience and opinions) (Greenhalgh & Hurwitz, 1999).
    - Also note that what is not recorded may also be crucial to

treating an individual patient (Taylor, 2006).

3. Consistency of information
   - Information should accord with physicians' knowledge (Taylor, 2006); i.e., experiential or tacit knowledge.
4. Format (or Simple Interface) (Raghavan, 2009)
   - User-friendly presentation of information (Taylor, 2006).
5. Unambiguous (or understandable) information
   - Standardisation of terminology/medical vocabulary both within and across natural language communities (Sharma *et al.*, 2009; Taylor, 2006).

Physician Attributes

The literature review in Chapter II shows that physicians' major concerns about their professions are: (i) altruism towards patients, (ii) autonomy and (iii) litigation avoidance. This construct internalises these elements from the perspective of physicians' relationships with their colleagues and patients. It is a measure of end-user attributes.

1. Autonomy (Agostini *et al*., 2007)
   - The meaning of this term appears to be taken for granted in the medical literature. However, it appears to be acceptable to see autonomy as the authority to deal with each patient as an individual (see Holsinger & Beaton, 2006; Taylor, 2006). It is compatible with Cummings and Huse's (1989) general definition of autonomy − the degree to which a job provides freedom and discretion in scheduling work and determining methods.
   - It may be interpreted as the power of exercising physicians' professional ethic as they "are trained to deal with patients as individuals" (Taylor, 2006, p.8).
   - It may also be perceived as a form of power or concerns for patient welfare (altruistic physician assumption; see Arrow, 1963; 1986, for example).
2. Changes in physician-patient relationship
   - Physicians may perceive that applying IT to consultation

may depersonalise the interactions with patients (Gadd & Penrod, 2000) or dehumanise medicine (Taylor, 2006).

- Physicians may approach patients in a more paternalistic fashion or encourage patient involvement (Fitter, 1986).
- Physician-patient relationship is a crucial element in clinical decision-making (Førde, 1998). So, this element is related to Perceived Net Benefits of using CDSS.

3. Control
    - Patient's data may be used to assess physicians' performance (Taylor, 2006).
4. Ego bias
    - Physicians may be overly optimistic that they know enough to make the decisions (Ely *et al*., 1992) and do not consult the existing electronic knowledge resources.
    - Ego bias is considered as a psychological factor that contributes to medical/clinical systematic errors (Stempsey, 2009). Its relationship with Perceived Net Benefits can be inferred.
5. Interest in ITs
    - The more an individual talks about IT with co-workers, the more likely it is that a new system will improve that individual's productivity (Papa, 1990).
6. Job satisfaction
    - The existing evidence suggests that IT may also impose stress and time pressure (Kraemer & Danziger, 1990).
    - Job dissatisfaction may affect the quality of healthcare (Holsinger & Beaton, 2006).
7. Job security/Deskilling may be possible (Alvesson & Kärreman, 2001), but Aydin (2005) suggests that this does not appear to be an issue in the healthcare sector.
8. Legal liability aversion (DesRoches *et al.*, 2008)
9. Practice experience
    - It can be a proxy of knowledgeability or a physician's age.
    - Non-medical users tend to give the systems more control and

trust (Beatty, 1999). This suggests that knowledgeability affects a user attitude towards a system.

- Codified medical knowledge is considered as information rather than knowledge (Taylor, 2006). Alavi and Leidner (2001) note that information is converted to knowledge once it is processed in the mind of individuals. A shared human knowledge base is the pre-requisite of shared understanding for the same piece of data, information or knowledge (*ibid.*). So, more experienced physicians may benefit more from using the systems and be more willing to use them if the systems can provide them appropriate codified knowledge.
- Experienced physicians tend to apply intuition and novices use principles for making decisions (Stempsey, 2009). CDSS are rule-based systems (Raghavan, 2009). Also Holsinger and Beaton (2006) note that the newer generation of physicians will be much more dexterous with information technology and distance communications than their predecessors. So, physicians with less practice experience may be more willing to use CDSS.
- It is difficult to have a correct anticipation about the result of this element. Any robust result will provide insights into IT training decisions or research.

10. User experience (Holsinger & Beaton, 2006)
11. User pattern
    - Sittig (2009) considers that it is important to consider whether a system is applied before, during or after the patient encounters when it is created.

User Satisfaction

This construct measures (i) the extent to which the system has been used and (ii) the users are satisfied with their use of the system (Jennex & Olfman, 2006). In this study, it only measures the user satisfaction. Landrum *et al*. (2008) note that this construct is about a user’s feeling regarding the system (HIT used for consultation in the context of this study).

Perceived Net Benefits

In the D&M (2003) and J&O models, the Net Benefits construct is defined as the overall impact of a system on organisation performance and on an individual's performance in the workplace as a result of that individual's use of a system (*ibid.*).

In this study, it only represents an average user's perception about the impacts of the use of a system on one's performance. This is because an individual's self-assessment on one's performance may not necessarily be transformed into the actual impacts. For example, Maij *et al.* (2002) notice that healthcare institute structure shapes IT infrastructure and vice versa. This implies that the impacts of IT and the organisational changes interact each other. One may correctly assess the impacts on an individual. However, they may not be fully materialised into actual impacts. Therefore, this measure is relabelled as Perceived Net Benefits.

1. Efficient healthcare and safer medicine are the emphases of the European and US eHealth reforms (EC, 2007; eHealth Initiative, 2006). The following measures were considered:
   - Improving accuracy of decisions in diagnosis, preventive care, disease management, drug dosing, or drug prescribing (Garg *et al.*, 2005); and
   - Saving time
2. In Economics literature, heterogeneous choices are considered as a form of welfare. Also there has been a concern that knowledge codification will lead to homogenous choice in the healthcare sector (see Wyatt, 2001). The following elements were introduced:
   - Narrower/wider range of diagnostic choices; and
   - Narrower/wider range of treatment choices
   - In fact, decision-making can be defined as "the capacity to formulate alternatives, estimate effects, and make choices" (Kraemer & Danziger, 1990, p. 594).
3. Fewer unnecessary or follow-up visits appear to be a measure of efficiency (see Belongia & Schwartz, 1998; Ellis & McGuire, 1990).
4. Complementary use of explicit and tacit knowledge.
   - A system should facilitate bringing medical expert

judgement and computer knowledgebase together (Turban & Aronson, 2001).

- Note that neither physicians nor IT systems make error-free judgements (Taylor, 2006).

Intent to Use

The original construct, Intent to Use/Perceived Benefit, measures (i) perceptions of the benefits and (ii) impacts of the system by users and is based on the Thompson *et al*. (1991) Perceived Benefit model (Jennex & Olfman, 2006). In this study, Intent to Use is indeed comparable to DeLone and McLean's (1992; 2003) Intention to Use/Use construct.

Venkatesh *et al*. (2003) find a significant relationship between intention to use and actual usage. DeLone and McLean (2003) suggest that Intention to Use may be a more appropriate measure of System Use for some research contexts. Recently, Jennex (2008) notes that KM is the appropriate context to use Intent to Use as a measure of System Use. As discussed, medical decision-making is naturally a KM process (see Subsection 3.4.1, for example). Also, in this study, System Use is estimated by self-reported data. It appears that Intent to Use is an appropriate measure of CDSS Use. Therefore, this construct measures the willingness (or the likelihood) of using CDSS.

The Structure of the A Priori CDSS Model

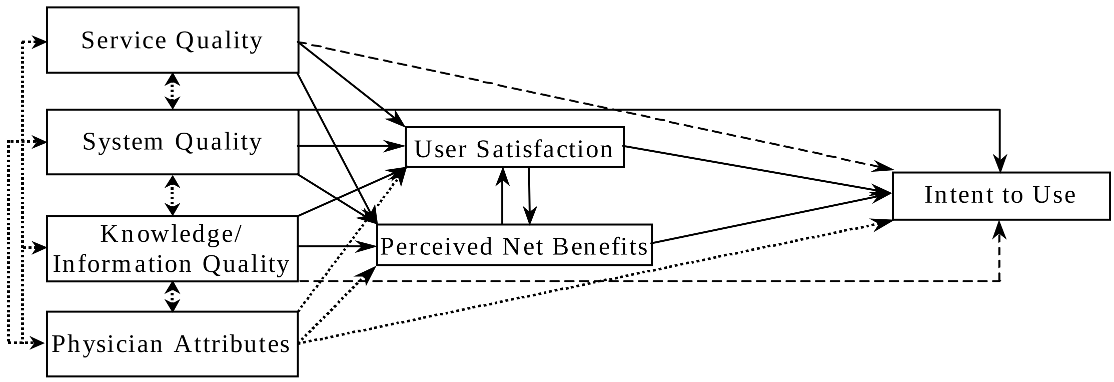
This CDSS Use model poses that Intent to Use is determined by the following constructs: (i) Perceived Net Benefits, (ii) User Satisfaction, (iii) Service Quality, (iv) System Quality, (v) Knowledge/Information Quality and (vi) Physician Attributes (see Figure 2, p.10 or p.110).

In the J&O model, the Net Benefits construct is the dependent variable. In this model, Intent to Use is the dependent variable. This setting is a proposition of Davis' (1989) Technology Acceptance Model (TAM). The author (*op. cit.*) suggests that perceived usefulness of a system determines intention to use, and behaviours are driven by one's intention and affect System Use. This setting is perfectly consistent with the classical economic theory of consumer choice. By this theory, benefit determines the demand of a service/good. Satisfaction (or utility) level determines the benefit.

However, users may revise their use decisions. It seems reasonable to assume that Perceived Net Benefits and User Satisfaction will influence each other. The causal path from Intent to Use to User Satisfaction has been removed due to Davis' (1989) TAM and the findings of Petter *et al.*'s (2008) review. Seddon (1997) has adapted a similar setting to re-specify the D&M (1992) model, but assumes away the direct relationship between System Use and IS Success (Net Benefits). The model has been empirically validated by Rai *et al.* (2002). Substantial empirical evidence suggests that Net Benefits determine Intent to Use (Petter *et al.*, 2008).

Figure 2: The *a priori* CDSS Use Model

(Duplicate)



The review in Subsection 3.4.2 suggests that the Physician Attributes construct appears to be associated with Net Perceived Benefit and User Satisfaction. No concrete evidence suggests that System Use and Physician Attributes are associated. This is represented by a dotted path. Other dotted paths denote that the under-use issue is a confluence of people, process, technology and professional intellect issues (see Subsections 2.5.3 and 3.4.1). Other paths are plotted in accordance with Petter *et al.*'s (2008) analysis of the empirical evidence on the D&M (2003) at an individual level of analysis. The dashed paths represent the relationships insufficiently supported empirically (see *ibid.*).

Note that different authors define and/or measure these IS/KMS Success constructs differently (Petter *et al.*, 2008; Gable *et al.*, 2008). Those empirical studies are not precisely comparable and may not lead to accurate and generalisable conclusions. That is, although the *a priori* model is built on a rigorous scientific foundation, its validity is subject to empirical tests.

In this subsection, the elements of each construct are introduced based on the theories and findings of the relevant disciplines. However, not all elements are operationalisable. The operationalisation is conditional on being able to establish a parsimonious instrument that allows comparisons with the existing theories and findings.

3.4.3 Variables to Be Tested

Each construct is considered to be a latent variable or factor (see Subsection 3.8.2). The dependent variable is Intent to Use. The independent variables are (i) Perceived Net Benefits, (ii) User Satisfaction, (iii) Service Quality, (iv) System Quality, (v) Knowledge/Information Quality and (vi) Physician Attributes (see Subsection 3.4.2 for details about each construct).

3.4.4 Research Hypotheses

The purpose of the quantitative research is to examine the proposed CDSS Use model illustrated in Figure 2. It captures the research questions derived from the literature survey. The hypotheses are stated as follows:

Hypothesis 1: Perceived Net Benefits determine Intent to Use.
Hypothesis 2: User Satisfaction determines Intent to Use.
Hypothesis 3: Service Quality determines Intent to Use.
Hypothesis 4: System Quality determines Intent to Use.
Hypothesis 5: Knowledge/Information Quality determines Intent to Use.
Hypothesis 6: Physician Attributes determine Intent to Use.
Hypothesis 7: The independent constructs associate with each other.

Hypotheses 1 to 6 examine the direct impacts of the six constructs on Intent to Use. Hypothesis 7 examines the (i) associations among the six constructs and (ii) the indirect impacts of Service Quality, System Quality, Knowledge/Information Quality, and Physician Attributes on Intent to Use through Perceived Net Benefits and User Satisfaction.

3.5. MEASUREMENT DEVELOPMENT

The survey instrument was developed by two techniques: (i) combining standardised measures with established reliability and validity − this technique is used by many researchers (Aydin, 2005); and (ii) developing items based on the stylised facts of the relevant IS systems when appropriate instruments could not be found − this technique is cited in the IS literature (Petter *et al.,* 2008). When the first technique was applied, the wording of the items was modified in accordance with the contexts of medical practice and eHealth. For example, Karlinsky (1999) notices that many clinicians vaguely equate medical informatics with computers (Sood *et al.*, 2009). Accordingly, (computer) system was used instead of CDSS, EMR or EHR, so that the survey would become more user-friendly to the respondents.

The English and Spanish versions of the survey instrument can be found in Appendix I. The Spanish version was the basis for conducting Computer Assisted Telephone Interviews (CATIs) by a firm specialising in survey projects. The seven hypothesised constructs were operationalised by 87 seven-point Likert items (1 through 7). The nine items regarding demographic information are on different Likert scales.

As mentioned, the Physician Attributes construct was derived from the readings of different disciplines. The other six constructs were originated from the IS/KM Success literature. IS Success is a widely accepted principal criterion for evaluating an IS (Rai *et al.*, 2002). This research area has been established for more than three decades, but is still in an evolutionary process (Gable *et al.*, 2008). There is little consensus about what is the appropriate measure (*ibid.*). It is, therefore, necessary to explain how each construct was operationalised.

3.6. OPERATIONALISATION OF THE MODEL

Medical practice is conducted under time pressure (Butler *et al.*, 2001; Charles *et al.*, 1997; Taylor, 2006). To develop a parsimonious but reliable instrument was the number one objective to ensure that the distraction to the physicians and patients would be minimal.

Accordingly, the six IS/KM Success constructs were operationalised largely on two parsimonious instruments − Gable *et al*. (2008) and Landrum *et al*. (2008). The former was derived from a series of survey studies and examined by rigorous qualitative and quantitative methods. The latter was validated by a sequential empirical study with knowledge workers who were users of two research libraries. Physicians are undoubtedly knowledge workers. The similarities of the two studies can be seen. The construct Physician Attributes that explicitly introduced people and process into the model was operationalised on the findings of various subdomains of the Medical literature and Medical Informatics.

Another baseline paper was DesRoches *et al.* (2008). The study employed a survey instrument developed based on expert consensus about EMR functionality via a modified Delphi process (*ibid.*). The survey instrument was not published, but the itemised results helped develop some items related to system features, perceived performance, the legal liability, etc. Also note that medical practice might vary from nations to nations, so the findings might not be directly applicable to the Spanish National Health System (NHS). As a consistency check, reference was also made to the EC (2008) report about Spanish GP's ICT use.

3.6.1 Service Quality

SERVQUAL is the most popular measure of Service Quality in the IS Success literature (Petter *et al.*, 2008). It is originated from the Marketing literature (*ibid.*). This measure has been criticised by various authors since its introduction to measure IS Service Quality (*ibid.*; Landrum *et al.*, 2008). Jiang *et al.* (2002) have applied confirmatory factor analysis to show that it is a satisfactory instrument for measuring IS Service Quality. However, how the score should be formed remains a debatable topic (Landrum *et al.*, 2008).

The original proposed measure is a difference score between expectation and performance of the IT services (see Parasuraman *et al.*, 1988).[21] Babakus and Boller (1992) note that the expectation portion of the SERVQUAL scale adds "no additional information." Cronin and Taylor (1992) consider performance alone give "richer information". Recently, Landrum *et al.* (2008) have developed a parsimonious instrument of IS Success measure. In this study, the service quality construct was operationalised based on Parasuraman *et al.*'s (1994) SERVQUAL items. Landrum *et al.* (2008) compare the reliability and validity of Performance with the difference scores (i)

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[21] Performance is also referred to as perception (see Babakus & Boller, 1992) or customer's satisfaction (Cronin & Taylor, 1992).

between Expectation and Performance and (ii) between Importance and Performance. The findings were concluded from the responses of 385 knowledge workers. The results confirmed that Performance alone is the best measure in terms of reliability and validity. The result is consistent with the findings of other studies (*ibid.*). It showed that the original 21 SERVQUAL survey items could be reduced into 13 items. The reliability assessment of SERVQUAL has scored a 0.96 Cronbach's (1951) alpha level. It is above the 0.80 recommended score and 0.70 is the minimum acceptable score (Nunnally, 1968). These 13 items were fully adapted as a SERVQUAL/SERVPERF scale.

Management support is part of the definition of Service Quality in the Jennex and Olfman (2006) model. It appears that this subdimension has not been empirically tested yet. Three items were elaborated based on two items from Aydin *et al.* (1999). They were originally developed by Schultz and Slevin (1975).

3.6.2 System Quality

As discussed in Subsection 3.4.1, incomplete functionality of the systems could be a cause of under-use of CDSS. For example, DesRoches *et al.* (2008) find that physicians who worked with fully functional EMR systems tend to be more satisfied with the systems than those who worked with basic systems. Accordingly, this construct focused on the system features that could facilitate the use of HIT for clinical practice.

Perceived Ease of Use is the most common measure (Petter *et al.*, 2008). Various studies have employed the two items developed by Doll and Torkzadeh (1998) (the Cronbach's (1951) alpha score is 0.85 in this study). Rai *et al.* (2002) obtained a 0.92 reliability score and Aydin (1999) a 0.93. One item was developed and added into this measure to reflect the finding of Medical Informatics (see Taylor, 2006).

Three survey items were adapted from Landrum *et al.* (2008) (its reliability score is 0.94). Two items regarding Sophistication and Flexibility were adapted from Gable *et al.* (2008). Eight items were inspired by its Consistency, Customisation and System Features items. As a cross-check, reference was made to the findings of some CDSS/HIT studies (see EC, 2008; DesRoches *et al.*, 2008; Sittig, 2009; Taylor, 2006; also Table 11, for details). A Control item was developed based on the opinions of Beatty (1999) and Turban and Aronson (2001).

Table 11: Summary of the Proposed Items

Construct	Item Origin	Reference(s)	Item I.D.	No. of Item(s)
Intent to Use				
	(Goodhue & Thompson, 1995)*; Rai *et al*., 2002		itU1	1
	Aydin *et al*., 1999; Kaplan & Duchon, 1989; (Kjerulff *et al*., 1982)*		itU7	1
		Bates *et al*., 2003	itU2 to itU4	3
		European Communities, 2008	itU5 to itU6	2
Knowledge/Information Quality				
Completeness	(Landrum *et al.,* 2008)*	European Communities, 2008; DesRoches *et al*., 2008; Greenhalgh & Hurwitz, 1999; Taylor, 2006	iKQ5 to iKQ12	8
Conciseness; Format; Understandability; Usability	Gable *et al*., 2008		iKQ1 to iKQ4	4
Relevance	Gable *et al*., 2008; Landrum *et al*., 2008		iKQ13	1
Perceived Net Benefit				
Effectiveness/Efficiency	(Davis, 1989)*; Landrum *et al*., 2008		ben1 to ben3; ben10 to ben11	5
Patient Welfare	(Gable *et al*., 2008)*	Wyatt (2001); Altruistic Assumption (see Arrow, 1963; 1986)	ben7	1
Performance	(Davis, 1989; Landrum *et al*., 2008)*	DesRoches *et al*., 2008	ben4 to ben6; ben8 to ben9	5
Physician Attributes				
Altruism	Aydin *et al*., 1999; (Schultz & Slevin, 1975)*		pa1; pa3	2
Altruism	Aydin *et al.*, 1999		pa2	1
Altruism		Holsinger & Beaton, 2006; Taylor, 2006	pa16	1
Altruism		Ellis & McGuire, 1986, 1990; Lane & Tsang 2008a,b	pa17	1
Altruism		Taylor, 2006	pa18	1
Autonomy	Aydin *et al*., 1998	Taylor, 2006	pa14	1
Autonomy	Aydin *et al*., 1999; (Schultz & Slevin, 1975)*	Taylor, 2006	pa12 to pa13	2
Autonomy	Cummings & Huse, 1989		pa15	1
Independence	Schultz & Slevin, 1975		pa9 to pa11	3
Litigation		DesRoches *et al*., 2008	pa19	1
Physician-Patient Relationship	Aydin *et al*., 1998		pa4 to pa7	4
Physician-Patient Relationship	Aydin *et al*., 1999		pa8	1
Service Quality				
Management Support	Aydin *et al*., 1999; (Schultz & Slevin, 1975)*		servQ1 & servQ3	2
	Aydin *et al*., 1999; (Schultz & Slevin, 1975)*		servQ2	1
SERVQUAL/SERVPERF	Landrum *et al*., 2008		servQ4 to servQ16	13
System Quality				
	Landrum *et al*., 2008		syQ5 to syQ6	2
Consistency	(Gable *et al*., 2008)*	Taylor, 2006	syQ8	1
Control		Beatty, 1999; Turban & Aronson, 2001	syQ9	1
Customisation	(Gable *et al*., 2008)*	Sittig, 2009	syQ10	1
Ease of learning	Gable *et al*., 2008; Landrum *et al*., 2008		syQ4	1
Ease of Use**	Aydin *et al*., 1999; (Doll & Torkzadeh, 1998)*; Gable *et al*., 2008		syQ1; syQ3	2
Ease of Use	(Doll & Torkzadeh, 1998)*	Taylor, 2006	syQ2	1
Flexibility; Sophistication	Gable *et al*., 2008		syQ7; SyQ11	2
System Features	(Gable *et al*., 2008)*	DesRoches *et al*., 2008	syQ12 to syQ16	5
System Features	(Gable *et al*., 2008)*	Sharma *et al.*, 2009; Taylor, 2006	syQ17	1
User Satisfaction				
	(Ives *et al*., 1983)*; Seddon & Yip, 1992		sat1 to sat3	3
	Seddon & Yip, 1992		sat4	1
				87

* indicates the origin of the concept/measure.
** Ease of Use is classified as an Information Quality item in Landrum *et al*. (2008).
+ Not highlighted items were adapted from the cited instruments.

3.6.3 Knowledge/Information Quality

Measuring Information Quality has been problematic for IS Success studies (Petter *et al*., 2008). Knowledge Quality scale appears to be a relatively new concept.

Four items regarding Conciseness, Format, Understandability and Usability were adapted from Gable *et al*. (2008). Note that clinicians and researchers are working in a "data overload" rather than a "data starvation" environment (van der Lei & van Bemmel, 2002). The introduction of new ITs leads to "information explosion" (Bali *et al*., 2009). The phrase "not concise enough" instead of "concise" was used for the Conciseness item to reflect this situation.

In Landrum *et al*. (2008), the Information Quality construct consists of Ease of Use, Relevance and Completeness (the reliability score is 0.88). These three items were fully adapted. However, following the convention of IS Success literature, Ease of Use item was classified under the System Quality construct. This might be examined at the statistical analysis stage. Completeness was elaborated into eight items in accordance with the functionality of EMR (see DesRoches *et al*., 2008; EC, 2008). In DesRoches *et al*. (2008), one of the survey items was Clinical Notes. It was developed into two items to reflect that a complete patient medical record should include information about clinical context (Taylor, 2006) and patient narrative (Greenhalgh & Hurwitz, 1999). As a result, Patient Data (personalised and contextual information) has been emphasised.

Note that knowledge is actionable and contextual (Davenport & Prusak, 1998). The KID (or DIK) school suggests that knowledge is personalised information (Alavi & Leidner, 2001; see Subsection 2.3.1). This construct emphasises integrating Patient Data into the process of practising medicine; i.e., information is transformed into actionable and contextual knowledge. Therefore, this measure should be seen as a Knowledge/Information Quality scale.

3.6.4 Physician Attributes

The extent of this construct appears to be unlimited. In this study, clinical decision-making is emphasised. A literature search suggests that there does not exist a standard instrument to explore clinical decision-making from an IS perspective. In fact, to understand how physicians make medical decisions remains a challenging topic in Medical literature (Stempsey, 2009).

Note that CDSS makes decisions based on clinical practice guidelines (Raghavan, 2009). The effect of implementing CDSS is akin to enforcing guideline-based medical practice. In the literature, guidelines are often considered as a threat to clinical autonomy (Elstein & Schwartz, 2002; Scott, 2001; ter Meulen, 2005). Interestingly, in Scott's (2001) study, physicians appeared to be willing to trade off their income to work in practices with guidelines that were likely to reduce their clinical autonomy. The author (*op. cit.*) suggests that this might be influenced by physicians' concerns about quality of care and/or litigation avoidance. It shows the importance of examining the physician-patient relationship aspect. In fact, this aspect is crucial to the production of clinical knowledge (Stempsey, 2009). To understand the relations between autonomy, altruism and litigation-avoidance from the perspective of physician-patient relationship is a goal of this study. Items were chosen and developed in this rubric.

Fifteen items were adapted from some well-developed survey instruments (See Aydin, 2005). Five items were adapted from Aydin *et al.* (1998). Six were adapted from Aydin *et al.* (1999) − it was originally a survey addressed to patients; four of these six items were originally developed by Schultz and Slevin (1975) and two of these six items were developed as a single index measure. Three items were adapted from Schultz and Slevin (1975), and one from Cummings and Huse (1989). Four items were developed based on the findings of the literature review (see DesRoches *et al.*, 2008; Ellis & McGuire, 1986, 1990; Greenhalgh & Hurwitz, 1999; Holsinger & Beaton, 2006; Lane & Tsang, 2008a,b; Taylor, 2006; see Table 11, p.115, for details).

3.6.5 Perceived Net Benefits

Perceived Usefulness or job impact is the most common measure of Net Benefits at the individual level (Petter *et al.*, 2008). A six-item scale of Perceived Usefulness was adapted. It was developed by Davis (1989) − a reputed paper in IS Success research (Petter *et al.*, 2008). This scale appears to be well researched and rather robust. For example, these items were phrased differently in Landrum *et al.* (2008) and Rai *et al.* (2002). Both studies obtained high Cronbach's (1951) alpha reliability scores − 0.97 and 0.96 respectively. Note that physician performance is usually assessed in different dimensions. The Performance item was elaborated into five items in accordance with the findings of DesRoches *et al.* (2008) on potential effects of adapting EMR.

Wyatt (2001) believes that the application (or development) of CDSS and informatics to medicine is intended to empower patient choice and contribute to health and welfare. This idea was developed into a Patient Welfare item with reference to the Awareness/Recall item in Gable *et al*. (2008). This item could be classified as Physician-Patient Relationship in the Physician Attributes construct. It was classified as Perceived Net Benefits given that physicians were assumed to be altruistic (see Arrow, 1963, 1986). Naturally, patient welfare will be a basis for physicians to self-assess their own performance.

3.6.6 User Satisfaction

The most popular instruments of this construct are Doll and Torkzadeh's (1998) End-User Computing Support (EUCS) and User Information Satisfaction (UIS) of Ives *et al*. (1983) (see Petter *et al*., 2008). However, these two instruments contain items of other constructs (Petter *et al*., 2008). To avoid establishing overlapping definitions, an alternative measure was sought. Two alternative popular measures were: (i) the single item measure of Rai *et al*. (2002) and (ii) the four-item measure from Seddon and Yip (1992) (see Petter *et al*., 2008). However, neither of these two measures appeared to be reliable *per se*.

Various authors consider that single item measures do have their merits (see Aydin, 2005). However, these measures have been criticised for possible measurement error and lack of discriminatory power (see Zmud and Boynton, 1991). On the other hand, Seddon and Yip (1992) performed a regression of the overall UIS on the short-form UIS. It was significant at the 0.01% level. The authors (*op. cit.*) admitted that its goodness of fit (adjusted R^2=0.33) was an issue. In a KMS study, this measure obtained a 0.9936 reliability score (Halawi *et al*., 2007). Perhaps there is only a moderate risk of adapting Seddon and Yip's (1992) measure. A blend of the two measures does not appear to be necessary.

Inarguably, medical/clinical decision-making is complex. It is unlikely that the system *per se* can adequately meet the knowledge/information needs. To reflect this idea, the phrase "most of the time" was introduced into the first item.

3.6.7 Intent to Use

The name of this measure is same as that of a subdimension in the Jennex and Olfman (2006) model. Indeed, the proposed measure comprises two concepts – (i) System Use and (ii) Intention. It operationalises (i) Davis' (1989) proposition that System Use is driven by Intention to Use and (ii) DeLone and McLean's (1992; 2003) System Use construct. There is no unique measurement of System Use (Petter *et al.*, 2008). One major issue is that self-reported use is an inaccurate measure of actual use (*ibid.*). Venkatesh *et al*. (2003) find a significant relationship between intention to use and actual usage. Accordingly, items regarding intentions were introduced. The resulting measure might reflect the potential levels of use.

A single item measure regarding System Use was adapted from Rai *et al.* (2002). It was originally constructed by Goodhue and Thompson (1995). An item was extracted from a measure of Personal Intentions (see Kaplan and Duchon, 1989). It was originally developed by Kjerulff *et al*. (1982). It consists of one item regarding positive intention and one negative intention. Perhaps the opposing nature of the two items might be the cause of low (0.53) or negative (–0.90) Cronbach's (1951) alpha score in the studies of Kaplan and Duchon (1988) and Aydin *et al.* (1999) respectively. Interestingly, these two items were adapted repeatedly for a series of multi-method longitudinal studies (see Kaplan & Duchon, 1988). The results were repeatedly published in various journals including the reputed academic journal *MIS Quarterly* (*ibid.*). There appeared to be a good reason to employ this measure. However, only the item about positive intention was adapted to ensure that the wording was consistent with other items of Intent to Use.

To identify the user patterns of different HITs, five items were developed. Bates *et al*. (2003) suggest that, in a consultation, a physician may have to take actions in (i) retrieving and keeping medical records, (ii) communicating with colleagues and patient(s), and (iii) recommending diagnostic test and therapy. Accordingly, three items were constructed to reflect those actions. Using the system to communicate with patients was not operationalised, as in-person consultation was a focus of this research. Two items were about using the Internet and assessing laboratory results through the systems. These two functions are cited in the EC (2008) report.

In conclusion, the seven constructs were operationalised by 87 Likert items (see

Table 11, p.115, for a summary). Fifty-three were adapted from some well-developed survey instruments. Thirty-four (highlighted in Table 11) were constructed based on the stylised facts or findings of different disciplines and/or inspired by certain items of some well-developed instruments.

3.7. ADMINISTRATION OF THE SURVEY

The survey instrument was multi-disciplinary in nature. Comments from a small group of experts from one single discipline may not be preferred to the instrument developed based on the findings that had been cross-checked with the theories and evidence from a wide range of disciplines. It was also the researcher's opinion that in-depth meanings of respondents should best be understood from repeated survey studies and/or in-depth interviews. The results of this study might be considered as an anecdotal study for future research. Therefore, no pilot test was arranged.

3.7.1 Survey Population Choice and The Survey Process

A search of PubMed suggested that HIT had been a fast growing research area for at least two decades.[22] Surveys regarding HIT use in the primary care sector of Spain had been conducted (see EC, 2008, for example). Although the research scope of this work was different from that study, it would be interesting to obtain findings from alternative clinical settings. Accordingly, the survey was conducted in the secondary healthcare sector (hospitals) of Spain.

Improving public healthcare services has been one of the motivations for implementing eHealth initiatives for the 32 European countries and the US (EC, 2007; eHealth Initiative, 2006). Encouraging the use of ICTs has been a focus of the Spanish NHS for at least 15 years (Monteagudo & Moreno, 2007). According to the authors (*op. cit.*) and EC (2007), Spain has implemented the Plan for Quality programme (or *Plan Avance*, the eGovernment strategic plan) in its NHS since 1 January 2006. The eHealth initiative, namely "Health on Line" is one of the objectives. In theory, physicians in the public healthcare sector should have been using HIT for consultation.

There are 17 independent administration regions (*comunidades autónomas*) in

[22] PubMed is the most widely used interface of MedLine (Sittig, 2009). MedLine is the most commonly used bibliographic database in clinical medicine (*ibid.*).

Spain (Monteagudo & Moreno, 2007). Andalusia (*Andalucía*) is one of the two successful cases in using networks for eHealth purpose (*ibid.*). Its regional healthcare IT network is considered as one of the most integrated ones in the world by a reputed CoP in KM for Medical Care, OpenClinical (http://openclinical.org/hitGlobalEuropeEU.html; accessed 1 December 2009). In theory, an interoperable EHR system has been installed in this region. It was apparently an ideal choice for developing a role model for optimal level of HIT implementation. The initial plan was to collect 200 sets of survey data from physicians who worked in the public hospitals of Andalusia. The experience of conducting surveys with other sectors suggested that a 1,000 potential respondent list was needed.

However, only 622 potential respondents could be identified from the Andalusia region (see Subsection 3.7.2, for details). So, it was necessary to conduct the survey in another region. Two regions appeared to be the best choices − Castile-La Mancha (*Castilla-La Mancha*) and Madrid. The former is the other successful case in using networks for eHealth purpose (Monteagudo & Moreno, 2007). The Andalusia search experience suggested that Madrid physicians were actively involved in publications. A search for Madrid physicians could definitely make up a 1,000 potential respondent list.

The choice of regions crucially determined the nature of this study. A survey study with Castile-La Mancha could potentially identify further research directions for developing a role model of optimal HIT implementation for consultation. A study with Madrid could potentially test the interoperability hypothesis if the sample size were large enough to perform a multiple-group analysis. Interoperability is generally considered to be crucial to fully deploy the benefits of any HIT system (Chaudhry, 2005).

An economist's instinct suggested that developing a role model seemed to be a more interesting topic. An attempt was made to collect sufficient records from Castile-La Mancha. However, only 150 usable potential respondent records could be identified. Madrid was finally chosen to be another region to conduct the survey study.

According to the Madrid government web (www.madrid.org), there are 15 non-specialist public hospitals in Madrid located in 11 zones. A hospital was randomly chosen and a PubMed search was then performed based on the same criteria applied to the Andalusia search. The records remained insufficient after the search. Another hospital was then randomly picked from the government list. A PubMed search would be performed on that hospital only if it was located in a zone that had not been chosen. This process continued until sufficient records were found. In the end, PubMed search was performed on four Madrid hospitals.

The survey instrument was translated into Spanish by a Management professor with extensive experience in survey studies (see Appendix I). The survey was conducted by a survey firm based on the 1,000-author list. The potential respondents were presumably physicians who worked in the public hospitals of Andalusia (622) or Madrid (378).

3.7.2 Sources of Contact Information

At the outset of the survey study, a directory of potential respondents did not exist. The potential respondents were identified from three types of information sources: (i) official websites, (ii) hospital websites and (iii) PubMed.

According to OpenClinical, SICESS is an excellent source for HIT related information (http://www.juntadeandalucia.es/salud/oficinavirtual/bienvenidaconsulta.jsp). It provides comprehensive information about hospitals in Andalusia. It includes information on available medical services of each principal hospital. It helped identify the public hospitals. Two subcategories were chosen (*general hospitales* and *alta resolución*). However, it did not provide the contact information of individual physicians.

In theory, a "cold call" approach could be employed; i.e., calling the switchboard in order to reach the heads of the units/departments (*jefes*) for interviews. However, this involved a substantial agency fee. Pervious experience also suggested that this approach usually results in a poor response rate. A "warm call" approach was the preferred approach. This approach requires having contact information for specific individuals. A browser search showed that not all hospitals had their own websites. It appeared to be pessimistic to look for the specific contact information on the web (except for one hospital which provided the contact information of all its unit/department heads).

Having noted that various hospitals tended to emphasise their research activities, a search with a bibliographic database was an apparent option. Information of authors' email addresses and affiliated units/departments could be found in PubMed directly in many cases. In theory, full contact information about authors could be found from the publications. However, if this approach was employed, only approximately 35 records could be found in about five hours. When duplication checks were applied, this approach would prove to be even less effective.

Accordingly, the final PubMed search strategies were that a record was taken if (i) a publication was published during the period of 1 January 2007 to 31 December 2009, (ii) an email and affiliated unit/department was readily available without downloading a publication. This approach allowed collecting 150 usable and non-duplicated records in five hours.

Each source of information had its respective limitations. Official sources provided full contact details of hospitals. Individual potential respondents could be identified from PubMed. In theory, it offers full details of the authors' affiliations. However, due to the poor Internet connection, this approach was not practical. Also, a significant proportion of the records were in English. For example, 129 out of the 575 Andalusia records and 174 out of the 473 Madrid records were in English. There was a concern that a significant proportion of potential respondents could not be reached. This implied that the contact information had to be consolidated and translated.

It may be necessary to mention that all the 622 usable Andalusia records were included into the database. Initially, it was thought that the Madrid data set comprised 300 Spanish and 173 English usable records. The former were all included in the database. Seventy-eight (78) English records were chosen in accordance with the alphabetical order of the potential respondents' first family names (records numbered 1−26, 75−100 and 148−173). In fact, the 378 Madrid records comprised 299 Spanish and 79 English records. After a VBA programme was improved, it identified that one Spanish record was indeed an English one. That record was not replaced by another record for 1/378 was an acceptable error by many standards. The researcher who searched for the contact information was also the researcher of the whole project (except the interview part). To minimise selection bias, the researcher was blinded from the hospital profiles and strictly complied with the sampling criteria. The specifically designed VBA programmes help standardise the procedures.

3.7.3 The Process of Screening and Consolidating Information from Different Sources

The data from PubMed were not in a readily usable format. Perhaps the most explicit illustration is to quote an example as follows:

> Abc JO
> Sección de Neurología, Hospital Torrecárdenas, 04009 Almería, España. abc101316@abc.com

A trivial observation suggested that many duplicated records were found. To filter out the duplicated records, it was necessary to extract the information about the author, unit, hospital and email address from each record. A trial showed that it took about one hour to collect 20 records if data collection, data transformations and duplication checks were performed simultaneously.

To ease the data collection task, one set of VBA programmes was developed to separate this task from others. As a result, about 300 potentially usable records could be collected in five hours.

There was no single reliable means for filtering out the duplicated records. For example, some authors used more than one email addresses. They might use one family name or two family names. This situation applied to authors' initials. To eliminate duplications, it only required exacting the initial(s), family name(s) and email address of each record. Due to uncertainty in collecting sufficient information to conduct a telephone survey, email and mailing addresses were prepared as alternative means of survey instrument distribution. While it was necessary to search for telephone numbers, gathering the additional information added little extra workload.

The data collection process was complicated by the authors' using hospital names that were different from those listed by the local governments. The government websites indicated that there were only 35 principal hospitals, but 169 hospital names were found from the PubMed data. Without verifying these pieces of information, a reliable contact list could not be generated. Fortunately, sufficient information could be found on the web to verify the contact information.

In the end, another set of programmes was developed to transform the data from the government and hospital websites. Two additional sets were developed to help consolidate the information and translate hospital and unit/department names. In total, four sets of VBA programmes were developed.

Complete and current information was insufficient to make up a good quality contact list. The major objective of this study was to develop a CDSS Use model from a clinical decision-making perspective. Stempsey (2009) notes that diagnostic reasoning and clinical reasoning are sometimes treated as equivalents of each other. The author (*op. cit.*) acknowledges the opinion of Barrows and Tamblyn (1980, p.19) that clinical reasoning involves "the cognitive process that is necessary to evaluate and manage a patient's medical problems." One feature of the programmes was to filter out authors who worked in units/departments that did not involve treatment decisions. For example, a pharmacist may not be a medication prescriber. Certain radiologists only perform radiodiagnoses. They were filtered out unless the information suggested that a pharmacist or radiologist was involved in interventions (see a sample programme in Appendix II, for the screening criteria).

3.7.4 The Development Process of the VBA Programmes and Database Quality

As noted, 169 hospital names were found in the two sets of PubMed data. However, this did not necessarily imply that 169 sets of codes were needed in order to input the addresses. Similarly, it did not require 106 (208) sets of codes to translate the hospital names (unit/department names) that were in English.

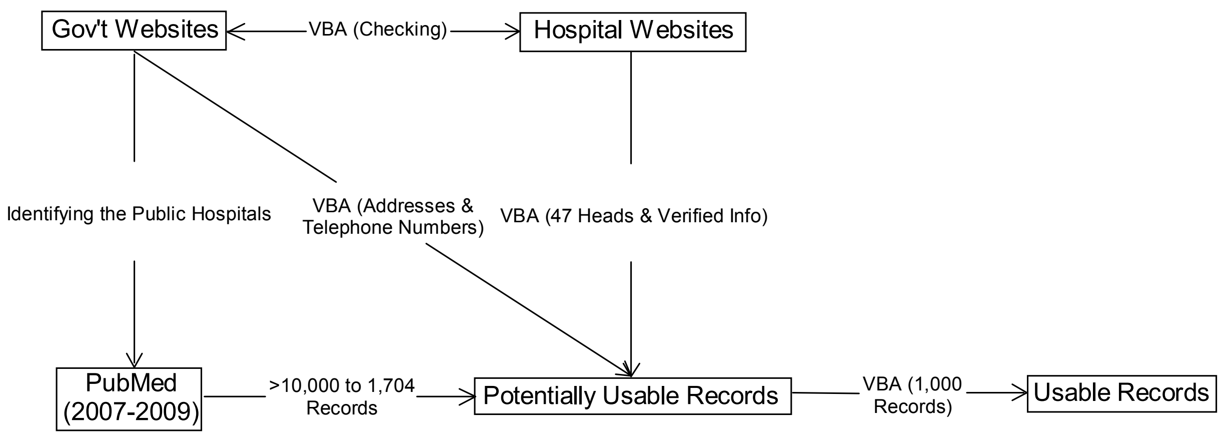
Coding technique was used to identify the minimal required codes. Coding is often applied to qualitative research. The process was undertaken with the Andalusia data set first, then the Madrid one.

Initially, it was thought that coding the hospital names of the PubMed data was the best strategy. With repeated coding, the number of hospital names was reduced from 129 to 89. The Andalusia government sites (SICESS and the general website) suggested that the maximum number of hospital names was 78, which included the 31 principal hospitals and the affiliated hospitals. It suggested that coding the official information might be a better strategy. In the end, only 52 sets of codes were needed to complete the contact information for the 575 records and another 47 sets for the heads (*jefes*) of a hospital. Coding technique was also applied to identify the codes needed for translating the English hospital and unit/department names into Spanish, and transcribing two abbreviated names into longhand (4 records in mixed languages were incidentally translated). The same strategy and process were applied to the Madrid data set. Some statistics regarding the programming process are listed in Table 12. The sampling process is depicted in Figure 11.

Table 12: Summary of Contact Information Quality and Coding Information

	Andalusia	Madrid
Original Number of PubMed Records	**981**	**723**
Number of usable PubMed Records (after the screening and checking processes)	575	473
Number of Records Chosen from PubMed	**575**	**378**
Heads (*Jefes*) of a Hospital	**47**	
Number of Codes Required to Complete the Contact Information	52 Sets	9 Sets
Number of Codes Required to Complete the Contact Information of Individuals	49 Sets	2 Sets
Number of Hospital Names	**129**	**40**
(in English)	32	8
Number of Hospital Names in English	**77**	**29**
Number of Codes Required	18 Sets	7 Sets
Number of Unit/Department Names in English	**129**	**79**
Number of Codes Required	75 Sets	52 Sets
Number of Transcribed Records	**2**	
Number of Translated Records	**133**	**80**

Figure 11: The Sampling Process



The quality of the data sets is suggested by the features of the programmes as follows:

1. It screened out the authors who might not be clinicians, e.g., Laboratories, Research Units, Radiodiagnostic Services, etc.;
2. It helped screen out the duplicated records in terms of email address, full

name, then first family name;

3. It helped screen out incomplete records such as missing email address, unit/department name, and/or hospital name;
4. It screened out unfamiliar simplified unit/department names, e.g., EP, ENT, FEA, etc.;
5. It transcribed a simplified unit/department name (ORL) into longhand (Otorrinolaringología);
6. It identified records that needed to be translated, e.g., English hospital names and English unit/department names;
7. It completed the contact information, e.g., mailing addresses, telephone numbers and fax numbers;
8. It inputted the Spanish names of hospitals and unit/departments that were in English; and
9. It made various reports available in one-click.

This approach is not only a skill-added approach, but also an effective, efficient, and reliable approach. In a previous research project, it took about three to four weeks to input and check approximately 780 records (once) from a single information source manually. That involved no screening criterion, duplication check and translation. In this study, multiple sources were used for identifying the potential respondents. It involved some translation/transcribing work and transforming data from different electronic formats. It only took one month to complete the entire process. The data were checked in accordance with various criteria at multiple stages. The value of taking this approach is evidenced by the rigorous screening and checking processes. With suitable adjustments, this approach can be applied for other research purposes.

3.8. The Choices of Analysis Facilities and Techniques

3.8.1 Analysis Facilities

The multi-platform freeware R (version 2.9.2) was the chosen statistical facility (available at http://cran.r-project.org). R is one of the most popular applications within the statistician community (Fox, 2006). Its codes are almost perfectly compatible with the commercial application S-PLUS (a computing environment of the statistical programming language, S) (Everitt, 2005; Fox, 2006). There are many reasons for using R. The choice was mainly determined by three crucial factors.

First, Fox (2006) considers that R has broader coverage of statistical methods than any other statistical applications. Its basic capabilities are comparable to a basic installation of SAS, but can be augmented by the ever-increasing large amount of contributed packages (*ibid.*). In other words, its capabilities are being improved all the time. Second, the number of survey items and the *a priori* model suggested that the analyses involved techniques for data/dimension reduction and Structural Equation Modelling (SEM). The analyses could be quite complicated. However, specialised packages for R were available to make these analyses easy. Its choice range of techniques is far wider than other popular applications. For example, SPSS offers very few rotation methods for factor analysis. Rotation is the crucial technique that makes factor analysis results more interpretable (Everitt, 2005). Third, voluminous resources for learning its operations are available on the web at zero financial cost. Very often, notes and books written by the authors of contributed packages can easily be found. This saves time in learning different authors' mathematical notations or expressions. In fact, the R-help documentation *per se* usually offers comprehensive coverage of various statistical procedures and the corresponding operations.

The analyses were done by various R packages, mainly by two packages: (i) `psych` version 1.0-88 and (ii) `sem` version 0.9-20 (see Revelle (2010) and Fox (2010) respectively). The statistics were converted into LaTeX format by `xtable` version 1.5-6.

3.8.2 Analysis Technique Choices

Various statistical procedures were involved. Descriptive statistics were applied to summarise demographic data and to preview data features at various stages in order to help determine the appropriate statistical analyses. Data/dimension reduction analyses were conducted by Exploratory Factor Analysis (EFA). Structural Equation Modelling (SEM) was conducted to test the *a priori* model. SEM is a combination of measurement of reliability and structural modelling by means of multiple equation regression (Fox, 2006). That is, SEM allows regression of a response variable (endogenous variable) on explanatory variables (*ibid.*). Unlike conventional regression techniques, SEM allows introducing latent variables into a model.

Two popular multivariate analysis procedures were considered to be applicable to reduce the complexity/dimension of the observed data − Principal Component Analysis

(PCA) and Exploratory Factor Analysis (EFA). PCA were introduced by K. Pearson in 1901 (Everitt, 2005) and EFA by C. Spearman in 1904 (Revelle, forthcoming). An application of PCA or EFA can reduce the complexity of observed data, but impose a risk of data misfit (*ibid*.). In an era where computing cost is successively diminishing, one may challenge the need to risk out the fit of a model to lower the computing cost. By Ockham's razor, "entities should not be multiplied needlessly; the simplest of two competing theories is to be preferred" (WordNet English Dictionary, http://wordnet.princeton.edu/). This parsimony principal remains a fundamental principal of science (Revelle, forthcoming). Also, fit is a desired property of a model, but can be overemphasised. For example, a professor (of London School of Economics) in Principles of Econometrics once noted: "it is not a 'sin' to have insignificant variables included in your specification… you should be careful … in the end, almost none of the variables appears individually significant" (Schafgans, 2005).

EFA was chosen after weighing the model philosophy, the strengths and weaknesses of EFA and PCA. The two procedures employ the same set of mathematical tools, but different model philosophy (Härdle & Léopold, 2007). A principal component is a weighted linear sum of observed variables (Revelle, forthcoming) that maximises the projected variance (Härdle & Léopold, 2007). The basis of FA (Factor Analysis) is that it describes (observed) manifest variables as the weighted linear sums of (unobservable) latent variables (Revelle, forthcoming). The relationship between variables can be represented by a correlation/covariance matrix of observed variables (R, say) that is the sum of the common factor matrix (FF', say) and a diagonal matrix of uniqueness (U^2, say) (i.e., $R \approx FF' + U^2$) (*ibid.*). FA aims to identify fewer underlying latent variables (constructs) to explain observed data (Revelle, forthcoming) in maximal interpretation (Härdle & Léopold, 2007). PCA is just a description of the observed variables by means of data whose dimension is lower than that of the original data (*ibid.*).

Both procedures have strengths and weaknesses. To solve for components is a straightforward exercise (Everitt, 2005; Revelle, forthcoming). To solve for factors is more complicated; it often involves trying alternative techniques (*ibid.*). PCA is one of the oldest and most widely employed methods of multivariate analysis (Everitt, 2005). FA is probably the most frequently used, but most controversial psychometric procedure (Revelle, forthcoming). PCA appears to be the risk averse choice. However, it tends to underestimate the importance of the major variables, but overestimate that of the least important variables (Revelle, forthcoming). This issue can be mitigated by including more components (*ibid.*). However, the data reduction purpose fades away. Other issues include (i) the estimates of PCA could change when new variables are introduced (*ibid.*) and (ii) when the variances of the original variables are very diverse, PCA may only include the variables that have the largest variances (Everitt, 2005). Point (ii) causes a concern that a seemingly significant variable may indeed be just a variable that presents significant amount of outliers. The application of rotation as part of the usual EFA procedure appears to be a source of scepticism (Everitt, 2005). Rotation is criticised for allowing the investigator to impose on the data whatever is required (*ibid.*). In fact, rotation is also often applied to PCA. So, the application of PCA should be equally controversial.[23] Everitt (2005) poses that rotation only makes an EFA solution more interpretable. It does not change the underlying mathematical properties (*ibid.*). Perhaps the real source of controversy may come from the indeterminacy of the factor scores (*ibid.*) or the model (Steiger, 1990). Härdle and Léopold (2007) add that the non-uniqueness of FA procedure may lead to subjective interpretation and a spectrum of results. Inarguably, FA offers an option to measure a phenomenon that cannot be measured directly (Everitt, 2005; Revelle, forthcoming).

