Information technology adoption in health care: when organisations and technology collide

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Abstract

The implementation of advanced information systems is enabling great social and organisational changes. However, health care has been one of the slowest sectors to adopt and implement information technology (IT). This paper investigates why this is so, reviewing innovation diffusion theory and its application to both health organisations and information technology. Innovation diffusion theory identifies variables that influence the 'innovativeness' of organisations and the rate at which a technology diffuses. When analysed, these variables show why IT implementation has progressed at a slower rate in health compared with other industry sectors. The complexity of health organisations and their fragmented internal structure constrain their ability to adopt organisation wide IT. This is further impacted upon by the relative immaturity of strategic health IT which is complicated and unable to show quantifiable benefits. Both organisational and technological factors lead to the slow adoption of strategic IT. On the other hand, localised IT solutions and those providing measurable cost reductions have diffused well.

Information Technology Adoption in Health Care

Changes in contemporary advanced industrial societies have been characterised as a period of transformation similar to the industrial revolution, the last great period of discontinuous social change. The current revolution has its foundation in information and communication technologies which are characterised as the precursors for moving us into the information age (Grove 1996; Hamel 1998).

One of the features of this revolution has been the way the health sector has generally lagged in the application of this technology (Shortliffe 1998). One could expect that health care, with its requirement for knowledge and information and its educated workforce, would be a rapid adopter of IT. This, however, appears not to be the case. Health tends to be a slow adopter of IT and one of the sectors that invests least (CSC 1998; CSC 1999). In Australia, the common belief is that hospitals spend between 1% and 1.5% of revenues on IT. This is lower than international experience in other industries, such as utilities (3.31%), financial services (5.0%), manufacturing (3.0%) and telecommunications (4.2%) (CSC 1999). Stand-alone, small IT solutions have been adopted but major, organisation-wide information systems are not as prevalent in health as in other industry sectors. This comparison shows that IT is not being accepted as readily in health as other sectors. This is not intended as a judgement of the merit of the amount spent on IT rather a measurement of the level to which IT innovations have been adopted by different industries.

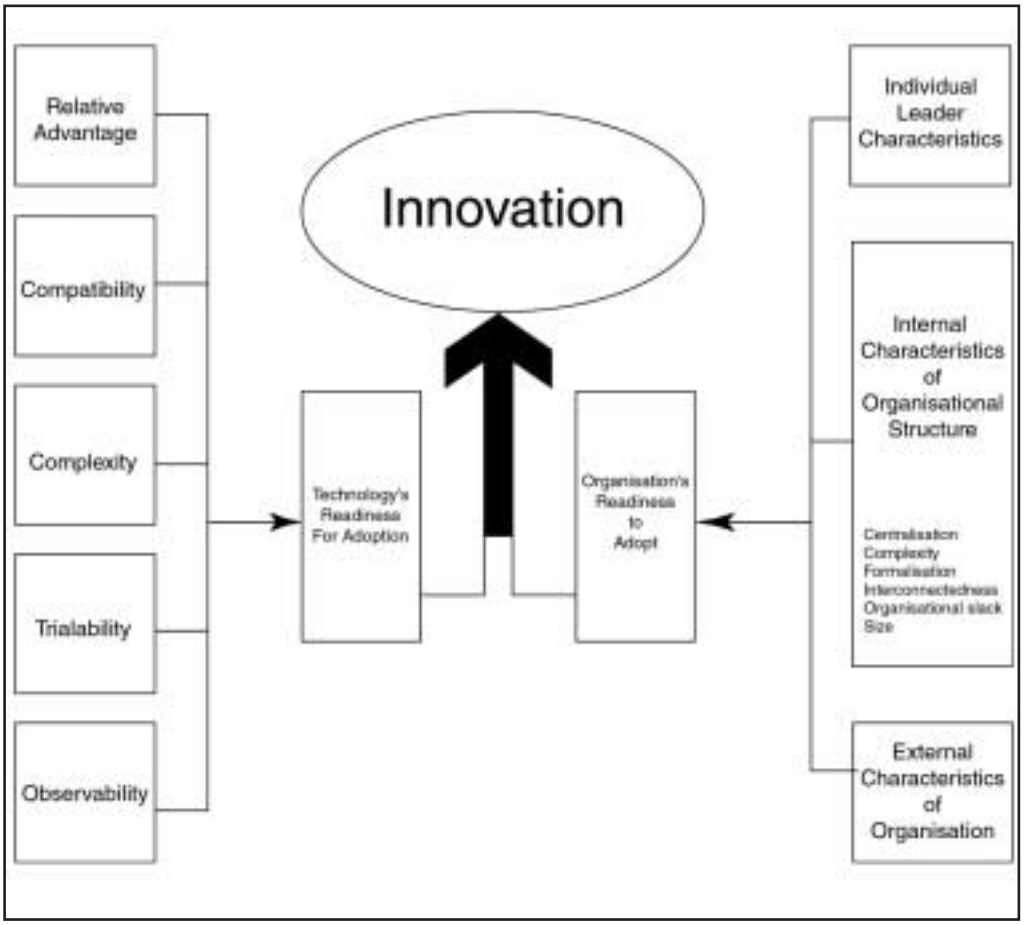
Innovation research has focused on two major areas: first, the organisation and determinants of its innovativeness and second, technologies and their rate of adoption (Rogers 1995). These two areas have been found to give a good indication of the rate of adoption of innovations in health (Meyer & Goes 1988). In outline, innovation theories propose that all innovations go through similar lifecycles. The cumulative number of adopters over time describes an S-shaped curve. The steepness of the S-curve, showing the rate of adoption, is determined by features of the organisation and the technology (Mahajan & Peterson 1985; Rogers 1995).

