

Exploring the Impact of IS theory on Health Informatics

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Abstract

We report the results of a citation analysis of the Health Informatics literature. The study takes the health informatics literature as its starting point, looking inward at the IS literature to seek evidence for the impact of IS theories in healthcare environments. A review of 286 references from the Health Informatics discipline confirms findings of earlier studies that the technology acceptance model is the dominant theory in use with some adaptations emerging.

1 Introduction

The field of Health Informatics (HI) evolved in parallel to that of Information Systems (IS). HI Emerged from Artificial Intelligence in medicine (AIM) and Computer Science (CS). HI has traditionally been concerned with the systematic processing of data, information and knowledge in medicine and healthcare. In a much quoted definition by the International Medical Informatics Association [1] the Health informatics domain was defined as covering “computational and informational aspects of processes and structures, applicable to any clinical or managerial discipline within the health sector whether on a remote (tele~) basis or not. Health informatics is delivered by operational health practitioners, academic researchers and educators, scientists and technologists in operational, commercial and academic domains”

The notion implied in this definition of informatics being delivered is an interesting one which goes to the heart of the philosophy of healthcare to provide, via established infrastructure, services to society.

Since the early 2000s, the health industry has undergone significant changes with the emergence of national health infrastructures and personal health records. Health spending continues to dominate public spending in OECD nations. An aging population provides a significant challenge to nations committed to economic development, world trade, and democracy. Information technology has been suggested as an enabler of improved clinical outcomes. During the same period of the early 2000s Information Systems within health environments have been embraced as a new test bed for Information Systems theories.

2 Background

There have been a number of papers exploring the rise of Health Information Technology research in “healthcare friendly” IS and management journals notably Chiasson and Davison [2] and, building on this, Romanow et al [3]. These authors set out a clear body of work in the IS domain addressing Healthcare Applications, and establish a useful framework for classifying papers shown in Table 1. The initial Chaisson and Davidson (2004) study identified 165 papers describing an IS artefact in a healthcare environment between 1985 and 2003. Romanow et al expanded this research to cover the period 2003-2011 resulting in a further 218 papers with a higher proportion of category three papers as defined in Table 1.

Type	Theory Context Strategy
1	IS only: authors primary attention is generalizable theory without consideration of interaction with the healthcare context
2	IS-healthcare: authors primary attention is generalizable theory with some consideration given to the interaction with the healthcare context
3	Healthcare-IS: authors examine phenomena in healthcare context, using theory to explain phenomena, possibly extending or building theory in this context
4	Healthcare only: authors primary attention is to describing IS or IT in healthcare context with little consideration of theory

Table 1. Theory and Context Relationship Chiasson and Davison [2]

The work at hand differs subtly from these review papers in that our starting point is the Health Informatics literature rather than Information Systems and management literature. We apply a different lens to look inwards at Information Systems rather than outward. Specifically with the aim of identifying the destination of IS theories, via their citations in the cogent discipline of HI.

Health information systems have emerged as an important test bed for IS theories. In order to deliver healthcare in a patient centered fashion, healthcare providers are faced with the challenge of collaborative and information intensive processes. These processes typically involve individuals from many disparate organizations performing a variety of roles. Thus, healthcare is a socially complex and inherently distributed environment which provides a challenge for IS researchers. It is well accepted that it is of benefit to both disciplines to explore the use of IS theories in healthcare environments [3].

The technology acceptance model [4] and later acceptance models including, significantly, Venkatesh et al's Unified Theory of Acceptance and Use of Technology UTAUT [5] are the dominant theories in Health Informatics research. DeLone and Maclean's IS success Model is also frequently used. [6]. Evaluation studies have dominated Health Informatics Research in the last two decades. These have evolved from studies analogous to randomized control trials, to studies seeking to identify the antecedents of IS success and acceptance in the complex interrupt-driven health environment [7] more precisely. In order to explore this complex environment HI researchers have adopted methodologies from both quantitative and qualitative sides of Information Systems popular methodologies include Kaplan and Duchon, [8], Klein [9] and Straub[10].