As discussed in Section 3.5, IS Success has been of research interest for over three decades (Gable *et al.*, 2008). Certain constructs are still not universally defined and/or measured (*ibid.*; Petter *et al.*, 2008). This situation suggests that some hidden facts remain unrevealed. EFA was chosen primarily due to (i) the intention of uncovering the hidden facts and (ii) avoiding the unadjustable weaknesses of PCA. With a careful interpretation of the results in accordance with the existing findings and theories, the "subjective" issue could be mitigated.

3.9. CONCLUSION

This chapter presents the research framework and methodology. A specific literature survey (focused on medical practice in relation to HIT use) was conducted to identify the direction to formulate the theoretical model. It also confirms that more

[23] Indeed, in an email discussion, Professor W. Revelle of Northwestern University suggests that principal components become components after rotation − the linear sums of the observed variables. Everitt (2005) consistently notes that principal components lose the defining property of accounting for maximal proportions of the total variation in the observed variables after rotation (p.76).

elements of people, process and professional intellect should be introduced into the baseline model to formulate and operationalise an assessment model of CDSS Use. The discussion shows that EMR/EHR systems required to meet the objectives of the current eHealth initiatives are actually KMSs (see EC, 2008, eHealth initiative, 2006; Hillestad *et al.*, 2005; Garets & Davis, 2006; and also Alavi & Leidner, 2001; Maier & Hädrich, 2006, for definitions of KMS).

Research hypotheses have also been outlined and preceded by a description of variables to be tested. This chapter details the development of (i) the measures to inform the proposed CDSS Use model and (ii) the survey data collection process. It gives a brief explanation about the data analysis methods and the statistical implementation, R, to be used for performing the statistical analyses. It explains the VBA programme development process and how the programmes helped quicken the sampling process. This approach has possibly identified a unique contact information database. It heightens the chance of producing new and unique research results.

CHAPTER IV

RESULTS

4.1. INTRODUCTION

This chapter presents the statistical analysis results of survey data collected from two hundred physicians from two regions in Spain. The focuses of this chapter are to assess (i) the survey instrument designed specifically for this study and (ii) the proposed CDSS Use model (see Chapter III). Various statistical techniques including Nonparametric Bootstrapping were applied. Demographic data are presented in diagrams. The performance of the survey instrument is suggested by the proportion of items validated by the Exploratory Factor Analysis and Cronbach's (1951) alpha reliability test. The proposed CDSS Use model was tested by a multiple-stage Structural Equation Modelling (SEM) process.

The background of the statistical procedure choices has been briefly discussed in Subsection 3.8.2. Bethlehem (2009) shares the view of a United Nations report (1964) that elaborate statistical techniques should be explained in a "survey documentation". Accordingly, results obtained from elaborate techniques will be preceded by a short introduction to the procedures and analysis strategies. Results will be interpreted in accordance with the existing theories and/or empirical studies. Contributions to specific research areas will be discussed in Chapter V.

4.2. INDICATORS OF SURVEY QUALITY

A thorough discussion of this aspect is a research question *per se*. This subsection only briefly discusses: the (i) survey process, (ii) response rate, (iii) sample size and (iv) profile of the research samples. Bethlehem (2009) considers giving details about the survey process to be a desirable feature of any "survey documentation". Response rate is an important indicator of survey quality (*ibid.*). The profile of the research sample should be described (*ibid.*). Sample size has been a frequent topic in any work involving statistical analysis.

4.2.1 Survey Process

The survey instrument was translated into Spanish by a professor in Management who had extensive experience in survey studies (see Appendix I for the original and translated versions of the instrument). Computer-assisted telephone interviews were conducted by a survey firm in April 2010. The firm was given a 1,000 potential respondent contact list − physicians who published during 2007 to 2009 and worked in public hospitals in Andalusia (622) and Madrid (378) (see Section 3.7 for the sampling process). It took 179.05 labour hours to collect 200 sets of survey data. Seven, presumably trained, interviewers were involved. The average talk time ranged from 1m34s to 3m11s per call.

An interview was considered as complete (*éxito*) if the respondent completed the 87 Likert items that operationalised the theoretical model. In total, 866 physicians were contacted. An excerpt from the firm's report is shown in Table 13.

Table 13: The Excerpt from the Survey Firm's Report

REGISTROS CON TELÉFONO	1.000	100%	
REGISTROS PENDIENTES DE CONTACTAR	*0*	*0,00%*	
CONTACTADOS	1.000	*100%*	
ABORTADOS (ERRONEOS)	131	*13,10%*	
NO CONTESTAN	3	*0,30%*	
CONTESTAN	866	*86,60%*	
		% CONTESTA	% REG.TOT
ÉXITO (Cualificados)	200	23,09%	20,00%
DESCUELGAN Nº NO CORRESPONDE	20	02,31%	02,00%
DUPLICADOS	-	00,00%	00,00%
IMPOSIBLE LOCALIZAR, (fax, cierre, etc..)	-	00,00%	00,00%
PENDIENTES DE FINALIZAR	354	40,88%	35,40%
AGOTADO Nº INTENTOS	170	19,63%	17,00%
NO INTERESA	121	13,97%	12,10%
ABANDONA	1	00,12%	00,10%

4.2.2 Response Rate

According to the report, the response rate was 23.09% (200/866) (see Table 13). A 20% response rate is generally considered as desirable (Yu & Cooper, 1983). Interestingly, no duplicated (*duplicados*) or out-of-reach (*imposible localizar*) record was found. The approach employed to synchronise incomplete contact information from various sources was proven to be a great success. The developed VBA programmes appear to be reliable.

4.2.3 Sample Size

No clear-cut general rule of thumb suggests what constitutes a sample as large (Raykov & Marcoulides, 2006, p.30). Some reviews on departures from multivariate normality suggest that with three or more indicators (observable variables) per factor, failures in converging solutions rarely occur if there are 150 or more cases (Loehlin, 2004). With three or more indicators per factor and sample sizes of 200 or more, improper solutions would pretty much be eliminated (*ibid.*). The author (*op. cit.*) also notes that a larger sample size may be needed for comparable accuracy in estimations of parameters and standard errors if the normality assumption does not hold. However, bootstrap would be an alternative solution to address this issue (*ibid.*; see also Sheskin, 2006). So, 200 cases are in an acceptable sample size range.

4.2.4 Profile of the Samples

Physicians who worked in public hospitals were chosen to be the potential respondents. Monteagudo and Moreno (2007) suggested that HIT had been implemented in the Spanish NHS for more than 15 years. In theory, they are HIT users.

A programme was written in R language to allow representing demographic and cross-sectional data simultaneously. Let us take Figure 15 as an example. Firstly a contingency table between physicians' affiliations and their regions was computed. The resulting table was then displayed in a bar chart.

The distributions of respondents by regions and areas are depicted in Figure 12 and Figure 13 respectively. The physician ratios of the two respective regions are roughly the same in terms of the potential respondents (62.2:37.8), contacted physicians (62.7:37.3) and the respondents (61.5:38.5). The response rates by areas appear to be generally proportional to the numbers of contacted physicians (see Figure 14). Seville and Madrid Area 3 physicians were the largest contacted groups for Andalusia and Madrid respectively. However, their response rates are the lowest − 14.84% and 16.39% respectively. The response rates of Almería and Madrid Area 2 are the highest − 52% and 38.46% respectively.

As expected, all respondents indicated that they worked in a hospital setting (see Figure 15). Other physicians' characteristics are represented by Figure 16 to Figure 23.

The gender ratio (Male:Female) is 57.9:42.1 (see Figure 16). This does not necessarily imply that male physicians were more willing to participate in the survey. An inference could be drawn if gender information of contacted physicians were available.

Figure 15 to Figure 23 show that physicians' characteristics are not normally distributed. They demonstrate obvious right or left skewness. Figure 18 shows that a majority (67.2%) of the respondents were experienced physicians who had been in practice for more than 10 years. Figure 19 shows that only 6.2% of the respondents were at senior management level. The results may reflect the opinions of the physicians where consultation was their primarily daily duty, rather than that of the management. Figure 22 shows that only 2.7% of the physicians did not use a computer at home. Figure 23 shows that only 13% of the physicians rarely or occasionally used HIT for consultation. In the EC (2008) report, only 66% of Spanish GPs indicated that they used a computer for consultations. The physicians in this study appeared to be relatively adoptive to HIT.

Figure 12: Respondents by Regions

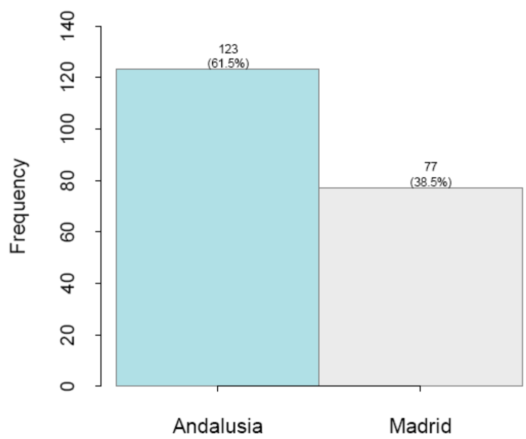


Figure 13: Respondents by Areas[24]

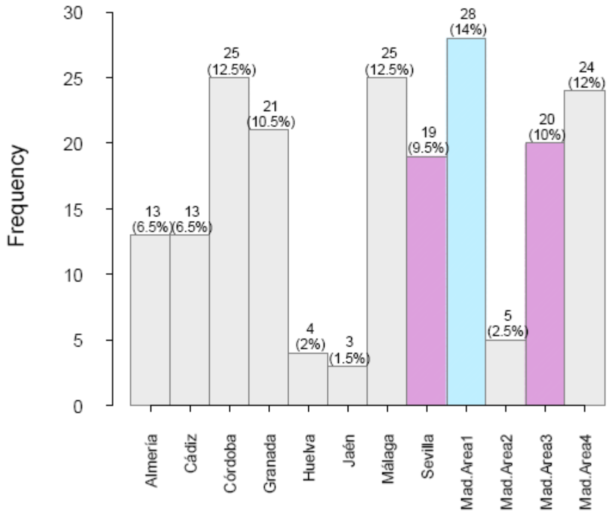
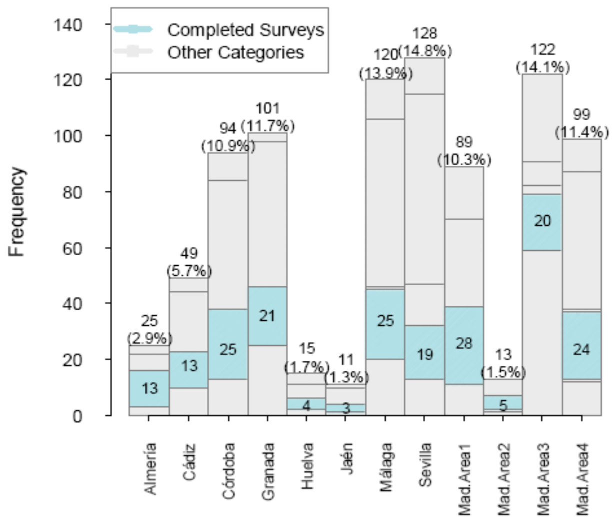


Figure 14: Proportions of Respondents by Areas



[24] Recall that only one hospital was chosen from each Madrid zone. To protect the identities of the respondents, the Madrid areas do not represent the actual zone numbers.

Figure 15: Respondents' Affiliations

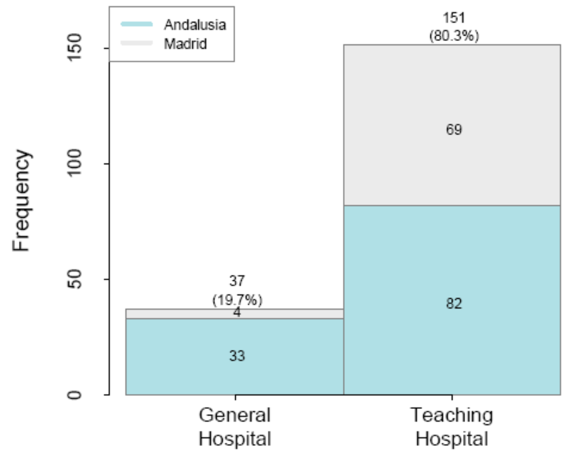


Figure 16: Gender

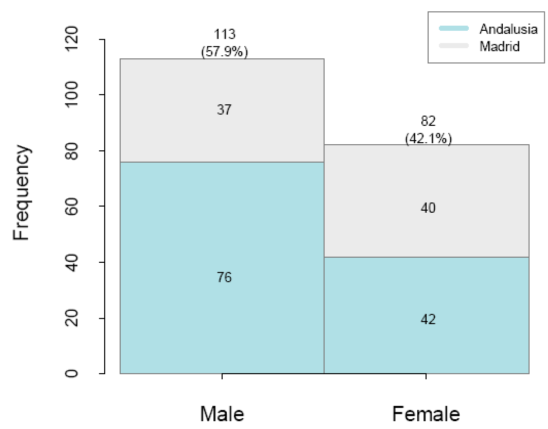


Figure 17: Years of Being in the Existing Affiliations

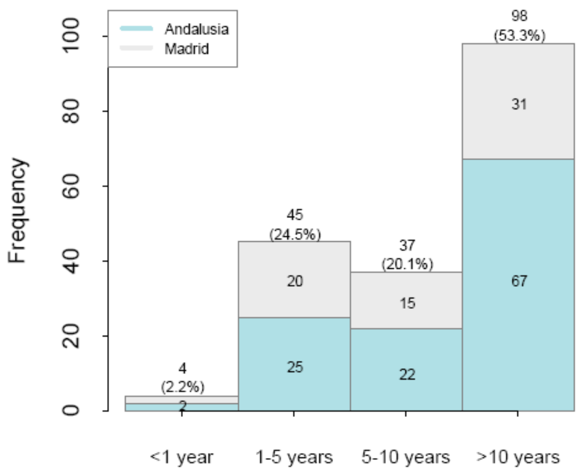


Figure 18: Years of Being in Practice

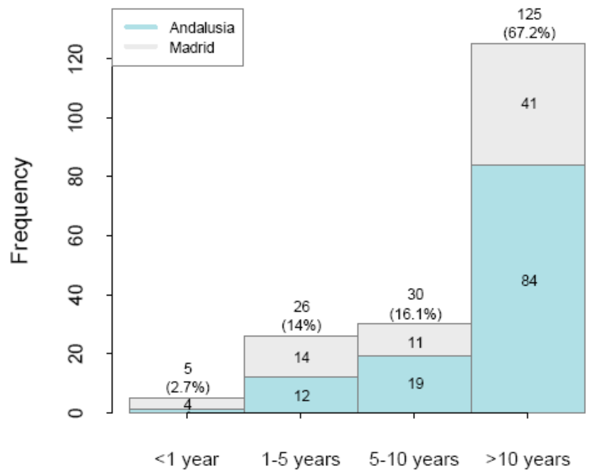


Figure 19: Seniority

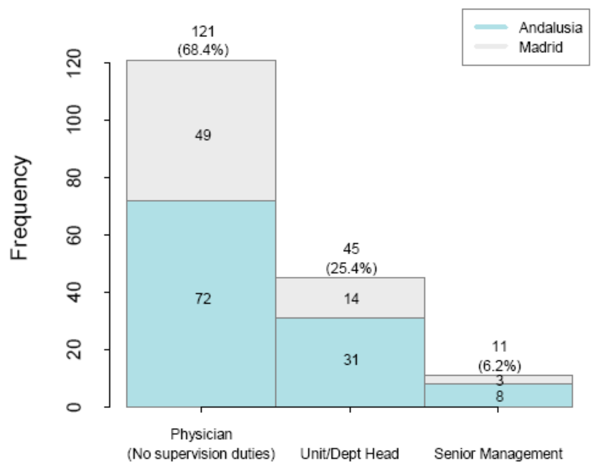


Figure 20: Time since last in Medical Training

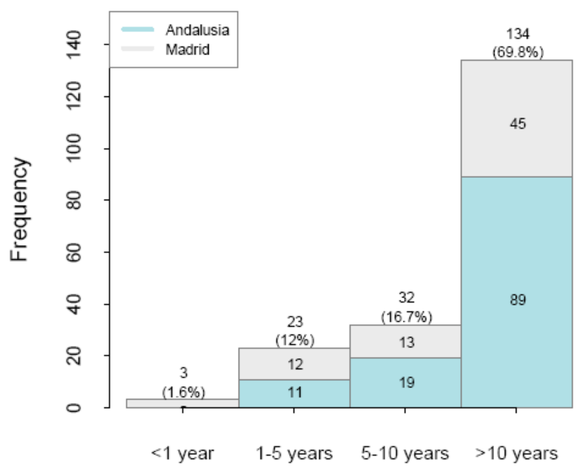


Figure 21: HIT Use was in the Medical School Curricula

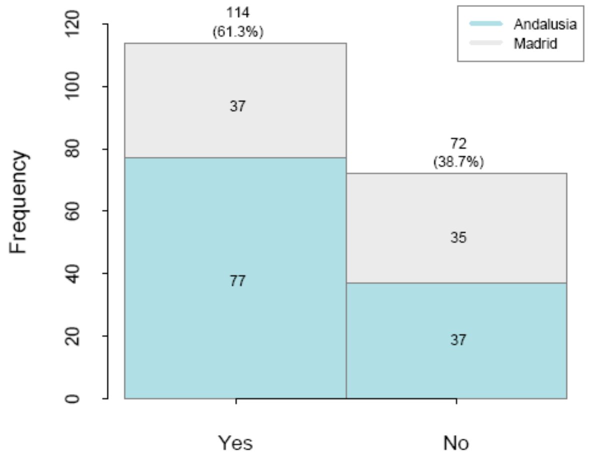


Figure 22: Use a Computer at Home

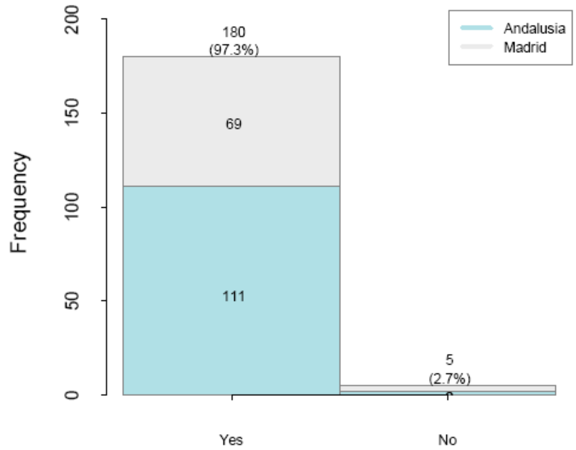
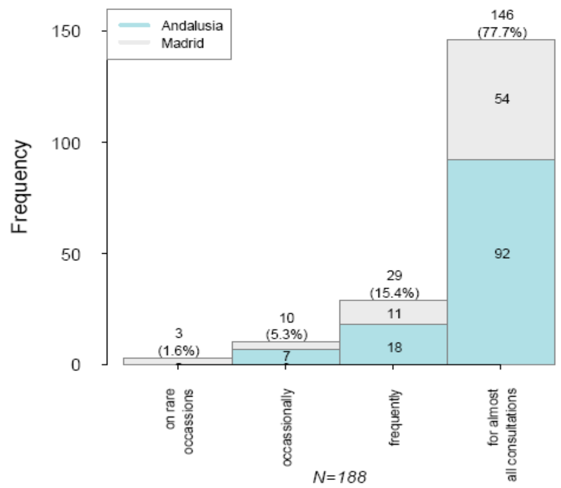


Figure 23: Frequency of HIT Use



Dansky *et al.* (1999) note that individuals' characteristics are associated with HIT acceptance. Table 14 shows that Frequency of HIT Use (namely *Freq.U*) and Gender are the only demographic aspects associated with dependency on HIT (the correlations are 0.54 and 21 respectively). In fact, *Freq.U* significantly correlates with all aspects of HIT use (Table 14). Figure 24 confirms that the physicians who indicated that they were dependent on HIT were predominately frequent HIT users. It evidences four potential consistency errors (see Bethlehem, 2009, for definition of consistency error). For example, one case indicated used HIT on rare occasions and answered "Moderately Agree" to the dependency question. Similarly, one (two) indicated occasionally used HIT, but replied "Agree" ("Strongly Agree") to the dependency question. However, the conclusion should not be affected by that 2% of potential consistency errors. Perhaps *Freq.U* may be introduced into the System Use or Intent to Use measure although Doll and Torkzadeh (1998) do not consider it to be the best measure of System Use. Particularly, Figure 25 suggests that *Freq.U* seems to correlate with each aspect of HIT Use more strongly than these HIT Use items *per se*. The two-tailed *t*-test results show that *Freq.U and itU*7 are the only items that significantly associate with other HIT use items (Table 15). The diagrams in the diagonal of Figure 25 suggest that the respondents were HIT adoptive as these eight items exhibit left-skewness to different extents.

Table 14 reveals that being trained for using HIT at the medical schools (namely, *Med.Train*) significantly and negatively associates with *itU*2 (using HIT as a recording tool) (Table 14). This aspect is also negatively associated with five other HIT use items, although not significantly. Holsinger and Beaton (2006) note that the newer generation of physicians would be more willing to use CDSS as they are more dexterous with ITs. If this proposition holds, then Table 14 may have revealed that physicians were not satisfied with the HIT training at the medical schools.

Table 14: Two-tailed Correlation Test − HIT Use and Physicians' Characteristics

	Gender	*Freq.U*	*H.Type*	*Emp.Yrs*	*Pra.Yrs*	*Grad.Yrs*	*Senior.*	*Med.Train*	*Hom.Usr*
*itU*1 Pearson Correlation	0.21	0.54	0.02	-0.12	-0.11	-0.13	-0.12	-0.06	0.02
p-value (Two-tailed)	0.003**	0.000***	0.779	0.107	0.136	0.080	0.111	0.458	0.782
No. of Respondents	193	186	186	182	184	190	175	184	183
*itU*2 Pearson Correlation	0.14	0.4	-0.01	-0.04	-0.07	-0.11	-0.01	-0.18	-0.09
p-value (Two-tailed)	0.052	0.000***	0.902	0.575	0.353	0.114	0.907	0.013*	0.244
No. of Respondents	192	186	186	182	184	190	176	184	183
*itU*3 Pearson Correlation	0.1	0.23	0.12	-0.1	-0.03	-0.03	-0.06	-0.07	-0.09
p-value (Two-tailed)	0.177	0.002**	0.093	0.166	0.652	0.684	0.401	0.381	0.246
No. of Respondents	189	183	182	178	180	186	173	180	179
*itU*4 Pearson Correlation	0.04	0.27	-0.02	0.11	0.12	0.12	0.13	-0.13	0.05
p-value (Two-tailed)	0.554	0.000***	0.784	0.135	0.116	0.094	0.095	0.068	0.475
No. of Respondents	194	187	187	183	185	191	176	185	184
*itU*5 Pearson Correlation	-0.01	0.21	0.11	-0.05	-0.09	-0.07	0.06	-0.07	0.07
p-value (Two-tailed)	0.857	0.004**	0.137	0.483	0.252	0.371	0.435	0.317	0.331
No. of Respondents	192	184	184	180	182	188	173	182	181
*itU*6 Pearson Correlation	0.03	0.16	0.01	0.03	0.07	0.09	0	0.04	-0.03
p-value (Two-tailed)	0.667	0.027*	0.838	0.732	0.328	0.216	0.958	0.584	0.724
No. of Respondents	195	188	188	184	186	192	177	186	185
*itU*7 Pearson Correlation	0.06	0.38	-0.05	0.09	0.07	0.07	0.03	-0.07	-0.07
p-value (Two-tailed)	0.377	0.000***	0.524	0.234	0.363	0.348	0.689	0.345	0.379
No. of Respondents	195	188	188	184	186	192	177	186	185

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Figure 24: Dependency and Frequency of HIT Use

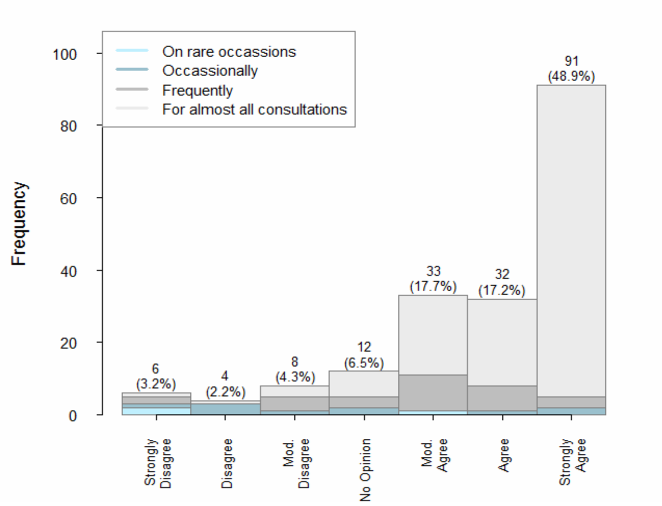


Figure 25: Correlations between HIT Use Aspects and Frequency of Use

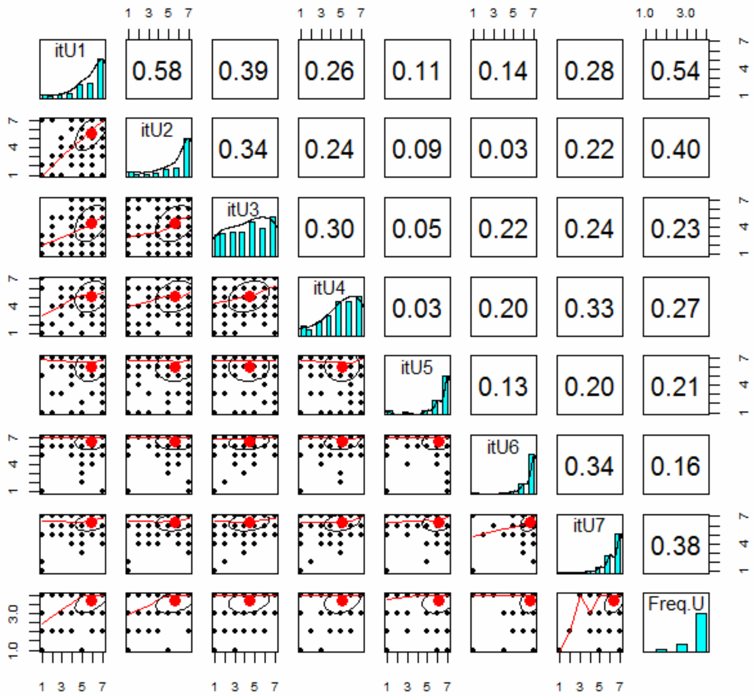


Table 15: Two-tailed Correlation Test − HIT Use and Frequency of HIT Use

		$itU1$	$itU2$	$itU3$	$itU4$	$itU5$	$itU6$	$itU7$	$Freq.U$
$itU1$	Pearson Correlation	1	0.58	0.39	0.26	0.11	0.14	0.28	0.54
	p-value (Two-tailed)	–	0.000***	0.000***	0.000***	0.143	0.045*	0.000***	0.000***
	No. of Respondents	198	195	193	197	194	198	198	186
$itU2$	Pearson Correlation	0.58	1	0.34	0.24	0.09	0.03	0.22	0.4
	p-value (Two-tailed)	0.000***	–	0.000***	0.001***	0.238	0.694	0.002**	0.000***
	No. of Respondents	195	197	192	196	193	197	197	186
$itU3$	Pearson Correlation	0.39	0.34	1	0.3	0.05	0.22	0.24	0.23
	p-value (Two-tailed)	0.000***	0.000***	–	0.000***	0.500	0.002**	0.001***	0.002**
	No. of Respondents	193	192	194	193	190	194	194	183
$itU4$	Pearson Correlation	0.26	0.24	0.3	1	0.03	0.2	0.33	0.27
	p-value (Two-tailed)	0.000***	0.001***	0.000***	–	0.680	0.004**	0.000***	0.000***
	No. of Respondents	197	196	193	199	195	199	199	187
$itU5$	Pearson Correlation	0.11	0.09	0.05	0.03	1	0.13	0.2	0.21
	p-value (Two-tailed)	0.143	0.238	0.500	0.680	–	0.074	0.005**	0.004**
	No. of Respondents	194	193	190	195	196	196	196	184
$itU6$	Pearson Correlation	0.14	0.03	0.22	0.2	0.13	1	0.34	0.16
	p-value (Two-tailed)	0.045*	0.694	0.002**	0.004**	0.074	–	0.000***	0.027*
	No. of Respondents	198	197	194	199	196	200	200	188
$itU7$	Pearson Correlation	0.28	0.22	0.24	0.33	0.2	0.34	1	0.38
	p-value (Two-tailed)	0.000***	0.002**	0.001***	0.000***	0.005**	0.000***	–	0.000***
	No. of Respondents	198	197	194	199	196	200	200	188

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

From a KM perspective, it is the HIT use for knowledge manipulation that matters. Figure 26 shows that only 52.6% of the physicians claimed that they "always" used HIT to assist making various clinical decisions (as they replied "Moderately Agree", "Agree" or "Strongly Agree" to this question). This situation is more appealing than the situation found in the EC (2008) report where only 42% of the GPs in Spain and 50% in the EU used CDSS.

The *itU*3 row in Table 14 suggests that *Freq.U* is the only physician characteristic significantly associated with CDSS Use (*itU3*) (at $p<0.01$). Figure 27 shows that a vast majority of the physicians agreed that the information from the systems was consistent with their medical knowledge. However, their opinions about using HIT to assist their clinical decisions were diverse, as the responses are fairly evenly distributed. The correlation between knowledge consistency and using CDSS functions is only 0.08.

Let us also discuss adopting HIT for traditional IT use – "storage and retrieval of coded knowledge" (Alavi & Leidner, 2001). The *itU*2 row in Table 15 shows that its correlation with *Freq.U* is stronger (0.40) than that of *itU*3 with *Freq.U* (0.23). Perhaps physicians are more willing to use HIT for the traditional information-processing purposes rather than for facilitating knowledge manipulation. Further investigation is required to prove or disprove this inference.

This subsection shows that the responses are fairly consistent (no apparent conflicting responses). Physician characteristics cannot sufficiently explain HIT use. However, there are some associations among HIT use, frequency of use, gender and being trained for using HIT at medical schools.

Figure 26: Always Use HIT to Assist Making Various Clinical Decisions

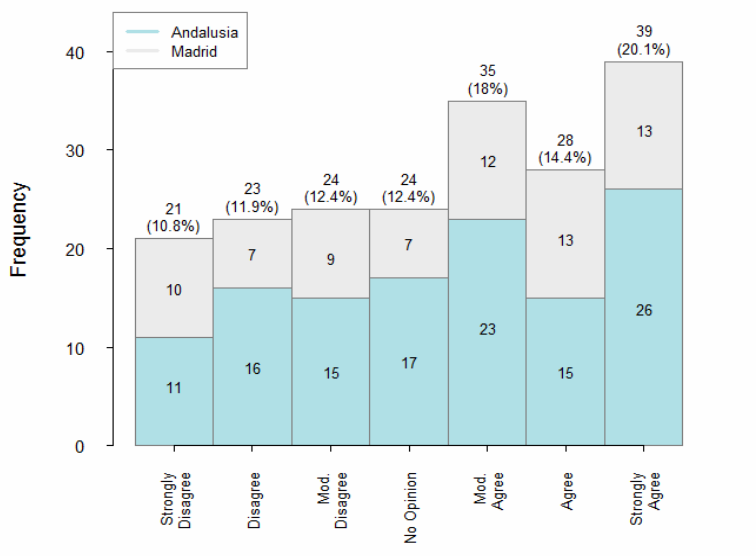
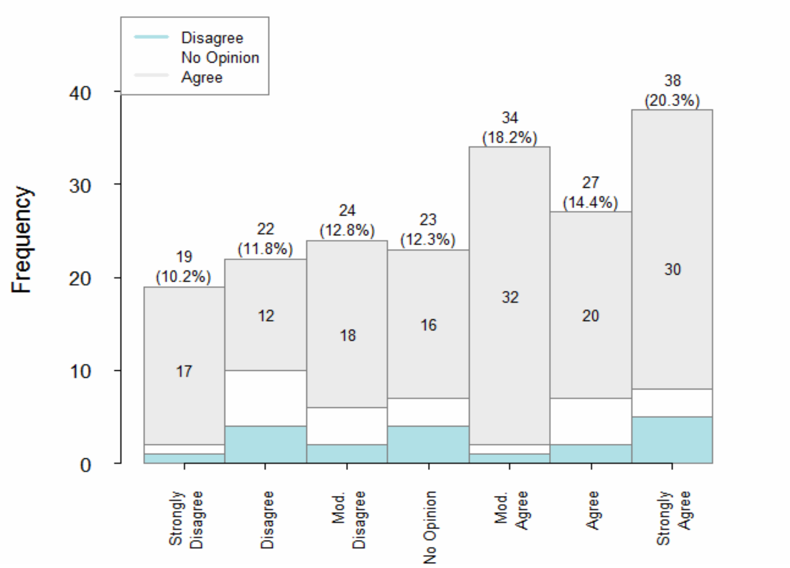


Figure 27: Use CDSS Related Technologies and Knowledge Consistency



4.3. Missing Data

This work has only dealt with one type of missing data − Item Nonresponse. Loehlin (2004) describes missing data as "a perennial problem" in latent variable modelling. Missing data can cause bias in estimations (Everitt, 2005). A common practical approach to this issue is imputation (Little, 2003). It is "the practice of 'filling in' missing data with plausible values" (Everitt, 2005, p.3). Its drawback is that it fails to reflect the uncertainty in estimation due to missing data (*ibid.*; Little, 2003). Multiple imputation methods have been developed recently to address this issue (*ibid.*). However, as Everitt (2005) notes, imputed values are not real measurements. This is inconsistent with a goal of this study – to establish an "empirical" assessment model.

Deletion is an alternative approach. Complete case (or listwise) deletion is the default setting of most statistical software packages (Everitt, 2005). It discards a case as soon as there is a missing value (Bethlehem, 2009). Conversely, pairwise deletion uses a case as soon as there is one value. Both methods assume that items are missing completely at random (Loehlin, 2004). The author (*op. cit.*) considers this assumption to be fairly strong, but also notes that both deletion methods "often work tolerably well" (p.76). When the sample size is large and only a few values are missed, it will not make much difference which deletion method is used (*ibid.*). When these conditions do not hold, pairwise deletion is usually preferred (*ibid.*). However, pairwise deletion is not perfect. Bethlehem (2009) and R-help documentation suggest that it can lead to inconsistent estimations. For example, it may produce a correlation whose value is not in the ±1 range. This fundamentally violates the definition of correlation (Bethlehem, 2009). Similarly, listwise deletion can also produce misleading analytical results (Everitt, 2005).

Table 16 shows that the missing value issue is severe. In an extreme case, an item was revealed to be missing as many as 32 (16%) values (the 53th variable). It was well beyond Everitt's (2005) recommended maximum missing values for applying listwise deletion − 5% or less. Also, if listwise deletion were applied, the sample size (*n*=150) would be merely large enough for performing SEM analysis (see Loehlin, 2004; also Subsection 4.2.3). Pairwise deletion became the reasonable choice.

Table 16: Descriptive Statistics of the 87 Likert Items

	var	n	mean	sd	median	min	max	skew	kurtosis
*itU*1	1	198	5.82	1.57	6.0	1	7	-1.46	1.58
*itU*2	2	197	5.64	1.92	7.0	1	7	-1.28	0.38
*itU*3	3	194	4.39	2.00	5.0	1	7	-0.24	-1.20
*itU*4	4	199	5.07	1.73	5.0	1	7	-0.78	-0.21
*itU*5	5	196	6.08	1.62	7.0	1	7	-2.09	3.49
*itU*6	6	200	6.57	0.94	7.0	1	7	-3.37	14.27
*itU*7	7	200	6.38	0.96	7.0	1	7	-2.16	6.52
*pa*1	8	196	5.98	1.30	6.0	1	7	-1.53	2.52
*pa*2	9	193	5.34	1.57	6.0	1	7	-0.97	0.31
*pa*3	10	197	5.19	1.69	6.0	1	7	-1.02	0.30
*pa*4	11	187	3.75	1.89	4.0	1	7	0.04	-1.11
*pa*5	12	190	2.76	2.01	2.0	1	7	0.70	-1.02
*pa*6	13	195	3.40	2.08	3.0	1	7	0.33	-1.23
*pa*7	14	188	5.09	1.80	6.0	1	7	-0.78	-0.39
*pa*8	15	191	3.29	2.07	3.0	1	7	0.37	-1.28
*pa*9	16	197	2.84	1.88	2.0	1	7	0.63	-0.96
*pa*10	17	197	3.33	1.95	3.0	1	7	0.34	-1.18
*pa*11	18	195	2.98	1.86	3.0	1	7	0.57	-0.89
*pa*12	19	195	4.71	1.97	5.0	1	7	-0.59	-0.87
*pa*13	20	200	5.18	1.73	6.0	1	7	-1.00	0.16
*pa*14	21	189	4.27	2.11	5.0	1	7	-0.24	-1.31
*pa*15	22	195	2.75	1.97	2.0	1	7	0.75	-0.93
*pa*16	23	188	6.27	1.57	7.0	1	7	-2.34	4.38
*pa*17	24	185	5.73	1.63	6.0	1	7	-1.63	2.04
*pa*18	25	192	6.18	1.17	7.0	1	7	-2.22	5.98
*pa*19	26	198	4.14	2.07	5.0	1	7	-0.22	-1.31
*ben*1	27	200	4.73	1.98	5.0	1	7	-0.54	-0.93
*ben*2	28	199	4.83	1.77	5.0	1	7	-0.56	-0.68
*ben*3	29	200	5.08	1.62	5.0	1	7	-0.82	0.02
*ben*4	30	199	4.31	1.85	5.0	1	7	-0.37	-0.93
*ben*5	31	187	3.41	1.77	3.0	1	7	0.25	-1.01
*ben*6	32	197	4.40	1.70	5.0	1	7	-0.47	-0.59
*ben*7	33	185	3.86	1.78	4.0	1	7	-0.14	-1.11
*ben*8	34	191	4.71	1.71	5.0	1	7	-0.65	-0.47
*ben*9	35	198	6.01	1.26	6.0	1	7	-1.60	2.34
*ben*10	36	199	5.07	1.65	5.0	1	7	-0.90	0.11
*ben*11	37	200	5.85	1.22	6.0	1	7	-1.37	2.09

$servQ1$	38	197	3.81	1.90	4.0	1	7	0.04	-1.20
$servQ2$	39	194	3.80	1.71	4.0	1	7	-0.08	-1.09
$servQ3$	40	192	3.90	1.77	4.0	1	7	-0.12	-1.05
$servQ4$	41	198	4.47	1.72	5.0	1	7	-0.45	-0.78
$servQ5$	42	196	4.78	1.68	5.0	1	7	-0.61	-0.43
$servQ6$	43	192	5.12	1.55	5.0	1	7	-0.94	0.36
$servQ7$	44	198	5.53	1.36	6.0	1	7	-1.05	0.97
$servQ8$	45	181	5.10	1.42	5.0	1	7	-0.90	0.55
$servQ9$	46	197	5.29	1.37	6.0	1	7	-1.00	0.80
$servQ10$	47	195	5.02	1.66	5.0	1	7	-0.73	-0.31
$servQ11$	48	188	4.71	1.64	5.0	1	7	-0.72	-0.27
$servQ12$	49	193	4.92	1.58	5.0	1	7	-0.65	-0.36
$servQ13$	50	193	4.85	1.57	5.0	1	7	-0.66	-0.16
$servQ14$	51	195	5.38	1.40	6.0	1	7	-1.03	0.94
$servQ15$	52	195	4.92	1.62	5.0	1	7	-0.63	-0.40
$servQ16$	53	168	4.96	1.41	5.0	1	7	-0.66	0.11
$iKQ1$	54	195	4.03	1.58	4.0	1	7	-0.17	-0.65
$iKQ2$	55	198	4.92	1.40	5.0	1	7	-0.69	0.16
$iKQ3$	56	199	5.07	1.29	5.0	1	7	-0.81	0.77
$iKQ4$	57	196	4.96	1.44	5.0	1	7	-0.90	0.60
$iKQ5$	58	194	5.52	1.61	6.0	1	7	-1.33	1.15
$iKQ6$	59	189	4.33	1.93	5.0	1	7	-0.39	-1.03
$iKQ7$	60	184	3.67	2.13	4.0	1	7	0.12	-1.41
$iKQ8$	61	188	4.11	1.83	4.0	1	7	-0.22	-0.99
$iKQ9$	62	181	4.32	1.87	5.0	1	7	-0.34	-1.02
$iKQ10$	63	179	3.08	1.94	3.0	1	7	0.35	-1.32
$iKQ11$	64	198	6.03	1.56	7.0	1	7	-1.92	2.95
$iKQ12$	65	187	4.32	1.77	5.0	1	7	-0.45	-0.69
$iKQ13$	66	190	3.61	2.07	4.0	1	7	0.05	-1.41
$syQ1$	67	200	4.96	1.45	5.0	1	7	-0.62	-0.18
$syQ2$	68	195	4.74	1.65	5.0	1	7	-0.75	-0.17
$syQ3$	69	198	4.84	1.51	5.0	1	7	-0.61	-0.25
$syQ4$	70	200	5.12	1.40	5.0	1	7	-0.71	0.23
$syQ5$	71	200	4.90	1.62	5.0	1	7	-0.76	-0.16
$syQ6$	72	195	4.52	1.55	5.0	1	7	-0.56	-0.42
$syQ7$	73	194	4.79	1.75	5.0	1	7	-0.84	-0.24
$syQ8$	74	190	5.26	1.36	5.5	1	7	-1.05	1.15
$syQ9$	75	190	4.78	1.69	5.0	1	7	-0.55	-0.56
$syQ10$	76	180	3.49	1.96	3.0	1	7	0.21	-1.28
$syQ11$	77	185	2.63	1.79	2.0	1	7	0.87	-0.43
$syQ12$	78	182	4.06	2.25	4.0	1	7	-0.10	-1.49
$syQ13$	79	175	2.88	2.00	2.0	1	7	0.71	-0.79
$syQ14$	80	191	4.78	2.12	6.0	1	7	-0.68	-1.02
$syQ15$	81	169	3.75	2.08	4.0	1	7	-0.04	-1.45
$syQ16$	82	170	3.52	2.02	3.5	1	7	0.11	-1.40
$syQ17$	83	182	3.79	2.29	4.0	1	7	-0.00	-1.59
$sat1$	84	193	4.26	1.67	5.0	1	7	-0.43	-0.71
$sat2$	85	196	4.63	1.53	5.0	1	7	-0.62	0.00
$sat3$	86	198	4.73	1.49	5.0	1	7	-0.65	0.04
$sat4$	87	197	4.64	1.61	5.0	1	7	-0.74	-0.25

4.4. EXPLORATORY FACTOR ANALYSIS (EFA)

The reasons for choosing EFA to determine factor (model) structure have been briefly discussed in Subsection 3.8.2. To be precise, there are various EFA methods. The two main EFA algorithms available in R are briefly discussed in Subsection 4.4.1. Analysis Strategies and the required facilities are outlined in Subsection 4.4.2. Readers may also turn to Subsection 4.4.3 for the statistical results.

4.4.1 Background of the Two EFA Algorithms

EFA was the chosen method for dimension reduction and determining factor structure. It is a regression model linking the manifest (observed/observable) variables to a set of unobservable (or known) latent variables (Everitt, 2005). As discussed in Subsection 3.8.2, a variety of EFA methods can be used (see Everitt 2005; Revelle, forthcoming). Hitherto, two main algorithms have been available within R − Principal Axes Factor Analysis (PA) and Maximum Likelihood Factor Analysis (ML) (Revelle, forthcoming).

PA is also referred to as Principal Factor Analysis (see Everitt, 2005 for example). It involves (i) successive eigenvalue decomposition of a reduced correlation matrix (*R*) and (ii) replacement of its diagonal with that of the common part matrix (FF') (the communalities) (Revelle, 2010). The procedure is repeated until the sum of communalities does not vary (i.e., convergence) (Revelle, forthcoming). What is the best initial communalities estimate is a debatable topic (*ibid.*). Everitt (2005) notes that an iterative approach can lead to Heywood (1931) cases of negative uniquenesses (by definition, uniquenesses are variances, so they cannot be negative).

Statisticians regard ML as the most respectable method of estimating the parameters in factor analysis modelling (Everitt, 2005). However, its applicability is conditional on normal distribution of residuals (*ibid.*; Revelle, forthcoming). Recent research shows that the ML method can also be employed when deviations from normality are minor (see Bollen, 1989; Jöreskog & Sörbom, 1993; for example), especially, if the primary interest is in parameter estimates (Raykov & Marcoulides, 2006). Loehlin (2004) notes that there seems to be a consensus that when the normality assumption is violated, the parameter estimates will still be consistent. However, there will be severe consequences on χ^2 statistics and standard errors (*ibid.*).

The essence of ML is about defining a type of distance measure between the observed covariance (or correlation) matrix and the predicted value of this matrix from the factor model (Everitt, 2005). Estimates of the loadings and the specific variances are found by minimising that distance measure (*ibid.*). Like PA, it is also an iterative procedure. In R, ML has been modified to avoid Heywood (1931) cases (Revelle, forthcoming). In theory, it was the preferred procedure if the normality assumption held.

To obtain interpretable results, rotations of factor solutions were performed to obtain simple structure. This approach was proposed by Thurstone (1947) (Revelle, forthcoming). An R package offers a wide range of rotation facilities for performing both orthogonal and oblique rotations (*ibid.*). An orthogonal rotation may be more appropriate for getting generalised results and an oblique rotation for results that "best fit" the data (Everitt, 2005, p.75). Kaiser's (1958) Varimax (orthogonal) rotation is the primary rotation method for this study. It is also a commonly used rotation method (*ibid.*).

Varimax iteratively maximises a quadratic function of the loadings until the factors are uncorrelated (Everitt, 2005). It produces loadings that represent correlations between factors and observed variable, but usually eliminates general factors (*ibid.*). An oblique rotation, e.g., Oblimin Rotation, might be performed if Varimax rotation cannot produce an interpretable solution. Some authors criticise rotation on the grounds that it "allows the investigator to impose on the data whatever type of solution they are looking for" (Everitt, 2005, pp.72−73; see also Subsection 3.8.2). However, such a criticism cannot be established since the distribution of the solutions will remain invariant after an application of rotation (Everitt, 2005).

4.4.2 EFA Strategies

There is no single prescription of techniques that will fit all latent modelling cases (Loehlin, 2004). However, there are strategies that may be helpful (*ibid.*). This shows the importance of outlining the modelling strategy before presenting the results.

The strategies mentioned in this subsection were generally applied to each hypothesised construct. Other strategies will be mentioned when applied.

A programme was written in R language, namely `fa.ml.pa`, to standardise the process and reduce the computing workload (see Appendix II). The EFA procedures are suggested by the features of the programme as follows:

1. Determining the optimal number of factors to extract by parallel

analysis;[25]

2. Applying pairwise deletion to the raw data and forming a correlation matrix;
3. Performing ML/PA EFA and Varimax rotation; and
4. Summarising the fit statistics and degree of freedom (*df*).

The facility for EFA is defaulted to extract one factor. The first feature is to determine the maximum number of EFA to be performed. For example, if the parallel analysis suggests the optimal number of factors to extract is five, then EFA will be performed five times. This approach is a more pragmatic approach than finding the optimal extraction by "trial and error."

The survey items were submitted to perform the above process in accordance with the posited constructs. Decisions about the number of subfactors to extract were made with reference to the summary of the fit statistics subject to the interpretability of each subfactor. Interpretability is important for determining factor structure (Loehlin, 2004).

The path diagram facility (`structure.diagram`) in `psych` was customised to identify the items that loaded significantly (at least ±0.40). Items loaded on the posited constructs less than 0.40 (in absolute value) would be dropped. It is consistent with Hair *et al.*'s (1998) recommendation for demonstrating convergent validity (the degree to which an item reflects the posited construct). In addition, if an item loaded on more than one construct, the largest loading would be chosen and the rest ignored. Revelle's (2010) `factor2cluster R` documentation suggests that this is actually what most people do. Any subfactor with three or more significant indicators would be submitted to Cronbach's (1951) alpha reliability analysis.

4.4.3 Results of Exploratory Factor Analysis

Theories and procedures were explained in the previous two subsections. This section only presents the loading statistics, path diagrams and summary of fit statistics in

[25] The parallel analysis in `psych` was used to determine the maximum number of factors to extract. It is based on the PA algorithm. Cattell's (1966) scree plot is part of the facility. Optimal extraction is suggested by the intersection point where one of the 20 simulated eigenvalues coincides with an actual eigenvalue. The existing research shows that parallel analysis is more reliable than the scree plot and Kaiser's (1970) eigenvalue (<1) rule (Loehlin, 2004). However, Revelle (forthcoming) suggests that it tends to over- (under-) extract factors if the sample size is large (small).

some cases. The results are presented in accordance with the order of the posited constructs in the survey instrument.

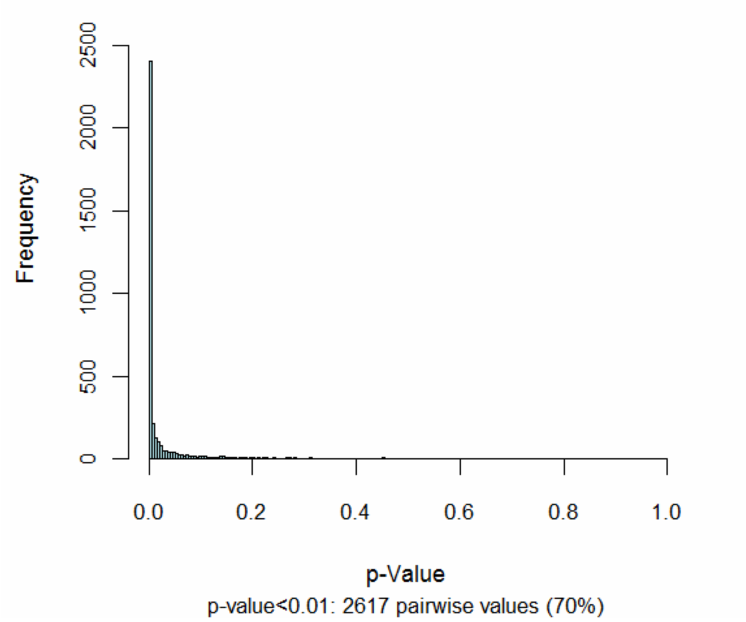
Conditions for Applying ML EFA

In theory, ML is the more respectable EFA method (Everitt, 2005, see also Subsection 4.4.1). However, it can only be applied if the normality assumption is not severely violated. It was necessary to assess the normality of the data to see if ML EFA was the appropriate choice.