Various mathematical models have been developed to analyse and predict innovation diffusion rates. The simplest model that approximates the diffusion of IT in health care is the mixed-influence model,

$$\frac{dN(t)}{dt} = (a + b\,N(t))[\overline{N} - N(t)]$$

that models the rate of diffusion of an innovation at a given time t where there are external influences, a; internal influences, b; prior adopters, $N(t)$; and potential adopters calculated by subtracting the number of prior adopters from the total number of potential adopters N—$N(T)$(Mahajan & Peterson 1985).

This paper will use theories described by Rogers(1995) to look at the organisational and technological factors determining the rate at which innovations diffuse in the health industry. These factors are seen as 'barriers' or 'enhancers' of the adoption of IT and their recognition should assist health managers when planning for it.



Analysis

This section will identify the key variables that impact on the diffusion of innovations and will review the status of these variables as they apply to health and IT. This allows conclusions to be drawn about the likely rate of diffusion of IT in health. First, a review of the organisational variables will be undertaken, followed by a review of the technological variables. The organisational and technological variables are summarised in Figure 1.

Organisational Variables

The variables that determine organisational innovativeness have been found to be the characteristics of the organisation's leaders, the internal characteristics of the organisation's structure and the external characteristics of the organisation. These variables have been researched for both health organisations and IT innovations in other organisations and found to correlate with an organisation's innovativeness (Mytinger 1968; Attewell 1992). Other studies have validated these variables for health innovations (Meyer & Goes 1988).

1. Leader characteristics

A positive attitude towards change within the organisation's leaders creates a positive influence on innovation (Rogers 1995). The involvement of senior managers in IT is believed to be important for its successful implementation (Gates & Hemingway 1999). Whilst a majority of executives are positive about IT, they tend to focus on the cost of it rather than the benefits being achieved (Schwartz 1992; Grindley 1999).

The leadership structure of health organisations is a complicating factor. Studies of management sub-cultures within health organisations have found distinct differences between medical managers, lay managers and medical staff. Medical managers believe in power structures, are independent and believe in two lines of responsibility for administrative and clinical management. Lay managers prefer a formal organisation, believe in a single line of responsibility and want transparent systems of accountability (Degeling et al. 1998). It has also been found that medical training teaches doctors to be self-reliant, preferring not to work as team members and rejecting support systems (Chassin 1998). These varying leadership styles suggest that leaders' attitudes to the adoption of IT innovations will be varied and confused. This is supported by other studies that find a "disunity of purpose" exists within health sector management (Braithwaite et al. 1995).

Studies have found that leaders sometimes feel threatened by IT because they are not able to keep up with the technology and changes it creates (Mansell & Silverstone 1996). If this held true of leaders of health organisations, it could be expected to slow their willingness to adopt IT innovations.

Overall, little has been published about the attitudes of leaders in the health industry towards either IT or innovation, nor are there any comparisons with leaders in other sectors. The literature points to fragmentation and 'tribal' groupings within the leadership structure and gives reasons for leaders to feel uncomfortable with IT but the actual impact has not been studied (Schneider & Bowen 1995).

2. Internal Characteristics

The internal organisational characteristics of importance are centralisation, complexity, formalisation, interconnectedness, organisational slack and size (Rogers 1995).