As recently as 2006 [11] scholars asserted that Information Systems was not yet a reference discipline. However, as suggested this does not mean that an Information systems is devoid of native theories, nor that the confluence with Health Informatics is a bad place to start developing them.

A preliminary analysis of the citation counts of Health Information Systems articles published in special issues during the early 2000s showed that they were cited more in the IS literature than they were in the HI literature. This result is consistent with a comment in Wade[11] attributed to Vessey [12] which suggested that ideas generated in the IS field are not being spread efficiently and that "a substantial number of them are leaving the field only to be reabsorbed back into it. Vessey [12] recognized this effect after an exhaustive review of diversity in the IS field revealed that IS "had become a reference discipline - but only to its own research!" [12]. Grover et al [13] presented a more optimistic analysis that concluded that IS is making progress in its influence among its classical reference disciplines management science, computer science, organization science and marketing.

In the case of Health Informatics it is possible the publication of special issues in the major IS journals, and the timing of these issues, has amplified the effect

of being "a reference discipline to ourselves". An unpublished preliminary study by the authors found that, for example the 2007 special issue of the European Journal of Information systems as a whole received 5 Cites in the HI literature and 15 in the IS literature).

In order to investigate the impact of IS further, we seek to explore the citation data at a finer level of granularity and in particular from the vantage point of the HI Journals to find which ideas are impacting the literature there.

RQ1 Which IS theories have been taken up in the HI literature

RQ2 Are there any trends over time in the uptake of IS theory

RQ3 Are IS theories being adapted for use in HI

RQ4 What is the demographic makeup of HI authors

The paper proceeds as follows; we present the literature selection methodology, the results and a short discussion.

3 Methodology

It is impossible to capture the HI citations of basket of eight journals by directly querying the citations of same, and then filtering them for HI because the first query has a vast amount of results even by journal. In other words this would only work if searching citations to particular IS articles.

In order to explore which particular articles, were "Jumping the fence" into the HI world we developed the cited reference query shown in Appendix 1. In an attempt to capture as many HI articles with a true Information systems focus, we created a search based on Sidorova's study of the core of the IS discipline [14]. In their 2008 MIS Quarterly article Sidorova et al attempted to enunciate the core of the IS discipline. Sidorova's study built on Orlikowski and Iacono's [15] conceptualization of Information Technology (IT) in Information Systems Research, and popularized the phrase "IT artefact" within the IS community. The core of the IS discipline has also been examined by a number of other IS researchers [16] [17]. Sidorova included 100 factors represented in the IS literature. We limited the search to the entire set of HI journals as defined by Thompson ISI science edition. In that edition there were 20 journals in total (but only those included in Table 2 cited IS journals). The 1603 papers with their full citation lists were exported to Endnote where a search was done via the field containing the citations to find basket of 8 journals. In order to make the data easier to query the data was also exported in tab delimited form to Excel from where macros were written to extract only the papers that had "basket of 8"

[18] citations in their reference lists (i.e. European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of the AIS, Journal of Information Technology, Journal of Management Information Systems, Journal of Strategic Information Systems, and MIS Quarterly). In this fashion it is possible to see not only the citations of IS Journals by HI journals but also which HI journal articles built on which particular IS Article. The top 20 results (i.e. any IS articles that were cited 4 times or more) are shown in Figure 4. This resulted in 286 key HI papers. Among these papers there are 627 total references to IS papers and 266 unique citations. Table 2 shows the sources of the HI journals.

Artificial Intelligence in Medicine	2
BMC Medical Informatics and Decision Making	14
CIN-Computers Informatics Nursing	20
Computer Methods and Programs in Biomedicine	2
Health Information Management Journal	6
IEEE Transactions on Information Technology in Biomedicine	13
Informatics for Health & Social Care	3
International Journal of Medical Informatics	87
International Journal of Technology Assessment in Health Care	4
Journal of Biomedical Informatics	20
Journal of Medical Internet Research	12
Journal of Medical Systems	23
Journal of the American Medical Informatics Association	42
Methods of Information in Medicine	38
Total	286

Table 2 The 14 HI Journal Sources (as defined by Thompson ISI science edition) that included reference to “Basket of 8” journals.