Raykov and Marcoulides (2006) suggest that if the observations are from a multivariate normal distribution, the bivariate distribution of each pair of variables should also be normally distributed. However, pairwise bivariate normality does not imply multivariate normality (*ibid.*). Accordingly, a pairwise bivariate normality test was conducted by operating the `hetcor` function in `polycor` (see Fox, 2006). It produced pairwise ML estimations and returned a contingency table of *p*-values for each pair of variables. The *p*-values are depicted in Figure 28. The limits of the *x*-axis show the range of the actual *p*-values. Obviously, the normality assumption was severely violated.

Rai *et al.* (2002) suggest that deviations from normality are considered to be acceptable if the skewness ranges from 0.477 to 1.965 and Kurtosis ranges from 0.102 to 6.750 (presumably, the authors are referring to absolute values). Table 16 (p.145) shows that 34 items (39.1%) are not within the skewness limits and four (4.6%) not within the Kurtosis limits. Skewness appears to be the major cause for severe non-normality. In any case, this extent of non-normality could not be considered as minor. PA became the preferred EFA algorithm.

Figure 28: *p*-Values of the Pairwise Bivariate Normality Test on the 87 Likert Items



Intent to Use (Items itU1 to itU7)

This hypothesised construct measures willingness (or the likelihood) to use HIT for consultation. It was composed of seven items. The loading and fit statistics are shown in Table 17. The parallel analysis result suggests that three was the optimal number of subfactors to extract. However, two subfactors were extracted as several fit indices suggested that this was a better choice.[26]

Communality and uniqueness statistics are also presented to allow readers to judge the reliability of each item. Revelle (forthcoming) regards a 0.70 communality or above as high (see Subsection 3.8.2, for definitions of communality and uniqueness). The author (*op. cit.*) also notes that if factor analysis is performed to analyse the structure of items, communalities are often low (between 0.2 and 0.4).

The path diagram helps identify items that loaded significantly (see Figure 29). Items (observed variables) are depicted in rectangles or squares. Factors (latent variables) are depicted in ellipses or circles. The path of an item will only be shown if the magnitude of its loading is above 0.40. Hair *et al.* (1998) consider ±0.3 to be the minimal acceptable level of loading, ±0.4 more important and ±0.5 practically significant. In practice, authors choose customary levels ranging from ±0.4 to ±0.7 (see Everitt, 2005;

[26] RMR refers to root mean square residual. Kline (2005) notes that a RMR not greater than 0.05 is an indicator of good fit. Other fit indices are discussed in Subsection 4.6.2

Halawi *et al.*, 2007; Landrum *et al.*, 2008; Rai *et al.*, 2002; Revelle, forthcoming, for example) and ±0.3 is the default of the `fa.diagram` facility. Hair *et al.* (1998) recommend ±0.4 to be the minimum to demonstrate convergent validity. Stevens (2002) recommends ±0.384 to be the customary level for a sample of 200 cases. For a sample of larger size, a lower level may be required (see *ibid.*).

Table 17: Exploratory Factor Analysis Result − Intent to Use

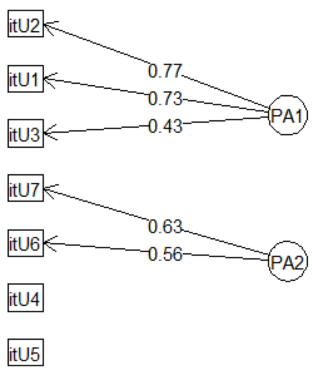
Loadings:

	PA1	PA2	Communality	Uniquenesse
itU1	0.73	0.21	0.57950	0.42050
itU2	0.77	0.06	0.59318	0.40682
itU3	0.43	0.32	0.29135	0.70865
itU4	0.29	0.39	0.23731	0.76269
itU5	0.06	0.21	0.04817	0.95183
itU6	0.02	0.56	0.31208	0.68792
itU7	0.21	0.63	0.43585	0.56415

Fit Statistics:

	χ^2	*df*	$\Pr(>\chi^2)$	NNFI/TLI	RMSEA	90% CI		RMR
Extracting 1 factor	51.001	14	0.000	0.720	0.117	0.116	0.121	0.060
Extracting 2 factors	8.011	8	0.432	1.000	0.011	0.011	0.031	0.022
Extracting 3 factors	3.374	3	0.338	0.987	0.028	0.028	0.053	0.012

Figure 29: Path Diagram − Intent to Use (EFA Result)



An Alternative Intent to Use Measure (Items itU1 to itU7 and Freq.U)

As shown in Subsection 4.2.4, *Freq.U* significantly correlates with *itU*1 and other aspects of HIT/CDSS use. Doll and Torkzadeh (1998) do not consider Frequency of IT Use is the best way to measure System Use. Indeed, this item was meant to be developed to check the consistency of the answers of the a.1 questions. However, the two-tailed correlation tests shown in Table 15 support introducing it into the Intent to Use measure.

The EFA results are shown in Table 18 and depicted in Figure 30. The optimal extraction was supposed to be three subfactors. However, extracting two subfactors allows a comparison with the preceding result shown in Table 17. The fit statistics preliminarily suggest that the original proposed Intent to Use might be a better choice. However, further tests are required to draw a prudent conclusion.

Table 18: Exploratory Factor Analysis Result − Introducing Frequency of HIT Use into the Intent to Use Measure

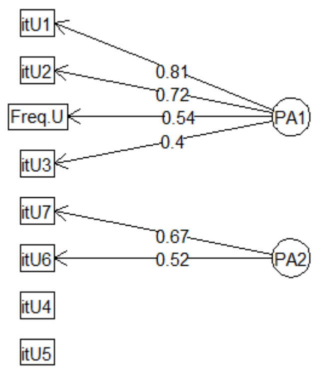
Loadings:

	PA1	PA2	Communality	Uniquenesse
itU1	0.81	0.18	0.68681	0.31319
itU2	0.72	0.07	0.52380	0.47620
itU3	0.40	0.29	0.24394	0.75606
itU4	0.28	0.39	0.22693	0.77307
itU5	0.09	0.23	0.06013	0.93987
itU6	0.03	0.52	0.27269	0.72731
itU7	0.22	0.67	0.49919	0.50081
Freq.U	0.54	0.34	0.41005	0.58995

Fit Statistics:

	χ^2	*df*	$\Pr(>\chi^2)$	NNFI/TLI	RMSEA	90% CI		RMR
Extracting 1 factor	63.993	20	0.000	0.782	0.107	0.106	0.110	0.057
Extracting 2 factors	18.947	13	0.125	0.955	0.050	0.050	0.056	0.029
Extracting 3 factors	5.646	7	0.582	1.019	0.000	0.000	0.030	0.014

Figure 30: Path Diagram − An Alternative Intent to Use Measure (EFA Result)



Physician Attributes (Items pa1 to pa19)

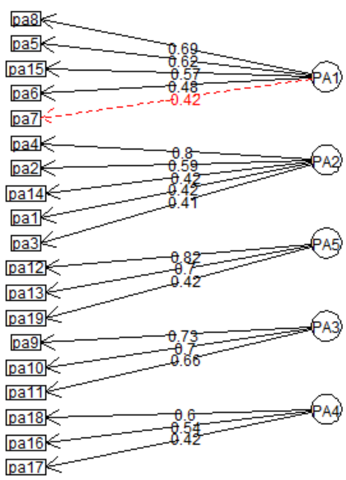
This construct was proposed to measure physicians' attitudes towards HIT and professional concern from the perspective of relationships with patients and colleagues. Nineteen items were proposed. The loading statistics are shown in Table 19 and illustrated in Figure 31.

The parallel analysis result and fit statistics consistently suggest extracting five subfactors. The dashed path of pa7 shows the one whose loading is negative. The interpretation of the item suggests that the score of this item may need to be reversed and dealt with in the next subsection.

Table 19: Exploratory Factor Analysis Result − Physician Attributes

	PA1	PA2	PA5	PA3	PA4	Communality	Uniquenesse
pa1	0.12	0.42	0.38	-0.05	0.21	0.37387	0.62613
pa2	0.04	0.59	0.33	-0.02	0.15	0.48198	0.51802
pa3	0.25	0.41	0.08	0.14	0.10	0.26673	0.73327
pa4	0.17	0.80	0.10	0.17	-0.08	0.72341	0.27659
pa5	0.62	0.05	0.06	0.12	0.02	0.40516	0.59484
pa6	0.48	0.18	0.17	0.18	0.07	0.32652	0.67348
pa7	-0.42	0.27	0.11	-0.08	0.06	0.27131	0.72869
pa8	0.69	0.03	0.12	0.19	0.10	0.53563	0.46437
pa9	0.22	0.12	0.11	0.73	0.02	0.60523	0.39477
pa10	0.13	0.03	0.08	0.70	0.06	0.52283	0.47717
pa11	0.29	0.09	0.14	0.66	-0.00	0.55060	0.44940
pa12	0.19	0.08	0.82	0.14	0.12	0.74918	0.25082
pa13	-0.12	0.28	0.70	0.19	-0.00	0.62509	0.37491
pa14	-0.19	0.42	0.11	0.05	-0.03	0.23241	0.76759
pa15	0.57	0.08	0.07	0.15	-0.09	0.36522	0.63478
pa16	-0.22	-0.06	0.01	0.05	0.54	0.34645	0.65355
pa17	0.09	0.21	0.02	0.01	0.42	0.23007	0.76993
pa18	0.09	-0.01	0.06	0.01	0.60	0.37072	0.62928
pa19	0.10	0.12	0.42	0.06	-0.03	0.20885	0.79115

Figure 31: Path Diagram − Physician Attributes (EFA Result)



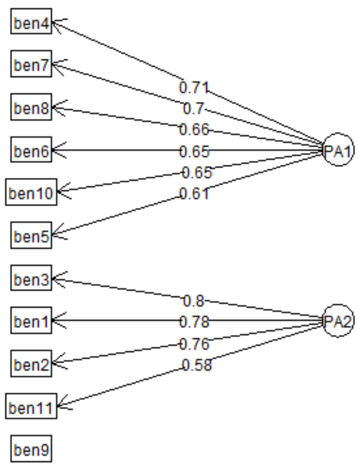
Perceived Net Benefits (Items ben1 to ben11)

This hypothesised construct measures the impacts of HIT use in the context of implementing more efficient and safer medical care. Eleven items were proposed. The loading statistics are available in Table 20 and illustrated in Figure 32.

Table 20: Exploratory Factor Analysis Result − Perceived Net Benefits

	PA1	PA2	Communality	Uniquenesse
ben1	0.21	0.78	0.64994	0.35006
ben2	0.46	0.76	0.78789	0.21211
ben3	0.36	0.80	0.77284	0.22716
ben4	0.71	0.34	0.62959	0.37041
ben5	0.61	0.35	0.49653	0.50347
ben6	0.65	0.32	0.52094	0.47906
ben7	0.70	0.22	0.53464	0.46536
ben8	0.66	0.30	0.52539	0.47461
ben9	0.24	0.39	0.21297	0.78703
ben10	0.65	0.56	0.72891	0.27109
ben11	0.53	0.58	0.61389	0.38611

Figure 32: Path Diagram − Perceived Net Benefits (EFA Result)



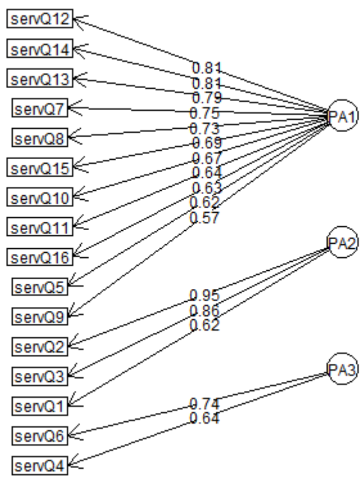
Service Quality (Items servQ1 to servQ16)

This construct is possibly a relatively new definition of Service Quality in the IS/KM Success literature. It operationalised the Management Support and IT Support subdimensions. Hitherto, the Management Support subdimension does not appear to have been empirically tested. Both the fit statistics and parallel analysis result suggest extracting three subfactors. Loading statistics are available in Table 21 and illustrated by Figure 33.

Table 21: Exploratory Factor Analysis Result − Service Quality

	PA1	PA2	PA3	Communality	Uniquenesse
servQ1	0.32	0.62	0.24	0.53632	0.46368
servQ2	0.25	0.95	0.18	0.98953	0.01047
servQ3	0.20	0.86	0.22	0.82095	0.17905
servQ4	0.45	0.40	0.64	0.77315	0.22685
servQ5	0.62	0.33	0.51	0.73981	0.26019
servQ6	0.32	0.26	0.74	0.72111	0.27889
servQ7	0.75	0.24	0.26	0.68587	0.31413
servQ8	0.73	0.20	0.13	0.59419	0.40581
servQ9	0.57	0.22	0.51	0.63675	0.36325
servQ10	0.67	0.23	0.44	0.70122	0.29878
servQ11	0.64	0.24	0.44	0.65649	0.34351
servQ12	0.81	0.25	0.36	0.84050	0.15950
servQ13	0.79	0.26	0.31	0.78934	0.21066
servQ14	0.81	0.25	0.23	0.76583	0.23417
servQ15	0.69	0.26	0.40	0.70900	0.29100
servQ16	0.63	0.22	0.43	0.62996	0.37004

Figure 33: Path Diagram − Service Quality (EFA Result)



Knowledge/Information Quality (Items iKQ1 to iKQ13)

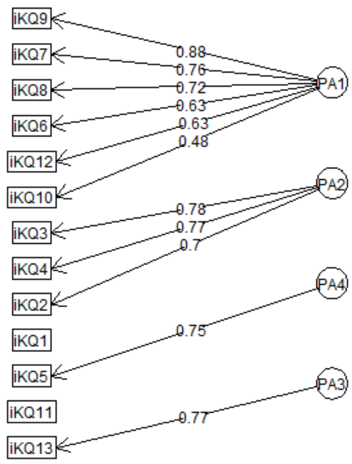
Petter *et al.* (2008) note that measures of Information Quality have been problematic in IS Success studies. Knowledge Quality has not been covered by Petter *et al.*'s (2008) extensive survey. This construct emphasises patient data (personalised information − a definition of Knowledge by KID/DIK School of Thought (see Subsection 2.3.1)). The result might be considered as a new measure in IS Success research.

Parallel analysis and the fit statistics suggest extracting four subfactors. The loading statistics are shown in Table 22 and illustrated by Figure 34. Johnson (1998) recommends not including a latent variable with only one significant loading. Loehlin (2004) notes that such a latent variable often causes measurement issues. PA3 and PA4 were, therefore, discarded and would not be submitted into reliability analysis.

Table 22: Exploratory Factor Analysis Result − Knowledge/Information Quality

	PA1	PA2	PA4	PA3	Communality	Uniquenesse
iKQ1	0.02	0.28	0.01	0.09	0.08748	0.91252
iKQ2	0.22	0.70	0.26	0.10	0.61371	0.38629
iKQ3	0.13	0.78	0.27	0.01	0.70100	0.29900
iKQ4	0.22	0.77	0.09	0.07	0.65378	0.34622
iKQ5	0.11	0.15	0.75	0.06	0.60435	0.39565
iKQ6	0.63	0.16	0.35	0.03	0.55232	0.44768
iKQ7	0.76	0.08	0.09	0.03	0.59953	0.40047
iKQ8	0.72	0.25	0.14	0.17	0.62555	0.37445
iKQ9	0.88	0.17	0.11	0.10	0.83070	0.16930
iKQ10	0.48	0.13	-0.03	0.37	0.38810	0.61190
iKQ11	0.19	0.21	0.38	0.06	0.22781	0.77219
iKQ12	0.63	0.12	0.24	0.36	0.59597	0.40403
iKQ13	0.20	0.19	0.11	0.77	0.67722	0.32278

Figure 34: Path Diagram − Knowledge/Information Quality (EFA Result)



System Quality (Items syQ1 to syQ17)

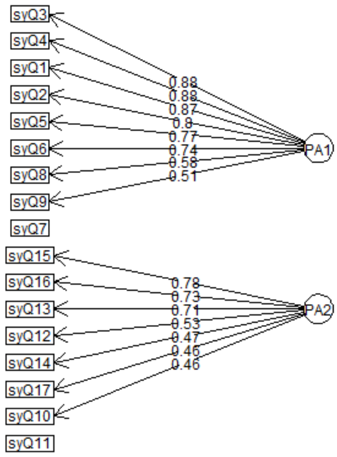
This hypothesised construct was adapted from Jennex and Olfman (2006). Items were chosen to fit the context of HIT/CDSS. Seventeen items were proposed.

Parallel analysis suggests extracting three subfactors, but the fit statistics indicate that two is a better choice. The loading statistics are shown in Table 23 and illustrated by Figure 35.

Table 23: Exploratory Factor Analysis Result − System Quality

	PA1	PA2	Communality	Uniquenesse
syQ1	0.87	0.10	0.75858	0.24142
syQ2	0.80	0.23	0.69562	0.30438
syQ3	0.88	0.11	0.78282	0.21718
syQ4	0.88	0.02	0.76904	0.23096
syQ5	0.77	0.11	0.60749	0.39251
syQ6	0.74	0.26	0.60791	0.39209
syQ7	0.34	0.28	0.19073	0.80927
syQ8	0.58	0.20	0.37695	0.62305
syQ9	0.51	0.19	0.29834	0.70166
syQ10	0.43	0.46	0.39535	0.60465
syQ11	0.30	0.34	0.20662	0.79338
syQ12	0.29	0.53	0.37045	0.62955
syQ13	0.01	0.71	0.50344	0.49656
syQ14	0.15	0.47	0.24267	0.75733
syQ15	0.11	0.78	0.61286	0.38714
syQ16	0.13	0.73	0.54463	0.45537
syQ17	0.06	0.46	0.21675	0.78325

Figure 35: Path Diagram − System Quality (EFA Result)



User Satisfaction (Items sat1 to sat4)

This hypothesised construct measures HIT user satisfaction. Four items were proposed. The loading statistics are shown in Table 24 and Figure 36 respectively. A 1.003 NNFI/TLI may appear to be peculiar to some. In fact, when the sample size is small, a NNFI/TLI greater than 1.0 suggests a good fit and a negative one a bad fit (Loehlin, 2004). RMSEA is in the 90% Confidence Interval (see Table 24). RMR is not far from 0. The fit of this measure appears to be excellent. In Seddon and Yip's (1992) study, these four items were phrased in short form. The fit was of an issue (R^2=0.33) (*ibid*.).

Table 24: Exploratory Factor Analysis Result − User Satisfaction

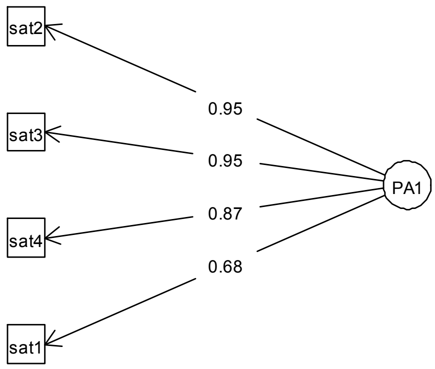
Loadings:

	PA1	Communality	Uniquenesse
sat1	0.68	0.45729	0.54271
sat2	0.95	0.90697	0.09303
sat3	0.95	0.89360	0.10640
sat4	0.87	0.75215	0.24785

Fit Statistics:

	χ^2	*df*	$Pr(>\chi^2)$	NNFI/TLI	RMSEA	90% CI		RMR
Extracting 1 factor	1.416	2	0.493	1.003	0.000	0.000	0.054	0.005

Figure 36: Path Diagram − User Satisfaction (EFA Result)



No item was found to load significantly on more than one subfactor during the analysis process. Hair *et al.* (1998) suggest that if no cross-loading of items on another construct is above 0.40, then discriminant validity is demonstrated (*ibid.*). Together with meeting the convergent validity criterion, construct validity is evident (*ibid.*). No oblique rotation was needed either in order to obtain a more interpretable solution.

Fifteen subfactors (with at least three significant loadings) were extracted. The EFA analysis shows that Frequency of Use might be introduced into the Intent to Use measure. This proposal will be further examined in Sections 4.5 and 4.6.

4.5. INTERNAL CONSISTENCY, RELIABILITY AND VALIDITY

There is no consensus about the definition of internal consistency (Revelle, forthcoming). Internal consistency is sometimes referred to as inter-relatedness of items (*ibid.*). The author (*op. cit.*) notes that internal consistency may better be referred to as the proportion of test variance due to all common factors such that a test's total score can correlate with some other measures. Various measures of reliability exist (*ibid.*). They all aim to suggest how observed scores are related to the true score (*ibid.*). Broadly speaking, reliability is the fraction of test variance that is the true score variance (Revelle & Zinbarg, 2009). This variance ratio can also be a measure of construct validity if it encompasses the internal structure of a scale (Zinbarg *et al.*, 2006). Revelle (forthcoming) recommends that reliability should be analysed by two or more measures. Cronbach's (1951) alpha (α) is the primary test for this study. This test was performed by the `alpha` function of `psych`. The reports included Guttman's (1945) sixth lower bound for reliability coefficients (λ_6). Readers who are familiar with the two tests may proceed to Subsection 4.5.2 to find out the results.

4.5.1 Reliability Test Choices

There exist various reliability measures (Revelle & Zinbarg, 2009). The focus of this subsection is to discuss Cronbach's (1951) alpha (α). A brief discussion of Guttman's (1945) sixth lower bound (λ_6) may be desirable for inquisitive readers.

Cronbach's (1951) α is the most common estimate of reliability (Revelle, forthcoming). It is easy to compute and to use Cronbach's (1951) α (Revelle & Zinbarg, 2009). It corresponds to Guttman's (1945) third lower bound (λ_3) (Revelle, forthcoming). It measures the average intercorrelation of the items (*ibid.*). That is, it is the mean of all possible split half reliabilities (*ibid.*). However, it is supposed to be a lower bound to the reliability (*ibid.*). Cronbach's (1951) α grossly underestimates the reliability of a test in many cases and grossly overestimates the reliability in some cases (Revelle & Zinbarg, 2009). Revelle (forthcoming) notes that it seems to be particularly inappropriate for measuring reliability in cluster analysis. It shows to be a poor estimate of internal consistency (Revelle & Zinbarg, 2009). Zinbarg *et al.* (2006) notice that it is also not a reliable measure of construct validity.

Guttman's (1945) λ_6 measures the amount of variance in each item that can be accounted for by the Squared Multiple Correlation (SMC) (or the error variance). SMC is a lower bound for the item communality. Guttman's (1945) λ_6 becomes a better estimate as the number of items increases. It is similar to another measure of reliability, Omega Total (ω_t), introduced by McDonald (1978). However, ω_t uses uniqueness estimates from factor analysis to find the error variances (Revelle, forthcoming). In other words, it is based on the sum of the squared loadings of all factors including general and specific factors (*ibid.*). The `omega` function in `psych` uses it as the basis for constructing higher factor models. McDonald's (1978, 1999) Omega Hierarchical (ω_h) and Omega Total (ω_t) coefficients consistently show to be the best estimate of reliability (Zinbarg *et al.*, 2006). Readers may also wish to explore Revelle's (1979) worst split half reliability coefficient, β, for a complete coverage of this topic.

The above discussion suggests that Cronbach's (1951) α may not be an ideal measure of reliability, internal consistency nor construct validity. However, it appears to be the primary reliability assessment in the IS/KM Success literature (see Chapter III). It allows comparing the results with other studies. Nunnally (1968) suggests that 0.7 is the minimum acceptable Cronbach's (1951) α score and 0.8 the recommended score. However, it is unclear what is considered to be the recommended Guttman's (1945) λ_6 reliability score. Cronbach's (1951) α becomes the ideal choice in this respect. Guttman's (1945) λ_6 results will not be presented, but briefly mentioned.

4.5.2 Results of Cronbach's (1951) Alpha Analysis

Theoretical background is outlined in the preceding subsection. This subsection only presents the results.

Alpha Reliability Analysis Strategies

In general, 0.7 is the minimum acceptable alpha level (see Nunnally, 1968). However, a lower limit of 0.6 would also be accepted given that the research was in an exploratory mode (*ibid.*). If a construct's alpha score was below 0.60, the item which had the lowest correlation with the total score (r) would be eliminated until the customary level of alpha was scored. A construct would be discarded if its alpha score was below 0.60 or had less than three indicators (see also Hatcher, 1994; Loehlin, 2004). Any item yielding an r smaller than 0.60 would also be removed iteratively. This approach was adapted from Torkzadeh and Doll (1999) where r=0.70 was the threshold level.

Alpha Reliability Analysis Results

The Intent to Use construct is a one-dimensional factor. The result of reliability analysis is given in Table 25. No item was required to be eliminated in order to obtain a 0.69 alpha score.

Table 25: Alpha Analysis Result − Intent to Use

	Corrected-item total correlation	Item overlap and scale reliability corrected correlation
Intent to Use (Standardised $\alpha = 0.69$)		
$itU1$	0.82	0.71
$itU2$	0.81	0.67
$itU3$	0.73	0.48

As discussed in Subsection 4.4.3, Frequency of HIT Use might be introduced into the Intent to Use measure. The alpha score of this revised definition and that of other constructs are listed in Table 26. This definition of Intent to Use appears to be preferred to the original proposed definition (*cf.* Table 25).

The EFA result suggests that the *pa*7 item in the Physician Attributes may have had the wrong sign (see Table 19 in p.154). The alpha score of the corresponding construct was below 0.60. *pa*7 obtained the lowest correlation with the total score (*r*). Its removal improved the reliability score substantially. This verified that it had a wrong sign (see Revelle, 2010). Reversing its score is the alternative approach (Loehlin, 2004; Revelle, 2010). This technique did help to obtain the same alpha score as if it were removed. However, *pa*7 was removed due to its low *r* level (0.55). Items *pa*14 and *syQ*17 were removed for the same reason.

One subfactor (with items *pa*16, *pa*17 and *pa*18) only scored 0.5 (standardised alpha). Eliminating an item did not improve the score or fulfil the three-indicator condition. In total, 14 out of 15 subfactors have been validated by the reliability analysis. Five subfactors surpass the 0.7 minimum acceptable level and nine the 0.8 recommended level (Nunnally, 1968). The analysis suggests that Frequency of HIT Use should be introduced into the Intent to Use measure.

Recall that Zinbarg *et al*. (2006) and Revelle (forthcoming) suggest that Cronbach's (1951) alpha is neither a robust measure of reliability, internal consistency nor construct validity. Let us suppose that Nunnally's (1968) recommendations on alpha score could be extended to the applications of Guttman's (1945) sixth lower bound reliability score (λ_6). If Guttman's (1945) λ_6 were used, only three subfactors would score below 0.70 marginally (one at 0.68 and two at 0.69).

Table 26: Summary of Cronbach's (1951) Alpha Reliability Tests

	Corrected-item total correlation	Item overlap and scale reliability corrected correlation
Intent to Use (Standardised $\alpha = 0.74$)		
$itU1$	0.83	0.78
$itU2$	0.78	0.67
$itU3$	0.65	0.44
$Freq.U$	0.73	0.59
Altruism (Standardised $\alpha = 0.72$)		
$pa1$	0.73	0.60
$pa2$	0.78	0.70
$pa3$	0.68	0.49
$pa4$	0.75	0.63
Autonomy (Standardised $\alpha = 0.71$)		
$pa12$	0.83	0.73
$pa13$	0.82	0.69
$pa19$	0.73	0.48
(Sub-conscious) Autonomy (Standardised $\alpha = 0.78$)		
$pa9$	0.85	0.73
$pa10$	0.83	0.69
$pa11$	0.83	0.68
Physician-Patient Relationship (Standardised $\alpha = 0.72$)		
$pa5$	0.75	0.63
$pa6$	0.68	0.49
$pa8$	0.80	0.72
$pa15$	0.72	0.59
Efficiency (Standardised $\alpha = 0.89$)		
$ben1$	0.84	0.77
$ben2$	0.91	0.89
$ben3$	0.90	0.87
$ben11$	0.82	0.73
Quality of Care (Standardised $\alpha = 0.88$)		
$ben4$	0.83	0.79
$ben5$	0.77	0.71
$ben6$	0.78	0.71
$ben7$	0.78	0.71
$ben8$	0.78	0.71
$ben10$	0.83	0.80
Management Support (Standardised $\alpha = 0.9$)		
$servQ1$	0.86	0.71
$servQ2$	0.95	0.95
$servQ3$	0.93	0.92
IT Support (Standardised $\alpha = 0.96$)		
$servQ5$	0.85	0.83
$servQ7$	0.83	0.82
$servQ8$	0.75	0.72
$servQ9$	0.80	0.77
$servQ10$	0.84	0.83
$servQ11$	0.83	0.80
$servQ12$	0.91	0.91
$servQ13$	0.89	0.88
$servQ14$	0.86	0.85
$servQ15$	0.85	0.84
$servQ16$	0.81	0.78

Contextual Information (Standardised $\alpha = 0.87$)		
$iKQ6$	0.76	0.68
$iKQ7$	0.80	0.75
$iKQ8$	0.82	0.80
$iKQ9$	0.88	0.89
$iKQ10$	0.66	0.54
$iKQ12$	0.79	0.73
Digestibility (Standardised $\alpha = 0.84$)		
$iKQ2$	0.86	0.76
$iKQ3$	0.89	0.82
$iKQ4$	0.85	0.73
Comprehensive Assistence (Standardised $\alpha = 0.8$)		
$syQ10$	0.63	0.50
$syQ12$	0.70	0.62
$syQ13$	0.75	0.69
$syQ14$	0.62	0.50
$syQ15$	0.81	0.79
$syQ16$	0.74	0.70
User Friendliness (Standardised $\alpha = 0.92$)		
$syQ1$	0.87	0.87
$syQ2$	0.84	0.82
$syQ3$	0.88	0.89
$syQ4$	0.87	0.86
$syQ5$	0.81	0.78
$syQ6$	0.80	0.76
$syQ8$	0.69	0.62
$syQ9$	0.62	0.53
User Satisfaction (Standardised $\alpha = 0.92$)		
$sat1$	0.80	0.67
$sat2$	0.94	0.94
$sat3$	0.94	0.94
$sat4$	0.90	0.87

4.6. Confirmatory Factor Analysis (CFA) – Correlational relationships

This section examines the relationships between the validated subfactors of each construct by the means of CFA. CFA is a special case of structural equation modelling. It does not include endogenous variables (Raykov & Marcoulides, 2006). CFA serves the purpose of confirming or disconfirming the details of an assumed factor structure (*ibid.*). It tests how well a model reproduces the data (Revelle, forthcoming). Subsections 4.6.1 and 4.6.2 outline the analysis process and strategies. The results of individual constructs are given in Subsection 4.6.3 and non-core constructs in Subsection 4.6.4.

4.6.1 CFA Procedures and Facilities

The analyses were conducted using a programme written in `R` language. Several auxiliary programmes were written to assist assessing and reporting the results. The process is suggested by the features of the analysis programme. It assembles the functions of four `R` packages as follows:

1. `cor` in `stats`;
2. `hetcor` in `polychor`; and

3. `structure.sem` in `psych`;
4. `sem` in `sem`;
5. `boot.sem` in `sem`; and
6. `structure.diagram` in `pysch`;

The `cor` function converts the raw data into a correlation matrix. It only deals with continuous data. The `hetcor` function allows forming a correlation matrix even if the data types are heterogeneous (e.g., ordinal, nominal, etc.). In any case, pairwise deletion is the default (see Section 4.4). Correlation is the computation basis for this study. It is commonly used for structural modelling research (Loehlin, 2004). It is more familiar to many in comparison with using covariance (*ibid.*). The programme also allows for using covariance. Covariance might be a better basis if a cross-sectional analysis were to be conducted (*ibid.*).

The `structure.sem` function helps create model specifications required for performing the `sem` function (CFA or SEM). By default, this function fixes the error variance of each latent variable to be equal to 1. It is a technique to establish a scale for a latent variable (Loehlin, 2004; Raykov & Marcoulides, 2006). This approach is considered to be simpler than the alternative approach (Raykov & Marcoulides, 2006). An alternative approach is to fix the loading of one indicator on each latent variable to 1 in order to form a normalised restriction (see Fox, 2006; Rai *et al.*, 2002; Raykov & Marcoulides, 2006).

The `sem` function fits (general) structural equation models (often called LISREL) in `R` (Fox, 2006).[27] It is based on the ML algorithm (*ibid.*). As discussed in Subsection 4.4.3, the data demonstrate severe non-normality. An application of the ML method to non-normally distributed data will still generate robust parameter estimations, but the χ^2 statistics and standard errors become unreliable (Bollen, 1989; Fox, 2006; Loehlin, 2004).

Various options could be considered to rectify the non-normality issue (Loehlin, 2004). Table 16 (p.145) shows that the data have been in the right domains. Non-normality does not appear to be contributed by input errors. Also input errors could not contribute to that substantial degree of non-normality. Editing the data does not seem to

[27] LISREL is a SEM application. It is also an acronym of *Li*near *S*tructural *Rel*ations (Loehlin, 2004).

be the remedy. Transforming the data is one of the proposals for addressing this issue (Härdle & Léopold, 2007; Loehlin, 2004). However, there is no guarantee that the transformation function is rightly chosen nor that multivariate normality will be produced (Loehlin, 2004). Bootstrap appeared to be a simpler and safer option. The `boot.sem` function is included to perform the bootstrap procedure. Basically, bootstrap is "sampling within a sample" (Gujarati, 1999). It is frequently applied to data that may not be derived from a normally distributed population (Sheskin, 2006). It only produces approximations, but they are usually more accurate than the measure of the population parameters (*ibid.*). Also, the technique has been clearly outlined by the contributor (John Fox) of the `sem` package in an academic paper. The bootstrap procedure could certainly be properly carried out if Fox's (2006) advice was followed closely.

The `boot.sem` function implements the nonparametric bootstrap for an independent random sample (Fox, 2006). The output can be seen as an add-on to the report of `sem`. The author (*op. cit.*) suggests that 100 replications should be sufficient for computing standard errors and normal theory confidence intervals. These specifications were adapted into the analysis programme. The function `structure.diagram` produces path diagrams.

4.6.2 CFA Strategies and Criteria

The 14 subfactors were submitted into the programmes mentioned in Subsection 4.6.1 in accordance with the respective posited constructs.

A two-stage process was employed. Each construct was submitted to perform a CFA based on the maximum likelihood algorithm. A construct was preliminarily confirmed if (i) it passed the fit criteria and (ii) the loadings of all observed variables were equal to or greater than 0.40. Any item loaded less than 0.40 might be eliminated iteratively. That is, the item with the smallest loading would be the first to be removed.

At the second stage, the bootstrap procedure would be applied. A factor would be confirmed if the bootstrap result showed that the z values (the ratio of loading to standard errors) of all the items were significant at $p<0.05$. A specification search would be conducted if a factor failed to reach this significance criterion. Convergent validity is demonstrated when this criterion is fulfilled (Segars, 1997).

Various authors suggest that a specification search may be conducted to improve the fit (see Loehlin, 2004; Raykov & Marcoulides, 2006, for example). One possible option is to fix all the paths between the observable and the latent variables to zero (*ibid.*). The paths are then freed iteratively in the order of values of the modification indices (*ibid.*). This facility in `sem` is based on the likelihood ratio χ^2 statistics. The severe non-normality issue implies that the χ^2 statistics and standard errors become unreliable (Bollen, 1989; Fox, 2006; Loehlin, 2004). The robustness of this search strategy appeared to be doubtful. Instead, a backward selection strategy was applied. That is, the z value of an item proven to be insignificant would not be loaded (fixing its path to zero) (see Raykov & Marcoulides, 2006). To justify the potentially incorrect estimations, the bootstrap results were used as the assessment basis. The least significant observable variable was the first to be dropped. This process continued until significance criterion was fulfilled.

The application of the 0.40 loading rule is fairly straightforward. The fit criteria are somewhat ambiguous. Rai *et al.* (2002) employed five fit indices (χ^2, RMSEA, GFI, AGFI and RNI) to assess two popular IS Success models. An insignificant χ^2 indicates a good fit if the normality assumption holds (see Loehlin, 2004). Due to the severe non-normality issue, it was not used as an assessment basis. It is only reported to follow the convention. The names of GFI and AGFI are self-explanatory – Goodness-of-Fit Index and (Parsimony-) Adjusted-Goodness-of-Fit respectively. Rai *et al.* (2002) recommend that, in IS research, the recommended threshold levels for GFI, and AGFI are 0.90s, but also note that 0.80s are the less restrictive threshold levels in IS research. RNI is not available from the `sem` output. Instead, Tucker Lewis Index Non-Normed Fit Index (NNFI or TLI) is available. It is a parsimony-adjusted version of the Relative Non-Centrality Index (RNI) (Loehlin, 2004). Bentler-Bonnett Normed Fit Index (NFI) is corresponding to GFI, but uses a different baseline as a fit comparison (*ibid.*). Benlter CFI (Comparative Fit Index) is also available from the `sem` output. It indicates the noncentrality of a model (Raykov & Marcoulides, 2006). The authors (*op. cit.*) suggest that there is no norm to judge how high these indices should be. However, the authors (*op. cit.*) recommend 0.95 or above for AGFI, CFI, GFI, NFI and NNFI/TLI to be the indicators of reasonable approximations. There is also an arbitrary rule of thumb that 0.90s represent a good fit (Loehlin, 2004). It appears to be reasonable to accept 0.80s to be the less restrictive threshold levels for AGFI and GFI and 0.90s for CFI, NFI and NNFI/TLI.

RMSEA (Root Mean Square Error of Approximation) is a popular index of model fit (Raykov & Marcoulides, 2006). It is the fit index that is least affected by sample size (*ibid.*). It provides information about noncentrality of a model (*ibid.*). Steiger (1989) suggests that a 0.10 RMSEA is "good" and below 0.05 "very good" (p.81) (Loehlin, 2004). This rule was applied when "NA" was shown in the 90% confidence interval of RMSEA. SRMR (Standardised Root Mean Residual) is also available from the `sem` output (Loehlin, 2004). It is the overall average of the size of residuals (*ibid.*). A smaller SRMR is preferred to a larger one (*ibid.*). However, it was unclear about the condition for setting 0.08 as a cut-off. It was, therefore, not included as a fit criterion.

4.6.3 CFA Results

This subsection presents the final definitions of the seven posited constructs. The results are the basis for the subsequent analyses.

Intent to Use

The CFA result of the original definition is presented in Table 27. The statistics appeared to be ineligible. In fact, a model with degree of freedom is called a "saturated model" (Raykov and Marcoulides, 2006). It fits the data perfectly, but is an untestable model (*ibid.*). The authors (*op. cit.*) consider models of this sort as of little research interest. Various options could be considered to address the issue. An immediately available one was to consider employing the alternative proposal. That is, to introduce the *Freq.U* item into the original definition. The CFA results are summarised in Table 28 and depicted in Figure 37.[28]

The SEM result based on the ML algorithm is presented under the Maximum Likelihood heading (the `sem` output). The bias-adjusted result is presented under the Nonparametric Bootstrap heading (the `boot.sem` output). Table 28 shows that the significance criterion is fulfilled. Table 29 shows that all the fit indices well surpass the recommended levels. In Figure 37, the directed arrows designate regression coefficients. Apparently, this is a viable option to measure Intent to Use. It would be the basis for the subsequent analyses.

[28] *Freq.U* is on a four-point scale. It fulfils the more than three-point criterion. So, it can be treated as a continuous variable for LISREL analysis (see Rai *et al.*, 2002). There was no need to compute a polyserial correlation.

Table 27: Original Proposal − Intent to Use (CFA Result)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Intent to Use (Original)	0	0	NA	1	NA	NA	NA	NA

* RMSEA Index 90% CI: (NA, NA)

Table 28: Path Statistics − Finalised Intent to Use Measure (CFA Result)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.87416	0.07111	12.29232	0.00000***	0.06935	12.60498	0.00000***
itU2 <— HIT.Use	0.66835	0.07246	9.22305	0.00000***	0.06829	9.78738	0.00000***
itU3 <— HIT.Use	0.45164	0.07449	6.06296	0.00000***	0.05880	7.68066	0.00000***
Freq.U <— HIT.Use	0.60657	0.07139	8.49607	0.00000***	0.08733	6.94541	0.00000***

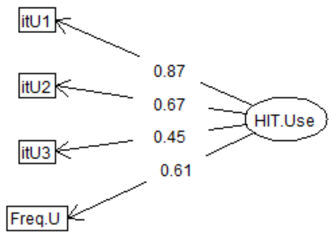
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 29: Fit Statistics − Finalised Intent to Use Measure (CFA Result)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Intent to Use	1.529	2	0	0.996	0.981	0.992	1.008	1

* RMSEA Index 90% CI: (NA, 0.1298)

Figure 37: Path Diagram − Finalised Intent to Use Measure (CFA Result)



The Other Six Constructs

The same analysis process was applied to the other six constructs. The SEM Analysis and Bootstrap results, and fit statistics are presented by Table 30 to Table 41. The path diagrams are shown by Figure 38 to Figure 43.

Physician Attributes, Knowledge/Information, Service Quality and System Quality were not supposed to be single-dimensional factors. CFA results suggested that they could all meet the significance criterion, but not the fit criteria. The CFA's only validated one non-saturated subfactor for each of the former three constructs. For the System Quality, none of the subfactors could meet the fit criteria even though the backward selection technique was repeatedly applied (see Subsection 4.6.2). An obvious solution was to completely discard the construct. Alternatively, a derivation of backward selection technique was applied as the last resort approach. That is, any observable variable with an insignificant *z* value at $p<0.05$ would be eliminated iteratively (this approach is applied for specification search in conventional multiple regression analysis (see Faraway, 2002)). Both subfactors could meet the significance criterion. However, only U.Friendly could also meet the fit criteria. The other subfactor required eliminating items until all the z values became significant at $p<0.001$. To ensure results were all generated by the same procedures, only the U.Friendly subfactor was kept.

No iterative process was needed for analysing the Perceived Net Benefits and User Satisfaction constructs. Table 33 and Table 41 show that the fits were excellent. The correlation between the two subfactors of Perceived Net Benefits is denoted by a bi-directional arrow (Figure 39). Table 32 shows that it is significantly at $p<0.001$.

Table 30: Path Statistics − Physician Attributes (CFA Result)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
pa5 <— Pat.Rel	0.61885	0.07673	8.06517	0.00000***	0.07898	7.83561	0.00000***
pa6 <— Pat.Rel	0.48469	0.07821	6.19736	0.00000***	0.07286	6.65219	0.00000***
pa8 <— Pat.Rel	0.79734	0.07558	10.54958	0.00000***	0.05841	13.65082	0.00000***
pa15 <— Pat.Rel	0.62181	0.07379	8.42689	0.00000***	0.06395	9.72379	0.00000***

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 31: Fit Statistics − Physician Attributes (CFA Result)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Physician Attributes	5.571	2	0.095	0.986	0.928	0.966	0.932	0.977

* RMSEA Index 90% CI: (NA, 0.1923)

Figure 38: Path Diagram − Physician Attributes (CFA Result)

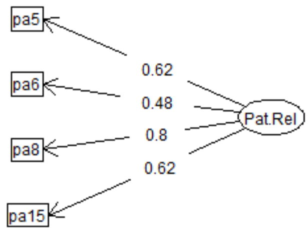


Table 32: Path Statistics − Perceived Net Benefits – (CFA Result)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
ben1 <— Efficiency	0.76304	0.06145	12.41643	0.00000***	0.05084	15.00883	0.00000***
ben2 <— Efficiency	0.91584	0.05561	16.46807	0.00000***	0.04367	20.97383	0.00000***
ben3 <— Efficiency	0.86050	0.05784	14.87792	0.00000***	0.04830	17.81501	0.00000***
ben11 <— Efficiency	0.76084	0.06185	12.30092	0.00000***	0.04274	17.80219	0.00000***
ben4 <— Qual.Care	0.78875	0.06108	12.91304	0.00000***	0.05174	15.24594	0.00000***
ben5 <— Qual.Care	0.71135	0.06384	11.14301	0.00000***	0.04771	14.90978	0.00000***
ben6 <— Qual.Care	0.71779	0.06346	11.31040	0.00000***	0.05564	12.90119	0.00000***
ben7 <— Qual.Care	0.69061	0.06442	10.72119	0.00000***	0.05578	12.38164	0.00000***
ben8 <— Qual.Care	0.69912	0.06415	10.89758	0.00000***	0.06691	10.44892	0.00000***
ben10 <— Qual.Care	0.85048	0.05877	14.47252	0.00000***	0.03381	25.15812	0.00000***
Qual.Care <-> Efficiency	0.84794	0.02922	29.02405	0.00000***	0.12462	6.80404	0.00000***

* indicates significance at p<0.05, ** at p<0.01 and *** at p<0.001

Table 33: Fit Statistics − Perceived Net Benefits (CFA Result)

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Perceived Net Benefits	80.353	34	0.083	0.926	0.881	0.938	0.951	0.963

* RMSEA Index 90% CI: (0.0595, 0.1063)

Figure 39: Path Diagram − Perceived Net Benefits (CFA Result)

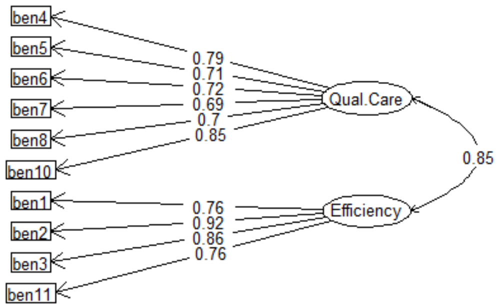


Table 34: Path Statistics − Service Quality (CFA Result)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
servQ5 <— IT.Support	0.82580	0.05820	14.18845	0.00000***	0.18324	4.50666	0.00001***
servQ15 <— IT.Support	0.83829	0.05773	14.52187	0.00000***	0.13636	6.14749	0.00000***
servQ16 <— IT.Support	0.78190	0.05985	13.06412	0.00000***	0.22608	3.45857	0.00054***
servQ7 <— IT.Support	0.81052	0.05880	13.78434	0.00000***	0.17655	4.59093	0.00000***
servQ8 <— IT.Support	0.73234	0.06146	11.91493	0.00000***	0.09199	7.96110	0.00000***
servQ9 <— IT.Support	0.76304	0.06046	12.62106	0.00000***	0.09645	7.91109	0.00000***
servQ10 <— IT.Support	0.83814	0.05771	14.52432	0.00000***	0.17992	4.65829	0.00000***
servQ11 <— IT.Support	0.81455	0.05861	13.89854	0.00000***	0.27196	2.99515	0.00274**
servQ12 <— IT.Support	0.92187	0.05421	17.00616	0.00000***	0.21251	4.33806	0.00001***
servQ13 <— IT.Support	0.89096	0.05556	16.03573	0.00000***	0.18520	4.81083	0.00000***
servQ14 <— IT.Support	0.85981	0.05686	15.12166	0.00000***	0.16125	5.33199	0.00000***

* indicates significance at p<0.05, ** at p<0.01 and *** at p<0.001

Table 35: Fit Statistic − Service Quality (CFA Result)

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Service Quality	181.796	44	0.125	0.87	0.805	0.915	0.917	0.934

* RMSEA Index 90% CI: (0.1068, 0.1447)

Figure 40: Path Diagram − Service Quality (CFA Result)

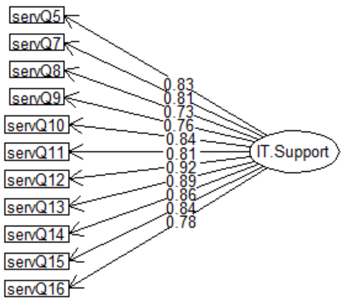


Table 36: Path Statistics − Knowledge/Information Quality (CFA Result)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
iKQ6 <— Context	0.67056	0.06521	10.28254	0.00000***	0.06933	9.67164	0.00000***
iKQ7 <— Context	0.73988	0.06284	11.77414	0.00000***	0.06684	11.07017	0.00000***
iKQ8 <— Context	0.82151	0.05967	13.76676	0.00000***	0.06935	11.84634	0.00000***
iKQ9 <— Context	0.91447	0.05641	16.21133	0.00000***	0.04282	21.35379	0.00000***
iKQ10 <— Context	0.53430	0.06844	7.80627	0.00000***	0.06948	7.68983	0.00000***
iKQ12 <— Context	0.69888	0.06460	10.81777	0.00000***	0.06142	11.37937	0.00000***

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 37: Fit Statistics − Knowledge/Information Quality (CFA Result)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Knowledge/Information Quality	33.293	9	0.116	0.95	0.883	0.945	0.932	0.959

* RMSEA Index 90% CI: (0.0758, 0.16)

Figure 41: Path Diagram − Knowledge/Information Quality (CFA Result)

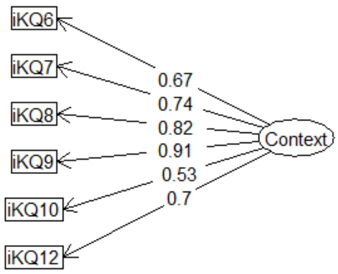


Table 38: Path Statistics − System Quality (CFA Result)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
syQ1 <— U.Friendly	0.89633	0.05606	15.98940	0.00000***	0.06346	14.12400	0.00000***
syQ2 <— U.Friendly	0.82513	0.05898	13.98949	0.00000***	0.06344	13.00660	0.00000***
syQ3 <— U.Friendly	0.93870	0.05442	17.24763	0.00000***	0.03227	29.08830	0.00000***
syQ6 <— U.Friendly	0.71841	0.06288	11.42582	0.00000***	0.07041	10.20262	0.00000***

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 39: Fit Statistics − System Quality (CFA Result)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
System Quality	8.942	2	0.132	0.978	0.891	0.985	0.964	0.988

* RMSEA Index 90% CI: (0.0532, 0.2255)

Figure 42: Path Diagram − System Quality (CFA Result)

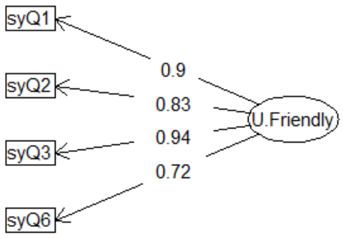


Table 40: Path Statistics − User Satisfaction (CFA Result)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
sat1 <— User.Sat	0.67612	0.06339	10.66671	0.00000***	0.07883	8.57717	0.00000***
sat2 <— User.Sat	0.95502	0.05308	17.99357	0.00000***	0.03455	27.63800	0.00000***
sat3 <— User.Sat	0.94075	0.05371	17.51533	0.00000***	0.05667	16.60015	0.00000***
sat4 <— User.Sat	0.86972	0.05659	15.36827	0.00000***	0.05320	16.34918	0.00000***

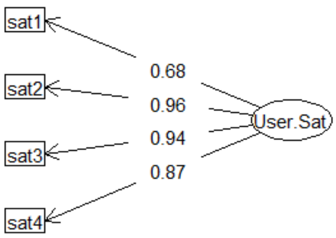
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 41: Fit Statistics − User Satisfaction (CFA Result)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
User Satisfaction	1.229	2	0	0.997	0.984	0.998	1.003	1

* RMSEA Index 90% CI: (NA, 0.1218)

Figure 43: Path Diagram − User Satisfaction (CFA Result)



Fourteen subfactors were submitted to perform CFA's. Eight subfactors were validated. This subsection confirms that the *Freq.U* item should be included in the Intent to Use measure.