Centralisation

Centralised organisations have been found to adopt innovations more slowly than decentralised ones. The more the power and control is centralised to a few individual leaders, the less innovative an organisation becomes (Rogers 1995). There appear to be neither published studies that measure the level of centralisation of health sector management, nor any comparing it with other sectors. As previously noted, studies have found differing purposes amongst health sector leaders, with differentiated management sub-cultures and the doctors' leadership role generally existing outside of the formal management structure (Braithwaite et al. 1995; Chassin 1998; Degeling et al. 1998). This suggests a complex organisation in terms of its management and control. Administrative managers appear to believe in centralised control yet the clinical groups seem to have their own structures and responsibilities. The fact that studies show differing goals within health organisations implies a significant degree

of decentralisation and independence. To expand on the tribal metaphor, in some regards the modern health organisation resembles a series of tribes with more or less common cultures and interests held together, in one alliance, by their management. Innovation within a tribal group is easier than innovation across the alliance.

Studies measuring the prevailing level of centralisation of IT management in health care have not been identified. However, observing the health sector, large, cross-organisational systems tend to fall within the control of a central IT group headed by a Chief Information Officer (CIO). Centralisation is not uniform for small systems but appears to be common for major systems.

As noted earlier, decentralisation encourages innovation (Rogers 1995). However, in health, the nature and power of the decentralised groups is unclear.

Complexity

The evidence indicates that organisations that are more complex tend to adopt innovations more rapidly due to the relatively high skill levels and professionalism of the staff they employ. Complexity also provides a need for innovation (Rogers 1995). Health care organisations are complex, use high technology, suffer from conflicting objectives and have complicated funding arrangements (Braithwaite et al. 1995). This would indicate a higher level of organisational innovativeness.

Formalisation

Increased formalisation and prescribed processes have been found to act as barriers to innovation (Rogers, 1995). The more formal or rigid an organisation is in its practices, the less innovation tends to occur. The level of formality in health organisations compared with other organisations does not appear to have been studied, however, health has been found to lack the formal quality systems found in other industries (Chassin 1998).

Interconnectedness

Interconnectedness is the level to which the social system within the organisation encourages communication between the different groups and members. Highly interconnected organisations have been found to be more innovative, as ideas can flow more easily (Rogers, 1995).

A number of studies have pointed to the tribal-alliance nature of interconnectedness in health organisations. Connections are strong within professional groups and weak across them. Clinicians and medical managers typify this (Degeling et al.1998). Overall, health organisations tend to be fragmented in their organisation and behaviours (Martin 1987; Braithwaite et al. 1995; Degeling et al.1998). This tribal approach to organisation structure would be expected to lead to rapid diffusion of innovations within a professional group but slow diffusion across the entire organisation.

Organisational slack

'Slack', or spare capacity and resources within the organisation, provides the capability and time for innovations to be developed. Organisations with slack are able to innovate more readily than those with no slack (Rogers, 1995). Whilst no measurements of internal slack in health or other organisations have been identified, it may be assumed that the constant funding pressure on health organisations has reduced organisational slack. However, no conclusions can be drawn about the impact on innovation.

Size

Large organisations have been found to be more innovative due to their increased access to resources and ability to employ expert staff that can specialise (Rogers 1995). This is supported by research into U.S. health departments (Mytinger 1968). Health organisations in Australia also tend to be large, especially state health departments. Therefore, these organisations should be more innovative than smaller organisations. However, noting that health organisations work and act as a series of allied tribes, then there will be times when the health organisation acts as a single, large entity and times when it acts as a number of small entities with varied interests. This will result in significantly different rates of diffusion depending upon the way the organisation approaches the innovation.

3. External characteristics of the organisation

The main variable of interest in relation to the external characteristics of an organisation is its openness to the outside world. The evidence indicates that organisations that are open to outside ideas and influences tend to adopt innovations more rapidly. Increased openness allows the organisation to learn of new ideas and evaluate them more easily (Rogers 1995).

A study on professional sub-cultures has shown the strong alignment of health workers to their professions (Degeling et al.1998). Certainly, it is observable that health professionals frequently mix with their peers to exchange ideas and form health-specific colleges and societies. Whether health workers are equally active in cross-sector colleges and societies is less obvious. However, such a pattern of openness to peer groups solely within health would be a limiting factor on diffusion of innovations from other sectors.

Technological Variables

The features of a technology that determine its rate of adoption are its relative advantage, compatibility, complexity, trialability and observability (Rogers 1995).