Results

A subset of 50 of the 286 references were downloaded and classified according to; (1) the theory context Chiasson and Davison [2] (Figure 1), the Intellectual community represented [16] (Figure 2), and the demographic of the authors, classed as either terms of Information Systems (I), Predominantly Health focused (H), Interdisciplinary Teams (M) and other which in this case was Management or Operations research (Figure 3). The abbreviation HCI appearing in Figure 1 refers to the class of IS community the work applies to, in this case at the interface between humans

and computers including ease of use and technology acceptance. See Appendix B for a breakdown of these classes.

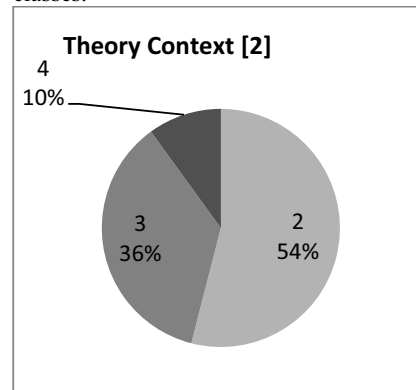


Figure 1

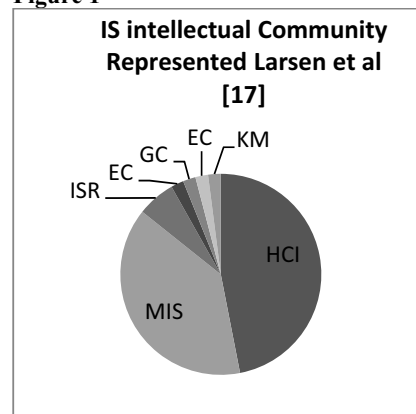


Figure 2

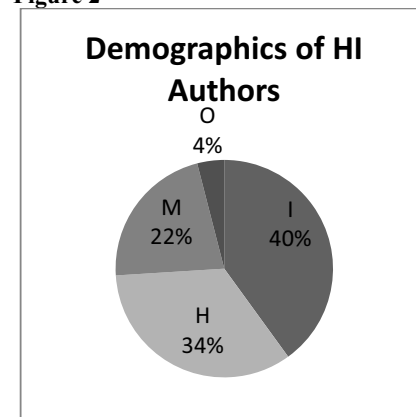


Figure 3

This sample revealed some interesting demographics with respect to RQ4 namely that more than half HI research is performed by IS researchers or interdisciplinary teams. The expected preponderance of category 4 papers is not present.