4.6.4 The Dimension of the Non-Core Part

This subsection reports the possible combinations of non-core constructs that could be formed.

Halawi *et al*. (2007) note that, over the last two decades, several organisations and categorisations of system success have been proposed. Zmud (1978) categorises MIS Success into usage, user performance and user satisfaction. Judging from the extensive review of Petter *et al*. (2008), IS researchers appear to test the D&M model based on this categorisation. Accordingly, Intent to Use, Perceived Net Benefits and User Satisfaction are treated as the "core constructs", say. The rest of the model is, therefore, treated as non-core constructs.

The minimum set of required constructs to form a D&M class of System Success model comprises the three core constructs, Information Quality and System Quality. The CFA result of Knowledge/Information Quality and System Quality is presented in Table 42 and Table 43 and Figure 44. The two constructs are significantly correlated at $p<0.001$ ($p=0.00022$). Knowledge/Information Quality and Service Quality do not appear to be correlated (see Table 44, Table 45 and Figure 45). Service Quality and System Quality are significantly correlated at $p<0.01$ and merely fulfil the fit criteria (AGFI is round up to 0.8 and NFI is 0.899) (see Table 46, Table 47 and Figure 46). It would not surprise readers that Knowledge/Information Quality, Service Quality and System Quality cannot form a non-core part that fulfils the fit criteria (AFGI was in 0.70s and several fit indices were in 0.80s).

Knowledge/Information Quality is correlated with Physician Attributes significantly at $p<0.05$ (see Table 48, Table 49 and Figure 47), but not with System Quality. These three constructs form a non-core part that fulfils the fit, loading and significance criteria (see Table 50, Table 51 and Figure 48). Table 51 shows that the NFI (0.897) is barely below the threshold level. However, as Raykov and Marcoulides (2006) emphasised, the fit of a model should not be evaluated based on one single index. This result is, therefore, taken as the definition of the non-core part for testing the proposed CDSS Use model.

Table 42: Path Statistics − Knowledge/Information and System Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
iKQ6 <— Context	0.67355	0.06507	10.35076	0.00000***	0.08947	7.52832	0.00000***
iKQ7 <— Context	0.73272	0.06296	11.63831	0.00000***	0.08032	9.12253	0.00000***
iKQ8 <— Context	0.82141	0.05963	13.77525	0.00000***	0.14504	5.66353	0.00000***
iKQ9 <— Context	0.91342	0.05635	16.20900	0.00000***	0.06471	14.11655	0.00000***
iKQ10 <— Context	0.53805	0.06833	7.87372	0.00000***	0.12633	4.25918	0.00002***
iKQ12 <— Context	0.70452	0.06442	10.93602	0.00000***	0.06835	10.30760	0.00000***
syQ1 <— U.Friendly	0.89275	0.05615	15.89825	0.00000***	0.10501	8.50189	0.00000***
syQ2 <— U.Friendly	0.83466	0.05876	14.20418	0.00000***	0.10780	7.74303	0.00000***
syQ3 <— U.Friendly	0.93307	0.05462	17.08358	0.00000***	0.13301	7.01503	0.00000***
syQ6 <— U.Friendly	0.72598	0.06270	11.57934	0.00000***	0.11734	6.18712	0.00000***
Context <-> U.Friendly	0.43067	0.06443	6.68410	0.00000***	0.11673	3.68957	0.00022***

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 43: Fit Statistics − Knowledge/Information and System Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Knowledge and System Quality	106.189	34	0.103	0.906	0.848	0.917	0.923	0.942

* RMSEA Index 90% CI: (0.0814, 0.1258)

Figure 44: Path Diagram − Knowledge/Information and System Quality

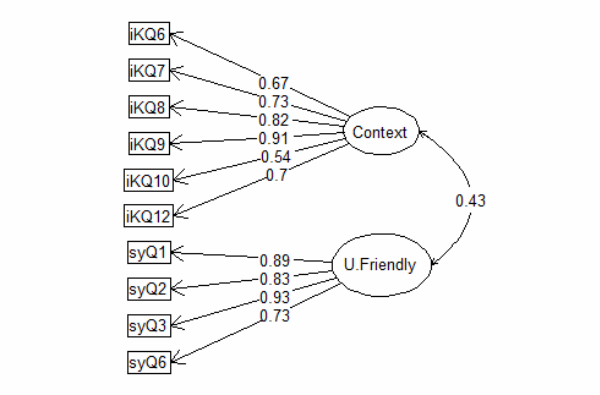


Table 44: Path Statistics − Knowledge/Information and Service Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
servQ5 <— IT.Support	0.82647	0.05818	14.20640	0.00000***	0.11457	7.21385	0.00000***
servQ15 <— IT.Support	0.83847	0.05772	14.52698	0.00000***	0.30060	2.78932	0.00528**
servQ16 <— IT.Support	0.78265	0.05982	13.08287	0.00000***	0.39676	1.97262	0.04854*
servQ7 <— IT.Support	0.81082	0.05879	13.79195	0.00000***	0.33613	2.41221	0.01586*
servQ8 <— IT.Support	0.73214	0.06147	11.91075	0.00000***	0.29325	2.49666	0.01254*
servQ9 <— IT.Support	0.76321	0.06045	12.62553	0.00000***	0.12462	6.12421	0.00000***
servQ10 <— IT.Support	0.83844	0.05769	14.53252	0.00000***	0.35977	2.33050	0.01978*
servQ11 <— IT.Support	0.81521	0.05858	13.91568	0.00000***	0.29077	2.80362	0.00505**
servQ12 <— IT.Support	0.92121	0.05424	16.98512	0.00000***	0.13405	6.87241	0.00000***
servQ13 <— IT.Support	0.89085	0.05557	16.03239	0.00000***	0.14084	6.32531	0.00000***
servQ14 <— IT.Support	0.85883	0.05690	15.09429	0.00000***	0.26083	3.29274	0.00099***
iKQ6 <— Context	0.66924	0.06520	10.26453	0.00000***	0.19004	3.52155	0.00043***
iKQ7 <— Context	0.74111	0.06279	11.80318	0.00000***	0.20024	3.70102	0.00021***
iKQ8 <— Context	0.82062	0.05970	13.74577	0.00000***	0.14286	5.74408	0.00000***
iKQ9 <— Context	0.91377	0.05639	16.20461	0.00000***	0.25164	3.63122	0.00028***
iKQ10 <— Context	0.53827	0.06837	7.87345	0.00000***	0.17068	3.15366	0.00161**
iKQ12 <— Context	0.69937	0.06454	10.83608	0.00000***	0.17631	3.96668	0.00007***
Context <-> IT.Support	0.27912	0.07011	3.98129	0.00007***	0.28712	0.97214	0.33098

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 45: Fit Statistics − Knowledge/Information and Service Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
K-Info and Service Quality	306.635	118	0.09	0.86	0.818	0.892	0.92	0.93

* RMSEA Index 90% CI: (NA, NA)

Figure 45: Path Diagram − Knowledge/Information and Service Quality

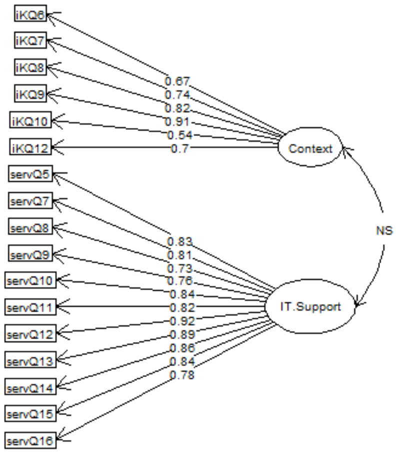


Table 46: Path Statistics − Service and System Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
servQ5 <— IT.Support	0.82705	0.05815	14.22266	0.00000***	0.29340	2.81886	0.00482**
servQ15 <— IT.Support	0.83945	0.05768	14.55463	0.00000***	0.20500	4.09484	0.00004***
servQ16 <— IT.Support	0.78509	0.05973	13.14332	0.00000***	0.26006	3.01884	0.00254**
servQ7 <— IT.Support	0.80966	0.05883	13.76333	0.00000***	0.20114	4.02535	0.00006***
servQ8 <— IT.Support	0.73260	0.06145	11.92203	0.00000***	0.29214	2.50765	0.01215*
servQ9 <— IT.Support	0.76437	0.06041	12.65342	0.00000***	0.08272	9.24078	0.00000***
servQ10 <— IT.Support	0.83691	0.05775	14.49198	0.00000***	0.29599	2.82753	0.00469**
servQ11 <— IT.Support	0.81534	0.05857	13.91976	0.00000***	0.22773	3.58030	0.00034***
servQ12 <— IT.Support	0.91986	0.05430	16.94168	0.00000***	0.16703	5.50710	0.00000***
servQ13 <— IT.Support	0.89176	0.05552	16.06084	0.00000***	0.20888	4.26921	0.00002***
servQ14 <— IT.Support	0.85807	0.05693	15.07332	0.00000***	0.11501	7.46054	0.00000***
syQ1 <— U.Friendly	0.89940	0.05592	16.08440	0.00000***	0.15986	5.62619	0.00000***
syQ2 <— U.Friendly	0.82952	0.05886	14.09301	0.00000***	0.19250	4.30926	0.00002***
syQ3 <— U.Friendly	0.92811	0.05479	16.94049	0.00000***	0.08153	11.38308	0.00000***
syQ6 <— U.Friendly	0.73160	0.06252	11.70223	0.00000***	0.13651	5.35939	0.00000***
IT.Support <-> U.Friendly	0.49586	0.05797	8.55442	0.00000***	0.15840	3.13040	0.00175**

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 47: Fit Statistics − Service and System Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Service and System Quality	287.533	89	0.106	0.852	0.8	0.899	0.915	0.928

* RMSEA Index 90% CI: (NA, NA)

Figure 46: Path Diagram − Service and System Quality

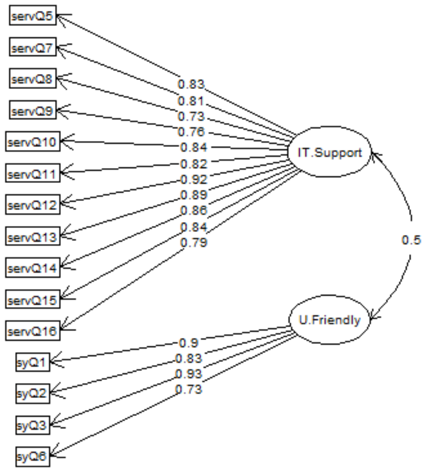


Table 48: Path Statistics − Physician Attributes and Knowledge/Information Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
pa5 <— Pat.Rel	0.63042	0.07691	8.19741	0.00000***	0.08381	7.52184	0.00000***
pa6 <— Pat.Rel	0.49186	0.07812	6.29620	0.00000***	0.08240	5.96903	0.00000***
pa8 <— Pat.Rel	0.78698	0.07542	10.43455	0.00000***	0.06556	12.00361	0.00000***
pa15 <— Pat.Rel	0.61782	0.07393	8.35659	0.00000***	0.07244	8.52921	0.00000***
iKQ6 <— Context	0.67167	0.06518	10.30509	0.00000***	0.06793	9.88822	0.00000***
iKQ7 <— Context	0.74184	0.06281	11.81111	0.00000***	0.07276	10.19641	0.00000***
iKQ8 <— Context	0.82177	0.05970	13.76470	0.00000***	0.06389	12.86200	0.00000***
iKQ9 <— Context	0.91173	0.05653	16.12887	0.00000***	0.04601	19.81650	0.00000***
iKQ10 <— Context	0.53426	0.06848	7.80199	0.00000***	0.08370	6.38340	0.00000***
iKQ12 <— Context	0.70142	0.06452	10.87193	0.00000***	0.05753	12.19285	0.00000***
Context <-> Pat.Rel	0.18418	0.08375	2.19911	0.02787*	0.09101	2.02366	0.04300*

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 49: Fit Statistics − Physician Attributes and Knowledge/Information Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Attributes and Knowledge Quality	59.977	34	0.062	0.944	0.91	0.925	0.954	0.965

* RMSEA Index 90% CI: (0.0349, 0.0873)

Figure 47: Path Diagram − Physician Attributes and Knowledge/Information Quality

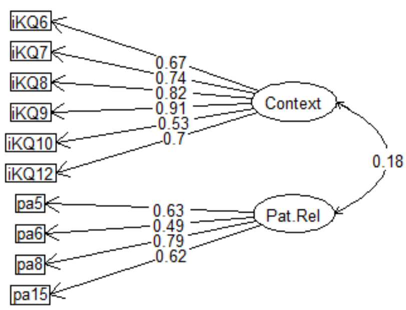


Table 50: Path Statistics − Physician Attributes, Knowledge/Information Quality and System Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
pa5 <— Pat.Rel	0.62768	0.07652	8.20287	0.00000***	0.13759	4.56200	0.00001***
pa6 <— Pat.Rel	0.48809	0.07789	6.26603	0.00000***	0.12907	3.78168	0.00016***
pa8 <— Pat.Rel	0.78922	0.07494	10.53203	0.00000***	0.06388	12.35443	0.00000***
pa15 <— Pat.Rel	0.62063	0.07375	8.41515	0.00000***	0.12045	5.15251	0.00000***
iKQ6 <— Context	0.67670	0.06517	10.38330	0.00000***	0.11261	6.00915	0.00000***
iKQ7 <— Context	0.73643	0.06306	11.67766	0.00000***	0.09939	7.40972	0.00000***
iKQ8 <— Context	0.82377	0.05977	13.78138	0.00000***	0.15527	5.30527	0.00000***
iKQ9 <— Context	0.91228	0.05657	16.12587	0.00000***	0.10705	8.52187	0.00000***
iKQ10 <— Context	0.53955	0.06852	7.87392	0.00000***	0.12395	4.35289	0.00001***
iKQ12 <— Context	0.70981	0.06446	11.01208	0.00000***	0.10582	6.70743	0.00000***
syQ1 <— U.Friendly	0.89336	0.05613	15.91573	0.00000***	0.10629	8.40491	0.00000***
syQ2 <— U.Friendly	0.83431	0.05876	14.19814	0.00000***	0.23263	3.58638	0.00034***
syQ3 <— U.Friendly	0.93266	0.05463	17.07290	0.00000***	0.22574	4.13150	0.00004***
syQ6 <— U.Friendly	0.72628	0.06268	11.58690	0.00000***	0.06327	11.47815	0.00000***
Pat.Rel <-> Context	0.19957	0.07574	2.63481	0.00842**	0.09154	2.18009	0.02925*
Context <-> U.Friendly	0.43610	0.06311	6.90991	0.00000***	0.12413	3.51337	0.00044***

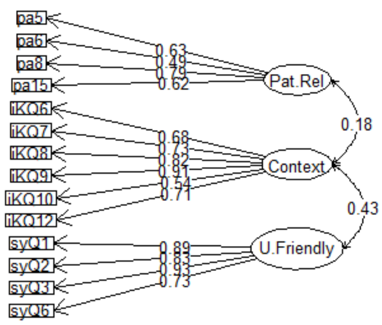
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 51: Fit Statistics − Physician Attributes, Knowledge/Information Quality and System Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Reduced Non-core	154.082	75	0.073	0.901	0.862	0.897	0.932	0.944

* RMSEA Index 90% CI: (0.0563, 0.0891)

Figure 48: Path Diagram − Physician Attributes, Knowledge/Information Quality and System Quality



4.7. STRUCTURAL REGRESSION (FACTOR) ANALYSIS (SRA)

CFA only identifies the covariance or correlational relationships between variables (Raykov & Marcoulides, 2006). It requires SRA to analyse explanatory relationships (*ibid.*). Subsection 4.7.1 reports the regression results of Intent to Use on each exogenous latent variable. Subsection 4.7.2 presents the empirical tests of the core constructs. The relationship between the core constructs and Service Quality is discussed in Subsection 4.7.3.

The analysis strategies and procedures mentioned in Section 4.6 remain applicable.

At the structural part building stage, no variable may be eliminated (Tempelaar *et al.*, 2007). However, fixed constraints may be imposed (*ibid.*).

4.7.1 Regression Results of Intent to Use on Each Exogenous Latent Variable

The constructs validated in Subsection 4.6.3 were submitted into the programme mentioned in Subsection 4.6.1. The results are depicted in Figure 49 to Figure 55 and represented by Table 52 to Table 65.

Both the Maximum Likelihood and Nonparametric Bootstrap results show that the z values of all the items were significant at $p<0.001$. In Figure 49, the word "NS" shown in the directed arrows indicates that the effect of Physician Attributes on Intent to Use is not significant at the $p<0.05$. However, Table 52 indicates that it can be considered to be significant at $p<0.10$. This is the significance level often applied for social science research (Gujarati, 1999). Had the bootstrap technique not be applied, Service Quality would have been considered as a significant determinant of HIT.Use at $p<0.10$ (see Table 58). Petter *et al.'s* (2008) literature review of empirical studies on the D&M (2003) indicates that insufficient evidence supports the hypothesis that Service Quality is a cause of Intent to Use/Use. The authors (*op. cit.*) also note that little literature has examined this aspect and the impact of Information Quality on Intent to Use/Use. Knowledge Quality is not discussed by the authors since it is not a construct in the D&M (2003) framework. The subsection appears to have opened up new findings.

The CFA result in Table 32 suggests that Efficiency and Qual.Care are strongly correlated. However, the correlation became greater than 1 when a SRA was performed. This fundamentally conflicts with the definition of correlation (Bethlehem, 2009). Perhaps a drawback of applying pairwise deletion is shown in the result. In order to conduct further analysis, SRA's were performed on the two subfactors individually (see Table 54 to Table 57, Figure 50 and Figure 51, for the SRA results). Readers who follow the text closely will find the regression results on System Quality and User Satisfaction self-explanatory.

Table 52: Path Statistics − Regression of Intent to Use on Physician Attributes

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.84715	0.07177	11.80441	0.00000***	0.06809	12.44140	0.00000***
itU2 <— HIT.Use	0.66676	0.07041	9.46900	0.00000***	0.06062	10.99973	0.00000***
itU3 <— HIT.Use	0.45425	0.07334	6.19344	0.00000***	0.06904	6.57938	0.00000***
Freq.U <— HIT.Use	0.60322	0.07011	8.60374	0.00000***	0.07509	8.03367	0.00000***
pa5 <— Pat.Rel	0.61727	0.07639	8.08104	0.00000***	0.07315	8.43876	0.00000***
pa6 <— Pat.Rel	0.49697	0.07877	6.30898	0.00000***	0.08317	5.97545	0.00000***
pa8 <— Pat.Rel	0.79555	0.07534	10.55897	0.00000***	0.05880	13.53084	0.00000***
pa15 <— Pat.Rel	0.61664	0.07378	8.35738	0.00000***	0.06915	8.91733	0.00000***
HIT.Use <— Pat.Rel	0.17145	0.09420	1.81999	0.06876	0.10150	1.68916	0.09119

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 53: Fit Statistics − Regression of Intent to Use on Physician Attributes

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
PA & Use	37.066	19	0.069	0.957	0.919	0.904	0.926	0.95

* RMSEA Index 90% CI: (0.0347, 0.102)

Figure 49: Path Diagram − Regression of Intent to Use on Physician Attributes

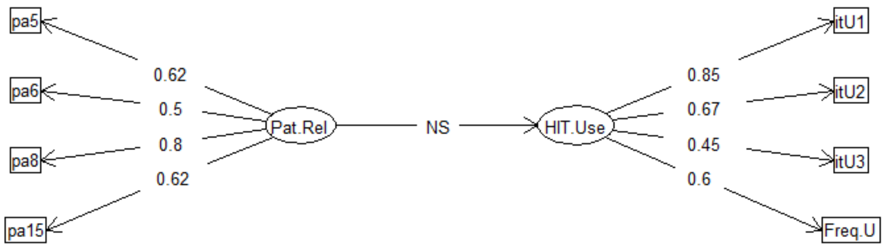


Table 54: Path Statistics − Regression of Intent to Use on Efficiency

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.73818	0.06772	10.90046	0.00000***	0.06856	10.76631	0.00000***
itU2 <— HIT.Use	0.62047	0.06313	9.82782	0.00000***	0.06116	10.14500	0.00000***
itU3 <— HIT.Use	0.42170	0.06638	6.35286	0.00000***	0.06484	6.50413	0.00000***
Freq.U <— HIT.Use	0.55329	0.06432	8.60191	0.00000***	0.08305	6.66205	0.00000***
ben1 <— Efficiency	0.77596	0.06139	12.64056	0.00000***	0.05397	14.37780	0.00000***
ben2 <— Efficiency	0.89482	0.05730	15.61564	0.00000***	0.03777	23.69218	0.00000***
ben3 <— Efficiency	0.88765	0.05760	15.40977	0.00000***	0.04266	20.80986	0.00000***
ben11 <— Efficiency	0.74325	0.06251	11.88926	0.00000***	0.05724	12.98486	0.00000***
HIT.Use <— Efficiency	0.50979	0.10088	5.05346	0.00000***	0.13362	3.81534	0.00014***

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 55: Fit Statistics − Regression of Intent to Use on Efficiency

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Efficiency & Use	44.024	19	0.081	0.946	0.898	0.941	0.949	0.965

* RMSEA Index 90% CI: (0.0499, 0.1131)

Figure 50: Path Diagram − Regression of Intent to Use on Efficiency

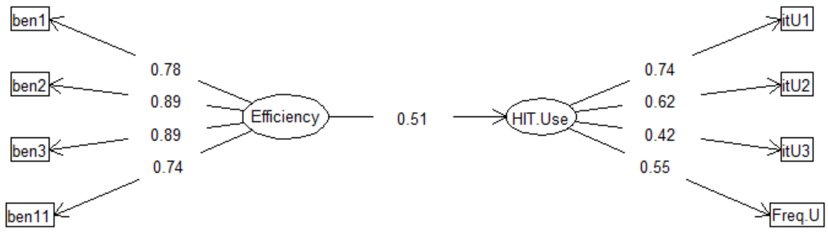


Table 56: Path Statistics − Regression of Intent to Use on Quality of Care

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>$\lvert z \rvert$)	Std. Error	z value	Pr(>$\lvert z \rvert$)
itU1 <— HIT.Use	0.71557	0.06722	10.64449	0.00000***	0.06739	10.61904	0.00000***
itU2 <— HIT.Use	0.60148	0.06208	9.68841	0.00000***	0.05752	10.45772	0.00000***
itU3 <— HIT.Use	0.42620	0.06400	6.65953	0.00000***	0.06156	6.92278	0.00000***
Freq.U <— HIT.Use	0.53145	0.06379	8.33112	0.00000***	0.08500	6.25266	0.00000***
ben4 <— Qual.Care	0.80103	0.06129	13.06898	0.00000***	0.03747	21.37814	0.00000***
ben5 <— Qual.Care	0.71629	0.06425	11.14766	0.00000***	0.03985	17.97434	0.00000***
ben6 <— Qual.Care	0.73486	0.06351	11.56992	0.00000***	0.05239	14.02776	0.00000***
ben7 <— Qual.Care	0.70723	0.06458	10.95148	0.00000***	0.05674	12.46404	0.00000***
ben8 <— Qual.Care	0.70856	0.06454	10.97913	0.00000***	0.06834	10.36856	0.00000***
ben10 <— Qual.Care	0.81377	0.06075	13.39481	0.00000***	0.04133	19.68995	0.00000***
HIT.Use <— Qual.Care	0.57650	0.10662	5.40725	0.00000***	0.13854	4.16126	0.00003***

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 57: Fit Statistics − Regression of Intent to Use on Quality of Care

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Qual.Care & Use	52.969	34	0.053	0.949	0.918	0.937	0.968	0.976

* RMSEA Index 90% CI: (0.0214, 0.0795)

Figure 51: Path Diagram − Regression of Intent to Use on Quality of Care

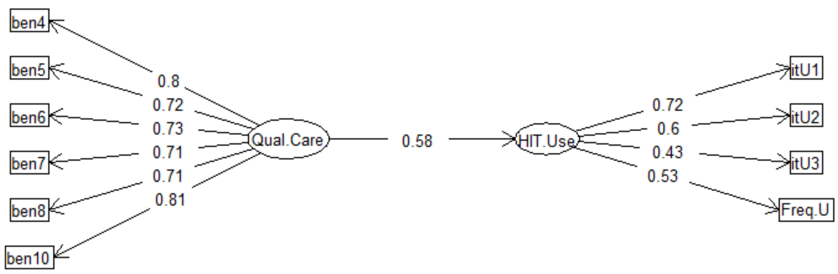


Table 58: Path Statistics − Regression of Intent to Use on Service Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.85205	0.07165	11.89180	0.00000***	0.06331	13.45864	0.00000***
itU2 <— HIT.Use	0.67265	0.07117	9.45164	0.00000***	0.07409	9.07905	0.00000***
itU3 <— HIT.Use	0.45503	0.07363	6.17980	0.00000***	0.07803	5.83122	0.00000***
Freq.U <— HIT.Use	0.59854	0.07049	8.49142	0.00000***	0.09358	6.39635	0.00000***
servQ5 <— IT.Support	0.82578	0.05820	14.18790	0.00000***	0.10199	8.09688	0.00000***
servQ15 <— IT.Support	0.83805	0.05774	14.51540	0.00000***	0.07433	11.27414	0.00000***
servQ16 <— IT.Support	0.78220	0.05984	13.07131	0.00000***	0.16332	4.78948	0.00000***
servQ7 <— IT.Support	0.81087	0.05879	13.79321	0.00000***	0.09747	8.31879	0.00000***
servQ8 <— IT.Support	0.73256	0.06146	11.91988	0.00000***	0.13610	5.38232	0.00000***
servQ9 <— IT.Support	0.76302	0.06046	12.62081	0.00000***	0.13822	5.52035	0.00000***
servQ10 <— IT.Support	0.83823	0.05770	14.52687	0.00000***	0.10579	7.92384	0.00000***
servQ11 <— IT.Support	0.81420	0.05862	13.88935	0.00000***	0.16200	5.02584	0.00000***
servQ12 <— IT.Support	0.92172	0.05421	17.00155	0.00000***	0.09062	10.17089	0.00000***
servQ13 <— IT.Support	0.89098	0.05556	16.03633	0.00000***	0.09306	9.57388	0.00000***
servQ14 <— IT.Support	0.85987	0.05686	15.12365	0.00000***	0.08948	9.60934	0.00000***
HIT.Use <— IT.Support	0.14946	0.08257	1.81017	0.07027	0.10398	1.43740	0.15061

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 59: Fit Statistics − Regression of Intent to Use on Service Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
servQ & Use	225.003	89	0.088	0.878	0.835	0.905	0.929	0.94

* RMSEA Index 90% CI: (0.0735, 0.102)

Figure 52: Path Diagram − Regression of Intent to Use on Service Quality

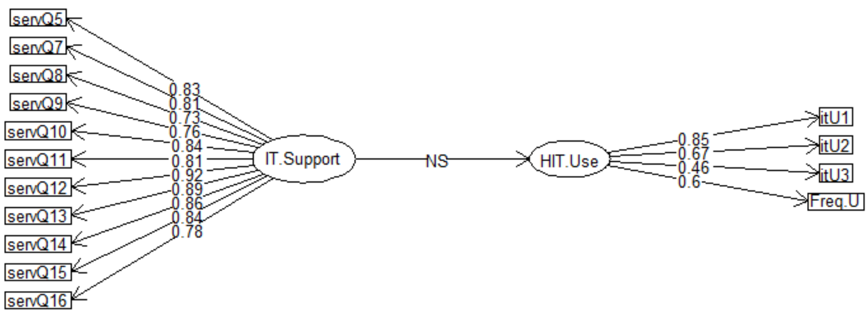


Table 60: Path Statistics − Regression of Intent to Use on Knowledge/Information Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.77933	0.06998	11.13585	0.00000***	0.06813	11.43968	0.00000***
itU2 <— HIT.Use	0.65066	0.06552	9.93042	0.00000***	0.06391	10.18111	0.00000***
itU3 <— HIT.Use	0.43522	0.06907	6.30147	0.00000***	0.07679	5.66798	0.00000***
Freq.U <— HIT.Use	0.56294	0.06737	8.35622	0.00000***	0.13069	4.30741	0.00002***
iKQ6 <— Context	0.66978	0.06517	10.27772	0.00000***	0.14385	4.65618	0.00000***
iKQ7 <— Context	0.73884	0.06281	11.76305	0.00000***	0.05762	12.82255	0.00000***
iKQ8 <— Context	0.82214	0.05960	13.79361	0.00000***	0.07558	10.87782	0.00000***
iKQ9 <— Context	0.91534	0.05628	16.26348	0.00000***	0.05467	16.74405	0.00000***
iKQ10 <— Context	0.53362	0.06841	7.80053	0.00000***	0.08314	6.41816	0.00000***
iKQ12 <— Context	0.69811	0.06455	10.81443	0.00000***	0.06687	10.43981	0.00000***
HIT.Use <— Context	0.39785	0.09393	4.23548	0.00002***	0.13508	2.94532	0.00323**

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 61: Fit Statistics − Regression of Intent to Use on Knowledge/Information Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
iKQ & Use	54.868	34	0.056	0.949	0.918	0.935	0.965	0.974

* RMSEA Index 90% CI: (0.0257, 0.0817)

Figure 53: Path Diagram − Regression of Intent to Use on Knowledge/Information Quality

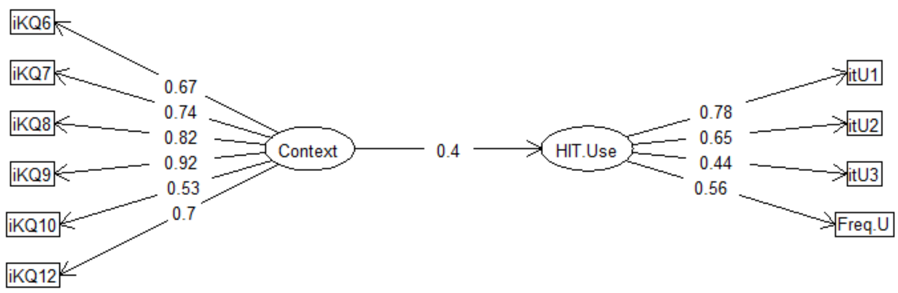


Table 62: Path Statistics − Regression of Intent to Use on System Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.80916	0.06905	11.71801	0.00000***	0.06101	13.26309	0.00000***
itU2 <— HIT.Use	0.64837	0.06717	9.65294	0.00000***	0.05815	11.15076	0.00000***
itU3 <— HIT.Use	0.43139	0.07045	6.12292	0.00000***	0.07406	5.82491	0.00000***
Freq.U <— HIT.Use	0.57803	0.06740	8.57612	0.00000***	0.09801	5.89779	0.00000***
syQ1 <— U.Friendly	0.89381	0.05611	15.92866	0.00000***	0.05527	16.17168	0.00000***
syQ2 <— U.Friendly	0.82705	0.05893	14.03362	0.00000***	0.07203	11.48239	0.00000***
syQ3 <— U.Friendly	0.94024	0.05434	17.30419	0.00000***	0.04785	19.65069	0.00000***
syQ6 <— U.Friendly	0.71680	0.06292	11.39290	0.00000***	0.06866	10.44023	0.00000***
HIT.Use <— U.Friendly	0.34176	0.08845	3.86391	0.00011***	0.11519	2.96685	0.00301**

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 63: Fit Statistics − Regression of Intent to Use on System Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
syQ & Use	42.336	19	0.079	0.953	0.911	0.948	0.957	0.971

* RMSEA Index 90% CI: (0.0466, 0.1105)

Figure 54: Path Diagram − Regression of Intent to Use on System Quality

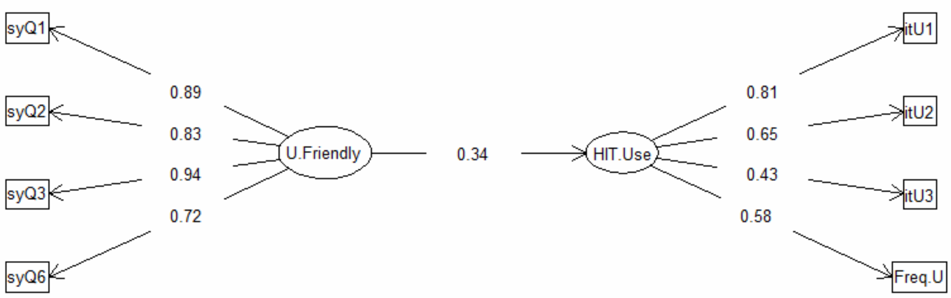


Table 64: Path Statistics − Regression of Intent to Use on User Satisfaction

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.75866	0.06907	10.98371	0.00000***	0.06530	11.61897	0.00000***
itU2 <— HIT.Use	0.64565	0.06422	10.05443	0.00000***	0.05456	11.83376	0.00000***
itU3 <— HIT.Use	0.43079	0.06824	6.31314	0.00000***	0.06070	7.09749	0.00000***
Freq.U <— HIT.Use	0.56295	0.06623	8.49979	0.00000***	0.07465	7.54165	0.00000***
sat1 <— User.Sat	0.67763	0.06334	10.69892	0.00000***	0.05873	11.53891	0.00000***
sat2 <— User.Sat	0.95393	0.05310	17.96401	0.00000***	0.03132	30.45721	0.00000***
sat3 <— User.Sat	0.94182	0.05365	17.55639	0.00000***	0.04622	20.37746	0.00000***
sat4 <— User.Sat	0.86928	0.05661	15.35651	0.00000***	0.04095	21.23035	0.00000***
HIT.Use <— User.Sat	0.43634	0.09384	4.64971	0.00000***	0.11336	3.84919	0.00012***

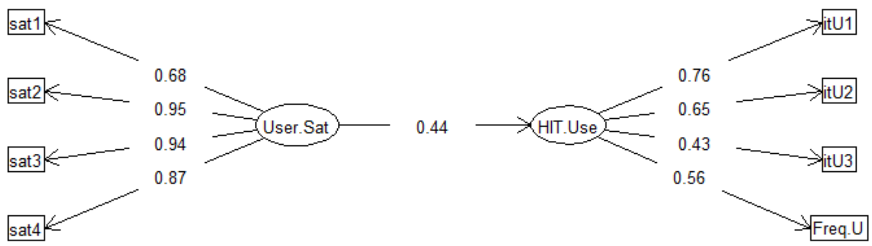
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 65: Fit Statistics − Regression of Intent to Use on User Satisfaction

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Sat & Use	22.918	19	0.032	0.973	0.948	0.975	0.994	0.996

* RMSEA Index 90% CI: (NA, 0.0731)

Figure 55: Path Diagram − Regression of Intent to Use on User Satisfaction



4.7.2 The Three Core Constructs

As mentioned in Subsection 4.7.1, regressing Intent to Use on the two Perceived Net Benefits subfactors obtained an inconsistent solution. This situation persisted when User Satisfaction was introduced into the SRA. In certain situations, the `sem` package returned a message "`Optimization probably did not converge`". Analysing the two subfactors separately appeared to be a reasonable approach.

The regression of Intent to Use on User Satisfaction and Efficiency required imposing equal constructs on *ben*2 and *ben*3 in order to fulfil the significance criterion (see Table 66 and Table 67). Figure 56 only shows the paths that are at least significant at $p<0.05$. This arrangement applies to the subsequent path diagrams. For the core constructs consist of Qual.Care, there was no need to impose the equal constraints on *sat*2 and *sat*3. The constraints were set purely because their estimates (and standard errors) were identical at two digits. The result is shown in Table 68 and Table 69 and depicted in Figure 57. The results shown in Table 66 and Table 68 are the basis for the subsequent analyses.

Table 66: Path Statistics − Regression of Intent to Use on Efficiency and User Satisfaction (Imposed Equal Constraints on *ben*2 and *ben*3)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.71597	0.06703	10.68089	0.00000***	0.07432	9.63388	0.00000***
itU2 <— HIT.Use	0.61853	0.06175	10.01678	0.00000***	0.13578	4.55525	0.00001***
itU3 <— HIT.Use	0.41747	0.06520	6.40269	0.00000***	0.06908	6.04365	0.00000***
Freq.U <— HIT.Use	0.54187	0.06376	8.49853	0.00000***	0.21629	2.50525	0.01224*
ben1 <— Efficiency	0.77979	0.06115	12.75144	0.00000***	0.12731	6.12535	0.00000***
ben2 <— Efficiency	0.88814	0.05072	17.51177	0.00000***	0.14416	6.16078	0.00000***
ben11 <— Efficiency	0.74998	0.06223	12.05179	0.00000***	0.07919	9.47126	0.00000***
sat1 <— User.Sat	0.53035	0.05102	10.39578	0.00000***	0.14004	3.78704	0.00015***
sat3 <— User.Sat	0.73667	0.04529	16.26493	0.00000***	0.10865	6.78010	0.00000***
sat2 <— User.Sat	0.74629	0.04511	16.54436	0.00000***	0.08750	8.52928	0.00000***
sat4 <— User.Sat	0.68327	0.04665	14.64702	0.00000***	0.11211	6.09460	0.00000***
User.Sat <— Efficiency	0.79438	0.10186	7.79867	0.00000***	0.13821	5.74778	0.00000***
HIT.Use <— Efficiency	0.38789	0.12199	3.17976	0.00147**	0.16575	2.34021	0.01927*
HIT.Use <— User.Sat	0.17244	0.09039	1.90778	0.05642	0.17654	0.97677	0.32869

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 67: Fit Statistics − Regression of Intent to Use on Efficiency and User Satisfaction (Imposed Equal Constraints on *ben*2 and *ben*3)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Core-Efficiency	87.775	52	0.059	0.931	0.896	0.944	0.97	0.976

* RMSEA Index 90% CI: (0.0365, 0.0797)

Figure 56: Path Diagram − Regression of Intent to Use on Efficiency and User Satisfaction (Imposed Equal Constraints on *ben*2 and *ben*3)

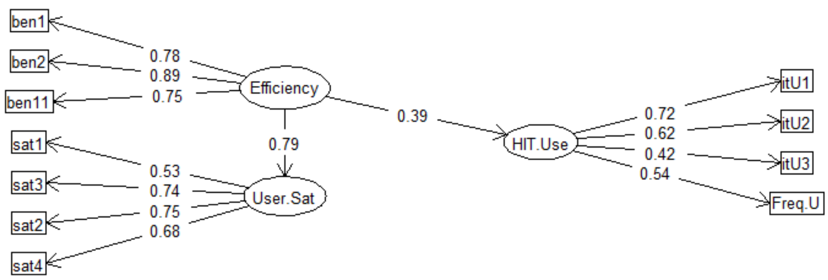


Table 68: Path Statistics − Regression of Intent to Use on Quality of Care and User Satisfaction (Imposed Equal Constraints on *sat*2 and *sat*3)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.69217	0.06638	10.42742	0.00000***	0.07090	9.76208	0.00000***
itU2 <— HIT.Use	0.59960	0.06073	9.87302	0.00000***	0.05845	10.25774	0.00000***
itU3 <— HIT.Use	0.41923	0.06284	6.67153	0.00000***	0.06059	6.91921	0.00000***
Freq.U <— HIT.Use	0.52115	0.06308	8.26184	0.00000***	0.11364	4.58586	0.00000***
ben4 <— Qual.Care	0.79774	0.06122	13.02979	0.00000***	0.06337	12.58842	0.00000***
ben5 <— Qual.Care	0.71166	0.06427	11.07384	0.00000***	0.03798	18.73616	0.00000***
ben6 <— Qual.Care	0.72787	0.06358	11.44788	0.00000***	0.05373	13.54627	0.00000***
ben7 <— Qual.Care	0.70334	0.06449	10.90556	0.00000***	0.06512	10.80095	0.00000***
ben8 <— Qual.Care	0.70803	0.06437	10.99915	0.00000***	0.06579	10.76190	0.00000***
ben10 <— Qual.Care	0.82717	0.06014	13.75295	0.00000***	0.05824	14.20388	0.00000***
sat1 <— User.Sat	0.56580	0.05372	10.53330	0.00000***	0.08626	6.55925	0.00000***
sat2 <— User.Sat	0.78772	0.04515	17.44840	0.00000***	0.21758	3.62044	0.00029***
sat4 <— User.Sat	0.72461	0.04923	14.71919	0.00000***	0.21400	3.38604	0.00071***
User.Sat <— Qual.Care	0.66789	0.09650	6.92121	0.00000***	0.14178	4.71071	0.00000***
HIT.Use <— Qual.Care	0.47408	0.12078	3.92533	0.00009***	0.14505	3.26845	0.00108**
HIT.Use <— User.Sat	0.17871	0.09104	1.96308	0.04964*	0.12341	1.44811	0.14759

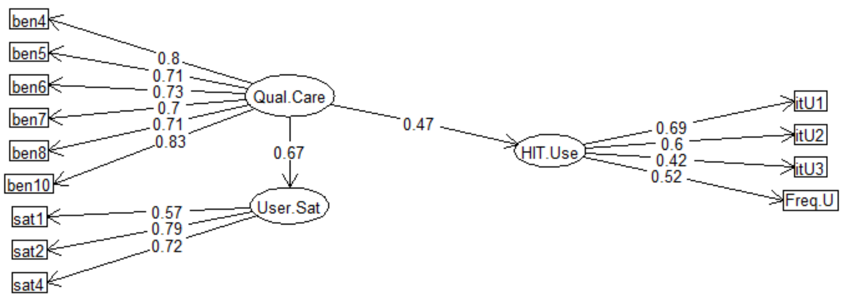
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 69: Fit Statistics − Regression of Intent to Use on Quality of Care and User Satisfaction (Imposed Equal Constraints on *sat*2 and *sat*3)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Core Constructs	111.777	75	0.05	0.927	0.898	0.932	0.971	0.976

* RMSEA Index 90% CI: (0.0288, 0.0681)

Figure 57: Path Diagram − Regression of Intent to Use on Quality of Care and User Satisfaction (Imposed Equal Constraints on *sat*2 and *sat*3)



4.7.3 Core Constructs and Service Quality

Subsection 4.6.4 shows that the Service Quality construct does not significantly impact Intent to Use. However, empirical studies suggest that it associates with Net Benefits and User Satisfaction (see Petter *et al.*, 2008). There is a need to test how it relates to the core constructs.

Table 70 shows that Service Quality is a not a significant determinant of Intent to Use. Unlike the result in Table 58, the sign of its estimate becomes negative. This aspect may be added into the further research agenda. Service Quality appears to impact User

Satisfaction and Net Perceived Benefits significantly and positively. User Satisfaction becomes a significant cause of Intent to Use at p<0.10. This result is not replicated by the model shown in Table 72 and depicted in Figure 59. Table 70 and Table 72 show that there are reasons to argue for introducing Service Quality into IS Success studies.

Table 70: Path Statistics − Core Constructs and Service Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.69198	0.06615	10.46073	0.00000***	0.07075	9.78030	0.00000***
itU2 <— HIT.Use	0.59618	0.06081	9.80342	0.00000***	0.08338	7.15007	0.00000***
itU3 <— HIT.Use	0.41622	0.06289	6.61794	0.00000***	0.05917	7.03423	0.00000***
Freq.U <— HIT.Use	0.52306	0.06276	8.33474	0.00000***	0.09227	5.66871	0.00000***
ben4 <— Qual.Care	0.75818	0.05872	12.91127	0.00000***	0.05361	14.14320	0.00000***
ben5 <— Qual.Care	0.67656	0.06145	11.01065	0.00000***	0.04868	13.89923	0.00000***
ben6 <— Qual.Care	0.69038	0.06126	11.27038	0.00000***	0.06741	10.24085	0.00000***
ben7 <— Qual.Care	0.66835	0.06172	10.82838	0.00000***	0.11853	5.63882	0.00000***
ben8 <— Qual.Care	0.67310	0.06149	10.94713	0.00000***	0.11583	5.81098	0.00000***
ben10 <— Qual.Care	0.78641	0.05736	13.71032	0.00000***	0.05008	15.70161	0.00000***
servQ5 <— IT.Support	0.82867	0.05809	14.26488	0.00000***	0.04336	19.10934	0.00000***
servQ15 <— IT.Support	0.84020	0.05765	14.57474	0.00000***	0.05657	14.85150	0.00000***
servQ16 <— IT.Support	0.78598	0.05970	13.16485	0.00000***	0.11800	6.66059	0.00000***
servQ7 <— IT.Support	0.81002	0.05881	13.77243	0.00000***	0.08120	9.97551	0.00000***
servQ8 <— IT.Support	0.73287	0.06144	11.92789	0.00000***	0.14052	5.21530	0.00000***
servQ9 <— IT.Support	0.76397	0.06042	12.64411	0.00000***	0.05869	13.01738	0.00000***
servQ10 <— IT.Support	0.83711	0.05774	14.49730	0.00000***	0.11283	7.41906	0.00000***
servQ11 <— IT.Support	0.81479	0.05860	13.90529	0.00000***	0.07096	11.48235	0.00000***
servQ12 <— IT.Support	0.91930	0.05432	16.92297	0.00000***	0.07256	12.66878	0.00000***
servQ13 <— IT.Support	0.89095	0.05556	16.03603	0.00000***	0.09082	9.80999	0.00000***
servQ14 <— IT.Support	0.85747	0.05695	15.05618	0.00000***	0.08375	10.23895	0.00000***
sat1 <— User.Sat	0.51189	0.04888	10.47264	0.00000***	0.10078	5.07921	0.00000***
sat2 <— User.Sat	0.71289	0.04143	17.20784	0.00000***	0.17655	4.03787	0.00005***
sat4 <— User.Sat	0.65897	0.04460	14.77511	0.00000***	0.07711	8.54642	0.00000***
Qual.Care <— IT.Support	0.32775	0.08140	4.02627	0.00006***	0.11639	2.81611	0.00486**
User.Sat <— IT.Support	0.49134	0.08962	5.48245	0.00000***	0.11204	4.38519	0.00001***
HIT.Use <— IT.Support	-0.08781	0.10125	-0.86729	0.38578	0.12832	-0.68433	0.49377
User.Sat <— Qual.Care	0.55584	0.09288	5.98419	0.00000***	0.14204	3.91318	0.00009***
HIT.Use <— Qual.Care	0.45455	0.11493	3.95504	0.00008***	0.15067	3.01674	0.00256**
HIT.Use <— User.Sat	0.19328	0.09145	2.11346	0.03456*	0.11523	1.67725	0.09349

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 71: Fit Statistics − Core Constructs and Service Quality

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Core & ServQ	515.195	270	0.068	0.839	0.806	0.873	0.928	0.935

* RMSEA Index 90% CI: (NA, NA)

Figure 58: Path Diagram − Core Constructs and Service Quality

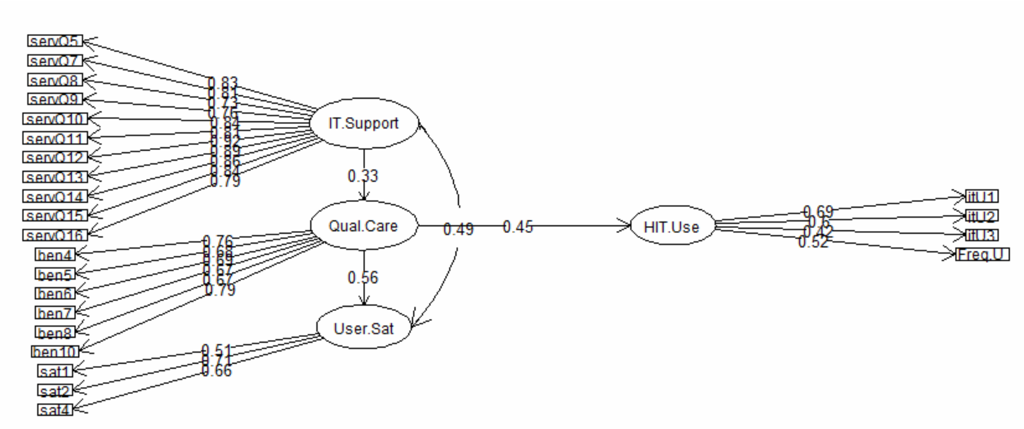


Table 72: Path Statistics − Core Constructs (Efficiency) and Service Quality

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.71630	0.06693	10.70189	0.00000***	0.08004	8.94942	0.00000***
itU2 <— HIT.Use	0.61682	0.06185	9.97277	0.00000***	0.07671	8.04124	0.00000***
itU3 <— HIT.Use	0.41588	0.06530	6.36908	0.00000***	0.07514	5.53466	0.00000***
Freq.U <— HIT.Use	0.54328	0.06366	8.53437	0.00000***	0.10029	5.41731	0.00000***
ben1 <— Efficiency	0.74806	0.05881	12.71908	0.00000***	0.09591	7.79993	0.00000***
ben2 <— Efficiency	0.85223	0.04922	17.31437	0.00000***	0.13270	6.42206	0.00000***
ben11 <— Efficiency	0.71987	0.06005	11.98714	0.00000***	0.12881	5.58880	0.00000***
servQ5 <— IT.Support	0.82863	0.05809	14.26356	0.00000***	0.11607	7.13883	0.00000***
servQ15 <— IT.Support	0.84048	0.05764	14.58220	0.00000***	0.06761	12.43179	0.00000***
servQ16 <— IT.Support	0.78573	0.05971	13.15874	0.00000***	0.13550	5.79864	0.00000***
servQ7 <— IT.Support	0.81013	0.05881	13.77479	0.00000***	0.09832	8.23975	0.00000***
servQ8 <— IT.Support	0.73254	0.06145	11.92050	0.00000***	0.12982	5.64279	0.00000***
servQ9 <— IT.Support	0.76394	0.06042	12.64335	0.00000***	0.10677	7.15488	0.00000***
servQ10 <— IT.Support	0.83720	0.05774	14.49943	0.00000***	0.12670	6.60756	0.00000***
servQ11 <— IT.Support	0.81499	0.05859	13.91025	0.00000***	0.10411	7.82818	0.00000***
servQ12 <— IT.Support	0.91911	0.05433	16.91646	0.00000***	0.09108	10.09145	0.00000***
servQ13 <— IT.Support	0.89093	0.05556	16.03536	0.00000***	0.09531	9.34768	0.00000***
servQ14 <— IT.Support	0.85765	0.05694	15.06129	0.00000***	0.09364	9.15927	0.00000***
sat1 <— User.Sat	0.47470	0.04609	10.29937	0.00000***	0.15013	3.16199	0.00157**
sat2 <— User.Sat	0.66851	0.04126	16.20393	0.00000***	0.10999	6.07796	0.00000***
sat3 <— User.Sat	0.65860	0.04149	15.87262	0.00000***	0.13235	4.97606	0.00000***
sat4 <— User.Sat	0.61494	0.04210	14.60791	0.00000***	0.15356	4.00465	0.00006***
Efficiency <— IT.Support	0.29336	0.07933	3.69817	0.00022***	0.11739	2.49907	0.01245*
User.Sat <— IT.Support	0.51480	0.09054	5.68589	0.00000***	0.13433	3.83246	0.00013***
HIT.Use <— IT.Support	-0.05040	0.09983	-0.50489	0.61363	0.16594	-0.30374	0.76132
User.Sat <— Efficiency	0.71256	0.09948	7.16292	0.00000***	0.14952	4.76562	0.00000***
HIT.Use <— Efficiency	0.36995	0.11733	3.15312	0.00162**	0.17369	2.12991	0.03318*
HIT.Use <— User.Sat	0.17295	0.09082	1.90436	0.05686	0.13091	1.32113	0.18646

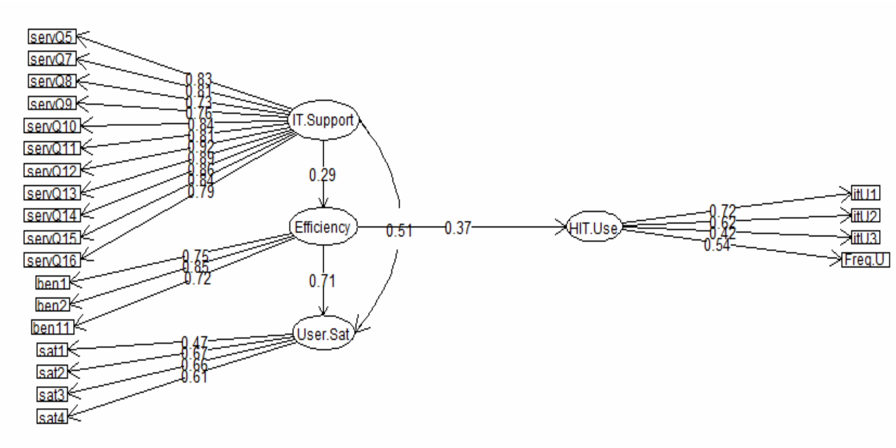
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 73: Fit Statistics − Core Constructs (Efficiency) and Service Quality

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Core-Efficiency & ServQ	440.913	225	0.069	0.845	0.81	0.888	0.934	0.941

* RMSEA Index 90% CI: (NA, NA)

Figure 59: Path Diagram − Core Constructs (Efficiency) and Service Quality



4.8. VERIFYING THE CDSS USE MODEL

Subsection 4.8.1 presents the empirical results of the proposed CDSS Use model and its related theories. A generalised integrated model is presented in Subsection 4.8.2.