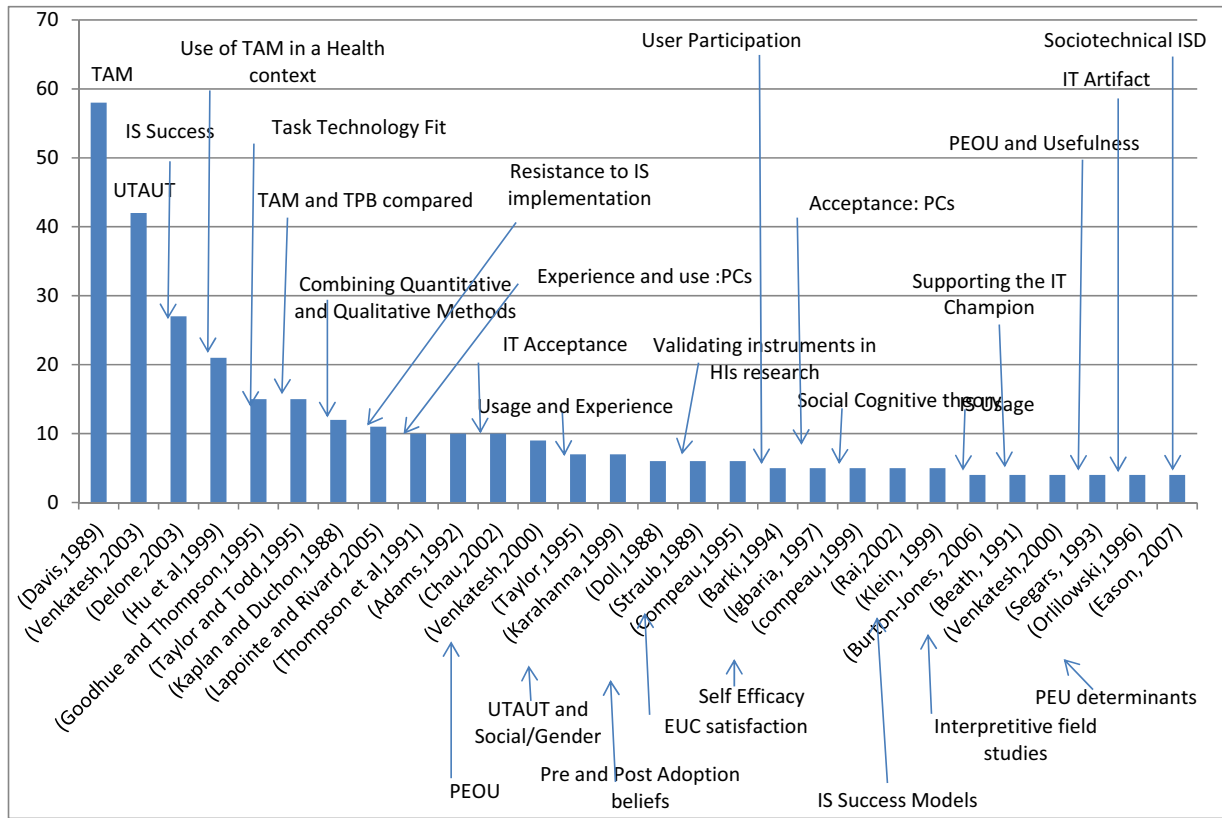


Figure 4. The 28 Information systems papers cited four times or more in the HI literature

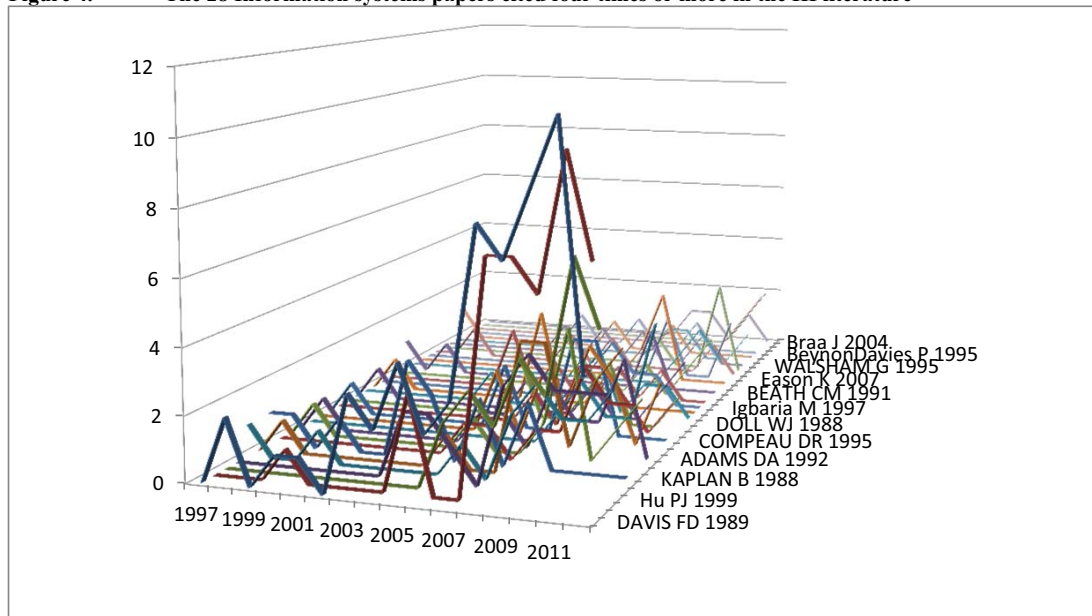


Figure 5 Uptake of IS theory in Health Informatics

In relation to RQ1, The most adopted theories from IS research fall into three categories; Technology acceptance, IS success and the Theory of Planned Behaviour [19]. Thirty two papers within the data set cited Ajzen, but since this work was not originally in the basket of 8 this realization came through reference to UTAUT [5]. There are three well cited methodological papers specifically Kaplan and Duchon, [8], Klein [9] and Straub [10] which is some evidence of a turn toward IS methodological approaches.