4.8.1 Empirical Results − The Proposed CDSS Use Model and Related Models

The analysis procedures and strategies outlined in Subsections 4.6.1 and 4.6.2 remain applicable. However, no items would be eliminated at this stage of analysis.

Core Constructs in Medical Decision-Making Context

Zmud's (1978) work may suggest that the most parsimonious CDSS Use model is possibly the core constructs. The most parsimonious models that explicitly relate medical decision-making factors to CDSS Use are possibly the two models illustrated by Figure 60 and Figure 61. The NFI indices (Table 75 and Table 77) are below the threshold level. Figure 60 and Figure 61 show that apart from the loadings being mostly above 0.60, the significance and other fit criteria are also met. Figure 60 presents Qual.Care (Quality of Care) to be the only determinant of HIT.Use (HIT use). However, Table 74 shows that Pat.Rel (Physician-Patient Relationship) significantly correlates with Context (Knowledge/Information Quality) and is a significant determinant of HIT.Use at $p<0.10$. The same results are replicated by the model consisting of Efficiency (see Table 76), but the latter becomes significant at $p<0.05$. It is puzzling that Pat.Rel negatively associate with Perceived Net Benefits and/or User Satisfaction. One possible explanation is that physicians have to allocate their time in dealing with the computer/system. On average, this might have shortened the duration of each encounter. As a result, physicians might perceive that the interactions with patients become depersonalised (Gadd & Penrod, 2000). This inference may be examined in future research.

Table 74: Path Statistics − Core Constructs in Medical Decision-Making Context

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.65080	0.06639	9.80262	0.00000***	0.09458	6.88102	0.00000***
itU2 <— HIT.Use	0.58185	0.05942	9.79151	0.00000***	0.06628	8.77795	0.00000***
itU3 <— HIT.Use	0.41396	0.06011	6.88611	0.00000***	0.18459	2.24252	0.02493*
Freq.U <— HIT.Use	0.49582	0.06235	7.95164	0.00000***	0.14742	3.36337	0.00077***
pa5 <— Pat.Rel	0.61770	0.07631	8.09422	0.00000***	0.08709	7.09248	0.00000***
pa6 <— Pat.Rel	0.49032	0.07837	6.25639	0.00000***	0.08932	5.48930	0.00000***
pa8 <— Pat.Rel	0.80036	0.07512	10.65407	0.00000***	0.06672	11.99521	0.00000***
pa15 <— Pat.Rel	0.61503	0.07366	8.34976	0.00000***	0.08209	7.49232	0.00000***
ben4 <— Qual.Care	0.73890	0.05852	12.62674	0.00000***	0.10083	7.32822	0.00000***
ben5 <— Qual.Care	0.65994	0.06066	10.87877	0.00000***	0.08534	7.73306	0.00000***
ben6 <— Qual.Care	0.67556	0.05966	11.32424	0.00000***	0.08829	7.65158	0.00000***
ben7 <— Qual.Care	0.65099	0.06085	10.69838	0.00000***	0.14763	4.40975	0.00001***
ben8 <— Qual.Care	0.65559	0.06066	10.80731	0.00000***	0.12564	5.21777	0.00000***
ben10 <— Qual.Care	0.76706	0.05619	13.65103	0.00000***	0.03263	23.50598	0.00000***
iKQ6 <— Context	0.67615	0.06488	10.42201	0.00000***	0.10021	6.74716	0.00000***
iKQ7 <— Context	0.73426	0.06282	11.68829	0.00000***	0.17801	4.12484	0.00004***
iKQ8 <— Context	0.81794	0.05971	13.69771	0.00000***	0.26377	3.10099	0.00193**
iKQ9 <— Context	0.91093	0.05632	16.17396	0.00000***	0.05891	15.46211	0.00000***
iKQ10 <— Context	0.54034	0.06822	7.92068	0.00000***	0.09141	5.91120	0.00000***
iKQ12 <— Context	0.70992	0.06414	11.06920	0.00000***	0.06452	11.00399	0.00000***
sat1 <— User.Sat	0.48524	0.04688	10.35072	0.00000***	0.22428	2.16348	0.03050*
sat2 <— User.Sat	0.67634	0.04059	16.66211	0.00000***	0.13872	4.87541	0.00000***
sat4 <— User.Sat	0.62133	0.04371	14.21600	0.00000***	0.06183	10.04858	0.00000***
Pat.Rel <-> Context	0.18113	0.08355	2.16790	0.03017*	0.10240	1.76885	0.07692
Qual.Care <— Pat.Rel	-0.07338	0.09115	-0.80500	0.42082	0.11186	-0.65598	0.51184
User.Sat <— Pat.Rel	-0.17679	0.09221	-1.91719	0.05521	0.11251	-1.57131	0.11611
HIT.Use <— Pat.Rel	0.20806	0.10678	1.94845	0.05136	0.12114	1.71761	0.08587
Qual.Care <— Context	0.41197	0.08917	4.62024	0.00000***	0.09886	4.16714	0.00003***
User.Sat <— Context	0.65564	0.10559	6.20950	0.00000***	0.13752	4.76763	0.00000***
HIT.Use <— Context	0.17015	0.12107	1.40540	0.15990	0.14559	1.16868	0.24253
User.Sat <— Qual.Care	0.49604	0.09318	5.32375	0.00000***	0.12845	3.86173	0.00011***
HIT.Use <— Qual.Care	0.44745	0.11527	3.88181	0.00010***	0.14241	3.14194	0.00168**
HIT.Use <— User.Sat	0.10497	0.09370	1.12025	0.26261	0.10252	1.02386	0.30590

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 75: Fit Statistics − Core Constructs in Medical Decision-Making Context

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Core & Medicine	381.568	243	0.054	0.87	0.839	0.861	0.936	0.944

* RMSEA Index 90% CI: (0.043, 0.0636)

Figure 60: Path Diagram − Core Constructs in Medical Decision-Making Context

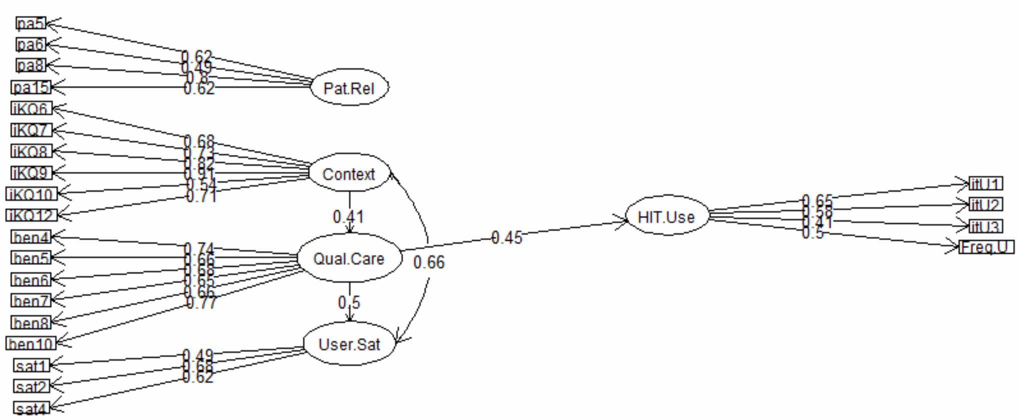


Table 76: Path Statistics − Core Constructs (Efficiency) in Medical Decision-Making Context

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.63507	0.06680	9.50700	0.00000***	0.08535	7.44111	0.00000***
itU2 <— HIT.Use	0.57484	0.05948	9.66471	0.00000***	0.06336	9.07306	0.00000***
itU3 <— HIT.Use	0.40058	0.05985	6.69325	0.00000***	0.05454	7.34509	0.00000***
Freq.U <— HIT.Use	0.49364	0.06158	8.01674	0.00000***	0.08323	5.93132	0.00000***
pa5 <— Pat.Rel	0.61651	0.07680	8.02724	0.00000***	0.09413	6.54926	0.00000***
pa6 <— Pat.Rel	0.47706	0.07787	6.12616	0.00000***	0.07628	6.25374	0.00000***
pa8 <— Pat.Rel	0.82517	0.07396	11.15757	0.00000***	0.06124	13.47381	0.00000***
pa15 <— Pat.Rel	0.59109	0.07277	8.12219	0.00000***	0.08239	7.17407	0.00000***
ben1 <— Efficiency	0.68872	0.05663	12.16185	0.00000***	0.12003	5.73795	0.00000***
ben2 <— Efficiency	0.78923	0.04847	16.28251	0.00000***	0.14845	5.31631	0.00000***
ben11 <— Efficiency	0.66822	0.05702	11.71828	0.00000***	0.05607	11.91844	0.00000***
iKQ6 <— Context	0.67681	0.06487	10.43273	0.00000***	0.10605	6.38221	0.00000***
iKQ7 <— Context	0.73483	0.06281	11.69892	0.00000***	0.10167	7.22737	0.00000***
iKQ8 <— Context	0.81734	0.05975	13.67874	0.00000***	0.36961	2.21135	0.02701*
iKQ9 <— Context	0.91072	0.05634	16.16557	0.00000***	0.09123	9.98267	0.00000***
iKQ10 <— Context	0.54000	0.06822	7.91513	0.00000***	0.07922	6.81650	0.00000***
iKQ12 <— Context	0.71029	0.06413	11.07625	0.00000***	0.10518	6.75287	0.00000***
sat1 <— User.Sat	0.45049	0.04410	10.21627	0.00000***	0.12276	3.66962	0.00024***
sat2 <— User.Sat	0.63621	0.04006	15.88302	0.00000***	0.16532	3.84845	0.00012***
sat3 <— User.Sat	0.62254	0.04057	15.34521	0.00000***	0.16184	3.84671	0.00012***
sat4 <— User.Sat	0.58002	0.04117	14.08823	0.00000***	0.07921	7.32253	0.00000***
Pat.Rel <-> Context	0.17717	0.08322	2.12885	0.03327*	0.10561	1.67762	0.09342
Efficiency <— Pat.Rel	-0.38553	0.09621	-4.00706	0.00006***	0.12892	-2.99051	0.00279**
User.Sat <— Pat.Rel	0.02541	0.09887	0.25696	0.79721	0.10098	0.25159	0.80136
HIT.Use <— Pat.Rel	0.36652	0.12117	3.02478	0.00249**	0.15778	2.32294	0.02018*
Efficiency <— Context	0.41982	0.09028	4.65023	0.00000***	0.10390	4.04075	0.00005***
User.Sat <— Context	0.64795	0.10611	6.10627	0.00000***	0.13235	4.89575	0.00000***
HIT.Use <— Context	0.20887	0.12356	1.69052	0.09093	0.15223	1.37210	0.17003
User.Sat <— Efficiency	0.65721	0.10166	6.46506	0.00000***	0.10983	5.98389	0.00000***
HIT.Use <— Efficiency	0.53728	0.13318	4.03418	0.00005***	0.18908	2.84149	0.00449**
HIT.Use <— User.Sat	0.02168	0.09579	0.22633	0.82095	0.12052	0.17988	0.85724

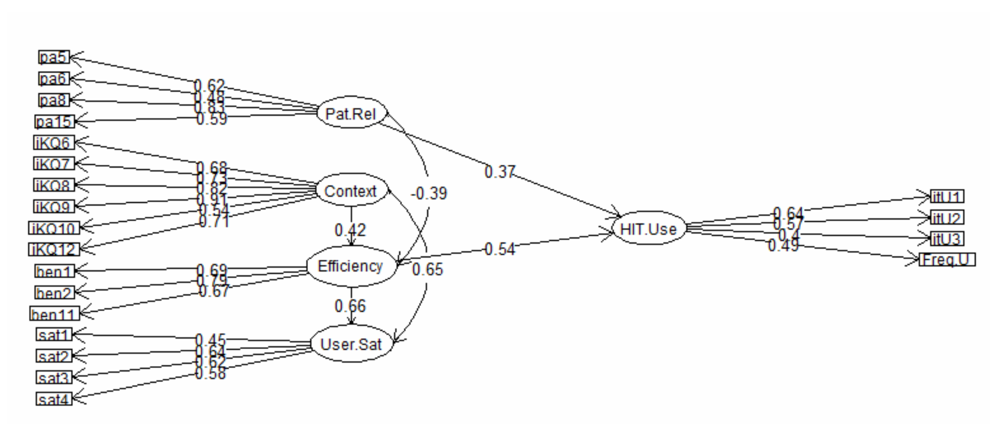
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 77: Fit Statistics − Core Constructs (Efficiency) in Medical Decision-Making Context

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Core-Efficiency & Medicine	323.338	200	0.056	0.876	0.843	0.878	0.941	0.949

* RMSEA Index 90% CI: (0.0443, 0.0666)

Figure 61: Path Diagram − Core Constructs (Efficiency) in Medical Decision-Making Context



DeLone and McLean (1992)

As discussed in Subsection 4.6.4, System Quality could not form a measurement model with System Quality and Knowledge/Information Quality. To test the original model based on the J&O model (2006) does not appear to be practical. An alternative pragmatic approach is to examine the predecessor of its baseline model − the D&M (1992) model.

Table 79 shows that this model does not fit as well as the parsimonious model does (*cf*. Table 75). Figure 62 presents Qual.Care as the only significant determinant of HIT.Use. In fact, Table 78 shows that Context is a significant determinant of HIT.Use and U.Friendly (System Quality) that of Qual.Care at p<0.10. Table 80 also supports the two relationships at p<0.05 and p<0.001 respective, but not that between Context and Efficiency. Table 78 merely supports the D&M (1992) model except for User.Sat is a significant determinant of HIT.Use (see Figure 1 in p.9).

Table 78: Path Statistics − D&M (1992) Class of Integrated Model

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.67279	0.06570	10.23966	0.00000***	0.07397	9.09607	0.00000***
itU2 <— HIT.Use	0.59022	0.05942	9.93320	0.00000***	0.04928	11.97765	0.00000***
itU3 <— HIT.Use	0.40997	0.06142	6.67478	0.00000***	0.05385	7.61314	0.00000***
Freq.U <— HIT.Use	0.50311	0.06255	8.04297	0.00000***	0.07703	6.53164	0.00000***
ben4 <— Qual.Care	0.72771	0.05761	12.63067	0.00000***	0.05344	13.61798	0.00000***
ben5 <— Qual.Care	0.64965	0.05981	10.86264	0.00000***	0.05271	12.32588	0.00000***
ben6 <— Qual.Care	0.66775	0.05911	11.29586	0.00000***	0.05858	11.39940	0.00000***
ben7 <— Qual.Care	0.64104	0.05974	10.73069	0.00000***	0.06207	10.32812	0.00000***
ben8 <— Qual.Care	0.64563	0.05959	10.83545	0.00000***	0.06609	9.76899	0.00000***
ben10 <— Qual.Care	0.75009	0.05500	13.63696	0.00000***	0.03747	20.01764	0.00000***
iKQ6 <— Context	0.67451	0.06493	10.38760	0.00000***	0.05715	11.80254	0.00000***
iKQ7 <— Context	0.73163	0.06288	11.63483	0.00000***	0.05805	12.60277	0.00000***
iKQ8 <— Context	0.81815	0.05967	13.71223	0.00000***	0.05684	14.39464	0.00000***
iKQ9 <— Context	0.91454	0.05615	16.28620	0.00000***	0.02750	33.25664	0.00000***
iKQ10 <— Context	0.54009	0.06820	7.91981	0.00000***	0.07162	7.54100	0.00000***
iKQ12 <— Context	0.70613	0.06426	10.98811	0.00000***	0.05378	13.12885	0.00000***
syQ1 <— U.Friendly	0.88804	0.05639	15.74785	0.00000***	0.03416	25.99520	0.00000***
syQ2 <— U.Friendly	0.84564	0.05837	14.48708	0.00000***	0.04362	19.38595	0.00000***
syQ3 <— U.Friendly	0.92395	0.05496	16.81149	0.00000***	0.02769	33.36798	0.00000***
syQ6 <— U.Friendly	0.73778	0.06230	11.84175	0.00000***	0.05267	14.00838	0.00000***
sat1 <— User.Sat	0.38110	0.03763	10.12677	0.00000***	0.05805	6.56502	0.00000***
sat2 <— User.Sat	0.52753	0.03459	15.25027	0.00000***	0.06019	8.76494	0.00000***
sat4 <— User.Sat	0.48624	0.03618	13.43799	0.00000***	0.04295	11.32165	0.00000***
Context <-> U.Friendly	0.43826	0.06421	6.82527	0.00000***	0.07426	5.90179	0.00000***
Qual.Care <— Context	0.30616	0.09427	3.24763	0.00116**	0.11958	2.56035	0.01046*
User.Sat <— Context	0.44514	0.10576	4.20918	0.00003***	0.12039	3.69759	0.00022***
HIT.Use <— Context	0.22452	0.11543	1.94506	0.05177	0.12662	1.77321	0.07619
Qual.Care <— U.Friendly	0.22322	0.09231	2.41801	0.01561*	0.11964	1.86567	0.06209
User.Sat <— U.Friendly	0.94239	0.12632	7.46026	0.00000***	0.15738	5.98804	0.00000***
HIT.Use <— U.Friendly	0.17841	0.13968	1.27729	0.20150	0.17361	1.02763	0.30412
User.Sat <— Qual.Care	0.47754	0.09626	4.96091	0.00000***	0.10899	4.38143	0.00001***
HIT.Use <— Qual.Care	0.44918	0.11392	3.94302	0.00008***	0.13428	3.34517	0.00082***
HIT.Use <— User.Sat	-0.02386	0.09563	-0.24950	0.80298	0.11323	-0.21070	0.83312

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 79: Fit Statistics − D&M (1992) Class of Integrated Model

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
D&M Type	436.788	243	0.063	0.857	0.823	0.869	0.928	0.937

* RMSEA Index 90% CI: (NA, NA)

Figure 62: Path Diagram − D&M (1992) Class of Integrated Model

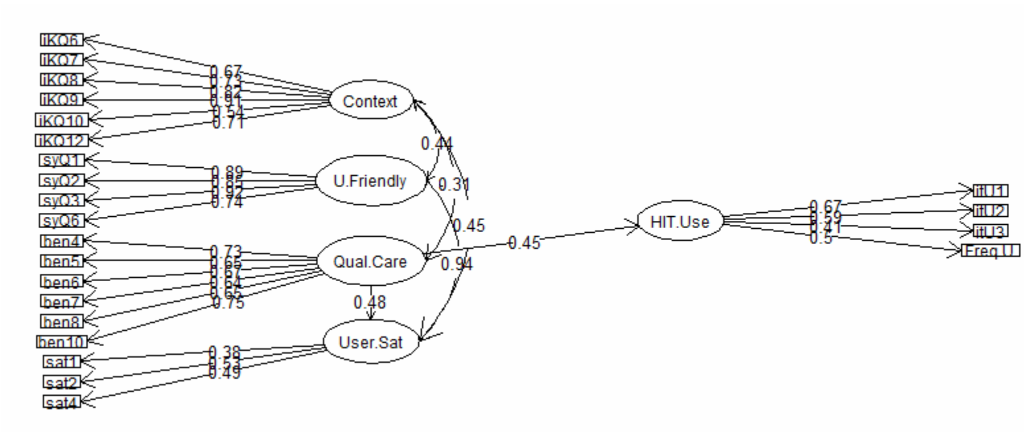


Table 80: Path Statistics − D&M (1992) Model (Efficiency)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.69014	0.06639	10.39465	0.00000***	0.06935	9.95183	0.00000***
itU2 <— HIT.Use	0.60725	0.06007	10.10972	0.00000***	0.05900	10.29203	0.00000***
itU3 <— HIT.Use	0.40762	0.06339	6.43039	0.00000***	0.05730	7.11335	0.00000***
Freq.U <— HIT.Use	0.51985	0.06314	8.23331	0.00000***	0.09907	5.24741	0.00000***
ben1 <— Efficiency	0.69081	0.05529	12.49499	0.00000***	0.04895	14.11304	0.00000***
ben2 <— Efficiency	0.78750	0.04682	16.82143	0.00000***	0.06165	12.77329	0.00000***
ben11 <— Efficiency	0.66539	0.05598	11.88564	0.00000***	0.05285	12.58900	0.00000***
iKQ6 <— Context	0.67602	0.06492	10.41374	0.00000***	0.07871	8.58868	0.00000***
iKQ7 <— Context	0.73312	0.06285	11.66385	0.00000***	0.06934	10.57300	0.00000***
iKQ8 <— Context	0.81675	0.05974	13.67115	0.00000***	0.14563	5.60822	0.00000***
iKQ9 <— Context	0.91364	0.05621	16.25480	0.00000***	0.07294	12.52531	0.00000***
iKQ10 <— Context	0.54003	0.06820	7.91827	0.00000***	0.09272	5.82422	0.00000***
iKQ12 <— Context	0.70735	0.06423	11.01212	0.00000***	0.07010	10.09134	0.00000***
syQ1 <— U.Friendly	0.88757	0.05641	15.73355	0.00000***	0.05081	17.46682	0.00000***
syQ2 <— U.Friendly	0.84521	0.05839	14.47578	0.00000***	0.06070	13.92481	0.00000***
syQ3 <— U.Friendly	0.92419	0.05496	16.81597	0.00000***	0.03849	24.00804	0.00000***
syQ6 <— U.Friendly	0.73884	0.06229	11.86133	0.00000***	0.05387	13.71647	0.00000***
sat1 <— User.Sat	0.36944	0.03684	10.02883	0.00000***	0.07367	5.01477	0.00000***
sat2 <— User.Sat	0.51899	0.03495	14.84940	0.00000***	0.07147	7.26113	0.00000***
sat3 <— User.Sat	0.50869	0.03511	14.48935	0.00000***	0.09090	5.59625	0.00000***
sat4 <— User.Sat	0.47438	0.03525	13.45752	0.00000***	0.18158	2.61243	0.00899**
Context <-> U.Friendly	0.43837	0.06423	6.82531	0.00000***	0.10348	4.23634	0.00002***
Efficiency <— Context	0.16552	0.09096	1.81968	0.06881	0.11740	1.40990	0.15857
User.Sat <— Context	0.52048	0.10578	4.92058	0.00000***	0.13371	3.89256	0.00010***
HIT.Use <— Context	0.28617	0.11644	2.45771	0.01398*	0.12076	2.36979	0.01780*
Efficiency <— U.Friendly	0.42729	0.09559	4.47011	0.00001***	0.12643	3.37977	0.00073***
User.Sat <— U.Friendly	0.84331	0.12524	6.73340	0.00000***	0.17170	4.91159	0.00000***
HIT.Use <— U.Friendly	0.10485	0.13494	0.77703	0.43714	0.16891	0.62076	0.53476
User.Sat <— Efficiency	0.53977	0.09783	5.51727	0.00000***	0.11378	4.74405	0.00000***
HIT.Use <— Efficiency	0.37945	0.11192	3.39046	0.00070***	0.13212	2.87205	0.00408**
HIT.Use <— User.Sat	-0.01754	0.09470	-0.18518	0.85308	0.11781	-0.14887	0.88166

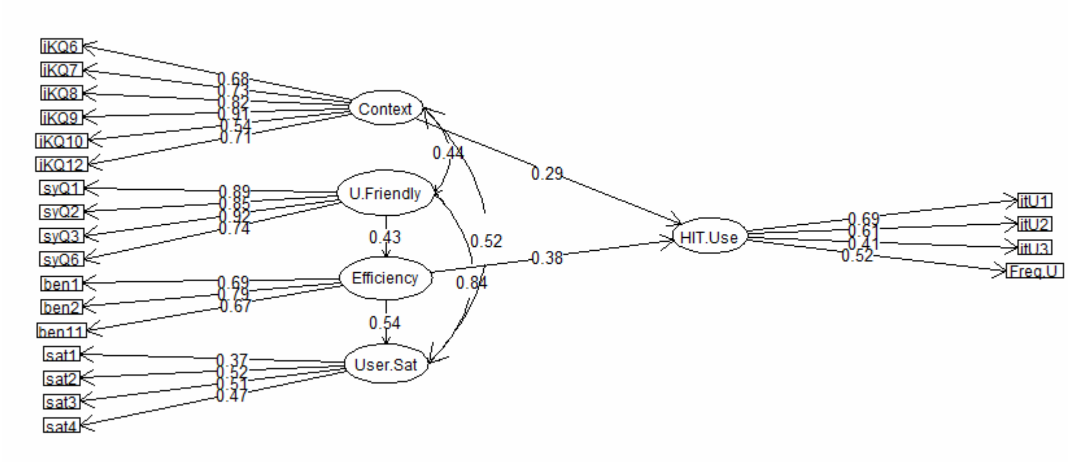
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 81: Fit Statistics − D&M (1992) Model (Efficiency)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
D&M (Efficiency)	359.367	200	0.063	0.864	0.827	0.888	0.938	0.946

* RMSEA Index 90% CI: (NA, NA)

Figure 63: Path Diagram − D&M (1992) Model (Efficiency)



Revised CDSS Use Model

Table 83 shows that the fit of this model is less appealing than the two preceding models shown in Table 75 and Table 79. However, it is also a validated model. The path diagram (Figure 64) again presents Qual.Care as the only significant determinant of HIT.Use. Table 82 shows that Pat.Rel is a significant determinant of HIT.Use and U.Friendly is that of Qual.Care at $p<0.10$. The corresponding relationships seem to be more significant for the model shown in Table 84. The CDSS model appears to be better fitted by the dataset consisting of the Efficiency construct. However, its loading and standard error ratios are not so significant for a few variables. On the other hand, the Efficiency model validates more paths between latent variables. Table 82 and Table 84 suggest that the prediction of the proposed CDSS is reasonably accurate.

Table 82: Path Statistics − CDSS Use Model

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.64800	0.06602	9.81534	0.00000***	0.07447	8.70145	0.00000***
itU2 <— HIT.Use	0.57757	0.05910	9.77195	0.00000***	0.04948	11.67235	0.00000***
itU3 <— HIT.Use	0.40908	0.05986	6.83408	0.00000***	0.04934	8.29039	0.00000***
Freq.U <— HIT.Use	0.49223	0.06196	7.94425	0.00000***	0.07875	6.25026	0.00000***
pa5 <— Pat.Rel	0.61857	0.07623	8.11498	0.00000***	0.08123	7.61533	0.00000***
pa6 <— Pat.Rel	0.49190	0.07825	6.28582	0.00000***	0.09522	5.16595	0.00000***
pa8 <— Pat.Rel	0.79940	0.07505	10.65136	0.00000***	0.06416	12.45980	0.00000***
pa15 <— Pat.Rel	0.61419	0.07363	8.34207	0.00000***	0.07019	8.75024	0.00000***
ben4 <— Qual.Care	0.72693	0.05759	12.62258	0.00000***	0.05317	13.67258	0.00000***
ben5 <— Qual.Care	0.64961	0.05972	10.87732	0.00000***	0.04686	13.86352	0.00000***
ben6 <— Qual.Care	0.66770	0.05903	11.31059	0.00000***	0.05160	12.94097	0.00000***
ben7 <— Qual.Care	0.63918	0.05985	10.67967	0.00000***	0.05571	11.47332	0.00000***
ben8 <— Qual.Care	0.64429	0.05962	10.80641	0.00000***	0.05477	11.76335	0.00000***
ben10 <— Qual.Care	0.74930	0.05499	13.62705	0.00000***	0.03565	21.02089	0.00000***
iKQ6 <— Context	0.67802	0.06501	10.42914	0.00000***	0.06027	11.25029	0.00000***
iKQ7 <— Context	0.73536	0.06297	11.67710	0.00000***	0.04572	16.08312	0.00000***
iKQ8 <— Context	0.82015	0.05981	13.71162	0.00000***	0.05463	15.01234	0.00000***
iKQ9 <— Context	0.91291	0.05639	16.18893	0.00000***	0.02812	32.46278	0.00000***
iKQ10 <— Context	0.54191	0.06837	7.92625	0.00000***	0.07110	7.62134	0.00000***
iKQ12 <— Context	0.71210	0.06427	11.07906	0.00000***	0.04840	14.71239	0.00000***
syQ1 <— U.Friendly	0.88812	0.05639	15.74993	0.00000***	0.03447	25.76258	0.00000***
syQ2 <— U.Friendly	0.84562	0.05837	14.48689	0.00000***	0.03945	21.43575	0.00000***
syQ3 <— U.Friendly	0.92389	0.05496	16.81019	0.00000***	0.02076	44.49776	0.00000***
syQ6 <— U.Friendly	0.73776	0.06230	11.84139	0.00000***	0.04194	17.59283	0.00000***
sat1 <— User.Sat	0.37794	0.03750	10.07982	0.00000***	0.03007	12.56837	0.00000***
sat2 <— User.Sat	0.52377	0.03454	15.16453	0.00000***	0.04150	12.61996	0.00000***
sat4 <— User.Sat	0.48244	0.03612	13.35748	0.00000***	0.03512	13.73709	0.00000***
Pat.Rel <–> Context	0.19699	0.07543	2.61172	0.00901**	0.07385	2.66731	0.00765**
Qual.Care <— Pat.Rel	-0.04873	0.09221	-0.52846	0.59718	0.11211	-0.43466	0.66381
User.Sat <— Pat.Rel	-0.12760	0.09595	-1.32986	0.18357	0.12183	-1.04738	0.29493
HIT.Use <— Pat.Rel	0.21048	0.10715	1.96436	0.04949*	0.12689	1.65883	0.09715
Context <–> U.Friendly	0.44361	0.06291	7.05157	0.00000***	0.07552	5.87424	0.00000***
Qual.Care <— Context	0.31952	0.09835	3.24875	0.00116**	0.12701	2.51565	0.01188*
User.Sat <— Context	0.48272	0.11149	4.32977	0.00001***	0.12738	3.78954	0.00015***
HIT.Use <— Context	0.16649	0.12172	1.36787	0.17135	0.14924	1.11564	0.26458
Qual.Care <— U.Friendly	0.21639	0.09340	2.31679	0.02051*	0.12032	1.79836	0.07212
User.Sat <— U.Friendly	0.93286	0.12668	7.36403	0.00000***	0.17178	5.43059	0.00000***
HIT.Use <— U.Friendly	0.18382	0.14168	1.29739	0.19450	0.18262	1.00659	0.31413
User.Sat <— Qual.Care	0.47452	0.09656	4.91438	0.00000***	0.11789	4.02502	0.00006***
HIT.Use <— Qual.Care	0.46118	0.11635	3.96376	0.00007***	0.13793	3.34362	0.00083***
HIT.Use <— User.Sat	0.00232	0.09744	0.02379	0.98102	0.10864	0.02133	0.98298

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 83: Fit Statistics − CDSS Use Model

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
CDSS Use	579.053	337	0.06	0.839	0.807	0.841	0.917	0.926

* RMSEA Index 90% CI: (NA, NA)

Figure 64: Path Diagram – CDSS Use Model

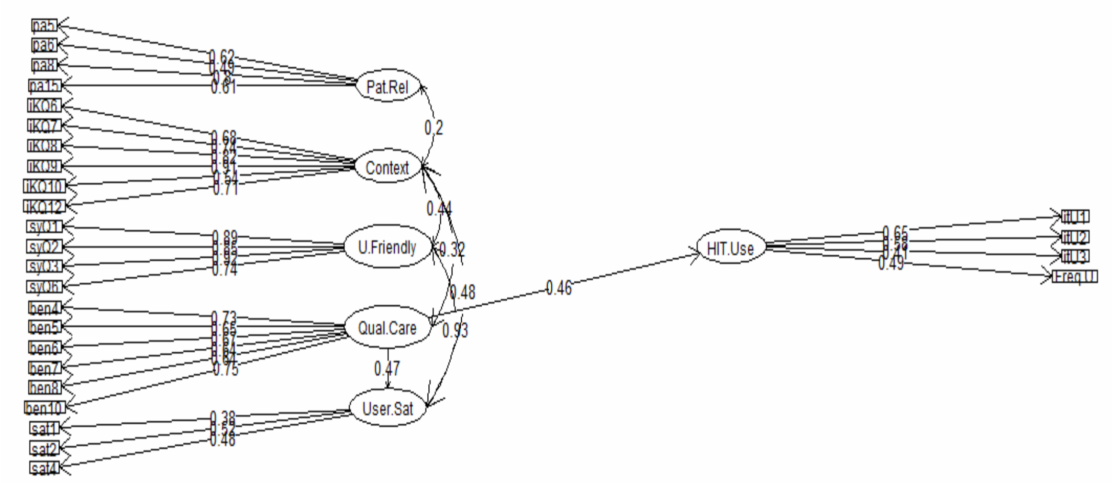


Table 84: Path Statistics – CDSS Use Model (Efficiency)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	$\Pr(>\lvert z\rvert)$	Std. Error	z value	$\Pr(>\lvert z\rvert)$
itU1 <— HIT.Use	0.63481	0.06664	9.52664	0.00000***	0.08201	7.74083	0.00000***
itU2 <— HIT.Use	0.57340	0.05930	9.66885	0.00000***	0.04999	11.47083	0.00000***
itU3 <— HIT.Use	0.39788	0.05983	6.65046	0.00000***	0.04366	9.11233	0.00000***
Freq.U <— HIT.Use	0.49244	0.06139	8.02111	0.00000***	0.07687	6.40574	0.00000***
pa5 <— Pat.Rel	0.61791	0.07666	8.06012	0.00000***	0.07994	7.72917	0.00000***
pa6 <— Pat.Rel	0.47893	0.07776	6.15927	0.00000***	0.08898	5.38237	0.00000***
pa8 <— Pat.Rel	0.82345	0.07386	11.14835	0.00000***	0.06582	12.50999	0.00000***
pa15 <— Pat.Rel	0.59061	0.07280	8.11248	0.00000***	0.07027	8.40503	0.00000***
ben1 <— Efficiency	0.64828	0.05366	12.08212	0.00000***	0.04602	14.08659	0.00000***
ben2 <— Efficiency	0.74282	0.04619	16.08330	0.00000***	0.05088	14.59907	0.00000***
ben11 <— Efficiency	0.62901	0.05396	11.65699	0.00000***	0.04597	13.68396	0.00000***
iKQ6 <— Context	0.67867	0.06502	10.43818	0.00000***	0.06711	10.11299	0.00000***
iKQ7 <— Context	0.73607	0.06297	11.68895	0.00000***	0.04626	15.91196	0.00000***
iKQ8 <— Context	0.81957	0.05986	13.69049	0.00000***	0.06100	13.43504	0.00000***
iKQ9 <— Context	0.91280	0.05642	16.17981	0.00000***	0.03668	24.88753	0.00000***
iKQ10 <— Context	0.54153	0.06838	7.91934	0.00000***	0.06623	8.17639	0.00000***
iKQ12 <— Context	0.71248	0.06428	11.08443	0.00000***	0.04734	15.05167	0.00000***
syQ1 <— U.Friendly	0.88757	0.05641	15.73311	0.00000***	0.03687	24.07489	0.00000***
syQ2 <— U.Friendly	0.84527	0.05839	14.47737	0.00000***	0.03702	22.83529	0.00000***
syQ3 <— U.Friendly	0.92411	0.05496	16.81365	0.00000***	0.04000	23.10021	0.00000***
syQ6 <— U.Friendly	0.73889	0.06229	11.86248	0.00000***	0.05067	14.58195	0.00000***
sat1 <— User.Sat	0.36931	0.03683	10.02734	0.00000***	0.06620	5.57894	0.00000***
sat2 <— User.Sat	0.51871	0.03498	14.82793	0.00000***	0.15920	3.25823	0.00112**
sat3 <— User.Sat	0.50839	0.03514	14.46898	0.00000***	0.05265	9.65569	0.00000***
sat4 <— User.Sat	0.47415	0.03526	13.44690	0.00000***	0.11444	4.14306	0.00003***
Pat.Rel <-> Context	0.19372	0.07510	2.57955	0.00989**	0.08406	2.30467	0.02119*
Efficiency <— Pat.Rel	-0.36151	0.09703	-3.72574	0.00019***	0.10681	-3.38471	0.00071***
User.Sat <— Pat.Rel	0.03421	0.10166	0.33647	0.73652	0.11518	0.29697	0.76649
HIT.Use <— Pat.Rel	0.36835	0.12142	3.03375	0.00242**	0.16066	2.29276	0.02186*
Context <-> U.Friendly	0.44379	0.06292	7.05303	0.00000***	0.06820	6.50742	0.00000***
Efficiency <— Context	0.26144	0.09850	2.65425	0.00795**	0.12215	2.14037	0.03232*
User.Sat <— Context	0.51278	0.11070	4.63208	0.00000***	0.14338	3.57639	0.00035***
HIT.Use <— Context	0.20695	0.12395	1.66966	0.09499	0.14092	1.46858	0.14195
Efficiency <— U.Friendly	0.40591	0.09762	4.15802	0.00003***	0.11679	3.47556	0.00051***
User.Sat <— U.Friendly	0.84221	0.12533	6.72017	0.00000***	0.18190	4.62999	0.00000***
HIT.Use <— U.Friendly	0.11446	0.14042	0.81507	0.41503	0.16111	0.71045	0.47743
User.Sat <— Efficiency	0.52002	0.09942	5.23054	0.00000***	0.12006	4.33129	0.00001***
HIT.Use <— Efficiency	0.50793	0.12556	4.04521	0.00005***	0.16552	3.06875	0.00215**
HIT.Use <— User.Sat	-0.02854	0.09877	-0.28896	0.77261	0.10560	-0.27028	0.78695

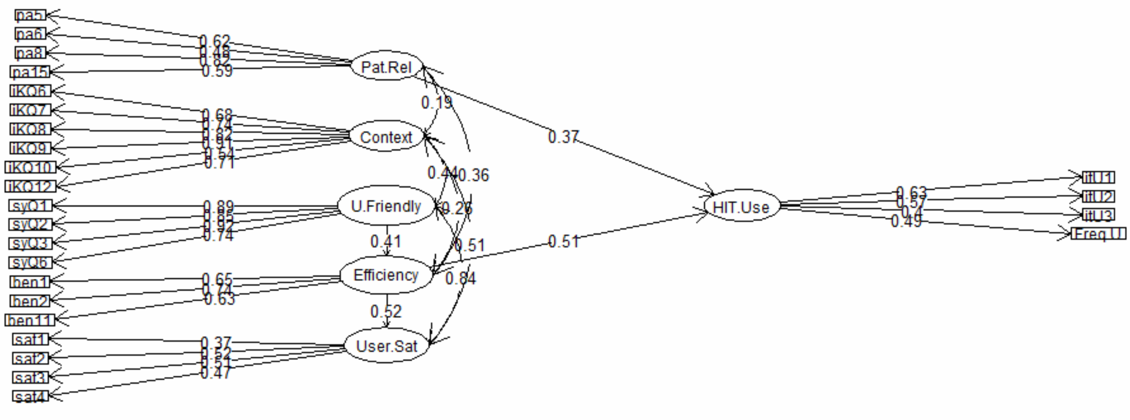
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 85: Fit Statistics − CDSS Use Model (Efficiency)

	χ^2	*df*	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
CDSS-Efficiency Use	491.8	286	0.06	0.847	0.812	0.86	0.927	0.936

* RMSEA Index 90% CI: (NA, NA)

Figure 65: Path Diagram − CDSS Use Model (Efficiency)



CDSS Use Model in Donabedian's (1980) Framework

So far, the results suggest that User Satisfaction impacts CDSS Use slightly. Hebert (2001) has formulated a model based on the D&M (1992) model and the taxonomy of Donabedian's (1980) quality of care assessment model. The author (*op. cit.*) notes that D&M's (1992) Information Quality and System Quality correspond to Donabedian's (1980) Structure construct, and Individual and Organisational Impacts to Donabedian's (1980) Outcome construct. In that framework, User satisfaction is not included (Hebert, 2001). It appears that Pat.Rel fulfils the definition of Hebert's (2001) Process of Care construct. It would be interesting to examine this line of thinking while the available data makes it possible to do so.

Table 87 shows that the fit of this model appears to be better than that of the revised CDSS Use model (*cf.* Table 83). However, the degrees of freedom (*df*'s) are substantially smaller. Raykov and Marcoulides (2006) note that a model with more *df*'s offers more dimensions to disconfirm it. It is generally the preferred model (*ibid.*). Table 86 and Figure 66 show that the implications of this model are similar to that of the CDSS Use model. The result may indicate that User Satisfaction should not be eliminated. This conclusion extends to the models built on the Efficiency construct (see Table 88 and Table 89).

Table 86: Path Statistics − CDSS Use in Donabedian's (1980) Framework

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	$\Pr(>\lvert z\rvert)$	Std. Error	z value	$\Pr(>\lvert z\rvert)$
itU1 <— HIT.Use	0.65002	0.06597	9.85344	0.00000***	0.07094	9.16290	0.00000***
itU2 <— HIT.Use	0.57676	0.05906	9.76535	0.00000***	0.06310	9.14008	0.00000***
itU3 <— HIT.Use	0.40872	0.05987	6.82687	0.00000***	0.08237	4.96221	0.00000***
Freq.U <— HIT.Use	0.49238	0.06191	7.95344	0.00000***	0.09908	4.96962	0.00000***
pa5 <— Pat.Rel	0.61803	0.07651	8.07785	0.00000***	0.09674	6.38892	0.00000***
pa6 <— Pat.Rel	0.49323	0.07851	6.28233	0.00000***	0.11982	4.11652	0.00004***
pa8 <— Pat.Rel	0.80133	0.07550	10.61433	0.00000***	0.07620	10.51654	0.00000***
pa15 <— Pat.Rel	0.61118	0.07362	8.30200	0.00000***	0.08855	6.90175	0.00000***
ben4 <— Qual.Care	0.72366	0.05777	12.52633	0.00000***	0.12100	5.98087	0.00000***
ben5 <— Qual.Care	0.64884	0.05986	10.83923	0.00000***	0.06572	9.87318	0.00000***
ben6 <— Qual.Care	0.66607	0.05914	11.26171	0.00000***	0.06989	9.52994	0.00000***
ben7 <— Qual.Care	0.64119	0.05987	10.70946	0.00000***	0.07234	8.86417	0.00000***
ben8 <— Qual.Care	0.64314	0.05974	10.76496	0.00000***	0.22393	2.87207	0.00408**
ben10 <— Qual.Care	0.75187	0.05494	13.68410	0.00000***	0.05125	14.66991	0.00000***
iKQ6 <— Context	0.67662	0.06513	10.38933	0.00000***	0.21664	3.12330	0.00179**
iKQ7 <— Context	0.73541	0.06305	11.66423	0.00000***	0.29631	2.48188	0.01307*
iKQ8 <— Context	0.82392	0.05973	13.79486	0.00000***	0.15425	5.34128	0.00000***
iKQ9 <— Context	0.91313	0.05647	16.17146	0.00000***	0.09664	9.44864	0.00000***
iKQ10 <— Context	0.54057	0.06846	7.89574	0.00000***	0.15376	3.51558	0.00044***
iKQ12 <— Context	0.70831	0.06443	10.99391	0.00000***	0.14574	4.85998	0.00000***
syQ1 <— U.Friendly	0.89176	0.05618	15.87422	0.00000***	0.29860	2.98645	0.00282**
syQ2 <— U.Friendly	0.83518	0.05874	14.21912	0.00000***	0.22416	3.72579	0.00019***
syQ3 <— U.Friendly	0.93360	0.05458	17.10368	0.00000***	0.20233	4.61431	0.00000***
syQ6 <— U.Friendly	0.72590	0.06270	11.57741	0.00000***	0.29071	2.49695	0.01253*
Pat.Rel <-> Context	0.19712	0.07563	2.60638	0.00915**	0.09240	2.13338	0.03289*
Qual.Care <— Pat.Rel	-0.04928	0.09220	-0.53445	0.59303	0.14383	-0.34259	0.73191
HIT.Use <— Pat.Rel	0.21023	0.10585	1.98614	0.04702*	0.13330	1.57710	0.11477
Context <-> U.Friendly	0.43615	0.06312	6.90955	0.00000***	0.11952	3.64914	0.00026***
Qual.Care <— Context	0.32289	0.09790	3.29830	0.00097***	0.12978	2.48799	0.01285*
HIT.Use <— Context	0.16776	0.11140	1.50589	0.13209	0.15221	1.10213	0.27040
Qual.Care <— U.Friendly	0.21543	0.09269	2.32429	0.02011*	0.14704	1.46517	0.14287
HIT.Use <— U.Friendly	0.18621	0.10449	1.78210	0.07473	0.13285	1.40165	0.16102
HIT.Use <— Qual.Care	0.46132	0.10531	4.38051	0.00001***	0.15733	2.93221	0.00337**

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 87: Fit Statistics − CDSS Use in Donabedian's (1980) Framework

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Donabedian	446.145	243	0.065	0.851	0.816	0.83	0.902	0.913

* RMSEA Index 90% CI: (NA, NA)

Figure 66: Path Diagram − CDSS Use in Donabedian's (1980) Framework

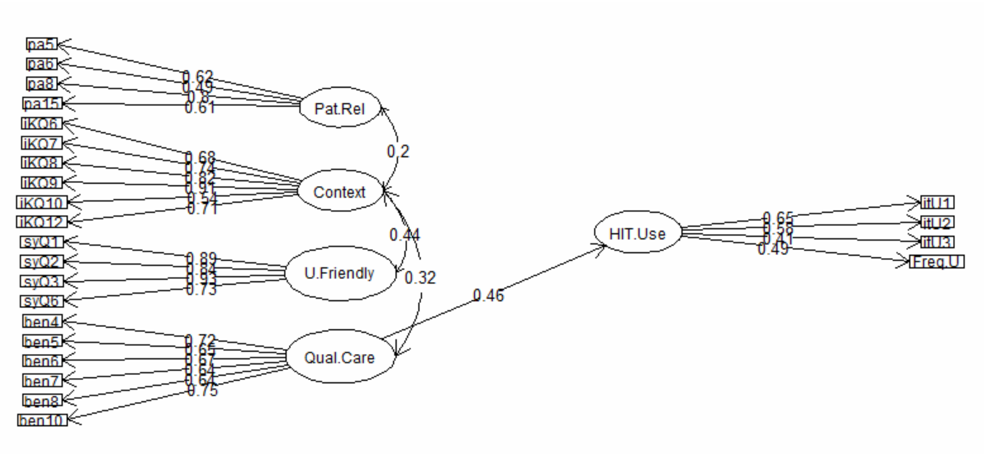


Table 88: Path Statistics − Donabedian-CDSS Use Model (Efficiency)

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.63555	0.06657	9.54771	0.00000***	0.09011	7.05330	0.00000***
itU2 <— HIT.Use	0.57289	0.05919	9.67804	0.00000***	0.06470	8.85385	0.00000***
itU3 <— HIT.Use	0.39768	0.05977	6.65351	0.00000***	0.07459	5.33143	0.00000***
Freq.U <— HIT.Use	0.49267	0.06130	8.03653	0.00000***	0.07324	6.72671	0.00000***
pa5 <— Pat.Rel	0.61773	0.07663	8.06122	0.00000***	0.08930	6.91720	0.00000***
pa6 <— Pat.Rel	0.47864	0.07774	6.15706	0.00000***	0.09632	4.96939	0.00000***
pa8 <— Pat.Rel	0.82346	0.07382	11.15426	0.00000***	0.07188	11.45670	0.00000***
pa15 <— Pat.Rel	0.59105	0.07276	8.12353	0.00000***	0.08586	6.88403	0.00000***
ben1 <— Efficiency	0.64721	0.05376	12.03873	0.00000***	0.11906	5.43587	0.00000***
ben2 <— Efficiency	0.74528	0.04612	16.15914	0.00000***	0.21259	3.50575	0.00046***
ben11 <— Efficiency	0.62379	0.05413	11.52464	0.00000***	0.10300	6.05614	0.00000***
iKQ6 <— Context	0.67458	0.06518	10.34953	0.00000***	0.08676	7.77487	0.00000***
iKQ7 <— Context	0.73477	0.06308	11.64761	0.00000***	0.06090	12.06555	0.00000***
iKQ8 <— Context	0.82566	0.05967	13.83635	0.00000***	0.10217	8.08154	0.00000***
iKQ9 <— Context	0.91375	0.05645	16.18642	0.00000***	0.06629	13.78497	0.00000***
iKQ10 <— Context	0.53870	0.06850	7.86391	0.00000***	0.07944	6.78156	0.00000***
iKQ12 <— Context	0.70819	0.06445	10.98749	0.00000***	0.06793	10.42479	0.00000***
syQ1 <— U.Friendly	0.89195	0.05617	15.87967	0.00000***	0.11277	7.90981	0.00000***
syQ2 <— U.Friendly	0.83680	0.05868	14.25973	0.00000***	0.11511	7.26948	0.00000***
syQ3 <— U.Friendly	0.93230	0.05462	17.06855	0.00000***	0.09446	9.86995	0.00000***
syQ6 <— U.Friendly	0.72598	0.06267	11.58493	0.00000***	0.09995	7.26347	0.00000***
Pat.Rel <-> Context	0.19376	0.07527	2.57408	0.01005*	0.09332	2.07614	0.03788*
Efficiency <— Pat.Rel	-0.36215	0.09695	-3.73530	0.00019***	0.11111	-3.25924	0.00112**
HIT.Use <— Pat.Rel	0.36776	0.12110	3.03691	0.00239**	0.14344	2.56388	0.01035*
Context <-> U.Friendly	0.43693	0.06310	6.92496	0.00000***	0.08896	4.91170	0.00000***
Efficiency <— Context	0.26512	0.09796	2.70637	0.00680**	0.12590	2.10583	0.03522*
HIT.Use <— Context	0.19227	0.11180	1.71977	0.08547	0.13775	1.39578	0.16278
Efficiency <— U.Friendly	0.40248	0.09680	4.15773	0.00003***	0.13091	3.07460	0.00211**
HIT.Use <— U.Friendly	0.09171	0.10993	0.83427	0.40413	0.12633	0.72596	0.46787
HIT.Use <— Efficiency	0.49354	0.11137	4.43154	0.00001***	0.14995	3.29135	0.00100***

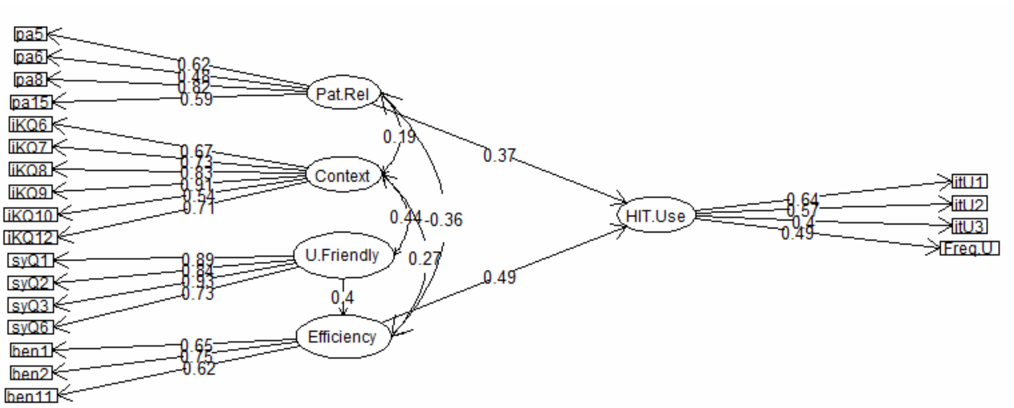
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 89: Fit Statistics − Donabedian-CDSS Use Model (Efficiency)

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Donabedian-Efficiency	366.329	201	0.064	0.862	0.826	0.853	0.916	0.927

* RMSEA Index 90% CI: (NA, NA)

Figure 67: Path Diagram − Donabedian-CDSS Use Model (Efficiency)



Outcome and CDSS Use Model

Perhaps it may also be interesting to explore the relationship between medical decision-making factors, outcome and use. This model obtains the highest AGFI and GFI levels (see Table 91). The path diagram (Figure 68) presents Context and Qual.Care to be the significant determinants of HIT.Use. Table 91 shows that Pat.Rel significantly associates with Context at $p<0.10$. Table 92 confirms all the hypothesised relationships between latent variables despite the fact that two paths are only significant at $p<0.10$. From a KM perspective, these two models consistently show that Knowledge aspects impact HIT/CDSS Use directly.