Of interest were the many references to Hu et al [21]. As an early health reference in the mainstream IS discipline, it has been pivotal in bringing TAM to telemedicine initially and from there the broader Health Informatics arena.

The use of TAM is manifested most frequently as part of evaluation or usability studies. Three of the Top 10 cited HIT papers from [3] are present in our results namely [20] [21] and [22]. Also the popularity and longevity of TAM [4], remarked upon in Romanow et al [3], is borne out here. Possibly more interesting are cites relating to papers nearer to the right hand side of the figure. Articles Citing Rai and Venkatesh are more concerned with the learning organisation [23-26]. These articles focus on user satisfaction, psychological engagement and ownership. Citations to [27] often occur in the growing body of literature surrounding lessons learnt from the UK NpFIT System for example [22, 28-30]. Klein and Myers [9] work on carrying out interpretive field studies has been taken up in a field study concerning the subjective nature of “quality” in medical images [31]

In addressing RQ3 the major adaptations were of TAM. A number of researchers have taken on redesign of the Technology Acceptance Model in a Health Setting [32, 33]. Melas et al introduced Physicians specialty as a moderating factor. Tung et al added the non-health-specific constructs trust and perceived financial cost into the model. A health specific TAM was suggested by Holden in 2010 [34] More recently Dunnebeil et al [35] recognized six important health specific antecedents to Perceived Ease of Use and Perceived Usefulness

4 Discussion

There is some evidence that IS research is having an impact on the associated field of Health Informatics. There are a number of researchers publishing in both areas that are facilitating this. A Social network analysis of authors across the disciplines would provide evidence of this mean of spreading theory. As in mainstream IS, the dominant theory in Health IS is TAM, but there is evidence some interest in socio technical approaches, critical theory, knowledge management and communications approaches. It is interesting that as of 2012 there were no citations dated later than 2007, or earlier than 1997, in the highly cited group of IS papers illustrated in Figures 4 and 5.

In relation to RQ2 the topic of Health Information Systems has been “on fire” since 2004 [3] so it is reasonable to assume that there is likely to be a change in the near future. A full bibliography is available on request.