Table 90: Path Statistics − Outcome and HIT/CDSS Acceptance Model

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.65964	0.06676	9.88122	0.00000***	0.06894	9.56792	0.00000***
itU2 <— HIT.Use	0.58252	0.05980	9.74058	0.00000***	0.05702	10.21526	0.00000***
itU3 <— HIT.Use	0.41669	0.06048	6.88979	0.00000***	0.05253	7.93293	0.00000***
Freq.U <— HIT.Use	0.49812	0.06270	7.94476	0.00000***	0.07753	6.42517	0.00000***
pa5 <— Pat.Rel	0.62108	0.07707	8.05879	0.00000***	0.07411	8.38033	0.00000***
pa6 <— Pat.Rel	0.49479	0.07889	6.27198	0.00000***	0.08991	5.50320	0.00000***
pa8 <— Pat.Rel	0.80049	0.07622	10.50214	0.00000***	0.07359	10.87835	0.00000***
pa15 <— Pat.Rel	0.60785	0.07372	8.24491	0.00000***	0.06667	9.11800	0.00000***
ben4 <— Qual.Care	0.73797	0.05868	12.57609	0.00000***	0.04966	14.85908	0.00000***
ben5 <— Qual.Care	0.66266	0.06072	10.91372	0.00000***	0.04586	14.44965	0.00000***
ben6 <— Qual.Care	0.68348	0.05954	11.47841	0.00000***	0.04520	15.12157	0.00000***
ben7 <— Qual.Care	0.65334	0.06093	10.72218	0.00000***	0.05584	11.69999	0.00000***
ben8 <— Qual.Care	0.65531	0.06081	10.77675	0.00000***	0.06315	10.37632	0.00000***
ben10 <— Qual.Care	0.76140	0.05652	13.47093	0.00000***	0.04235	17.97932	0.00000***
iKQ6 <— Context	0.67216	0.06509	10.32735	0.00000***	0.05479	12.26811	0.00000***
iKQ7 <— Context	0.73897	0.06280	11.76689	0.00000***	0.05210	14.18460	0.00000***
iKQ8 <— Context	0.82200	0.05962	13.78641	0.00000***	0.05250	15.65849	0.00000***
iKQ9 <— Context	0.91254	0.05637	16.18786	0.00000***	0.03332	27.38610	0.00000***
iKQ10 <— Context	0.53629	0.06838	7.84326	0.00000***	0.07732	6.93594	0.00000***
iKQ12 <— Context	0.70093	0.06443	10.87913	0.00000***	0.05614	12.48485	0.00000***
Pat.Rel <-> Context	0.18138	0.08363	2.16879	0.03010*	0.09664	1.87687	0.06054
Qual.Care <— Pat.Rel	-0.07353	0.09122	-0.80606	0.42021	0.10379	-0.70847	0.47865
HIT.Use <— Pat.Rel	0.18822	0.10416	1.80706	0.07075	0.11899	1.58177	0.11370
Qual.Care <— Context	0.41015	0.08907	4.60498	0.00000***	0.11360	3.61041	0.00031***
HIT.Use <— Context	0.23615	0.10314	2.28966	0.02204*	0.11803	2.00068	0.04543*
HIT.Use <— Qual.Care	0.49582	0.10650	4.65577	0.00000***	0.11476	4.32030	0.00002***

* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 91: Fit Statistics − Outcome and HIT/CDSS Acceptance Model

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Outcome & Use	256.079	164	0.053	0.887	0.856	0.859	0.934	0.943

* RMSEA Index 90% CI: (0.0401, 0.0654)

Figure 68: Path Diagram − Outcome and HIT/CDSS Acceptance Model

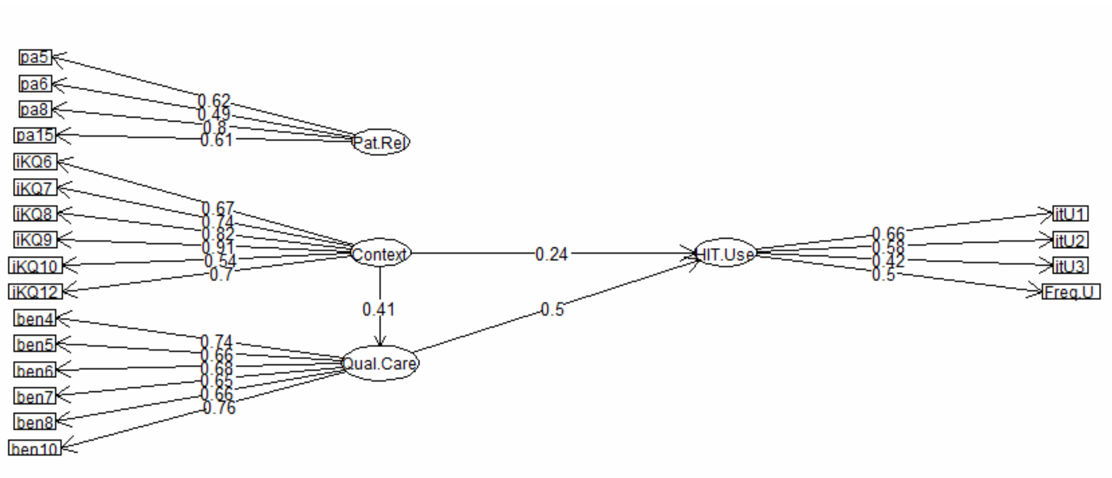


Table 92: Path Statistics − Outcome-Efficiency and HIT/CDSS Acceptance Model

	Estimate	Maximum Likelihood			Nonparametric Bootstrap		
		Std. Error	z value	Pr(>|z|)	Std. Error	z value	Pr(>|z|)
itU1 <— HIT.Use	0.63800	0.06697	9.52621	0.00000***	0.07831	8.14736	0.00000***
itU2 <— HIT.Use	0.57459	0.05955	9.64802	0.00000***	0.05767	9.96289	0.00000***
itU3 <— HIT.Use	0.40117	0.05996	6.69053	0.00000***	0.06716	5.97319	0.00000***
Freq.U <— HIT.Use	0.49471	0.06164	8.02607	0.00000***	0.09212	5.37052	0.00000***
pa5 <— Pat.Rel	0.61645	0.07682	8.02489	0.00000***	0.08086	7.62380	0.00000***
pa6 <— Pat.Rel	0.47683	0.07787	6.12315	0.00000***	0.08429	5.65716	0.00000***
pa8 <— Pat.Rel	0.82546	0.07400	11.15553	0.00000***	0.06341	13.01711	0.00000***
pa15 <— Pat.Rel	0.59090	0.07268	8.13018	0.00000***	0.08045	7.34512	0.00000***
ben1 <— Efficiency	0.68723	0.05673	12.11437	0.00000***	0.10585	6.49233	0.00000***
ben2 <— Efficiency	0.79177	0.04842	16.35168	0.00000***	0.06877	11.51272	0.00000***
ben11 <— Efficiency	0.66266	0.05722	11.58138	0.00000***	0.07004	9.46127	0.00000***
iKQ6 <— Context	0.66937	0.06513	10.27796	0.00000***	0.07473	8.95678	0.00000***
iKQ7 <— Context	0.73692	0.06285	11.72482	0.00000***	0.05765	12.78201	0.00000***
iKQ8 <— Context	0.82450	0.05952	13.85224	0.00000***	0.08379	9.84006	0.00000***
iKQ9 <— Context	0.91321	0.05633	16.21317	0.00000***	0.04111	22.21445	0.00000***
iKQ10 <— Context	0.53443	0.06840	7.81335	0.00000***	0.07903	6.76243	0.00000***
iKQ12 <— Context	0.70119	0.06443	10.88308	0.00000***	0.07637	9.18170	0.00000***
Pat.Rel <-> Context	0.17625	0.08318	2.11886	0.03410*	0.09956	1.77033	0.07667
Efficiency <— Pat.Rel	-0.38461	0.09608	-4.00314	0.00006***	0.09640	-3.98970	0.00007***
HIT.Use <— Pat.Rel	0.36488	0.12094	3.01705	0.00255**	0.11893	3.06815	0.00215**
Efficiency <— Context	0.41887	0.09006	4.65098	0.00000***	0.10047	4.16908	0.00003***
HIT.Use <— Context	0.22314	0.10516	2.12187	0.03385*	0.12602	1.77063	0.07662
HIT.Use <— Efficiency	0.54810	0.11365	4.82248	0.00000***	0.13659	4.01282	0.00006***

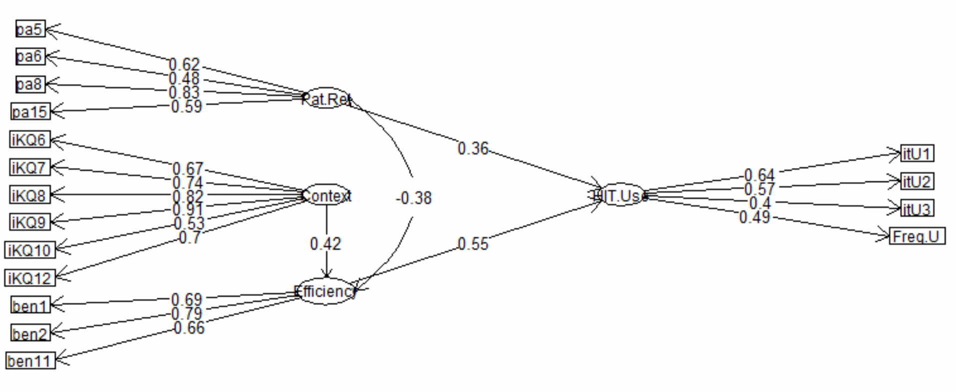
* indicates significance at $p<0.05$, ** at $p<0.01$ and *** at $p<0.001$

Table 93: Fit Statistics − Outcome-Efficiency and HIT/CDSS Acceptance Model

	χ^2	df	RMSEA	GFI	AGFI	NFI	NNFI/TLI	CFI
Outcome-Efficiency & Use	216.374	130	0.058	0.895	0.862	0.874	0.935	0.945

* RMSEA Index 90% CI: (0.0439, 0.0711)

Figure 69: Path Diagram − Outcome-Efficiency and HIT/CDSS Acceptance Model



The above results show that the models built on Efficiency fit the data slightly better than those built on Qual.Care. However, the degrees of freedom of the latter models are substantially larger than that of the former models. So, the latter ones are the preferred models as there are more dimensions to disconfirm them (see Raykov & Marcoulides, 2006). Ideally, the changes in χ^2 statistics should also be analysed (*ibid.*). Due to the prevalence of severe non-normality, reliable conclusions cannot be drawn from the comparisons of changes in χ^2.

The results presented in this subsection appear to validate all these models to some extent. The choice of model is depended on the policy goal and objective. For example, the models built on Quality of Care are more medical-specific in comparison with those built on Efficiency. The former models may be more relevant to eHealth policy-making. The D&M (1992) model may be more relevant for making IT investment decisions. A policy-maker who is keen on making decisions from a more dynamic view may prefer the CDSS Use model. A medical care unit head may prefer the Donabedian (1980) type of CDSS Use model or the Outcome (-Efficiency) and HIT/CDSS Acceptance model where quality of care and/or the process are emphasised.

4.8.2 The Generalised CDSS Use Model

The results of the integrated model have been shown in Table 82 to Table 85 and depicted in Figure 64 and Figure 65. The NFI's are below the threshold level. However, other fit indices suggest that the models fit the data reasonably well. This result is, therefore, considered to be acceptable. Perhaps readers may also wish to know the respective item correlation matrix and two-tailed *t*-test result in Appendix III.

Figure 64 and Figure 65 depict the models in terms of the item identities. This approach allows readers to trace back the items and apply their own interpretations to evaluate the models. Figure 70 and Figure 71 may be the more reader-friendly versions. Figure 72 summarises the results shown in Table 70, Table 72, Table 82 and Table 84, and re-expresses them in the IS Success terminology. It is preceded by the originally proposed CDSS Use model (Figure 2, p.204).

Figure 70: Path Diagram − Re-expression of the CDSS Use Model

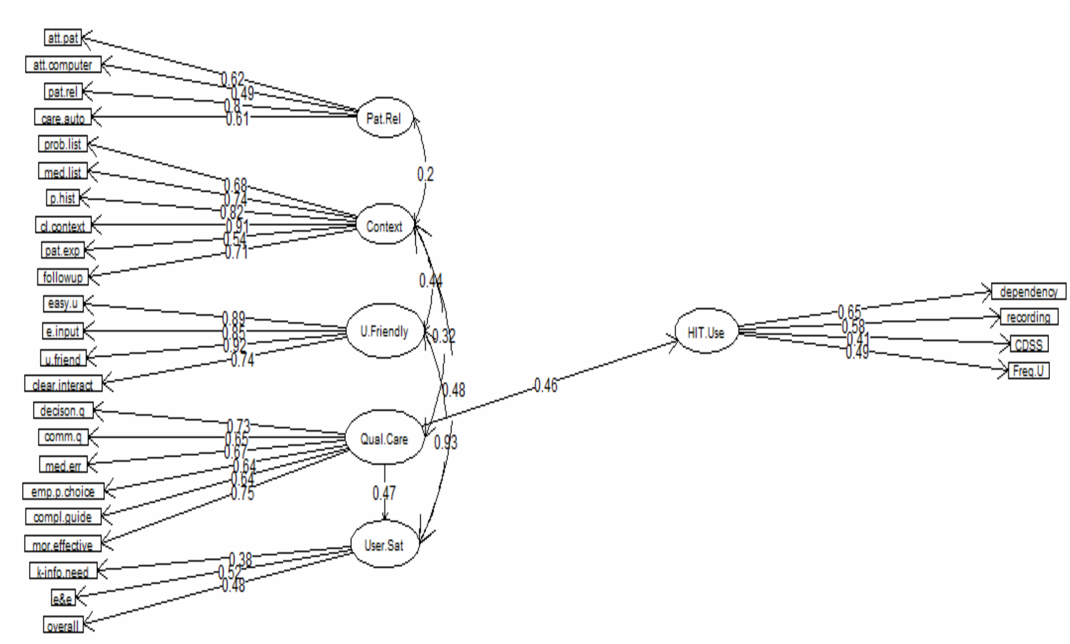


Figure 71: Path Diagram − Re-expression of the CDSS Use Model (Efficiency)

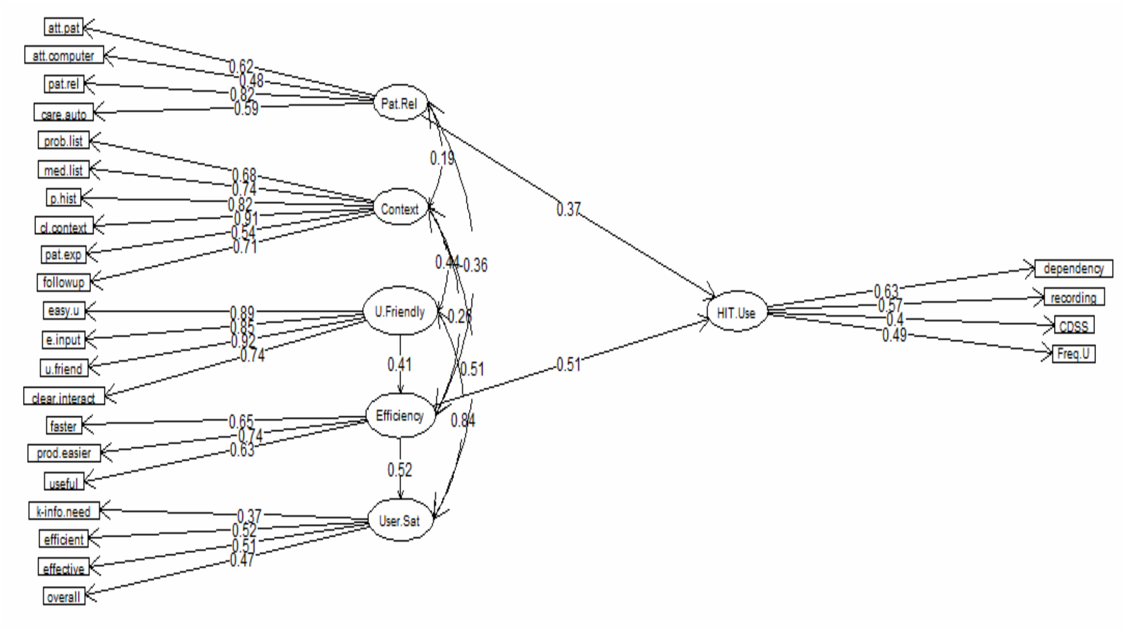


Figure 2: The *A Prior* CDSS Use Model

(Duplicate)

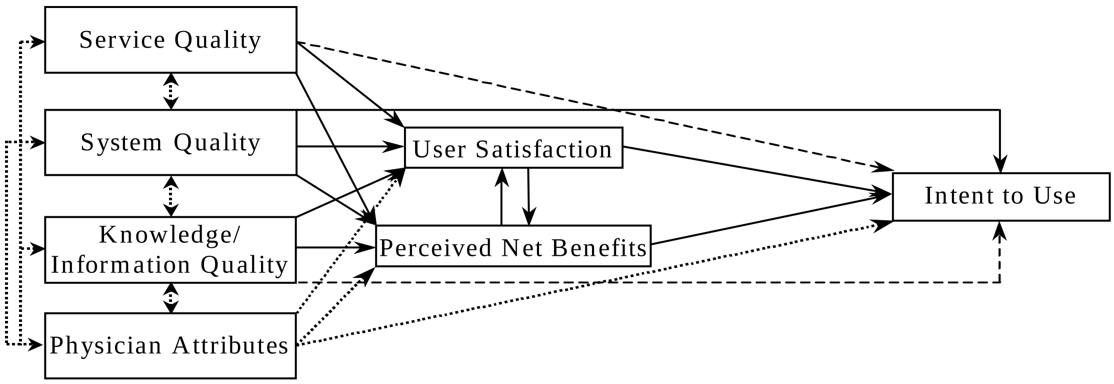
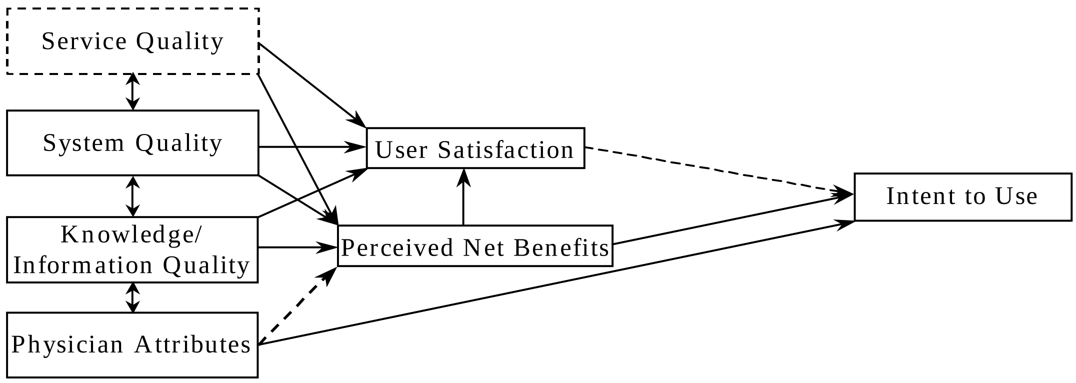


Figure 72: The Validated CDSS Use Model



The results presented in Subsection 4.6.4 suggest that Service Quality cannot be introduced into the non-core part. This conclusion is expected given that the introduction of Service Quality into the DeLone and McLean (1992; 2003) framework has been debatable (Petter *et al.*, 2008). Service Quality is introduced into Figure 72 based on the results shown in Table 70 and Table 72. It is depicted in dashed borders to indicate that it was not tested with the other constructs simultaneously.

The relationships among the other six constructs are depicted based on the results shown in Table 82 and Table 84. The path between Physician Attributes and User Satisfaction is in a dashed path since it is only supported by the statistics in Table 84.

DeLone and McLean's (1992) seminal paper note that the impacts of User Satisfaction on Intent to Use/Use could be positive, negative or neutral. In fact, User Satisfaction tends to be positively related to HIT usage (Hikmet & Bhattacherjee, 2009), and strongly related to Use when measured by System Dependence (Rai *et al.*, 2002). The model replicates this proposition, but the effect is shown to be insignificant except for the statistics in Table 70. It would be prudent to assume that User Satisfaction has impacts on HIT/CDSS Use. In further research, it may be interesting to refine the definition of User Satisfaction and Intent to Use to see if stronger evidence can be obtained to support this assumption. From a policymaking perspective, it will be interesting to find out the mechanism to channel the impacts of the non-core constructs on User Satisfaction into positive and significant influence on HIT/CDSS use.

The impacts of System Quality on HIT/CDSS use appear to be channelled by Perceived Net Benefits and Physician Attributes through Knowledge/Information Quality. As repeatedly mentioned, medical decision-making is a KM process. Trivially, Knowledge/Information Quality and System Quality are inseparable elements for building a system that can positively impact knowledge work. The result does show that they are significantly associated (correlation: 0.44; see Table 82 and Table 84). Turunen (2009) notes that models for evaluating Health Information Systems "have been almost nonexistent" (p.580). The Physician Attributes construct is largely developed from the reading of different disciplines. No *a priori* information could accurately predict its impacts. Both Table 82 and Table 84 show that it significantly impacts HIT/CDSS use and Knowledge/Information Quality at different significance levels. It supports the proposition that the contexts of medical practice should be introduced into the assessment/evaluation of CDSS Use and its impacts.

4.9. CONCLUSION

This chapter focuses on the results regarding the performance of the proposed CDSS Use model and that of the survey instrument. It also presents statistics about respondents' characteristics and the performance of the approach for gathering potential respondent information.

At the onset of the survey study, no contact information was readily available. VBA programmes were written up to synchronise incomplete information from different sources. No out-of-reach or duplicated record was found during the data collection process. This approach to identifying potential respondents appears to be reliable.

Sixty-nine out of the 88 survey items (78.41%) were validated by the EFA and Cronbach's (1951) alpha reliability analysis. Five scales score at least 0.70 and nine scales score at least 0.80 – the recommended level (Nunnally, 1968). The survey instrument appears to be fairly robust.

The proposed CDSS Use model is partially validated by the multi-stage Factor Analysis process. The statistical procedure is complicated by (i) item nonresponse and (ii) non-normality in substantial degrees. The former was dealt with by pairwise deletion and the latter by bootstrapping. The inconsistent solutions appear to be implied by the applications of pairwise deletion. As a result, the theoretical model had to be tested by two subsets of data. Bootstrapping was meant to be a remedy to the unreliable estimations of standard errors (and probabilities) due to the prevalence of severe non-normality. It turned out to be crucial for formulating parsimonious empirical CDSS models.

The model was assessed by (i) a 0.40 loading requirement, (ii) the widely accepted fit criteria and (iii) significant ratios of loading to standard error (z values) at $p<0.05$. The SEM results computed based on the maximum likelihood algorithm indicate that almost all the items surpassed the 0.40 loading requirement and z values are highly significant ($p<0.001$). However, due to the prevalence of severe non-normality, the standard errors are likely to be unreliably estimated (Bollen, 1989; Fox, 2006; Loehlin, 2004). Accordingly, the estimated z values from the bootstrap results were used as the basis to perform model specification search − backward selection. This strategy provided information to eliminate some items. The bootstrap results also served as a reliable basis to evaluate the CDSS model. A range of related theories have also been tested. The results show that the *a prior* CDSS Use model only requires a few amendments. Its fit is reasonably good.

The empirical results evidence the importance of introducing the contexts of a profession and the type of IS under study into IS evaluations. This approach appears to be relatively new in the IS Success research field. The model and method deserve further development.

CHAPTER V

CONCLUSIONS

5.1. SUMMARY OF LITERATURE REVIEW, RESEARCH PURPOSE, PROCESS AND RESULTS

The two research questions stated in Section 1.4 were identified from an extensive literature review (Chapter II). Refinements were made in accordance with the findings of a literature review focused on eHealth and medical practice (Chapter III). A Computerised Clinical Decision Support System (CDSS) Use model was formulated and operationalised to explore an imperative issue in leveraging (medical) professional intellect through new ITs (Chapter III). The statistical results and data collection process were presented in Chapter IV.

The literature review shows that implementing eHealth is comparable in many respects to implementing technology-facilitated KM in a sector reliant on expert economics. With appropriate application of KM strategy, eHealth can facilitate wiser use of professional intellect to deliver medicine more effectively and efficiently. A simple and quantifiable model has been derived to help determine the optimal KM strategy. The validity of this model is subject to empirical test. A more imperative task is to implement judicious adoption of IT into medical practice so that these eHealth/KM initiatives can leverage medical professional intellect to “much higher levels.” Identifying the contributing factors to under-use of ITs is a prerequisite for achieving this ideal state.

Reluctance is an explanation for the under-use issue (Orlikowski, 2000; Raghavan, 2009). In fact, this issue is caused by a confluence of people, process, technology and professional intellect issues. An integrative CDSS Use model has been proposed and operationalised to explore these elements. The model has been partially validated by performing a multi-stage Factor Analysis (FA) process on the survey data collected from 200 physicians (see Figure 72 in p.204; *cf*. Figure 2). The bootstrap technique was applied to justify the unreliable estimates of standard errors and probabilities due to the prevalence of severe non-normality. Pairwise deletion was applied to address the severe item nonresponse issue. A drawback of this technique appears to be shown in the result of a two-dimensional core construct − Perceived Net Benefits. Accordingly, the CDSS Use model was validated by two subsets of survey items. The two sets of analyses lead to slightly different, but perfectly consistent conclusions.

The validated CDSS model implies that:

1. Adopting HIT for consultation involves a mixture of people, process, technology and professional intellect issues (Research Question 1) − shown by the paths among the seven latent variables in see Figure 72 (in p.204); and
2. The reasons for using HIT for consultation are suggested by the latent variables and shown by the observable variables (or survey items) (see Figure 70 and Figure 71 in p.203), e.g., concerns about relationships with patients, user-friendliness of the technologies, completeness of codified patient data, etc. (Research Question 2).

The implications are many-fold. Chapter IV has discussed those implications related to IS studies in general. Section 5.2 will discuss other implications and contributions in terms of three disciplines: (i) KM and Organisational Studies, (ii) IS Success and (iii) Evidence-based Medical Practice under the eHealth/KM climate. Justifications of the results and few future research directions are proposed in Section 5.3 as a closing section.

5.2. IMPLICATIONS AND CONTRIBUTIONS TO THE RELATED DISCIPLINES

The under-use issue is a confluence of people, process, technology and professional intellect issues. The CDSS Use model offers a tool to explain the issue in a simple but comprehensive manner. It has direct implications on eHealth policy-making. This work can also contribute to three research areas: (i) KM and Organisational Studies, (ii) IS Success and (iii) governing medical practice.

5.2.1 Knowledge Management and Organisational Studies

OECD (2004) notes that "organisations are increasingly paying attention to their systems of [KM]... [T]he need for [it] as a systematic corporate strategy is becoming far more urgent for a number of reasons" (pp.1–2). Eventually, organisations are increasingly reliant on expert economics. To have a KM framework is essential for strategic planning.

KM is largely regarded as a process involving various activities (Alavi & Leidner, 2001). In practice, KM processes may not be captured. Gupta *et al.*'s (2004) paradox of expertise is an example − "[experts] know more than [they] can tell" (Polanyi, 1966a, p.4). Medical practice is another example. Knowledge *per se* is the product of medical care (Arrow, 1963). The product and the production activity are identical (*ibid.*). Clinical decision-making is so complex that it may never be fully understood (Stempsey, 2009). Clearly it is not always possible to model KM activities.

This work proposes that the KM activities may not be captured, but can be shown by the stylised facts of a profession. This is because knowledge is shown in the actions of knowers (Davenport & Prusak, 1998). Accordingly, an extensive literature survey was conducted to obtain and generalise the stylised facts of the work procedures and the operations of medical practices. The resulting stylised facts were then internalised into the CDSS Use model. The empirical test shows that the CDSS Use model only required a few refinements. This preliminarily suggests that, with suitable application of appropriate Mathematical and Statistical techniques, this approach can be applied to formulate a KM model even if the KM process can hardly be modelled directly.

Subsection 2.3.8 shows that CoP is considered to be beneficial to KM. However, empirical evidence also suggests that CoP is hard to be evolved and harder to sustain. Its impacts are constrained by various factors. Subsection 2.5.2 shows that physicians are naturally in a permanent CoP network. This property suggests that the health sector is the ideal industry in which to study the impacts of CoP and the possibilities of establishing similar environments in other organisations that rely on expert economics.

5.2.2 Information System Success

IS Success research has been established for more than three decades, but is still in an evolutionary process (Gable *et al*., 2008). There is still little consensus on what is the appropriate measure (*ibid.*). Over the last decade, little progress has been made in measuring information success (Petter *et al*., 2008). The focus of the research appears to be on single dimensions (*ibid.*). Few IS Success studies work on formulating models or measures to portray a holistic view (*ibid.*). Turunen (2009) notes that models for evaluating Health Information Systems "have been almost nonexistent" (p.580). This work proposed, operationalised and validated an integrated CDSS Use model.

A Physician Attributes construct has been introduced into the Jennex and Olfman (2006) KMS Success (J&O) model to form the CDSS model. It represents the major concerns of medical practices: (i) altruism towards patients, (ii) autonomy and (iii) litigation avoidance. The other constructs are defined (or redefined) based on (i) other generalised stylised facts of medical practice and CDSS related technologies, and/or (ii) the theories and findings about IS Success. This could be one of the very few works that incorporates the contexts of a profession and the specific type of systems into a system assessment model. The model also reserves the "both complete and parsimonious" properties of the D&M model.

This work empirically tests several under-studied or not yet operationalised constructs. The measures of Information Quality *per se* are problematic in IS studies (Petter *et al.*, 2008). The J&O (2006) model introduces Knowledge Quality and Management Support into the D&M (2003) model. These constructs do not appear to have been operationalised. This work operationalised and tested the Management Support and Knowledge/Information dimensions. The measure of Service Quality has been a debatable topic (Petter *et al.*, 2008; Landrum *et al*. 2008). The EFA and Cronbach's (1951) alpha test validated 11 of Landrum *et al*.'s (2008) 13-item abridged SERVPERF measure. These two tests also validated 15 of out of the 19 Physician Attribute items developed/adapted from the works of different disciplines. Doll and Torkzadeh (1998) do not consider that Frequency of IT Use (*Freq.U*) is the best way to measure System Use. (Petter *et al.*, 2008). The multi-stage Factor Analysis shows that *Freq.U* should be an integrated part of the measure. Analyses were also performed to test: (i) whether Information Quality determines System Use, (ii) whether Service Quality determines System Use (see Petter *et al*., 2008) and (iii) the associations among Knowledge/Information Quality, Physicians Attributes, Service Quality and System Quality. These relationships are still under-studied (see Petter *et al.*, 2008) or not yet studied.

This work postulates that a system evaluation/assessment model should internalise the nature of a profession. Forty-one items (including the *Freq.U* item) were adapted or developed from medical publications. Twenty-nine (70.73%) of them were validated by the EFA and Cronbach's (1951) alpha test. The percentage is lower than the overall one (78.41%). However, 50% (13/26) of items in the CDSS Use model built on the

Efficiency definition originated in medical publications (see Table 94 and Table 95). These items account for 64.29% (18/28) of the other validated CDSS Use model (see Table 94 and Table 95). The results indicate the value of introducing the stylised facts of a profession into the model formulation.

Table 94: Commonly Used Items of the Two Empirical CDSS Use Models

Construct	Item Origin	Reference(s)	Item I.D.	IS	Medicine	Mgt
Intent to Use						
	(Goodhue & Thompson, 1995)*; Rai *et al*., 2002		itU1	1		
		Bates *et al*., 2003	itU2 to itU3		2	
		DesRoches *et al*., 2008	Freq.U		1	
Physician Attributes						
Physician-Patient Relationship	Aydin *et al*., 1998		pa5 & pa6		2	
Physician-Patient Relationship	Aydin *et al*., 1999		pa8		1	
Autonomy	Cummings & Huse, 1989		pa15			1
Knowledge/Information Quality						
Completeness	(Landrum *et al.,* 2008)*	European Communities, 2008; DesRoches *et al*., 2008; Greenhalgh & Hurwitz, 1999; Taylor, 2006	iKQ6 to iKQ10 & iKQ12		6	
System Quality						
Ease of Use	Aydin *et al*., 1999; (Doll & Torkzadeh, 1998)*; Gable *et al*., 2008		syQ1; syQ3	2		
	(Doll & Torkzadeh, 1998)*	Taylor, 2006	syQ2		1	
	Landrum *et al*., 2008		syQ6	1		
User Satisfaction						
	(Ives *et al*., 1983)*; Seddon & Yip, 1992		sat1 to sat3	3		
	Seddon & Yip, 1992		sat4	1		
No. of Items				8	13	1

* indicates the origin of the concept/measure.
+ Not highlighted items were adapted from the cited instruments.

Table 95: Definitions of the Two Perceived Net Benefits Constructs

Construct	Item Origin	Reference(s)	Item I.D.	IS	Medicine
Efficiency	(Davis, 1989)*; Landrum *et al*., 2008		ben1 to ben3 & ben11	4	
Quality of Care					
Performance	(Davis, 1989; Landrum *et al*., 2008)*	DesRoches *et al*., 2008	ben4 to ben6 & ben8		4
Patient Welfare	(Gable *et al*., 2008)*	Wyatt (2001) & Arrow (1963; 1986)	ben7		1
Effectiveness	(Davis, 1989)*; Landrum *et al*., 2008		ben10	1	

* indicates the origin of the concept/measure.
+ Not highlighted items were adapted from the cited instruments.

In conclusion, this work explores the under-studied areas of IS Success research. It also employs relatively new techniques to formulate and operationalise a model.

5.2.3 Evidence-Based Medical Practice Under the eHealth/KM Climate

This work helps understand the under-use issue from the perspectives of (i) the relations between CDSS technologies and medical practice and (ii) the physician-patient relationship.

Chaudhry (2007) indicates that the actual impacts of computerised clinical decision-making technologies have been of particular research interest. However, IS evaluation models designed for healthcare contexts "have been almost nonexistent" (Turunen, 2009, p.580). IS Success is a widely accepted principal criterion for evaluating an IS (Rai *et al.*, 2002). This CDSS Use model aims to help in evaluating HIT use from the perspective of clinical/medical decision-making (a form of KM process) and IS Success. It incorporates the contexts of CDSS related technologies and the nature of medical practice into a derivation of the D&M model without losing its major strengths − being "both complete and parsimonious."

A medical consultation is a human encounter (Stempsey, 2009). Human issues are often associated with culture issues. Culture as an explanation for certain medical issues is cited from time to time. For example, Taylor (2006) notes that culture differences are a source of difficulties in codifying medical records. Over 150 definitions of culture can be found in Kroeber and Kluckhohn's (1952) work. That number of definitions suggests that one can easily build a culture-related framework on an incorrectly chosen definition. In the view that culture is shown in the behaviours and/or organisational structures, this aspect has not been directly addressed. Indeed, the result shows that culture may not be overly emphasised. Note that the medical practice aspect was operationalised largely based on the Anglo-Saxon experience. As discussed in Subsection 5.2.2, these items account for 50% to 64.29% of the items in the two empirical CDSS Use models. The result indicates that medical practices may not be as diverse as they are often portrayed. It appears to be relatively paramount to internalise the contexts of medical decision-making and the operations of healthcare institutes into a model.

The physician-patient relationship is crucial to medical decision-making (see Butler *et al.*, 2001; Charles *et al.*, 1997; Stempsey, 2009). Various models have been derived (Butler *et al.*, 2001; Charles *et al.*, 1997). The relationship can switch from one model to any other on the continuum of models within one single encounter (Charles *et al.*, 1999). Also note that clinical reasoning is not exactly scientific (Stempsey, 2009). Obviously, medical practices are situational and cannot be fully captured by a set of algorithms (*ibid.*) or a single model (Gafni *et al.*, 1998). This work shows that medical practice is not necessarily to be modelled as a specific process or episode. The stylised facts about medical practice can be generalised from a review of the specific medical decision-making process and the operations of the healthcare institute under study. With the application of SEM techniques, the stylised facts can be integrated into the CDSS Use model as observable variables (*cf.* Lane & Tsang, 2008a,b − a Bayesian updating process derived in the context of antibiotic prescribing decisions).

Altruism seems to have been a crucial economic assumption of physician-patient modelling since Kenneth J. Arrow's (1963) seminal paper in Health Economics. Treating patients as individuals has been much emphasised during medical training (Holsinger & Beaton, 2006; Taylor, 2006). Autonomy is seen as the hallmark of physician professionalism (Holsinger & Beaton, 2006). Surprisingly, these two dimensions seem to disappear from the model. Indeed, these two elements can be seen from the empirical models.

Altruism is a concern about patient welfare. Treating patients as individuals (item pa16) is not part of the model. Nevertheless, this idea is shown in the items of the Context and Pat.Rel dimensions. For the model built on Qual.Care, this idea becomes more apparent. The result suggests that the physicians' concerns over patients do not extend beyond the technical level. By definition, their professional ethic is impersonal and unemotional (Starbuck, 1992). Autonomy is suggested by item pa15.

The model built on the Qual.Care dimension directs us to Scott's (2001) inference about physicians' willingness in trading off their income to work in practices with guidelines that are likely to reduce their clinical autonomy. The author (*op. cit.*) infers that this may be influenced by physicians' concerns about quality of care and/or litigation avoidance (*ibid.*). The items show that guidelines, and concerns about quality of care and autonomy are intertwined. Item *pa*19 (more aware of legal liability) is not in the model. It remains difficult to judge whether physicians' willingness to comply with guidelines originates from concerns about patient welfare or their own interests since compliance with guidelines is a measure of performance (see Butler *et al.*, 2001; ter Meulen, 2005, for example). Perhaps this aspect should be examined in further research. However, the items of the Pat.Rel and Context dimensions certainly suggest that physicians are concerned about their relationships with patients and the quality of personalised information (knowledge by KID/DIK school; see Subsection 2.3.1). It appears that writing clear and simple guidelines to suggest the potential patient benefits is likely to be an effective strategy to encourage compliance with guidelines.

The results also support the findings of Agostini *et al.* (2007) regarding physicians' perceptions about the benefits and limitations of a reminder system (see Subsection 2.5.3). Unlike that work, user-interface is not a crucial element.

This work demonstrates an approach to formulate a quantifiable CDSS Use model. This research direction can potentially help deploy eHealth to enable practising truly EbM with minimal "divide" between management and physicians. It can help in understanding medical practice on an objective basis and thus mitigate the "divide." This is because the "divide", in some sense, originates from a lack of understanding about medical practice (see Edwards, 2005). A "divide" free healthcare institute can generally help produce better healthcare outcomes (*ibid.*). As repeatedly mentioned, medical practice *per se* is complex. Further research is needed.

5.3. JUSTIFICATIONS OF THE RESULTS AND FURTHER RESEARCH

I hope that dedicated research efforts and careful planning are evidenced by the content of this work. However, it remains an anecdotal research work due to the complexity of each discipline involved and the limited research scope (one research work can only investigate a limited number of research questions). There is much room for further improvements. A few further research directions are mentioned in this subsection from both theoretical and empirical aspects. This subsection ends with a statement of research ambitions.

5.3.1 Theoretical Work

Two separate theoretical frameworks have been proposed to (i) determine optimal KM strategy (Section 2.4) and (ii) explain CDSS use (or HIT use for consultation) (Subsection 3.4.2).

The CDSS Use model was chosen for an empirical study, as mitigating the under-use issue is hypothesised as the prerequisite for achieving a desirable eHealth outcome. In fact, the two issues should ideally be studied simultaneously. For example, the extents to which IT are adopted into practice may be a determinant of KM strategy. KM strategy has a role in determining the comparative advantages in using one knowledge dimension against others through using IT. It may also directly impact Knowledge/Information Quality. The CDSS model may have to be justified accordingly.

The CDSS Use model allows the discussion of HIT/CDSS adoption from an integrative approach of people, process, technology and knowledge. However, medical practice (or any professional/expert practice) is complex. Medical practice cannot be exhaustively reflected by those 19 survey items (*pa*1 to *pa*19). There is still much to be done to better understand this aspect. An intensive search of the job design literature may be needed to refine the Physician Attributes construct. For example, Dansky *et al*. (1999) incorporate the findings of job design literature to formulate an EMR acceptance model. The validated model supports Taylor's (2006) proposition that clinical contextual information should be part of patient data. The author (*op. cit.*) proposes that systems should include templates for recording medical records and the respective clinical contexts. This may imply that, in further research, the CDSS Use model should be customised to fit practices of different clinical categories or settings. As another example, CDSS appears to improve physicians' performance most of the time (Garg *et al*., 1995). The effects on patient outcomes remain under-studied and, when studied, inconsistent (*ibid.*). Ideally, patients' opinions about the impacts of the systems should be internalised into the model.

5.3.2 Empirical Work

Three broad areas can be further improved: (i) operationalisation of the theoretical model, (ii) data collection and (iii) statistical procedures.

Operationalisation of the Theoretical Model

Eighty-eight Likert items, including the *Freq.U* item, were submitted to perform EFA and Cronbach's (1951) alpha reliability test. Sixty-nine (78.41%) items were validated by the analyses. Nine out of the 14 subfactors score above 0.80 alpha levels. The outcome suggests that the techniques used to operationalise the model are fairly effective. As discussed in Subsection 5.2.2, the items adapted or developed from Health/Medical Informatics publications appear to outperform those items adapted from the well-established survey instruments of IS studies. In further research, a Systematic Review on CDSS/HIT studies may be introduced into the model operationalisation process. A PubMed search should prove that Systematic Review is indeed a popular Medical research method.

Data Collection

The following content discusses the issues related to (i) identifying potential respondents, (ii) sample size, (iii) data collection method and (iv) the language issue.

The potential respondents were authors identified by a PubMed search. Physicians are encouraged to do research (Wyatt, 2001). As expected, most respondents were experienced physicians. About 67.2% of the physicians had been in practice for more than 10 years and only 16.7% for less than five years. The samples may not be representative cases. Ideally, the sample should be randomly chosen from the entire medical community. Nevertheless, efforts have been put forth to minimise sample selection bias. For example, the researcher was blinded from the hospital profiles and strictly complied with the sampling criteria.

The cross-sectional analyses were only limited to a descriptive level (a presentation of demographic data diagrams). Multiple-group analyses of certain issues might be performed if the sample size were larger. For example, the respondents appear to be more adoptive to HITs in comparison with those reported in the EC (2008) paper. Simultaneously, Figure 27 (p.144) shows that a vast majority of the physicians considered the codified knowledge from the systems to be consistent with their medical knowledge. With application of multiple-group analysis, it might be possible to find out if HIT adoption was related to practice experience or relevance of the codified knowledge. This requires a larger sample size of less experienced physicians. It would also be interesting to perform multiple-group analyses by (i) regions and (ii) clinical categories or settings. The former can test the interoperability assumption (see Subsection 3.4.1 for an explanation). The latter can test if there is a need to derive models with respect to clinical categories or settings (see Subsection 5.2.3).

Knowledge is actionable (Davenport & Prusak, 1998). In further research, it may be interesting to study HIT adoption by participate observations. For example, in Torkzadeh and Doll’s (1999) study, the survey method was complemented by experienced system analysts’ assessments of IS impacts based on the observations of participants’ performing certain operations with the systems. Venkatesh *et al.* (2003) find a significant relationship between intention to use and actual usage. In this work, the usage was inferred from the self-reported data. Ideally, it should be estimated from real usage data.

The original survey instrument was designed in English. The instrument used as a basis for conducting the interviews was translated by a professor in Management with much survey experience. Uncertainty in failing to translate the exact meanings of another language can never be eradicated (Stevick, 1989). However, the uncertainty should be very slight judging from the consistency of the results with the theories and findings of other studies. The language issue should be more bearable than conducting nation-wide studies where respondents' first languages can be diverse.

Statistical Procedures

The following content discusses the strategies to deal with (i) the major drawbacks of the statistical procedures and (ii) the severe non-normality issue – the crucial assumption of full information maximum likelihood method.

In this work, Factor Analyses were employed to validate the proposed model. One of the criticisms against Factor Analysis is that the procedures lack non-uniqueness (Härdle & Léopold, 2007). This may lead to subjective interpretation and a spectrum of results (*ibid.*). However, this should not undermine the credibility of the results as they were interpreted in accordance with the theories and findings of other studies. In this work, the results were obtained from a set of rules (see Subsections 4.6.1 and 4.6.2). The procedures were well documented. Other researchers should be able to replicate the same results by applying the exact procedures and facilities to the same set of data.

The severe non-normality issue has been justified by the bootstrap results. In further research, this issue may be addressed by transforming the data (Härdle & Léopold, 2007; Loehlin, 2004). If the transformation function is rightly chosen, in general, multivariate normality can usually be produced (Loehlin, 2004). In this work, the items were treated as if they were continuous variables. In further research, the Factor Analyses may be derived from polychoric correlations if one is concerned about categorical effects (see Raykov & Marcoulides, 2006). Indeed, the R programmes written up to perform the analyses allows formulating correlations from any data type. The programmes can also simultaneously transform the data to produce asymptotically multivariate normality. It would be interesting to compare the results with this work.