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Appendix A

Publication Name=(J MED INTERNET RES Or J AM MED INFORM ASSN Or IEEE ENG MED BIOL Or STAT MED Or INT J MED INFORM Or BMC MED INFORM DECIS Or MED DECIS MAKING Or MED BIOL ENG COMPUT Or STAT METHODS MED RES Or J BIOMED INFORM Or IEEE T INF TECHNOL B Or ARTIF INTELL MED Or METHOD INFORM MED Or INT J TECHNOL ASSESS Or COMPUT METH PROG BIO Or J MED SYST Or J EVAL CLIN PRACT Or INFORM HEALTH SOC CA Or CIN-COMPUT INFORM NU Or HEALTH INF MANAG J Or J CANCER EDUC Or BIOMED TECH) AND Topic=(("Information systems" OR "information technology") AND("Decision support systems" or "Measurement instruments" or "technology acceptance" or economics or "Human Resources" or "Competitive Advantage" or "Virtual Teams" or "IT adoption" or "IS planning" or "Group support systems" or "Resource-based view" or communication or media or "self efficacy" or "Database design" or "data modelling" or "Group decision support systems" or GDSS or "Information systems success" or "Electronic meeting systems" or "IS Discipline" or "E-marketplaces" or prototyping or "knowledge management" or "knowledge transfer" or "top management" CIO or CEO or outsourcing or value or investment or "project failure" or EDI or "interorganizational systems" or (structure and (centralised or decentralised)) or (Critical issues and (information systems)) or Trust or development or maintenance or "power and politics" or "Customer service" or "Information centers" or "Risk management" or "Web site design" or "systems analyst" or programmer or "Trading systems" or coordination or "user satisfaction" or "job satisfaction" or "Problem solving" or "online consumer" or "Electronic brainstorming" or "Real options and option pricing" or "electronic networks" or "social networks" or "Executive information systems" or "Training" or learning or education or "Systems development methodologies" or interviews or "knowledge acquisition" or "End user computing" or creativity or "programming languages" or "query languages" or "intelligent systems" or "Supply chain management" or "Cost-benefit analysis" or "Industry" or "research methodology" or "Business process reengineering" or roles or "neural networks" or "data mining" or control or "Expert systems" or "MIS" or ERP or "IS implementation" or conflict or Task or Ethics or Environment or "object oriented" or "Data quality" or "IS quality" or "Error detection" or "cost estimation" or "effort estimation" or Auctions or "dynamic pricing" or "user interface" or graphical or "innovation" or personalization or privacy or "Strategic alignment" or "service quality" or SERVQUAL or attitude or change or "IT adoption" or "Classification framework" or "national culture" or "organizational culture" or "application domain" or negotiations or collaboration or communities or "digital libraries" or infrastructure or standards or security or "public sector" or "Critical Success Factors" or "knowledge-based" or ("user participation" and "system development") or manufacturing or multimedia or "document management" or Banking or "IT usage" or "resource allocation" or "global IT" or internet or "social integration")