5.3.3 Heading to a New Era of Medical/Professional Practice

This chapter summarises the literature review, research purpose and process, implications and contributions to several disciplines. This work demonstrates that implementing eHealth is comparable to implementing technology-facilitated KM. Implementing eHealth could be an opportunity to leverage medical professional intellect through information technology. This would eventually lead to safer and more effective and efficient medicine. However, if the use of information technology is overly emphasised, medical practice could also become practising digitalised "cookbook medicine" − practice that is governed by rule-based codified knowledge − this can marginalise the opportunities of tacit medical knowledge generation and lead to homogenous treatment. These adverse outcomes can be prevented by applying appropriate KM polices, e.g., KM strategy, to triangulate people, process and technology such that information and knowledge resources can be used to judiciously care for patients. This work shows an approach to derive policy-making tools in this direction. Much more extensive research is required in order to produce a deeper account. Due to the complexity of each discipline involved, only a few aspects and future research directions could be briefly discussed.

I hope this work can contribute to research in judicious HIT implementation to facilitate practising the truly Evidence-based Medicine that "integrates the best evidence with clinical expertise and patients' choice" (Sackett *et al.*, 1996). Let us hope that work of a similar nature is in the research pipeline. Let us also hope that this work will contribute to research that can lead to wider access to safer and more effective and efficient medicine − the very purpose of most current eHealth or KM oriented healthcare reforms (see EC, 2007; eHealth Initiative, 2006; WHO, 2006).

APPENDIX I

SURVEY INSTRUMENT

A.1A THE ORIGINAL VERSION

<u>Instructions:</u> In this survey instrument, (computer) system refers to any electronic system or computer you use for your daily duties including consultations.

For this section, each statement is set in a 7-point scale: “1 Strongly Disagree (SD)”, “2 Disagree (DA)”, “3 Moderately Disagree (MDA)”, “4 No Opinion or Uncertain (No)”, “5 Moderately Agree (MA)”, “6 Agree (A)” and “7 Strongly Agree (SA)”. There are no right or wrong answers. Please answer *each* question by circling only one number.

a.1 Intent to Use

No. (I.D.)		**SD**	**DA**	**MDA**	**No**	**MA**	**A**	**SA**
1 (itU1)	I am dependent on the system for my consultations.	1	2	3	4	5	6	7
2 (itU2)	I always use the system to record patients’ medical records.	1	2	3	4	5	6	7
3 (itU3)	I always use the system to assist my clinical decisions including diagnoses, therapies and referrals.	1	2	3	4	5	6	7
4 (itU4)	I use the system as much as possible to communicate or coordinate with my colleagues.	1	2	3	4	5	6	7
5 (itU5)	I usually get the laboratory results via the system.	1	2	3	4	5	6	7
6 (itU6)	I often use the Internet to search for information.	1	2	3	4	5	6	7
7 (itU7)	Overall, I use the system as much as possible.	1	2	3	4	5	6	7

a.2 Physician Attributes

No. (I.D.)		**SD**	**DA**	**MDA**	**No**	**MA**	**A**	**SA**
1 (pa1)	I use the system as my Department/Centre will perform better.	1	2	3	4	5	6	7
2 (pa2)	I use the system as it helps improve patient satisfaction with care.	1	2	3	4	5	6	7
3 (pa3)	I use the system as the top management sees the system as being important.	1	2	3	4	5	6	7
4 (pa4)	I use the system as patients tend to prefer my using a computer.	1	2	3	4	5	6	7
5 (pa5)	I pay less attention to patients after using the system.	1	2	3	4	5	6	7

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
6 (pa6)	My attention is focused on the chart/computer.	1	2	3	4	5	6	7
7 (pa7)	I can still spend enough time with patients.	1	2	3	4	5	6	7
8 (pa8)	The system interferes my relationships with patients.	1	2	3	4	5	6	7
9 (pa9)	I need to communicate with my colleagues or supervisor more.	1	2	3	4	5	6	7
10 (pa10)	I need the help of my colleagues more.	1	2	3	4	5	6	7
11 (pa11)	I need to consult my colleagues or supervisor more often before making decisions for non-routine (or uncommon) cases.	1	2	3	4	5	6	7
12 (pa12)	My performance will be more closely monitored.	1	2	3	4	5	6	7
13 (pa13)	I have more control over my job.	1	2	3	4	5	6	7
14 (pa14)	The system allows me to treat patients as individuals.	1	2	3	4	5	6	7
15 (pa15)	The system adversely affects my independence and freedom in how I deliver patient care.	1	2	3	4	5	6	7
16 (pa16)	It is a professional ethic to treat each patient as an individual.	1	2	3	4	5	6	7
17 (pa17)	I usually take patient preference into consideration when I make a clinical decision.	1	2	3	4	5	6	7
18 (pa18)	An understandable medical record should include clinical contextual information.	1	2	3	4	5	6	7
19 (pa19)	I am more aware of the legal liability after the system has been implemented.	1	2	3	4	5	6	7

a.3 Perceived Net Benefits/Usefulness

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
1 (ben1)	The system enables me to accomplish tasks faster.	1	2	3	4	5	6	7
2 (ben2)	The system enables me to be more productive.	1	2	3	4	5	6	7
3 (ben3)	The system makes it easier to do my job.	1	2	3	4	5	6	7
4 (ben4)	The system improves quality of clinical decisions.	1	2	3	4	5	6	7
5 (ben5)	The system improves quality of communication with patients.	1	2	3	4	5	6	7
6 (ben6)	The system helps avoiding medication errors.	1	2	3	4	5	6	7

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
7 (ben7)	The system empowers patient choice as it enhances my awareness of alternative care, e.g., diagnoses, medications, therapies, etc.	1	2	3	4	5	6	7
8 (ben8)	The system improves delivery of care that meets guidelines.	1	2	3	4	5	6	7
9 (ben9)	The system helps timely access to patient records.	1	2	3	4	5	6	7
10 (ben10)	Overall, the system enhances my effectiveness.	1	2	3	4	5	6	7
11 (ben11)	Overall, I find the system useful on my job.	1	2	3	4	5	6	7

a.4 Service Quality

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
1 (servQ1)	Top management has provided sufficient training to utilise the system.	1	2	3	4	5	6	7
2 (servQ2)	Top management has provided sufficient resource to utilise the system.	1	2	3	4	5	6	7
3 (servQ3)	Top management has provided sufficient resource to implement the system.	1	2	3	4	5	6	7
4 (servQ4)	The system support unit shows readiness to respond to users' requests.	1	2	3	4	5	6	7
5 (servQ5)	The system support unit is dependable in handling my user problems.	1	2	3	4	5	6	7
6 (servQ6)	The system support unit shows willingness to help users.	1	2	3	4	5	6	7
7 (servQ7)	The system support staff are courteous with users.	1	2	3	4	5	6	7
8 (servQ8)	The system support staff instils confidence in users (they can be relied on).	1	2	3	4	5	6	7
9 (servQ9)	The system support staff often have the knowledge to answer users' questions.	1	2	3	4	5	6	7
10 (servQ10)	The system support staff give users individual attention.	1	2	3	4	5	6	7
11 (servQ11)	The system support staff have the users' best interests at heart.	1	2	3	4	5	6	7
12 (servQ12)	The system support staff deal with users in a catering fashion.	1	2	3	4	5	6	7
13 (servQ13)	The system support staff understand the needs of users.	1	2	3	4	5	6	7
14 (servQ14)	The system support staff generally have good relations with users.	1	2	3	4	5	6	7
15 (servQ15)	The communication between the system support staff and users is harmonious.	1	2	3	4	5	6	7
16 (servQ16)	The system support unit insists on accuracy of information.	1	2	3	4	5	6	7

a.5 Knowledge/Information Quality

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
1 (iKQ1)	Information from the system is not concise enough.	1	2	3	4	5	6	7
2 (iKQ2)	Information from the system appears to be readable, clear and well formatted	1	2	3	4	5	6	7
3 (iKQ3)	Information from the system uses terminology or vocabulary that is easy to understand.	1	2	3	4	5	6	7
4 (iKQ4)	Information from the system is generally in a readily usable form.	1	2	3	4	5	6	7
5 (iKQ5)	The system contains essential patients' demographic information.	1	2	3	4	5	6	7
6 (iKQ6)	Patient data from the system usually include complete patient problem lists.	1	2	3	4	5	6	7
7 (iKQ7)	Patient data from the system usually include complete electronic lists of medications taken by patients.	1	2	3	4	5	6	7
8 (iKQ8)	Patients' medical histories from the system are usually detailed enough.	1	2	3	4	5	6	7
9 (iKQ9)	Patient data from the system usually include essential clinical context information.	1	2	3	4	5	6	7
10 (iKQ10)	Patient data from the system include patient narrative about patients' experience and opinions.	1	2	3	4	5	6	7
11 (iKQ11)	I can retrieve laboratory results from the system.	1	2	3	4	5	6	7
12 (iKQ12)	Patient follow-up notes from the system are usually detailed enough.	1	2	3	4	5	6	7
13 (iKQ13)	The system generally provides reports, reminders or alerts that seem to be exactly what are needed.	1	2	3	4	5	6	7

a.6 System Quality

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
1 (syQ1)	The system is easy to use.	1	2	3	4	5	6	7
2 (syQ2)	The system allows inputting data without (or with little) typing.	1	2	3	4	5	6	7
3 (syQ3)	The system is user friendly.	1	2	3	4	5	6	7
4 (syQ4)	The system is easy to learn.	1	2	3	4	5	6	7
5 (syQ5)	The system is easy to become skilful at using.	1	2	3	4	5	6	7

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
6 (syQ6)	The system interacts with me in a clear and understandable way.	1	2	3	4	5	6	7
7 (syQ7)	The system requires only the minimum number of fields and screens to achieve a task.	1	2	3	4	5	6	7
8 (syQ8)	Information from the system is usually consistent with my medical knowledge.	1	2	3	4	5	6	7
9 (syQ9)	I have the absolute control over when the system should intervene my clinical procedures.	1	2	3	4	5	6	7
10 (syQ10)	I can easily adjust the alert level.	1	2	3	4	5	6	7
11 (syQ11)	The system's user interface can be easily adapted to my preferences.	1	2	3	4	5	6	7
12 (syQ12)	The alerts for potentially drug allergy are usually useful rather than intrusive.	1	2	3	4	5	6	7
13 (syQ13)	The alerts for potentially dangerous medication interactions are usually useful rather than intrusive.	1	2	3	4	5	6	7
14 (syQ14)	The alerts for critical laboratory values are usually useful rather than intrusive.	1	2	3	4	5	6	7
15 (syQ15)	The suggestions for providing preventive care are usually useful rather than intrusive.	1	2	3	4	5	6	7
16 (syQ16)	The reminders for ordering critical laboratory tests are usually useful rather than intrusive.	1	2	3	4	5	6	7
17 (syQ17)	I can access to comprehensive electronic directories (or yellow pages) of other practitioners/specialists.	1	2	3	4	5	6	7

a.7 User Satisfaction

No. (I.D.)		SD	DA	MDA	No	MA	A	SA
1 (sat1)	The system meets the information/knowledge needs for my area of responsibilities most of the time.	1	2	3	4	5	6	7
2 (sat2)	The system is efficient.	1	2	3	4	5	6	7
3 (sat3)	The system is effective.	1	2	3	4	5	6	7
4 (sat4)	Overall, I am satisfied with the system as a consultation tool.	1	2	3	4	5	6	7

b. Demographic Information

Please check the most appropriate box for *each* of the following questions:

1. Gender: ☐ Male ☐ Female

2. I use the system:

☐ On rare occasions ☐ Occasionally ☐ Frequently
☐ For almost all consultations

3. I work in a: ☐ Healthcare Centre ☐ General Hospital
☐ Teaching Hospital ☐ Other Setting

4. I have been working in this hospital for:

☐ <1 year ☐ 1−5 years ☐ 5−10 years ☐ More than 10 years

5. I have been in practice for:

☐ <1 year ☐ 1−5 years ☐ 5−10 years ☐ More than 10 years

6. I have graduated from the medical school for:

☐ <1 year ☐ 1−5 years ☐ 5−10 years ☐ More than 10 years

7. I am ☐ a physician (no supervision duties) ☐ a unit/department supervisor
☐ at a senior management level

8. Using an electronic system has been part of my medical school's curricula:

☐ Yes ☐ No

9. I use computer at home ☐ Yes ☐ No

We guarantee that your responses will be kept ***strictly confidential***.

Many thanks for your participation

***

A.1B The Translated Version (Basis for Conducting CATIs)

1. Intención de usar el sistema informático.

	1 Totalmente en desacuerdo 2 3 4 5 6 7 Totalmente de acuerdo
1.- Dependo del sistema informático para realizar mis consultas	1 2 3 4 5 6 7
2.- Siempre uso el sistema informático para grabar los datos de los pacientes	1 2 3 4 5 6 7
3.- Siempre uso del sistema informático como asistente en mis decisiones clínicas, incluyendo diagnósticos, terapia y referencias	1 2 3 4 5 6 7
4.- Uso el sistema informático todo lo que puede para comunicarme o coordinarme con mis colegas	1 2 3 4 5 6 7
5.- Usualmente los resultados de laboratorio me llegan por el sistema informático	1 2 3 4 5 6 7
6.- A menudo utilizo Internet para buscar información.	1 2 3 4 5 6 7
7.- Intento usar el sistema informático todo lo posible	1 2 3 4 5 6 7

1. Actitudes del médico

	1 Totalmente en desacuerdo 2 3 4 5 6 7 Totalmente de acuerdo
1.- Utilizo el sistema para que mi departamento/centro funcione mejor	1 2 3 4 5 6 7
2.- Utilizo el sistema para ayudar a mejorar la satisfacción de los pacientes	1 2 3 4 5 6 7
3.- Utilizo el sistema ya que la dirección considera que es importante	1 2 3 4 5 6 7
4.- Utilizo el sistema por que los pacientes prefieren que yo lo use	1 2 3 4 5 6 7
5.- Presto menos atención a los pacientes después de usar el sistema informático	1 2 3 4 5 6 7
6.- En la consulta, mi atención esté centrada en el ordenador	1 2 3 4 5 6 7
7.- Puedo dedicar todavía tiempo suficiente a los pacientes	1 2 3 4 5 6 7
8.- El sistema interfiere en mi relación con los pacientes	1 2 3 4 5 6 7
9.- Debido al sistema, tengo que ponerme en contacto con los compañeros o jefes más a menudo	1 2 3 4 5 6 7
10.- Necesito ayudar más a mis compañeros.	1 2 3 4 5 6 7
11.- Necesito consultar más a menudo a mis compañeros o jefes antes de tomar decisiones para casos no rutinarios	1 2 3 4 5 6 7
12.- Mi rendimiento está más controlado	1 2 3 4 5 6 7
13.- Tengo más control sobre mi trabajo	1 2 3 4 5 6 7
14.- El sistema me permite tratar a los pacientes como personas	1 2 3 4 5 6 7
15.- El sistema interfiere negativamente en mi independencia y libertad a la hora de tratar con los pacientes.	1 2 3 4 5 6 7
16.- La ética profesional me obliga a tratar a los pacientes como a personas (y no simples números)	1 2 3 4 5 6 7
17.- Normalmente tengo en consideración las preferencias de los pacientes al tomar decisiones clínicas.	1 2 3 4 5 6 7
18.- Considero que los registros médicos tienen que incluir información clínica sobre el contexto para la toma de decisiones.	1 2 3 4 5 6 7
19.- Soy más consciente de las cuestiones legales desde que el sistema informático fue puesto en marcha	1 2 3 4 5 6 7

1. Beneficios percibidos por el uso del sistema El sistema:

	1 Totalmente en desacuerdo 2 3 4 5 6 7 Totalmente de acuerdo
1.- Me facilita realizar más rápido las tareas	1 2 3 4 5 6 7
2.- Me permite ser más productivo	1 2 3 4 5 6 7

3.- Hace más fácil mi trabajo	1 2 3 4 5 6 7
4.- Mejora la calidad de mis decisiones	1 2 3 4 5 6 7
5.- Mejora la comunicación con los pacientes	1 2 3 4 5 6 7
6.- Me ayuda a evitar los errores médicos	1 2 3 4 5 6 7
7.- Da protagonismo a la posibilidad de elección del paciente al facilitarme cuidados alternativos (posibles técnicas diagnóstico, medicación, terapias, …)	1 2 3 4 5 6 7
8.-Mejora la prestación de cuidados que están reglados	1 2 3 4 5 6 7
9.- Me permite acceso actualizado a los registros de los pacientes	1 2 3 4 5 6 7
10.- Sobre todo, me permite mejorar mi efectividad	1 2 3 4 5 6 7
11.- Sobre todo, lo encuentro útil en mi trabajo	1 2 3 4 5 6 7

1. Calidad del sistema informático

	1 2 3 4 5 6 7 Totalmente en desacuerdo — Totalmente de acuerdo
1.- La dirección a dado suficiente formación para utilizar el sistema informático	1 2 3 4 5 6 7
2.- La dirección a destinado suficientes recursos para el uso del sistema informático	1 2 3 4 5 6 7
3.- La dirección a destinado suficientes recursos al implantación del sistema informático	1 2 3 4 5 6 7
4.- La unidad de servicio técnico es eficiente en el manejo de mis problemas como usuario	1 2 3 4 5 6 7
5.- La unidad de servicio técnico se muestra deseosa de ayudar	1 2 3 4 5 6 7
6.- La unidad de servicio técnico está preparada para solucionar los requerimientos de los usuarios	1 2 3 4 5 6 7
7.- El personal de la unidad de servicio técnico son considerados con los usuarios	1 2 3 4 5 6 7
8.- El personal de la unidad de servicio técnico confía en los usuarios	1 2 3 4 5 6 7
9.- El personal de la unidad de servicio técnico sabe responder a las cuestiones de los usuarios	1 2 3 4 5 6 7
10.- El personal de la unidad de servicio técnico presta atención personalizada	1 2 3 4 5 6 7
11.- El personal de la unidad de servicio técnico tiene en primera consideración los intereses de los usuarios	1 2 3 4 5 6 7
12.- El personal de la unidad de servicio técnico trata a los usuarios con gran interés	1 2 3 4 5 6 7
13.- El personal de la unidad de servicio técnico entiende las necesidades de los usuarios	1 2 3 4 5 6 7
14.- El personal de la unidad de servicio técnico tiene buenas relaciones con los usuarios	1 2 3 4 5 6 7
15.- La comunicación entre el personal de la unidad de servicio técnico y los usuarios es fluida	1 2 3 4 5 6 7
16.- La unidad de servicio técnico presta especial atención a la fiabilidad de la información	1 2 3 4 5 6 7

1. Calidad de la información

	1 2 3 4 5 6 7 Totalmente en desacuerdo — Totalmente de acuerdo
1.- La información no es suficientemente concisa	1 2 3 4 5 6 7
2.- La información se presenta de manera legible, clara y con un formato agradable	1 2 3 4 5 6 7
3.- La información usa una terminología simple de entender	1 2 3 4 5 6 7

4.- La información del sistema se presenta lista para ser usada	1 2 3 4 5 6 7
5.- La información incluye los datos demográficos esenciales del paciente	1 2 3 4 5 6 7
6.- Los datos de los pacientes incluyen una lista detallada de los problemas médicos	
7.- Los datos del paciente incluyen la lista completa de los medicamentos utilizados por el mismo	1 2 3 4 5 6 7
8.- Las historias médicas son suficientemente detalladas normalmente	1 2 3 4 5 6 7
9.- Los datos de los pacientes incluyen la información sobre la situación clínica del paciente	1 2 3 4 5 6 7
10.- Los datos del paciente incluyen las declaraciones de los pacientes sobre las pasadas opiniones y experiencias	1 2 3 4 5 6 7
11.- Puedo recuperar los resultados de laboratorio de los pacientes.	1 2 3 4 5 6 7
12.- Las notas de seguimiento de los pacientes son suficientemente detalladas	1 2 3 4 5 6 7
13.- El sistema generalmente proporciona informes, recordatorios, o alertas que parecen ser las que se necesitan en cada caso.	1 2 3 4 5 6 7

1. Calidad del sistema

	1 2 3 4 5 6 7 Totalmente en desacuerdo … Totalmente de acuerdo
1.- El sistema es fácil de usar	1 2 3 4 5 6 7
2.- Permite introducir datos fácilmente	1 2 3 4 5 6 7
3.- Es sistema informático es sencillo para el usuario	1 2 3 4 5 6 7
4.- Es fácil aprender a usarlo	1 2 3 4 5 6 7
5.- Es fácil aprender a usarlo simplemente usándolo	1 2 3 4 5 6 7
6.- El sistema interactúa conmigo de una manera clara y comprensible	1 2 3 4 5 6 7
7.- Requiere un número de pantallas y campos para realizar una tarea	1 2 3 4 5 6 7
8.- La información es consistente con mi conocimiento médico	1 2 3 4 5 6 7
9.- Tengo el control absoluto para decidir como interviene en mis procedimientos clínicos	1 2 3 4 5 6 7
10.- Puedo ajustar fácilmente los niveles de alerta del sistema	1 2 3 4 5 6 7
11.- Se puede modificar la interface de usuario fácilmente	1 2 3 4 5 6 7
12.- Da información sobre alergias a los medicamentos de manera cómoda	1 2 3 4 5 6 7
13.- Da información útil sobre posibles interacciones entre medicamentos	1 2 3 4 5 6 7
14.- Alerta sobre valores anormales en los resultados de laboratorio	1 2 3 4 5 6 7
15.- Las sugerencias sobre cuidados preventivos son normalmente útiles	1 2 3 4 5 6 7
16.- Las sugerencias de mandar pruebas de laboratorio son normalmente útiles.	1 2 3 4 5 6 7
17.- El sistema tiene un directorio de médicos/especialistas.	1 2 3 4 5 6 7

1. Satisfación del usuario con el sistema informático

	1 2 3 4 5 6 7 Totalmente en desacuerdo … Totalmente de acuerdo
1.- El sistema contiene la información/conocimiento necesaria para realizar mis responsabilidades la mayoría de las veces	1 2 3 4 5 6 7
2.- El sistema es eficiente	1 2 3 4 5 6 7

3.- El sistema es efectivo	1 2 3 4 5 6 7
4.- Sobre todo, estoy satisfecho con el sistema como herramienta en la consulta	1 2 3 4 5 6 7

INFORMACIÓN GENERAL

1.- Género Hombre____ Mujer____

2.- Utilizo el sistema informático:

En raras ocasiones___ ocasionalmente___ Frecuentemente___ Casi siempre___

3.- Tipo de centro de trabajo:

Centro de salud___ Hospital___ Hospital Universitario:___ Otro___

4.- Llevo trabajando en este puesto:

<1 año___ 1-5 años__ 5-10 años__ Más 10 años___

5.- Ejerzo la medicina desde:

<1 año___ 1-5 años__ 5-10 años__ Más 10 años___

6.- Me gradué en la facultad de medicina hace:

<1 año___ 1-5 años__ 5-10 años__ Más 10 años___

7.- El cargo que ocupo es:

Médico (sin responsabilidades de gestión)___ Jefe de unidad ___

Un cargo de mayor responsabilidad___

8.- He recibido formación en el uso de sistemas informáticos:

Si___ No___

9.- Uso habitualmente el ordenador en casa:

Si__ No___

APPENDIX II

SAMPLES OF DEVELOPED PROGRAMMES

A.2A A VBA PROGRAMME WRITTEN TO SCREEN OUT NON-CLINICIANS

```
Sub ContSpecInfoChk()
'Data quality check

Dim i, j, SeaRow, SeaCol, InRow, InCol As Integer

SeaRow = 1
SeaCol = 1
InRow = 1
InCol = 1

    MultiStageHiClear
    MultiStageRemarkClear

    Do While Worksheets(2).Cells(SeaRow, SeaCol).Value <> ""

        Application.StatusBar = "Checking data quality of " _
                                & WorksheetFunction.Sum(InRow) & " records"

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Analysis*" Or _
          Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*An?lisis*" Then _
            Worksheets(2).Cells(InRow, InCol + 8).Value = _
            Worksheets(2).Cells(InRow, InCol + 8).Value & "*Research Unit?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Econo*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Research Unit?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Experiment*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Research Unit?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Invest*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Research Unit?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Laborator*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Research Unit?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Research*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Research Unit?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Biochemistry*" And _
          Not Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Cl?nic*" Or _
          Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Bioqu?mica*" And _
          Not Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Cl?nic*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user
```

```
      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Biotechnolog*" And
_
          Not Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Cl?nic*" Then
_
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Coordina*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Diagn*" Then _
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Farm*" And _
          Not Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Cl?nic*" Then
_
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Pharm*" And _
          Not Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Cl?nic*" Then
_
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Radiolog*" Or _
          Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*Radiodiagn*" Then
_
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*radiolog*" Or _
          Worksheets(2).Cells(SeaRow, SeaCol + 9).Value Like "*radiodiagn*" Then
_
          Worksheets(2).Cells(InRow, InCol + 8).Value = _
          Worksheets(2).Cells(InRow, InCol + 8).Value & "*Not Doctors?"
              'Not an usual CDSS user

      If Worksheets(2).Cells(SeaRow, SeaCol + 7).Value Like "*@*.com. *" Then _
          Worksheets(2).Cells(SeaRow,   SeaCol   +   7).Replace   what:="com.   ",
replacement:="com; "
              'Extracting Email Address

      If Worksheets(2).Cells(SeaRow, SeaCol + 7).Value Like "*@*" Then _
          Worksheets(2).Cells(SeaRow,   SeaCol   +   7).Replace   what:="*.   ",
replacement:=""
              'Extracting Email Address

      If Worksheets(2).Cells(SeaRow, SeaCol + 7).Value Like "*@*" Then _
          Worksheets(2).Cells(SeaRow,   SeaCol   +   7).Replace   what:="*,   ",
replacement:=""
              'Extracting Email Address from unusual format

      If Worksheets(2).Cells(SeaRow, SeaCol + 7).Value Like "*@*; *" And _
          Not  Worksheets(2).Cells(SeaRow,  SeaCol  +  7).Value  Like  "*;  *@*;  *"
Then _
          Worksheets(2).Cells(SeaRow,   SeaCol   +   7).Replace   what:=";   *",
replacement:=""
              'Extracting Email Address from unusual format

      If Worksheets(2).Cells(SeaRow, SeaCol + 7).Value Like "*; *@*; *" Then _
```

```
            Worksheets(2).Cells(SeaRow, SeaCol + 8).Value = "*Edit Email Address"
                'Extracting Email Address from unusual format

        SeaRow = SeaRow + 1
        InRow = InRow + 1


    Loop

        Worksheets(2).Range("A:Z").Select
        Selection.Sort Key1:=Worksheets(2).Columns(InCol+8),Order1:=xlAscending, _
        Key2:=Worksheets(2).Columns(InCol+6),Order2:=xlAscending,
Key3:=Worksheets(2).Columns(InCol + 0), _
        Order3:=xlAscending, Header:=xlNo, OrderCustom:=1, MatchCase:=False, _
        Orientation:=xlTopToBottom, DataOption1:=xlSortNormal

    Application.StatusBar = "Run ContSpecInfoChkDupEmail?"

MultiStageHi

End Sub
```

A.2B An R Programme Written to Perform Exploratory Factor Analysis

```
fa.ml.pa<-function (data, fm="ml", screename, n.obs=200, rotate="varimax",
hetcor=F)
        {
        cl <- match.call()
        require(psych)
        if (hetcor)
                {
                require(polycor)
                S<-hetcor(data,use="pairwise",std.err=F)$correlations
                }
        else {S<-cor(data, use="pairwise")}
        nbr<-fa.parallel(S, main=paste ("Parallel Analysis Scree Plots",
screename),n.obs=n.obs)
        nf<-nbr$nfact
        ml.pa.result<-lapply(1:nf, function(nf) fa(S,nf,fm=fm,rotate=rotate,
n.obs=n.obs))
        fit<-vector()
        prob<-vector()
        dof<-vector()
        for (i in 1:nf)
                {
                fit[i]<-ml.pa.result[[i]]$STATISTIC
                prob[i]<-ml.pa.result[[i]]$PVAL
                dof[i]<-ml.pa.result[[i]]$dof
                }
        summary<-round(matrix(c(fit,prob,dof),nrow=nf),5)
        colnames(summary)<-c("Chi sq", "Pr (>Chi sq)", "df")
        rownames(summary)<-paste("Factor(s) to extract:", 1:nf)
        result<-list(Call=cl, Analysis=ml.pa.result, Summary=summary)
        return(result)
        }
```

APPENDIX III

ITEM CORRELATION MATRICES AND TWO-TAILED *t*-TEST RESULTS

A.3A CDSS USE MODEL PRESENTED IN TABLE 82

Table 96: Item Correlation Matrix of the CDSS Use Model

Items	pa5	pa6	pa8	pa15	iKQ6	iKQ7	iKQ8	iKQ9	iKQ10	iKQ12	syQ1	syQ2	syQ3	syQ6	ben4	ben5	ben6	ben7	ben8	ben10	sat1	sat2	sat3	sat4	itU1	itU2	itU3	Freq.U
pa5	1																											
pa6	0.39	1																										
pa8	0.48	0.37	1																									
pa15	0.36	0.25	0.52	1																								
iKQ6	0.14	0.09	0.09	0.01	1																							
iKQ7	0.21	0.13	0.15	0.08	0.59	1																						
iKQ8	0.12	0.09	0.13	0.07	0.51	0.55	1																					
iKQ9	0.16	0.1	0.06	0.03	0.59	0.68	0.78	1																				
iKQ10	0.12	0.07	0	0.1	0.36	0.41	0.36	0.5	1																			
iKQ12	0.15	0.18	0.13	0.09	0.51	0.53	0.61	0.6	0.44	1																		
syQ1	-0.01	0.05	-0.12	-0.12	0.22	0.12	0.26	0.3	0.23	0.28	1																	
syQ2	0.1	0.18	0.02	-0.04	0.42	0.27	0.41	0.43	0.34	0.48	0.72	1																
syQ3	0.06	0.05	-0.03	-0.12	0.31	0.15	0.28	0.33	0.24	0.34	0.85	0.77	1															
syQ6	0.03	0.05	-0.07	-0.02	0.3	0.18	0.35	0.39	0.35	0.34	0.64	0.66	0.65	1														
ben4	-0.06	0.11	-0.05	0.06	0.14	0.06	0.16	0.2	0.21	0.12	0.15	0.2	0.2	0.23	1													
ben5	-0.05	0.04	-0.12	-0.04	0.21	0.08	0.19	0.21	0.16	0.15	0.14	0.2	0.17	0.23	0.64	1												
ben6	-0.07	0.14	-0.1	0.01	0.23	0.17	0.21	0.29	0.23	0.24	0.03	0.08	0.09	0.13	0.6	0.51	1											
ben7	0.15	0.1	0.04	0.21	0.19	0.22	0.19	0.17	0.24	0.21	0.15	0.17	0.17	0.22	0.52	0.48	0.51	1										
ben8	0.05	0.08	0.03	0.07	0.22	0.19	0.22	0.21	0.12	0.18	0.15	0.23	0.23	0.22	0.53	0.51	0.51	0.6	1									
ben10	0.04	0.14	-0.09	0.04	0.27	0.25	0.32	0.39	0.28	0.26	0.35	0.44	0.37	0.41	0.66	0.55	0.6	0.59	0.56	1								
sat1	0.06	0.15	0.04	0	0.39	0.36	0.3	0.4	0.15	0.39	0.41	0.5	0.5	0.41	0.31	0.28	0.32	0.27	0.36	0.47	1							
sat2	0.02	0.11	-0.06	-0.09	0.44	0.35	0.44	0.53	0.38	0.47	0.57	0.66	0.6	0.63	0.4	0.34	0.34	0.3	0.34	0.49	0.64	1						
sat3	0.04	0.06	-0.09	-0.1	0.38	0.29	0.38	0.48	0.35	0.45	0.58	0.64	0.6	0.58	0.39	0.35	0.34	0.32	0.37	0.52	0.65	0.9	1					
sat4	0.03	0.13	-0.03	-0.08	0.38	0.27	0.38	0.47	0.32	0.45	0.55	0.62	0.55	0.57	0.38	0.35	0.28	0.37	0.41	0.53	0.58	0.83	0.81	1				
itU1	0	0.2	0.08	0	0.15	0.19	0.22	0.26	0.14	0.16	0.18	0.24	0.26	0.14	0.26	0.28	0.34	0.16	0.25	0.33	0.24	0.26	0.27	0.2	1			
itU2	0.04	0.29	0.08	0.03	0.26	0.28	0.27	0.32	0.17	0.27	0.23	0.37	0.25	0.15	0.24	0.24	0.32	0.25	0.27	0.32	0.28	0.34	0.33	0.31	0.58	1		
itU3	0.16	0.17	0.21	0.13	0.15	0.17	0.24	0.23	0.17	0.18	0.14	0.12	0.13	0.12	0.35	0.32	0.36	0.31	0.31	0.3	0.27	0.23	0.25	0.25	0.39	0.34	1	
Freq.U	0.08	0.22	0.11	0.02	0.15	0.06	0.17	0.15	0.04	0.14	0.12	0.22	0.21	0.08	0.22	0.2	0.22	0.18	0.21	0.3	0.17	0.21	0.25	0.22	0.54	0.4	0.23	1

Table 97: Item Correlation Matrix of the CDSS Use Model (Significant at *p*<0.001)

Items	*pa5*	*pa6*	*pa8*	*pa15*	*iKQ6*	*iKQ7*	*iKQ8*	*iKQ9*	*iKQ10*	*iKQ12*	*syQ1*	*syQ2*	*syQ3*	*syQ6*	*ben4*	*ben5*	*ben6*	*ben7*	*ben8*	*ben10*	*sat1*	*sat2*	*sat3*	*sat4*	*itU1*	*itU2*	*itU3*	*Freq.U*
pa5	1																											
pa6	**0.39**	1																										
pa8	**0.48**	**0.37**	1																									
pa15	**0.36**	0.25	**0.52**	1																								
iKQ6					1																							
iKQ7					**0.59**	1																						
iKQ8					**0.51**	**0.55**	1																					
iKQ9					**0.59**	**0.68**	**0.78**	1																				
iKQ10					**0.36**	**0.41**	**0.36**	**0.5**	1																			
iKQ12					**0.51**	**0.53**	**0.61**	**0.6**	**0.44**	1																		
syQ1							0.26	0.3		0.28	1																	
syQ2					**0.42**	0.27	**0.41**	**0.43**	**0.34**	**0.48**	**0.72**	1																
syQ3					**0.31**		0.28	**0.33**		**0.34**	**0.85**	**0.77**	1															
syQ6					0.3		**0.35**	**0.39**	**0.35**	**0.34**	**0.64**	**0.66**	**0.65**	1														
ben4														0.23	1													
ben5															**0.64**	1												
ben6								0.29							**0.6**	**0.51**	1											
ben7															**0.52**	**0.48**	**0.51**	1										
ben8															**0.53**	**0.51**	**0.51**	**0.6**	1									
ben10					0.27	0.25	**0.32**	**0.39**	0.28	0.26	**0.35**	**0.44**	**0.37**	**0.41**	**0.66**	**0.55**	**0.6**	**0.59**	**0.56**	1								
sat1					**0.39**	**0.36**	0.3	**0.4**		**0.39**	**0.41**	**0.5**	**0.5**	**0.41**	**0.31**	0.28	**0.32**	0.27	**0.36**	**0.47**	1							
sat2					**0.44**	**0.35**	**0.44**	**0.53**	**0.38**	**0.47**	**0.57**	**0.66**	**0.6**	**0.63**	**0.4**	**0.34**	**0.34**	0.3	**0.34**	**0.49**	**0.64**	1						
sat3					**0.38**	0.29	**0.38**	**0.48**	**0.35**	**0.45**	**0.58**	**0.64**	**0.6**	**0.58**	**0.39**	**0.35**	**0.34**	**0.32**	**0.37**	**0.52**	**0.65**	**0.9**	1					
sat4					**0.38**	0.27	**0.38**	**0.47**	**0.32**	**0.45**	**0.55**	**0.62**	**0.55**	**0.57**	**0.38**	**0.35**	0.28	**0.37**	**0.41**	**0.53**	**0.58**	**0.83**	**0.81**	1				
itU1								0.26				0.24	0.26		0.26	0.28	**0.34**		0.25	**0.33**	0.24	0.26	0.27		1			
itU2		0.29			0.26	0.28	0.27	**0.32**		0.27		**0.37**	0.25		0.24		**0.32**	0.25	0.27	**0.32**	0.28	**0.34**	**0.33**	**0.31**	**0.58**	1		
itU3							0.24								**0.35**	**0.32**	**0.36**	**0.31**	**0.31**	0.3	0.27		0.25	0.25	**0.39**	**0.34**	1	
Freq.U																				0.3			0.25		**0.54**	**0.4**		1

*Values in boldface exceed 0.30 in absolute value

A.3B CDSS USE MODEL (EFFICIENCY) PRESENTED IN TABLE 84

Table 98: Item Correlation Matrix of the CDSS Use Model (Efficiency)

Items	pa5	pa6	pa8	pa15	iKQ6	iKQ7	iKQ8	iKQ9	iKQ10	iKQ12	syQ1	syQ2	syQ3	syQ6	ben1	ben2	ben3	ben11	sat1	sat2	sat3	sat4	itU1	itU2	itU3	Freq
pa5	1																									
pa6	0.39	1																								
pa8	0.48	0.37	1																							
pa15	0.36	0.25	0.52	1																						
iKQ6	0.14	0.09	0.09	0.01	1																					
iKQ7	0.21	0.13	0.15	0.08	0.59	1																				
iKQ8	0.12	0.09	0.13	0.07	0.51	0.55	1																			
iKQ9	0.16	0.1	0.06	0.03	0.59	0.68	0.78	1																		
iKQ10	0.12	0.07	0	0.1	0.36	0.41	0.36	0.5	1																	
iKQ12	0.15	0.18	0.13	0.09	0.51	0.53	0.61	0.6	0.44	1																
syQ1	-0.01	0.05	-0.12	-0.12	0.22	0.12	0.26	0.3	0.23	0.28	1															
syQ2	0.1	0.18	0.02	-0.04	0.42	0.27	0.41	0.43	0.34	0.48	0.72	1														
syQ3	0.06	0.05	-0.03	-0.12	0.31	0.15	0.28	0.33	0.24	0.34	0.85	0.77	1													
syQ6	0.03	0.05	-0.07	-0.02	0.3	0.18	0.35	0.39	0.35	0.34	0.64	0.66	0.65	1												
ben1	-0.16	0	-0.18	-0.07	0.16	0.1	0.27	0.25	0.09	0.2	0.29	0.37	0.32	0.32	1											
ben2	-0.19	0.05	-0.24	-0.01	0.13	0.11	0.26	0.27	0.19	0.2	0.31	0.35	0.29	0.28	0.73	1										
ben3	-0.2	0.02	-0.28	-0.13	0.15	0.07	0.23	0.25	0.22	0.18	0.37	0.38	0.39	0.29	0.69	0.79	1									
ben11	-0.09	0.03	-0.19	-0.15	0.19	0.16	0.25	0.24	0.13	0.21	0.28	0.3	0.33	0.3	0.53	0.67	0.67	1								
sat1	0.06	0.15	0.04	0	0.39	0.36	0.3	0.4	0.15	0.39	0.41	0.5	0.5	0.41	0.39	0.35	0.36	0.35	1							
sat2	0.02	0.11	-0.06	-0.09	0.44	0.35	0.44	0.53	0.38	0.47	0.57	0.66	0.6	0.63	0.47	0.49	0.51	0.49	0.64	1						
sat3	0.04	0.06	-0.09	-0.1	0.38	0.29	0.38	0.48	0.35	0.45	0.58	0.64	0.6	0.58	0.47	0.48	0.5	0.51	0.65	0.9	1					
sat4	0.03	0.13	-0.03	-0.08	0.38	0.27	0.38	0.47	0.32	0.45	0.55	0.62	0.55	0.57	0.47	0.55	0.48	0.52	0.58	0.83	0.81	1				
itU1	0	0.2	0.08	0	0.15	0.19	0.22	0.26	0.14	0.16	0.18	0.24	0.26	0.14	0.16	0.24	0.35	0.33	0.24	0.26	0.27	0.2	1			
itU2	0.04	0.29	0.08	0.03	0.26	0.28	0.27	0.32	0.17	0.27	0.23	0.37	0.25	0.15	0.15	0.3	0.34	0.39	0.28	0.34	0.33	0.31	0.58	1		
itU3	0.16	0.17	0.21	0.13	0.15	0.17	0.24	0.23	0.17	0.18	0.14	0.12	0.13	0.12	0.25	0.24	0.29	0.26	0.27	0.23	0.25	0.25	0.39	0.34	1	
Freq.U	0.08	0.22	0.11	0.02	0.15	0.06	0.17	0.15	0.04	0.14	0.12	0.22	0.21	0.08	0.14	0.24	0.34	0.31	0.17	0.21	0.25	0.22	0.54	0.4	0.23	1

Table 99: Item Correlation Matrix of the CDSS Use Model (Efficiency) (Significant at p<0.001)

Items	$pa5$	$pa6$	$pa8$	$pa15$	$iKQ6$	$iKQ7$	$iKQ8$	$iKQ9$	$iKQ10$	$iKQ12$	$syQ1$	$syQ2$	$syQ3$	$syQ6$	$ben1$	$ben2$	$ben3$	$ben11$	$sat1$	$sat2$	$sat3$	$sat4$	$itU1$	$itU2$	$itU3$	$Freq.U$
$pa5$	1																									
$pa6$	**0.39**	1																								
$pa8$	**0.48**	**0.37**	1																							
$pa15$	**0.36**	0.25	**0.52**	1																						
$iKQ6$					1																					
$iKQ7$					**0.59**	1																				
$iKQ8$					**0.51**	**0.55**	1																			
$iKQ9$					**0.59**	**0.68**	**0.78**	1																		
$iKQ10$					**0.36**	**0.41**	**0.36**	**0.5**	1																	
$iKQ12$					**0.51**	**0.53**	**0.61**	**0.6**	**0.44**	1																
$syQ1$							0.26	0.3		0.28	1															
$syQ2$					**0.42**	0.27	**0.41**	**0.43**	**0.34**	**0.48**	**0.72**	1														
$syQ3$					**0.31**		0.28	**0.33**		**0.34**	**0.85**	**0.77**	1													
$syQ6$					0.3		**0.35**	**0.39**	**0.35**	**0.34**	**0.64**	**0.66**	**0.65**	1												
$ben1$							0.27	0.25			0.29	**0.37**	**0.32**	**0.32**	1											
$ben2$							0.26	0.27			**0.31**	**0.35**	0.29	0.28	**0.73**	1										
$ben3$			-0.28					0.25			**0.37**	**0.38**	**0.39**	0.29	**0.69**	**0.79**	1									
$ben11$							0.25				0.28	0.3	**0.33**	0.3	**0.53**	**0.67**	**0.67**	1								
$sat1$					**0.39**	**0.36**	0.3	**0.4**		**0.39**	**0.41**	**0.5**	**0.5**	**0.41**	**0.39**	**0.35**	**0.36**	**0.35**	1							
$sat2$					**0.44**	**0.35**	**0.44**	**0.53**	**0.38**	**0.47**	**0.57**	**0.66**	**0.6**	**0.63**	**0.47**	**0.49**	**0.51**	**0.49**	**0.64**	1						
$sat3$					**0.38**	0.29	**0.38**	**0.48**	**0.35**	**0.45**	**0.58**	**0.64**	**0.6**	**0.58**	**0.47**	**0.48**	**0.5**	**0.51**	**0.65**	**0.9**	1					
$sat4$					**0.38**	0.27	**0.38**	**0.47**	**0.32**	**0.45**	**0.55**	**0.62**	**0.55**	**0.57**	**0.47**	**0.55**	**0.48**	**0.52**	**0.58**	**0.83**	**0.81**	1				
$itU1$								0.26				0.24	0.26			0.24	**0.35**	**0.33**	0.24	0.26	0.27		1			
$itU2$		0.29			0.26	0.28	0.27	**0.32**		0.27		**0.37**	0.25			0.3	**0.34**	**0.39**	0.28	**0.34**	**0.33**	**0.31**	**0.58**	1		
$itU3$							0.24								0.25	0.24	0.29	0.26	0.27		0.25	0.25	**0.39**	**0.34**	1	
$Freq.U$																0.24	**0.34**	**0.31**			0.25		**0.54**	**0.4**		1

*Values in boldface exceed 0.30 in absolute value

REFERENCES

Aarons, J. 2006. Epistemology and Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Achrol, S.R. and Philip, K. 1999. Marketing in the Networked Economy. *Journal of Marketing*, 63, pp.146–163.

Agostini, J.V., Concato, J. and Inouye, S.K. 2007. Improving Sedative-Hypnotic Prescribing in Older Hospitalized Patients: Provider-Perceived Benefits and Barriers of a Computer-Based Reminder. *Journal of General Intern Medicine*, 23(Suppl. 1), pp.32–36.

Alavi, M. and Leidner, D.E. 2001. Knowledge Management and Knowledge Management Systems: Conceptual Foundations, and Research Issues. *MIS Quarterly*, 1(25), pp.107–136.

Alexander, J.A. and Hordes, M.W. 2003. The Service Marketing Challenge: How to Defy Obstacles and Better Promote Your Offerings. *Professional Service Journal*, 3(17). www.internetviznewsletter.com/PSJ/e_article 000198268.cfm?x=b11,0.

Alvesson, M. 1993a. Organisation as Rhetoric: Knowledge-Intensive Firms and the Struggle with Ambiguity. *Journal of Management Studies*, 30, pp.997–1016.

______. 1993b. Cultural-Ideological Modes of Management Control: A Theory and a Case Study of a Professional Service Company. In S. Deetz, ed., *Communication Yearbook*. London: Sage.

Alvesson, M. and Kärreman, D. 2001. Odd Couple: Making Sense of the Curious Concept of Knowledge Management. *Journal of Management Studies*, 38(7), pp.995–1018.

Amesse, F. and Cohendet, P. 2001. Technology Transfer Revisited from the Perspective of the Knowledge-Based Economy. *Research Policy*, 30, pp.1459–1478.

Angus, J. 1998. The Organisation and Knowledge. *Information Week*, 700, pp.14–16.

APQC. 2006. *Process Classification Framework*. http://www.apqc.org/portal/apqc/ksn/X.pdf?paf_gear_id=contentgearhome&paf_dm=full&pageselect=contentitem&docid=121388.

Ariely, G. 2006. Intellectual Capital and Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Arrow, K.J. 1962. The Implications of Learning by Doing. *Review of Economic Studies*, 29, pp.155–173.

______. 1963. Uncertainty and the Welfare Economics of Medical Care. *American Economic Review*, 53(5), pp.941–973.

______. 1986. Agency and the Market. In K.J. Arrow and M.D. Intriligator, eds., *Handbook of Mathematical Economics*, Vol. III. Amsterdam: Elsevier.

Austin, R.D. 1996. *Measuring and Managing Performance in Organizations*. New York: Dorset House Publishing.

Aydin, C.E. 2005. Survey Methods for Assessing Social Impacts of Computers in Healthcare Organizations. In James Anderson and Carolyn Aydin, eds., *Evaluating the Organizational Impact of Health Care Information Systems*, 2nd ed. New York: Springer Verlag.

Aydin, C.E., Anderson, J.G., Rosen, P.N., Felitti, V.J. and Weng, H.C. 1998. Computers in the Consulting Room: Clinician and Patient Perspectives. *Health Care Management Science*, 1, pp. 61–74.

Aydin, C.E., Gregory, K., Korst, L. Polaschek, J. and Chamorro, T. 1999. Panel: Making It Happen: Organizational Changes Required to Implement an Electronic Medical Record in a Large Medical Center. *AMIA '99 Annual Symposium*, Washington, DC, 6–10 November, 1999.

Aydin, C.E. and Rice, R.E. 1991. Social Worlds, Individual Differences, and Implementation: Predicting Attitudes Toward a Medical Information System. *Information and Management*, 20, pp.119–136.

______. 1992. Bringing Social Worlds Together: Computers as Catalysts for New Interactions in Healthcare Organizations. *J Health Soc Behav*, 33, pp.168–185.

Babakus, E. and Boller, G.W. 1992. An Empirical Assessment of the SERVQUAL Scale. *Journal of Business Research*, 24(3), pp. 253–268.

Balconi, M. 2002. Tacitness, Codification of Technological Knowledge and the Organisation of Industry. *Research Policy*, 31(3), pp.357–379.

Bali, R.K., Dwivedi, A. and Naguib, R. 2009. Issues in Clinical Knowledge Management: Revisiting Healthcare Management. In Joseph Tan, ed., *Medical Informatics: Concepts, Methodologies, Tools, and Applications*. Hershey, PA: Idea Group Publishing.

Barney, J.B. 1991a. Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17, pp.99–120.

______. 1991b. Types of Competition and the Theory of Strategy: Towards An Integrative Framework. *Academy of Management Review*, 11(4), pp.791–800.

Baroni de Carvalho, R. and Ferreira, M.A.T. 2006. Knowledge Management Software. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Barrows, H.S. and Tamblyn, R.M. 1980. *Problem Based Learning: An Approach to Medical Education.* New York: Springer.

Barth, S. 2000. KM Horror Stories. *Knowledge Management Magazine*, 3, pp.37–40.

Bates, D.W., Ebell, M., Gotlieb, E., Zapp, J. and Mullins, H.C. 2003. A Proposal for Electronic Medical Records in U.S. Primary Care. *Journal of the American Medical Informatics Association*, 10(1), pp.1–10.

Beatty, P.C.W. 1999. User Attitudes to Computer-Based Decision Support in Anesthesia and Critical Care: A Preliminary Survey. *The Internet Journal of Anesthesiology*, 3(1).

Becerra-Fernandez, I. and Sabherwal, R. 2006. ICT and Knowledge Management Systems. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Beckman, T. J. 1999. The Current State of Knowledge Management. In J. Liebowitz, ed., *Knowledge Management Handbook.* New York: CRC Press.

Belongia, E.A. and Schwartz, B. 1998. Strategies for Promoting Judicious Use of Antibiotics by Doctors and Patients. *BMJ*, 317, pp.668–71.

Bennet, A. and Tomblin, M.S. 2006. A Learning Network Framework for Modern Organizations: Organizational Learning, Knowledge Management and ICT Support. *The Journal of Information and Knowledge Management Systems*, 36(3), pp.289–303.

Berztiss, A.T. 2006. Capability Maturity. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Bethlehem, J. 2009. *Applied Survey Methods: A Statistical Perspective*. Hoboken, NJ: Wiley.

Birkinshaw, J. 2001. Making Sense of Knowledge Management. *Ivey Business Journal*, 65, pp.32–36.