Appendix B A Sample of 50 HI References, their IS Citations and classification

Larsen et al Classification	HI Author Name	HI Journal	MIDate	Type(1-4)	ID	
EC	Walther, J. B., S. Pingree, R. P. Hawkins and D. B. Buller	Journal of Medical Internet Research	2005	2	O	
	WATSON RT MIS QUART V12 P463 1988					
GC	Ndira, S. P., K. D. Rosenberger and T. Wetter	Methods of Information in Medicine	2008	4	H	
	Braa J MIS QUART V28 P337 2004					
HCI	Aggelidis, V. P. and P. D. Chatzoglou	International Journal of Medical Informatics	2009	2	I	
	TAYLOR S INFORM SYST RES V6 P144 1995, DeLone WH J MANAGE INFORM SYST V19 P9 2002, Hu PJ J MANAGE INFORM SYST V16 P91 1999 Taylor S MIS QUART V19 P561 1995, Venkatesh V MIS QUART V27 P425 2003					
	Basoglu, N., T. U. Daim and U. Topacan	Journal of Medical Systems	2012	3	I	
	Karahanna E MIS QUART V23 P183 1999, Chang IC DECIS SUPPORT SYST V44 P350 2007, Taylor S MIS QUART V19 P561 1995, Venkatesh V MIS QUART V27 P425 2003 THOMPSON RL MIS QUART V15 P125 1991					
	Dillon, T. W., R. Blankenship and T. Crews	CIN-Computers Informatics Nursing	2005	2	I	
	Marakas GM INFORM SYST RES V9 P126 1998, Agarwal R INFORM SYST RES V11 P418 2000, COMPEAU DR MIS QUART V19 P189 1995, Venkatesh V INFORM SYST RES V11 P342 2000					
	Edwards, G., R. R. Kitzmiller and S. Breckenridge-Sproat		2012	3	H	
	Simon SJ INFORM SYST RES V7 P466 1996					
	Flynn, D., P. Gregory, H. Makki and M. Gabbay	International Journal of Medical Informatics	2009	2	I	
	Eason K J INF TECHNOL V22 P257 2007 DeLone WH J MANAGE INFORM SYST V19 P9 2002 BEATH CM MIS QUART V15 P355 1991 Reardon JL EUR J INFORM SYST V16 P681 2007					
	Hertzum, M.		2011	4	I	
	Venkatesh V MIS QUART V27 P425 2003 DAVIS FD MIS QUART V13 P319 1989 Fichman RG INFORM SYST RES V10 P255 1999 Orlikowski WJ INFORM SYST RES V7 P63 1996					
	Holden, R. J.	International Journal of Medical Informatics	2010	2	I	
	Venkatesh V MIS QUART V27 P425 2003					
	Koo, C., Y. Wati, K. Park and M. K. Lim	Journal of Medical Internet Research	2011		M	
	Nelson RR J MANAGE INFORM SYST V21 P199 2004, Chang IC DECIS SUPPORT SYST V44 P350 2007, DAVIS FD MIS QUART V13 P319 1989, Rai A INFORM SYST RES V13 P50 2002, McKinney V INFORM SYST RES V13 P296 2002 Jiang ZJ MIS QUART V31 P475 2007, Choudhury V MIS QUART V32 P179 2008 DeLone WH J MANAGE INFORM SYST V19 P9 2002, Bhattacharjee A MIS QUART V25 P351 2001 Wixom BH INFORM SYST RES V16 P85 2005					
	Lanham, H. J., L. K. Leykum and R. R. McDaniel	JAMIA	2012		H	
	Curseu PL J INF TECHNOL V21 P249 2006 Tanriverdi H INFORM SYST RES V21 P822 2010 Merali Y J INF TECHNOL V21 P210 2006 Vidgen R INFORM SYST RES V20 P355 2009 Dube L MIS QUART V27 P597 2003					
	Lau, A. S. M.	Journal of Medical Internet Research	2011		I	
	Lederer AL DECIS SUPPORT SYST V29 P269 2000 Iacovou CL MIS QUART V19 P465 1995 DAVIS FD MIS QUART V13 P319 1989 TAYLOR S INFORM SYST RES V6 P144 1995					
	Lee, S.	CIN -Computers Informatics Nursing	2012	3	H	
	Nelson RR J MANAGE INFORM SYST V21 P199 2004 DeLone WH J MANAGE INFORM SYST V19 P9 2002 GOODHUE DL MIS QUART V19 P213 1995					
	Lupianez-Villanueva, F., M. Hardey, J. Torrent and P. Ficapal	International Journal of Medical Informatics	2010		M	
	DAVIS FD MIS QUART V13 P319 1989					
	Melas, C. D., L. A. Zampetakis, A. Dimopoulou and V. Moustakis	Journal of Biomedical Informatics	2011	2	I	
	Hu PJ J MANAGE INFORM SYST V16 P91 1999 Venkatesh V MIS QUART V27 P425 2003 Bhattacharjee A EUR J INFORM SYST V16 P725 2007					

	DAVIS FD MIS QUART V13 P319 1989 Chau PYK J MANAGE INFORM SYST V18 P191 2001 DAVIS FD MIS QUART V13 P319 1989				
	Or, C. K. L., B. T. Karsh, D. J. Severtson, L. J. Burke, R. L. Brown and P. F. Brennan	JAMIA	2011	2	H
	TAYLOR S INFORM SYST RES V6 P144 1995 Venkatesh V MIS QUART V27 P425 2003 Hu PJ J MANAGE INFORM SYST V16 P91 1999				
	Otieno, G. O., T. Hinako, A. Motohiro, K. Daisuke and N. Keiko	International Journal of Medical Informatics	2008		M
HCI	GOODHUE DL MIS QUART V19 P213 1995 DeLone WH J MANAGE INFORM SYST V19 P9 2002				
	Segerstahl, K. and H. Oinas-Kukkonen		2011	4	I
	van der Heijden H MIS QUART V28 P695 2004 Myers MD MIS QUART V21 P241 1997				
	Sicotte, C., G. Pare, M. P. Moreault, A. Lemay, L. Valiquette and J. Barkun	Methods of Information in Medicine	2009	2	
	Venkatesh V MIS QUART V27 P425 2003 Jasperson JS MIS QUART V29 P525 2005				
	Tung, F. C., S. C. Chang and C. M. Chou	International Journal of Medical Informatics	2008		I
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