Blackler, F. 1995. Knowledge, Knowledge Work and Organizations: An Overview and Interpretation. *Organization Studies*, 16, pp.1021–1046.

Blackler, F., Reed, M. and Witaker, A. 1993. Epilogue: An Agenda for Research. *Journal of Management Studies*, 30(6), pp.1017–1020.

Boisot, M. and Griffiths, D. 1999. Possession is Nine Tenths of the Law: Managing a Firm's Knowledge Base in a Regime of Weak Appropriability. *International Journal of Technology Management*, 17(6), pp.662–676.

Boland, R.J., Jr. and Tenkasi, R.V. 1995. Perspective Making and Perspective Taking in Communities of Knowing. *Organization Science*, 6(4), pp.350–372.

Bolisani, E. and Scarso, E. 1999. Information Technology Management: A Knowledge-Based Perspective. *Technovation*, 19, pp.209–217.

Bollen, K.A. 1989. *Structural Equations with Latent Variables*. New York: Wiley.

Bontis, N. 2001. Assessing Knowledge Assets: A Review of the Models Used to Measure Intellectual Capital. *International Journal of Management Review*, 3(1), pp.41–60.

Boring, E.G. 1929. *A History of Experimental Psychology*. New York: Century.

Boudreau, M., Gefen, D. and Straub, D.W. 2001. Validation in IS research: A State-of-the-Art Assessment. *MIS Quarterly*, 25(1), pp.1–24.

Bower, A. 2005. *The Diffusion and Value of Healthcare Information Technology*, Pub. No. MG-272-HLTH. Santa Monica, CA: RAND.

Brooking, A. 1996. *Intellectual Capital: Core Assets for the Third Millennium Enterprise.* London: Thomson Business Press.

Brown, J.S. and Duguid, P. 1998. Organizing Knowledge. *California Management Review*, 40(3), pp.90–111.

______. 2001. Knowledge and Organization: A Social-Practice Perspective. *Organization Science*, 12(2), pp.198–213.

Buchholz, W. 2006. Ontology. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Burden, P.R. 2000. *Knowledge Management: The Bibliography*. Information Today. http://domin.dom.edu/faculty/SRIKANT/lis88001/kmbib.html.

Butler, C.C., Kinnersley, P., Prout, H., Rollnick, S., Edwards, A. and Elwyn, G. 2001. Antibiotics and Shared Decision Making in Primary Care. *Journal Antimicrobial Chemotherapy*, 48, pp.435–440.

Butler, T. 2006. Anti-Foundational Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Butler, T. and Murphy, C. 2006. Work and Knowledge. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Cattell, R.B. 1963. Theory of Fluid and Crystallized Intelligence: A Critical Experiment. *Journal of Educational Psychology*, 54, 1−22.

______. 1966. The Scree Test for the Number of Factors. *Multivariate Behavioral Research*, 1(2), pp.245–276.

Charles, C., Gafni, A. and Whelan, T. 1997. Shared Decision-Making in the Medical

Encounter: What Does it Mean? (Or, It Takes at Least Two to Tango). *Social Science and Medicine*, 44(5), pp.681–692.

______. 1999. Decision-Making in the Physician-Patient Encounter: Revisiting the Shared Treatment Decision-Making Model. *Social Science and Medicine*, 49, pp.651−661.

Chaudhry, B. 2005. *Health Information Technology (HIT) Adoption − Standards and Interoperability*, Pub. No. WR-313. Santa Monica, CA: RAND.

______. 2007. Computerized Clinical Decision Support: Will It Transform Healthcare? *J Gen Intern Med*, 23(Suppl 1), pp.85–87.

Chaudhry, B., Wang, J., Wu, S. *et al*. 2006. Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. *Ann Intern Med*, 144(10), pp.742–752.

Choo, C.W., Detlor, B. and Turnbull, D. 2000. *Web Work: Information Seeking and Knowledge Work on the World Wide Web*. Dordrecht: Kluwer Academic Publishers.

Coakes, E. and Clarke, S. 2006. The Concept of Communities of Practice. In Elayne Coakes and Steve Clarke, eds., *Encyclopedia of Communities of Practice in Information and Knowledge Management.* Hershey, PA: Idea Group Publishing.

Conner, K.R. 1991. A Historical Comparison of Resource Based Theory and Five schools of Thought within Industrial Organization Economics: Do We Have a New Theory of the Firm. *Journal of Management*, 17, pp.121–154.

Conner, K.R. and Prahalad, C.K. 1996. A Resource-Based Theory of the Firm: Knowledge versus Opportunism. *Organization Science*, 7(5), pp.477–501.

Constant, D., Kiesler, S. and Sproull, L. 1994. What's Mine Is Ours, or Is It? A Study of Attitudes about Information Sharing. *Information Systems Research*, 5(4), pp.400−421.

Corral, K., Griffin, J. and Jennex, M. E. 2005. Expert's Perspective: The Potential of Knowledge Management in Data Warehousing. *Business Intelligence Journal*, 10(1), pp.36–40.

Counte, M.A., Kjerulff, K.H., Salloway, J.C. and Campbell, B.C. 1987. Adapting to the Implementation of a Medical Information System: A Comparison of Short- versus Long-Term Findings. *Journal of Medical Systems*, 11, pp.11–20.

Cronbach, L.J. 1951. Coefficient Alpha and the Internal Structure of Tests. *Psychometrika*, 16, pp.297−334.

Cronin, J.J. and Taylor, S.A. 1992. Measuring Service Quality: A Reexamination and

Extension. *Journal of Marketing*, 56(3), pp. 55–68.

Cummings, T.G. and Huse, E.F. 1989. *Organization Development and Change*, 4th ed. St. Paul, MN: West.

Dansky, K.H., Gamm, L.D., Vasey, J.J. and Barsukiewicz, C.K. 1999. Electronic Medical Records: Are Physician Ready? *Journal of Healthcare Management*, 44(6), pp.440–455.

Dash, J. 1998. Knowledge is Power. *Software Magazine*, 18(1), pp.46–51.

Davenport, D.L. and Holsapple, C.W. 2006. Knowledge Organisation. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Davenport, T.H., De Long, D.W. and Beers, M.C. 1998. Successful Knowledge Management Projects. *Sloan Management Review*, 39(2), pp.43–57.

Davenport, T.H. and Prusak, L. 1998. *Working Knowledge: How Organisations Manage What They Know.* Boston: Harvard Business School Press.

Davis, F.D. 1989. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), pp.318–346.

Delio, M. 2000. Proving we're Productive. *Journal of Knowledge Management*, 3(7), pp.47–50.

DeLone, W.H. and McLean, E.R. 1992. Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, 3, pp.60–95.

______. 2003. The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems*, 19(4), pp.9–30.

de Lusignan, S., Pritchard, K. and Chan, T. 2002. A Knowledge-Management Model for Clinical Practice. *Journal of Postgraduate Medicine*, 48(4), pp.297–303.

Denning, S. 1998. *What Is Knowledge Management*? http://www.worldbank.org/ks/index.html.

Descartes, R. 1640. *Meditations on First Philosophy* (Translated by John Cottingham and Published in 1996). Cambridge: Cambridge University Press.

DesRoches, C.M., Campbell, E.G., Rao, S.R. *et al*. 2008. Electronic Health Records in Ambulatory Care − A National Survey of Physicians. *The New England Journal of Medicine*, 359(1), pp.50−60.

DeTore, A. and Balliet-Milholland, J. 2003. Transforming Theory into Fact: Hands-on Knowledge Management Initiatives Built on a Reinsurer's Pile of Junk. In Clyde W. Holsapple, ed., *Handbook on Knowledge Management: Knowledge Directions*, Vol 2.

Berlin: Springer-Verlag.

Dingsøyr, T. 2006. Postmorten Reviews. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Doll, W.J. and Torkzadeh, G. 1998. Developing a Multidimensional Measure of System-Use in an Organizational Context. *Information & Management*, 33(4), pp.171–185.

Donabedian, A. 1980. *Explorations in Quality Assessment and Monitoring: The Definition of Quality and Approaches to Its Assessment*, Vol. I. Ann Arbor, MI: Health Administration Press.

Drucker, P. 1998. The Coming of the New Organisation. *Harvard Business Review on Knowledge Management*. Boston, MA: Harvard Business School Press, pp.1–20.

______. 2000. Knowledge Work. *Executive Excellence*, 17(4), pp.11–12.

Duffy, J. 2000. The KM Technology Infrastructure. *Information Management Journal*, 34(2), pp.62–66.

Edvinsson, L. and Malone, M.S. 1997. *Intellectual Capital: Realizing Your Company's True Value by Finding its Hidden Brainpower*. New York: Harper Business.

Edwards, N. 2005. Doctors and Managers: Building a New Relationship. *Clinical Medicine*, 5(6), pp.577–579.

eHealth Initiative. 2006. *Improving the Quality of Healthcare Through Health Information Exchange. Selected Findings from eHealth Initiative's Third Annual Survey of Health Information Exchange Activities at the State, Regional and Local Levels*, September 25, 2006. http://toolkits.ehealthinitiative.org/assets/ Documents/ eHI2006HIESurvey ReportFinal09.25.06.pdf. [Accessed: 6 May 2009].

Einbinder, J.S., Klein, D.A. and Safran, C.S. 1997. Making Effective Referrals: A Knowledge-Management Approach. *Proc AMIA Annu Fall Symp*, pp.330–334.

Ein-Dor, P. 2006. Taxonomies of Knowledge. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Ekbia, H. and Hara, N. 2006. Incentive Structures in Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Elstein, A.S. and Schwartz, A. 2002. Clinical Problem Solving and Diagnostic Decision Making: A Selective Review of the Cognitive Research Literature. In J André Knottnerus, ed., *The Evidence Base of Clinical Diagnosis*. London: BMJ Books.

Ellis, R.P. and McGuire, T.G. 1986. Provider of Behaviour under Prospective Reimbursement: Cost Sharing and Supply. *Journal of Health Economics*, 5(2), pp.129–152.

______. 1990. Optimal Payment Systems for Health Services. *Journal of Health Economics*, 9(4), pp.375–396.

Ely J.W., Burch R.J., Vinson D.C. 1992. The Information Needs of Family Physicians: Cases Specific Clinical Questions. *J Fam Pract*, 35(3), pp.265–269.

European Communities (EC). 2004. *e-Health − Making Healthcare Better for European Citizens: An Action Plan for a European eHealth Area*, Brussels, 30 April 2004, COM (2004) 356 final. http://www.europea.eu. [Accessed: 5 July 2009].

______. 2007. eHealth Priorities and Strategies in European Countries. *eHealth ERA Report*, Brussels, March 2007. http://www.europea.eu. [Accessed: 5 July 2009].

______. 2008. *Benchmarking ICT Use among General Practitioners in Europe 2007 − Country Profile: Spain*. http://www.europea.eu. [Accessed: 15 September 2009].

Evans, D. and Volery, T. 2000. Online Business Development Services for Entrepreneurs: An Exploratory Study. *Proceedings of the ICSB World Conference*. Brisbane.

Evans, R.G. 1997. Health Care Reform: Who’s Selling the Market, and Why. *Journal of Public Health Medicine*, 19(1), pp.45–49.

Everitt, B. 2005. *An R and S-PLUS® Companion to Multivariate Analysis*. London: Springer-Verlag.

Fahey, L. and Prusak, L. 1998. The Eleven Deadliest Sins of Knowledge Management. *California Management Review*, 40(3), pp.265–276.

Fama, E.F. 1980. Agency Problems and the Theory of the Firm. *Journal of Political Economy*, 88, pp.288–307.

Faraway, J.J. 2002. *Practical Regression and ANOVA Using R*. http://CRAN.R-project.org/. [Accessed: 22 September 2009].

Fehr, E. and Rockenbach, B. 2003. Detrimental Effects of Sanctions on Human Altruism. *Nature*, 422(6928), pp.137–140.

Field, M.J. and Lohr, K.B. 1992. *Guidelines for Clinical Practice: From Development to Use*. Washington, DC: National Academy Press.

Fink, D. and Disterer, G. 2006. Knowledge Management in Professional Service Firms. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Fitter, M. 1986. Evaluation of Computers in Primary Healthcare: The Effect on Doctor-Patient Communication. In H.E. Peterson and W. Schneider, eds., *Human-Computer Communications in Health Care*. Amsterdam: Elsevier, pp.67–80.

Fliedner, G. and Vokurka, R. 1997. Agility: The Next Competitive Weapon. *APICS*, Online Edition, 7(1), pp.56–59. http://www.apics.org/magazine/jan97/agility.htm.

Foley, K. 2001. Knowledge Management: Key to Collaboration. *Information Week*, 8(7), pp.78–83.

Førde, R. 1998. Competing Conceptions of Diagnostic Reasoning − Is There a Way Out? *Theoretical Medicine and Bioethics*, 19, pp.59–72.

Fox, J. 2006. Structural Equation Modeling With the sem Package in R. *Structural Equation Modeling*, 13(3), pp.465–486.

______. 2010. *sem: Structural Equation Models*. R Package Version 0.9-20. http://CRAN.R-project.org/package=sem.

Fransman, M. 1998. Information, Knowledge, Vision, and Theories of the Firm. In G. Dosi, D.J. Teece and J. Chytry, eds., *Technology, Organisation, and Competitiveness: Perspectives on Industrial and Corporate Change*. New York: Oxford University Press.

fraserhealth. 2007. *Will Technology Save Us*? http://www.chcm.ubc.ca/documents/Woods6feb07.pdf. [Accessed: 30 August 2008].

Gable, G.G., Sedera, D. and Chan, T. 2008. Re-conceptualizing Information System Success: The IS-Impact Measurement Model. *Journal of the Association for Information Systems*, 9(7), pp.377–408.

Gadd, C.S. and Penrod, L.E. 2000. Dichotomy between Physicians' and Patients' Attitudes Regarding EMR Use during Outpatient Encounters. *Proceedings of the AMIA Annual Symposium*, Washington, DC, pp. 275–279.

Gafni, A., Charles, C. and Whelan, T. 1998. The Physician-Patient Encounter: The Physician as a Perfect Agent for the Patient versus the Informed Treatment Decision-Making Model. *Social Science and Medicine*, 47(3), pp.347–354.

Garets, D. and Davis, M. 2006. Electronic Medical vs. Electronic Health Records: Yes, There Is a Difference. *HIMSS Analytics White Paper*, 26 January, 2006, http://www.himssanalytics.org. [Accessed: 15 September 2008].

Garg, A.X., Adhikari, N.K.J., McDonald, H. *et al*. 2005. Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes a Systematic Review. *JAMA*, 293(10), pp.1223–1238.

Garvin, D. 1993. Building a Learning Organization. *Harvard Business Review*, 71(4), pp.78–91.

Goodhue, D.L. and Thompson, R. 1995. Task-Technology Fit and Individual

Performance. *MIS Quarterly*, 19(2), pp.213–236.

Grant, R.M. 1996a. Toward a Knowledge-Based Theory of the Firm. *Strategic Management Journal*, 17, pp.109–122.

______. 1996b. Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration. *Organization Science*, 7(4), pp.375–387.

Greenhalgh T. and Hurwitz B. 1999. Narrative Based Medicine: Why Study Narrative? *BMJ*, 318, pp.48–50.

Grimshaw, J.M., Thomas, R.E., MacLennan, G *et al*. 2004. Effectiveness and Efficiency of Guideline Dissemination and Implementation Strategies. *Health Technol Assess*, 8(6), pp. iii–iv.

Gruber, T.R. 1995. Toward Principles for the Design of Ontologies Used for Knowledge Sharing. *International Journal of Human and Computer Studies*, 43(5/6), pp.907–928.

Gu, Y. 2004. Global Knowledge Management Research: A Bibliometric Analysis. *Scientometrics*, 61(2), pp.171–190.

Gujarati, D.N. 1999. *Essentials of Econometrics*, 2nd ed. Singapore: McGraw-Hill.

Gupta, J.N.D. and Sharma. S.K. 2004. Preface. In Jatinder N.D. Gupta and Sushil K. Sharma, eds., *Creating Knowledge Based Organisations*. Hershey, PA: Idea Group Publishing.

Gupta, J.N.D., Sharma. S.K. and Hsu, J. 2004. An Overview of Knowledge Management. In Jatinder N.D. Gupta and Sushil K. Sharma, eds., *Creating Knowledge Based Organisations*. Hershey, PA: Idea Group Publishing.

Guttman, L. 1945. A Basis for Analyzing Test-Retest Reliability. *Psychometrika*, 10(4), pp.255−282.

Hair, J.F. Jr., Anderson, R.E., Tatham, R.L. and Black, W.C. 1998. Multivariate Data Analysis, 5th ed. Upper Saddle River, NJ: Prentice Hall.

Halawi, L.A., McCarthy, R.V. and Aronson J.E. 2007. An Empirical Investigation of Knowledge-Management Systems' Success. *The Journal of Computer Information Systems*, 48(2), pp.121–135.

Hansen, M.T., Nohria, N. and Tierney, T. 1999. What's Your Strategy for Managing Knowledge? *Harvard Business Review*, 77(3−4), pp.106–116.

Härdle, W. and Léopold, S. 2007. *Applied Multivariate Statistical Analysis*, 2nd ed. Berlin, Heidelberg: Springer-Verlag.

Hatcher, L. 1994. *A Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equation Modeling*. Cary, NC: SAS Institute Inc.

Hauser, J. and Clausing, L. 1988. The House of Quality. *Harvard Business Review*, 3, pp.63–73.

Hayek, F.A. 1945. The Use of Knowledge in Society. *American Economic Review*, 35(4), pp.519–530.

Hebert, M. 2001. Telehealth Success: Evaluation Framework Development. *Proceedings of Medinfo 2001*, London, 2−5 September 2001.

Hedlund, G. 1994. A Model of Knowledge Management and the N-Form Corporation. *Strategic Management Journal*, 15(Special Issue, Summer), pp.73–90.

Heywood, H.B. 1931. On Finite Sequences of Real Numbers. *Proceedings of the Royal Society*, Series A. 134, pp.486−501.

Hikmet, N. and Bhattacherjee, A. 2009. The Impact of Professional Certifications on Healthcare Information Technology Use. In Joseph Tan, ed., *Medical Informatics: Concepts, Methodologies, Tools, and Applications*. Hershey, PA: Idea Group Publishing.

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R. and Taylor, R. 2005. Can Electronic Medical Record Systems Transform Health Care? Potential Health Benefits, Savings and Costs. *Health Affairs*, 24(5), pp.1103–1117.

Holsapple, C.W. and Jones, K. 2006. Knowledge Management Strategy Formulation. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Holsapple, C.W., Jones, K. and Singh, M. 2007. Linking Knowledge to Competitiveness: Knowledge Chain Evidence and Extensions? In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations*. Hershey, PA: Idea Group Publishing.

Holsapple, C.W. and Joshi, K.D. 2004. A Collaboratively Designed Ontology of Knowledge Management. *Journal of the American Society for Information Science and Technology*, 55(7), pp.593–612.

______. 2006. Knowledge Management Ontology. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Holsinger, J.W. and Beaton, B. 2006. Physician Professionalism for a New Century. *Clinical Anatomy*, 19, pp.473–479.

Hsiao, C.J., Burt C.W., Rechtsteiner E., Hing E., Woodwell D.A., Sisk J.E. 2008. Preliminary Estimates of Electronic Medical Records Use by Office-Based Physicians: United States. *Health E-Stat*. National Center for Health Statistics. 2008. Available from: http://www.cdc.gov/nchs/products/pubs/pubd/hestats/hestats.htm.

Hsu, H.Y.S. and Mykytyn, P.P., Jr. 2006. Intellectual Capital. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management. Hershey*, PA: Idea Group Publishing.

Ives, B., Olson, M. and Baroudi, J.J. 1983. The Measurement of User Information Satisfaction. *Communications of the ACM*, 26(10), pp.785–793.

Jasimuddin, S.M., Connell, N.A.D. and Klein, J.H. 2006. Understanding Organisational Memory. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Jennex, M.E. 2005. What Is KM? *International Journal of Knowledge Management*, 1(4), pp.i–iv.

______. 2006a. Knowledge Management Success Models. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

______. 2006b. Knowledge Management System Success Factors. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

______. 2007. What is Knowledge Management? In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations.* Hershey, PA: Idea Group Publishing.

______. 2008. Exploring System Use as a Measure of Knowledge Management Success. *Journal of Organizational and End User Computing*, 20(1), pp.50–63.

Jennex, M.E. and Croasdell, D. 2005. Editorial Preface: Is knowledge Management a Discipline? *International Journal of Knowledge Management*, 1(1), pp.i–v.

______. 2007. Knowledge Management as a Discipline. In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations.* Hershey, PA: Idea Group Publishing.

Jennex, M.E. and Olfman, L. 2006. A Model of Knowledge Management Success. *International Journal of Knowledge Management*, 2(3), pp.51–68.

______. 2007. Knowledge Management System Success Factors and Models. In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations*. Hershey, PA: Idea Group Publishing.

Jiang, J.J., Klein, G. and Carr, C.L. 2002. Measuring Information System Service Quality: SERVQUAL from the Other Side. *MIS Quarterly*, 26(2), pp.145–166.

Johnson, D.E. 1998. *Applied Multivariate Methods for Data Analysis*. Pacific Grove, CA: Brooks/Cole Publishing.

Johnson, W.H.A. 2007. Mechanisms of Tacit Knowing: Pattern Recognition and Synthesis. *Journal of Knowledge Management*, 11(4), pp.123–139.

Jöreskog, K.G. and Sörbom, D. 1993. *PRELIS2: A Preprocessor for LISREL*. Chicago, IL: Scientific Software Inc.

Kaiser, H.F. 1958. The Varimax Criterion for Analytic Rotation in Factor Analysis. *Psychometrika*, 23(3), pp.187−200.

______. 1970. A Second Generation Little Jiffy. *Psychometrika*, 35(4), pp.401–415.

Kalfoglou, Y. 2002. Exploring Ontologies. In S.K. Chang, ed., *Handbook of Software Engineering and Knowledge Engineering*, 1st ed. Singapore: World Scientific.

Kankanhalli, A., Tanudidjaja, F., Sutanto, J. and Tan, B. 2003. The Role of IT in Successful Knowledge Management Initiatives. *Communications of the ACM*, 46(9), pp.69–74.

Kankanhalli, A., Pee, L.G. and Tan, B.C.Y. 2007. Evaluation of Knowledge Management: A Review and Agenda for Future Research. In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations*. Hershey, PA: Idea Group Publishing.

Kaplan, B. and Duchon, D. 1988. Combining Qualitative and Quantitative Methods in Information Systems Research: A case Study. *MIS Quarterly*, 12 (4), pp.571–586.

______. 1989. A Job Orientation Model of Impact on Work Seven Months Post-Implementation. *Proceedings of Medinfo 89: Sixth World Congress on Medical Informatics*. Amsterdam: North-Holland, pp.1051–1055.

Kaplan, R. and Norton, D. 1996. *Translating Strategy into Action: The Balanced Scorecard*. Boston: Harvard Business School Press.

Karlinsky, H. 1999. Feature: Medical Informatics, Information Technology, and Psychiatry. *Bulletin Canadian Psychiatric Association*.

Kautz, K. and Mahnke, V. 2003. Value Creation through IT-Supported Knowledge Management? The Utilization of a Knowledge Management System in a Global Consulting Company. *Informing Science*, 6, pp.75–88.

King, W. 2006. Knowledge Transfer. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Kjerulff, K.H., Counte, J.A., Salloway, J.C. and Campbell, B.C. 1982. Predicting Employee Adaptation to the Implementation of a Medical Information System. *Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care*. Silver Springs, MD, IEEE Computer Society, pp. 392–397.

Kline, R. B. 2005. *Principles and Practice of Structural Equation Modeling*, 2nd ed. New York: Guilford Press.

Koenig, M.E.D. 2004. Knowledge Management Strategy: Codification versus

Personalization (A False Dichotomy). In M.E.D. Koenig and K.T. Srikantaiah, eds., *Knowledge Management Lessons Learned: What Works and What Doesn't*? Medford, NJ: Information Today.

Kraemer, K.L. 1991. *The Information Systems Research Challenge: Survey Research Methods*. Boston, MA: Harvard Business School.

Kraemer K.L. and Danziger, J.N. 1990. The Impacts of Computer Technology on the Worklife of Information Workers. *Social Science Computer Review*, 8, pp.592–613.

Krall, M.A. and Sittig, D.F. 2002. Clinicians' Assessments of Outpatient Electronic Medical Record Alert and Reminder Usability and Usefulness Requirements. *AMIA Proceedings*, pp.400−405.

Kroeber, A.L. and Kluckhohn, C. 1952. *Culture: A Critical Review of Concepts and Definitions.* New York: Vintage.

Kuhn, T.S. 1996. *The Structure of Scientific Revolutions*, 3rd ed. Chicago: University of Chicago Press.

Land, F., Nolas, S. and Amjad, U. 2006. Theoretical and Practical Aspects of Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Landrum, H., Prybutok, V.R., Kappelman, L.A. and Zhang, X. 2008. SERVCESS: A Parsimonious Instrument to Measure Service Quality and Information System Success. *The Quality Management Journal*, 15 (3), pp.17−25.

Lane, J. and Tsang, S. 2008a. Uncertainty in the Economics of Medical Decisions. *Singapore Economic Review*, 53(1), pp.81–101.

______. 2008b. Medical Decisions: A Two Stage Decision Model with Information Updating. In Wai-Mun, Chia and Hui-Ying Sng, eds., *Singapore and Asia in a Globalized World: Contemporary Issues and Policies.* Singapore: World Scientific.

Lave, J. and Wenger, E. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Laxminarayan, R. and Weitzman, M.L. 2002. On the Implications of Endogenous Resistance to Medications. *Journal of Health Economics*, 21(4), pp.709–718.

Liebeskind, J.P. 1996. Knowledge, Strategy, and the Theory of the Firm. *Strategic Management Journal*, 17(Winter), pp.93–107.

Liebowitz, J. 1999. *Knowledge Management Handbook*. Boca Raton, FL: CRC Press.

Liebowitz, J. and Beckman, T. 1998. *Knowledge Organizations: What Every Manager Should Know.* USA: St. Lucie Press.

Little, R.J. 2003. Bayesian Methods for Unit and Item Nonresponse. In R.L. Chambers and C.J. Skinner, eds., *Analysis of Survey Data*, Chichester: Wiley.

Loehlin, J.C. 2004. *Latent Variable Models: An Introduction to Factor, Path and Structural Equation Analysis*, 4th ed. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

McDermott, R. 1999. Why Information Technology Inspired but Cannot Deliver Knowledge Management. *California Management Review*, 41(4), pp.103–117.

McDonald, R.P. 1978. Generalizability in Factorable Domains: "Domain Validity and Generalizability", 1. *Educational and Psychological Measurement*, 38(1), pp.75–79.

______. 1999. *Test Theory: A Unified Treatment*. Hillsdale: Erlbaum.

McGrath, J.E. 1982. *Dilemmatics: The Study of Research Choices and Dilemmas*. Newbury Park, CA: Sage.

McGuire T.G. 2000. Physician agency. In A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, Vol. I. Amsterdam: Elsevier.

Maier, R. 2002. *Knowledge Management Systems: Information and Communication Technologies for Knowledge Management*. Berlin: Springer-Verlag.

______. 2004. *Knowledge Management Systems: Information and Communication Technologies for Knowledge Management*, 2nd ed. Berlin: Springer.

Maier, R. and Hädrich, T. 2006. Knowledge Management Systems. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Maij, E., Toussaint, P.J., Kalshoven, M., Poerschke M. and Zwetsloot-Schonk, J.H. 2002. Use Cases and DEMO: Aligning Functional Features of ICT-Infrastructure to Business Processes. *International Journal of Medical Informatics*, 65, pp.179–191.

Mangione-Smith, R., McGlynn, E. A., Elliott, M. N., Krogstad, P. and Brook, R. H. 1999. The Relationship between Perceived Parental Expectations and Pediatrician Antimicrobial Prescribing Behavior. *Pediatrics*, 103, pp.711–718.

Mangione-Smith, R., Stivers, T., Elliott, M., McDonald, L. and Heritage, J. 2003. Online Commentary during the Physical Examination: A Communication Tool for Avoiding Inappropriate Antibiotic Prescribing? *Social Science and Medicine*, 56(2), pp.313–320.

Mentzas, G., Apostolou, D., Young, R. and Abecker, A. 2001. Knowledge Networking: A Holistic Solution for Leveraging Corporate Knowledge. *Journal of Knowledge Management*, 5(1), pp.94–106.

Metaxiotis, K. 2006. Healthcare Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Mika, P. and Akkermans, H. 2004. Towards a New Synthesis of Ontology Technology and Knowledge Management. Submitted to *Knowledge Engineering Review* (April). http://www.cs.vu.nl/~pmika/research/papers/IR-BI-001.pdf.

Millward, B. 2000. *Knowledge-Centric Organizations.* CHIPS. http://www.chips.navy.mil/archives/00_apr/kco.htm.

Monteagudo, J.L. and Moreno, O. 2007. *eHealth Strategy and Implementation Activities in Spain: Report in the Framework of the eHealth ERA Project,* 29 May 2007, FP6-2005-IST-015854. http://www.ehealth-era.org. [Accessed: 7 October 2009].

Munkvold, G. 2006. Practice-Based Knowledge Integration. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Myers, B.L., Kappleman, L. and Prybutok, V.R. 1997. A Comprehensive Model for Assessing the Quality and Productivity of Information System Function: Towards a Theory for Information System Assessment. *Information Resources Management Journal*, 10(1), pp.6–25.

National Alliance for Health Information Technology (NAHIT). 2008. *Report to the Office of the National Coordinator for Health Information Technology on Defining Key Health Information Technology Terms,* 28 April 2008. http://www.nahit.org/images/pdfs/HITTermsFinalReport_051508.pdf.

Nelson, R.E. and Hsu, H.Y.S. 2006. A Social Network Perspective on Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Neville, M. and Powell, P. 2004. An Interactive System for the Collection and Utilization of Both Tacit and Explicit Knowledge. In Jatinder N.D. Gupta and Sushil K. Sharma, eds., *Creating Knowledge Based Organisations.* Hershey, PA: Idea Group Publishing.

Nicolau, D. 2002. Clinical and Economic Implications of Antimicrobial Resistance for the Management of Community-Acquired Respiratory Tract Infections. *J. Antimicrob Chemother,* 50(Suppl S1), pp.61–70.

Nonaka, I. 1991. The Knowledge Creating Company. *Harvard Business Review*, 69(6), pp.96–104.

______. 1994. A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, 5(1), pp.14–37.

Nonaka, I. and Konno, N. 1998. The Concept of "*Ba*": Building a Foundation for

Knowledge Creation. *California Management Review*, 40(3), pp.40–54.

Nonaka, I. and Peltokorpi, V. 2006. Objectivity and Subjectivity in Knowledge Management: A Review of 20 Top Articles. *Knowledge and Process Management,* 13(2), pp.73–82.

Nonaka, I. and Takeuchi, H. 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation.* Oxford: Oxford University Press.

Nunnally, J. 1968. *Psychometric Theory*, 2nd ed. New York: McGraw-Hill.

O'Brien, C. and Cambouropoulos, P. 2000. Combating Information Overload: a Six-Month Pilot Evaluation of a Knowledge Management System in General Practice. *Br J Gen Pract*, 50, pp.489–490.

O'Dell, C. and Grayson, C.J. 1998a. *If Only We Knew What We Know: The Transfer of Internal Knowledge and Best Practice*. New York: The Free Press.

______. 1998b. If Only We Knew What We Know: Identification and Transfer of Internal Best Practices. *California Management Review*, 40(3), pp.154–174.

Office of Technology Assessment (OTA). 1995. *Bringing Health Care Online: The Role of Information Technologies*. Washington, DC: US Government Printing Office.

Organisation for Economic Co-operation and Development (OECD). 2004. The Significance of Knowledge Management in the Business Sector. *OECD Observer*, July 2004. http://www.oecd.org/publications/Pol_brief. [Accessed: 5 July 2009].

Orlikowski, W.J. 2000. Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organization Science*, 11(4), pp.404–428.

Orlikowski, W.J. and Gash, D. 1994. Technological Frames: Making Sense of Information Technology in Organizations. *ACM Transactions on Information Systems*, 12, pp.174–207.

Orzano, A.J, Claire, R.M., Scharf, D. *et al*. 2008. A Knowledge Management Model: Implications for Enhancing Quality in Health Care. *Journal of the American Society for Information Science and Technology*, 59(3), pp.489–505.

Papa, M.J. 1990. Communication Network Patterns and Employee Performance with New Technology. *Communication Research*, 17, pp.344–368.

Parasuraman, A., Zeithamal, V.A. and Berry, L.L. 1988. SERVQUAL: A Multiple Item Scale for Measuring Consumer Perceptions of Service Quality. *Journal of Retailing,* 64(1), pp.12–40.

______. 1994. Reassessment of Expectations as a Comparison in Measuring Service Quality: Implications for Further Research. *Journal of Marketing*, 58(1), pp.111–124.

Peachey, T., Hall, D. and Cegielski, C. 2007. Knowledge Management Research: Are we Seeing the Whole Picture? In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations.* Hershey, PA: Idea Group Publishing.

Pearson, K. 1901. On Lines and Planes of Closest Fit to Systems of Points in Space. *Philosophical Magazine*, 2, pp.559−572.

Peteraf, M.A. 1993. The Cornerstones of Competitive Advantage: A Resource-Based View. *Strategic Management Journal*, 14, pp.179–191.

Petter, S., DeLone, W. and McLean, E. 2008. Measuring Information Systems Success: Models, Dimensions, Measures, and Interrelationships. *European Journal of Information Systems*, 17, pp.236–263.

Petty, R. and Guthrie, J. 2000. Intellectual Capital Literature Review: Measurement, Reporting and Management. *Journal of Intellectual Capital*, 1(2), pp.155–176.

Pfeffer, J. and Sutton, R.I. 2000. *The Knowing Doing Gap: How Smart Companies Turn Knowledge into Action*. Boston: Harvard Business School Press.

Polanyi, M. 1958. *Personal Knowledge: Towards a Post-Critical Philosophy*. London: Routledge and Kegan Paul.

______. 1966a. *The Tacit Dimension*. London: Routledge.

______. 1966b. The Logic of Tacit Inference. *Philosophy*, 41, pp.1–18.

Ponzi, L.J. 2004. Knowledge Management: Birth of a Discipline. In Michael E.D. Koenig and T. Kanti Srikantaiah, eds., *Knowledge Management Lessons Learned: What Works and What Doesn't*. Medford, NJ: Information Today.

Prahalad, C.K. and Hamel, G. 1990. The Core Competence of the Corporation. *Harvard Business Review*, 40(3), pp.79–91.

Prat, N. 2006. A Hierarchical Model for Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Prosser, H. and Walley, T. 2007. Perceptions of the Impact of Primary Care Organizations on GP Prescribing: The Iron Fist in the Velvet Glove? *Journal of Health Organization and Management*, 21(1), pp.5–26.

Prusak, L. 2006. Foreword. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Quinn, J.B., Anderson, P. and Finkelstein, S. 1996. Managing Professional Intellect: Making the Most of the Best. *Harvard Business Review*, 74(2), pp.71–80.

Raghavan, S. 2009. Medical Decision Support Systems and Knowledge Sharing Standards. In Joseph Tan, ed., *Medical Informatics: Concepts, Methodologies, Tools,* *and Applications*. Hershey, PA: Idea Group Publishing.

Rai, A., Lang, S.S. and Welker, R.B. 2002. Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis. *Information Systems Research*, 13(1), pp.5−69.

Raykov, T. and Marcoulides, G.A. 2006. *A First Course in Structural Equation Modeling*, 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Revelle, W. 1979. Hierarchical Cluster Analysis and the Internal Structure of Tests. *Multivariate Behavioral Research*, 14(1), pp.57−74.

______. 2010. *psych: Procedures for Psychological, Psychometric, and Personality Research*. R Package Version 1.0-92. http://CRAN.R-project.org/package=psych.

______. forthcoming. An Introduction to Psychometric Theory with Applications in R. Springer. http://personality-project.org/r/book.html.

Revelle, W. and Zinbarg, R.E. 2009. Coefficients Alpha, Beta, Omega and the GLB: Comments on Sijtsma. *Psychometrika*, 74(1), pp.145−154.

Ribière, V.M. and Román, J.A. 2006. Knowledge Flow. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

Roberts, J. 2000. From Know-How to Show-How? Questioning the Role of Information and Communication Technologies in Knowledge Transfer. *Technology Analysis & Strategic Management*, 12(4), pp.429–443.

Rogers, E.M. 1995. *Diffusion of Innovations*, 4th ed. New York: Free Press.

Rollett, H. 2003. *Knowledge Management Bibliography*. http://www2.iicm.edu/herwig/kmbib.html.

Roos, J., Roos, G., Dragonetti, N.C. and Edvinsson, L. 1998. *Intellectual Capital: Navigating in the New Business Landscape*. London: Macmillan.

Rubenstein-Montano, B., Liebowitz, J., Buchwalter, J. *et al*. 2001. A Systems Thinking Framework for Knowledge Management. *Decision Support Systems*, 31(1), pp.5–16.

Rubenstein-Montano, B.R. 2004. Virtual Communities as Role Models for Organisational Knowledge Management. In Jatinder N.D. Gupta and Sushil K. Sharma, eds., *Creating Knowledge Based Organisations*. Hershey, PA: Idea Group Publishing.

Ruggles, R. 1998. The State of the Notion: Knowledge Management in Practice. *California Management Review*, 40(3), pp.80–89.

Ryle, G. 1949. *The Concept of Mind*. London: Hutchinson.

Saaty, T. 1980. *The Analytic Hierarchy Process*. New York: McGraw Hill.

Sackett, D.L., Rosenberg, W.M., Gray, J.A., Haynes, R.B. and Richardson, W.S. 1996.

Evidence Based Medicine: What It Is and What It Isn't. *BMJ*, 312, pp.71–72.

Schafgans, M. 2005. *Lecture Notes on Principals of Econometrics*. London: London School of Economics and Political Science.

Schulz, M. and Jobe, L.A. 2001. Codification and Tacitness as Knowledge Management Strategies: an Empirical Exploration. *Journal of High Technology Management Research*, 12(1), pp.139–165.

Schultz, R.L. and Slevin, D.P. 1975. Implementation and Organizational Validity: An Empirical Investigation. In R.L. Schultz and D.P. Slevin, eds., *Implementing Operations Research/Management Science*. New York, NY: Elsevier.

Schultze, U. and Leidner, D. 2002. Studying Knowledge Management in Information Systems Research: Discourses and Theoretical Assumptions. *MIS Quarterly*, 26(3), pp.212–242.

Schwartz, D.G. 2006a. Preface: Knowledge Management as a Layered Multi-Disciplinary Pursuit. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

______. 2006b. Aristotelian View of Knowledge Management. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management*. Hershey, PA: Idea Group Publishing.

______. 2007. A Birds-Eye View of Knowledge Management. In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations*. Hershey, PA: Idea Group Publishing.

Schwartz, D.G., Divitini, M. and Brasethvik, T. 2000. *Internet-Based Organizational Memory and Knowledge Management*. Hershey, PA: Idea Group Publishing.

Scott, A. 2001. Eliciting GPs' Preferences for Pecuniary and Non-Pecuniary Job Characteristics. *Journal of Health Economics*, 20, pp.329–347.

Seddon, P.B. 1997. A Respecification and Extension of the DeLone and McLean Model of IS Success. *Information Systems Research*, 8(3), pp.240–253.

Seddon, P.B. and Yip, S.K. 1992. An Empirical Evaluation of User Information Satisfaction (UIS) Measures for Use with General Ledger Accounting Software. *Journal of Information Systems*, 6(1), 75–98.

Segars, A.H. 1997. Assessing the Unidimensionality of Measurement: A Paradigm and Illustration within the Context of Information System Research. *Omega*, 25(1), pp.107–121.

Shannon, C.E. and Weaver, W. 1949. *The Mathematical Theory of Communication*. Chicago, IL: University of Illinois Press.

Sharma, S.K., Wickramasinghe, N. and Gupta, J.N.D. 2009. Knowledge Management in Healthcare. In Joseph Tan, ed., *Medical Informatics: Concepts, Methodologies, Tools, and Applications.* Hershey, PA: Idea Group Publishing.

Sheskin, D.J. 2006. *Handbook of Parametric and Nonparametric Statistical Procedures*, 2nd ed. Boca Raton, FL: CRC Press LLC.

Sieloff, C. 1999. If Only HP Knew What HP Knows: The Roots of Knowledge Management at Hewlett-Packard. *Journal of Knowledge management*, 3(1), pp.47−53.

Silcock, J. and Ratcliffe, J. 1996. The 1990 GP Contract – Meeting Needs? *Health Policy*, 36, pp.199–207.

Simmons, L. 2004. Benchmarking with the Best Consultancies. *Knowledge Management Review*, 6(6), pp.28–31.

Sittig, D.F. 2009. An Overview of Efforts to Bring Clinical Knowledge to the Point of Care. In Joseph Tan, ed., *Medical Informatics: Concepts, Methodologies, Tools, and Applications.* Hershey, PA: Idea Group Publishing.

Skyrme, D.J. 1999. Knowledge Management: Making it Work. *The Law Librarian*, 31(2), pp.84–90.

Smith, A.D. and Rupp, W.T. 2003. Knowledge Workers: Exploring the Link among Performance Rating, Pay and Motivational Aspects. *Journal of Knowledge Management*, 7(1), pp.107–124.

Smith, P.G. and Reinertsen, D.G. 1998. *Developing Products in Half the Time*. Van Nostrand Reinhold.

Smith, R.G. and Farquhar, A. 2000. The Road Ahead for Knowledge Management. *AI Magazine*, 21(4), pp.17–40.

Sood, S.P., Keeroo, S., Mbarika, V.M.A., Prakash, N. and Seth, A. 2009. Medical Informatics: Thirty Six Peer-Reviewed Shades. In Athina A. Lazakidou and Konstantinos M. Siassiakos, eds., *Handbook of Research on Distributed Medical Informatics and E-Health.* Hershey, PA: Idea Group Publishing.

Spearman, C. 1904. "General Intelligence," Objectively Determined and Measured. *American Journal of Psychology*, 15(2), pp.201–292.

Spender, J.C. 1996. Making Knowledge the Basis of a Dynamic Theory of the Firm. *Strategic Management Journal*, 17, pp.45–62.

Spiegler, I. 2000. Knowledge Management: A New Idea or a Recycled Concept? *Communications of the Association for Information Systems*, 14(3).

Starbuck, W.H. 1992. Learning by Knowledge-Intensive Firms. *Journal of Management*

Studies, 29(6), pp.713–740.

______. 1993. Keeping a Butterfly and an Elephant in a House of Cards: The Elements of Exceptional Success. *Journal of Management Studies*, 30, pp.885–922.

Steiger, J. H. 1989. *EzPATH: Causal Modeling*. Evanston, IL: SYSTAT Inc.

______. 1990. Some Additional Thoughts on Components, Factors, and Factor Indeterminacy. *Multivariate Behavioral Research*, 25(1), pp.41–45.

Stein, E.W. 2007. Factors that Contribute to the Success of Knowledge Management Communities of Practice. In Murrey E. Jennex, ed., *Knowledge Management in Modern Organizations*. Hershey, PA: Idea Group Publishing.

Stempsey, W.E. 2009. Clinical Reasoning: New Challenges. *Theor Med Bioeth*, 30, pp.173−179.

Stevens, J. 2002. *Applied Multivariate Statistics for the Social Sciences*, 4th ed. Mahwah, NJ: Lawrence Erlbaum Associates.

Stevick, E.W. 1989. *Success with Foreign Languages: Seven Who Achieved It and What Worked for Them*. Hertfordshire: Prentice Hall.

Stiglitz, J.E. 1999a. *Public Policy for a Knowledge Economy*. London: The World Bank. http://www.worldbank.org/html/extdr/extme/knowledge-economy.pdf. [Accessed: 7 March 2009].

______. 1999b. Knowledge as a Global Public Good. In Inge Kaul, Isabelle Grunberg and Marc A. Stern, eds., *Global Public Goods: International Cooperation in the 21st Century*. New York: Oxford University.

Streatfield, D. and Wilson, T. 1999. Deconstructing "Knowledge Management." *Aslib Proceedings*, 51(3), pp.67–71.

Sullivan, P.H. 2000. *Value-Driven Intellectual Capital: How to Convert Intangible Corporate Assets into Market Value*. New York: Wiley.

Sveiby, K.E. 1997a. *The New Organizational Wealth: Managing and Measuring Knowledge-Based Assets*. San Francisco: Barrett-Kohler.

______. 1997b. *What Is Knowledge Management?* http://www.sveiby.com.au/KnowledgeManagement.html

Szulanski, G. 2003. *Sticky Knowledge: Barriers to Knowing in the Firm*. Thousand Oaks, CA: Sage.

Tauber, D. and Schwartz, D. 2006. Integrating Knowledge Management with the Systems Analysis Process. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Taylor, H. and Leitman, R. 2002. European Physicians Especially in Sweden, Netherlands and Denmark, Lead U.S. in Use of Electronic Medical Records. *Harris Interactive*, 2(16).

Taylor, J.C. and Bowers, D.G. 1972. *Survey of Organizations: A Machine Scored Standardized Questionnaire Instrument.* Ann Arbor, MI: Institute for Social Research, University of Michigan.

Taylor, P. 2006. *From Patient Data to Medical Knowledge: The Principles and Practice of Health Informatics*, BMJ Books. Oxford: Blackwell Publishing.

Teece, D.J. 1998. Research Directions for Knowledge Management. *California Management Review*, 40(3), page 289.

Tempelaar, D.T, van der Loeff, S.S. and Gijselaers, W.H. 2007. A Structural Equation Model Analyzing the Relationship of Students' Attitudes toward Statistics, prior Reasoning Abilities and Course Performance. *Statistics Education Research Journal*, 6(2), pp.78−102.

ter Meulen, R.H.J. 2005. The Ethical Basis of the Precautionary Principle in Health Care Decision Making. *Toxicology and Applied Pharmacology*, 207, S663–S667.

Terrett, A. 1998. Knowledge Management and the Law Firm. *Journal of Knowledge Management*, 2(1), pp.67–76.

Thompson, R.L., Higgins, C.A. and Howell, J.M. 1991. Personal Computing: Toward a Conceptual Model of Utilization. *MIS Quarterly*, 15(1), pp.125–143.

Thurstone, L.L. 1947. Multiple-Factor Analysis: A Development and Expansion of the Vectors of the Mind. The University of Chicago Press, Chicago, IL.

Tinbergen, J. 1952. *On the Theory of Optimal Policy*. North Holland Amsterdem.

Torkzadeh, G. and Doll, W.J. 1999. The Development of a Tool for Measuring the Perceived Impact of Information Technology on Work. *Omega*, 27(3), pp.327–339.

Tuomi, I. 1999. Data Is More than Knowledge: Implication of the Reversed Knowledge Hierarchy for Knowledge Management and Organizational Memory. *Journal of Management Information Systems*, 16, pp.103–117.

Turban, E. and Aronson, J.E. 2001. *Decision Support Systems and Intelligent Systems*, 6th ed. Upper Saddle River: NJ: Prentice Hall.

Turunen, P. 2009. A Cross-Cultural Framework for Evaluation. In Joseph Tan, ed., *Medical Informatics: Concepts, Methodologies, Tools, and Applications.* Hershey, PA: Idea Group Publishing.

United Nations. 1964. *Recommendations for the Preparation of Sample Survey Reports. Provisional Report*, Sales No. 64.XVII.4. New York: United Nations.

van der Lei, J. and van Bemmel, J.H. 2002. Diagnostic Decision Support: Contributions from Medical Informatics. In J André Knottnerus, ed., *The Evidence Base of Clinical Diagnosis.* London: BMJ Books.

Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D. 2003. User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), pp.425–478.

Walsham, G. 2001. Knowledge Management: The Benefits and Limitations of Computer Systems. *European Management Journal*, 19(6), pp.599–608.

______. 2002. What Can Knowledge Management Systems Deliver? *Management Communication Quarterly: McQ*, 16(2), pp.267–73.

Wernerfelt, B. 1984. A Resource-Based View of the Firm. *Strategic Management Journal*, 5(2), pp.171–180.

Wickramasinghe, N. 2006. Knowledge Creation. In David G. Schwartz, ed., *Encyclopedia of Knowledge Management.* Hershey, PA: Idea Group Publishing.

Willem, A. and Buelens, M. 2007. Knowledge Sharing in Public Sector Organizations: The Effect of Organizational Characteristics on Interdepartmental Knowledge Sharing. *Journal of Public Administration Research*, 17, pp.581–606.

Wilson, T.D. 2002. The Nonsense of 'Knowledge Management.' *Information Research*, 8 (1). http://informationr.net/ir/8-1/paper144.html. [Access: 8 May 2009]

Wong, H.J., Legnini, M.W., Whitmore, H.H. and Taylor, R.S. 2000. The Diffusion of Decision Support Systems in Healthcare: Are We There Yet? *Journal of Healthcare Management*, 45(4), pp.240−253.

World Health Organization (WHO). 2006. *WHO Knowledge Management Global Operational Plan 2006–2007,* France, 1 January 2006, EIP/KMS/2006.1. http://www.who.int. [Accessed: 7 May 2009].

______. 2010. *World Health Statistics 2010.* http://www.who.int/whosis/whostat/2010/en/. [Accessed: 23 August 2010].

Wyatt, J.C. 2001. Management of Explicit and Tacit Knowledge. *Journal of the Royal Society of Medicine* 94, pp.6–9.

Yu, J. and Cooper, H. 1983. A Qualitative Review of Research Design Effects in Response Rate to Questionnaire. *Journal of Marketing Research*, 36, pp.36–44.

Zack, M.H. 1999. Managing Codified Knowledge. *Sloan Management Review*, 40(4), pp.45–58.

Zinbarg, R., Yovel, I., Revelle, W. and McDonald, R. 2006. Estimating Generalizability to a Universe of Indicators that All have One Attribute in Common: A Comparison of Estimators for Omega. *Applied Psychological Measurement*, 30, pp.121−144.

Zmud, R.W. 1978. An Empirical Investigation of the Dimensionality of the Concept of Information. *Decision Sciences*, 9(2), pp.187–195.

Zmud, R.W. and Boynton, A.C. 1991. Survey Measures and Instruments in MIS: Inventory and Appraisal. In K.L. Kraemer, ed., *The Information Systems Research Challenge: Survey Research Methods*. Boston, MA: Harvard Business School, pp.149–180.