Relative Advantage

The relative advantage over existing technologies is a measure of how much improvement the innovation brings over the status quo. Highly advantageous innovations have been found to diffuse more rapidly than those with fewer advantages (Rogers 1995). The relative advantage of IT in health over traditional ways of doing work remains unclear. The whole subject of productivity gains from IT remains a topic of debate. Measurement techniques and available data give no clear answer (Brynjolfsson & Hitt 1995; Brynjolfsson & Yang 1996; Brynjolfsson & Hitt 1996; Cortada 1997; Strassmann 1997). One conclusion is that levels of IT spending and business performance are unrelated. Thus, it is not the amount that is spent on IT, but the way it is used that delivers relative advantage (Strassmann 1997). Evidence indicates that basic transaction processing systems and IT investments used to reduce costs show good returns on investment, whilst strategic IT initiatives are hard to quantify and have the highest level of failure (Stewart 1995; Weill & Broadbent 1998). This uncertainty about achieving advantage from strategic IT projects is due, in part, to the organisational change required to deliver significant benefits which may lead to unpredictable political reactions (Zuboff 1988; Davenport & Short 1990; Butler & Gibbons 1998). In health organisations, it appears that there is increasing belief in the value of IT, however, health managers claim they do not know the return they gain from IT (Chae et al. 1994; Sands et al. 1998; Shortliffe 1998; Dumont et al. 1998; Perreault & Metzger 1999; CSC 1999).

It seems, therefore, that there are significant relative advantages of IT over traditional processes for basic transaction systems and cost saving systems and that these types of systems should be widely adopted. However, more complex systems, and particularly strategic systems, have far more uncertainty about their relative advantages. In health there appears to be a belief that relative advantage can be achieved from strategic IT, such as clinical systems, but real barriers remain in the ability to deliver and measure that advantage. This assessment points to faster uptake of basic systems and slower uptake of clinical systems.

Compatibility

The compatibility of an innovation is a measure of how well it fits or clashes with the organisation's current culture, values, beliefs, practices, past experiences and investments. Research indicates that innovations that are highly compatible diffuse more rapidly than those that are less compatible (Rogers 1995).

In the management and administration areas of organisations, IT has developed great compatibility to the extent that managers have come to expect IT as a basic component of their support structure (Cortada 1997). However, bringing IT into new areas requires organisational and individual change (Zuboff 1988; Davenport & Short 1990). This change threatens individuals and can lead to politics and power struggles (Rosegger 1991; Schneider & Bowen 1995; Kotha 1998; Butler & Gibbons 1998). IT tends to integrate processes and break down organisational barriers. In health organisations though, this type of change is not so easy due to the multiple management structures and differing internal goals (Braithwaite et al. 1995).

Research into physicians' use of computers shows they find them useful for administration support and self-development but find them difficult for clinical work (Dick, Steen, & Detmer 1997). Significant compatibility issues are yet to be resolved with computers in the clinical setting. Issues such as how to replace paper medical records with a computer, have not been addressed successfully (Dick, Steen, & Detmer 1997).

The compatibility of health and IT is therefore mixed. There appears to be strong compatibility in the managerial/administration area whilst clinical IT remains less compatible. This would lead to a slow uptake of clinically-oriented IT whilst administrative uses, such as finance, payroll and records management should move ahead quickly.

Complexity

Evidence indicates that the complexity of an innovation directly impacts its rate of adoption. Innovations that are more complex diffuse more slowly than simple innovations (Rogers 1995).

Information technology, its management, successful use and social impact are complex subjects (Zuboff 1988; Strassmann 1997; Thorp 1998; Weill & Broadbent 1998). A number of studies report that IT is difficult to manage and the benefits hard to measure (Davenport & Short 1990; Bullen 1995; Strassmann 1997; Thorp 1998; Weill & Broadbent 1998). High levels of technical skills are required to run major IT projects and the technology is surrounded by jargon (Keen 1991; Smits, van der Poel, & Ribbers 1997; Weill & Broadbent 1998). Adding to the complexity, IT has been found to cause disruptive change in organisations (Zuboff 1988). Innovation diffusion theory would suggest that this level of complexity would lead to slower diffusion.

Observability

The increased observability of an innovation, which is the ability to see the innovation in effect elsewhere, appears to increase the rate of adoption (Rogers 1995). IT use is easily observed across a wide range of organisations and is now a major focus of capital investment for many organisations (Minoli 1994; Quinn & Baily 1994; DeLuca & Enmark Cagan 1996; Thorp 1998). However, as indicated above, health organisations invest less in IT than those in other industries (Shortliffe 1998; CSC 1999). Organisations have mostly applied IT to data related work. The success of IT in knowledge systems is less prevalent (Cortada 1997). Intuitively, the clinical processes of health could be perceived as knowledge-based rather than da ta processing-based.

The real benefits of IT have not been observable, because the effects have been too difficult to measure (Brynjolfsson & Yang 1996; Strassmann 1997). Some industries, such as banking, claim major gains, but little information has been published showing the returns (Whaling 1996). Successful IT in health is less easily observed. Health organisations often do not know, or cannot measure, the return they gain from IT and in many cases health IT projects are viewed as problematic (Stewart 1995; van Bemmel & Musen 1997; Heeks, Mundy, & Salazar 1999; CSC 1999). However, a number of health IT projects have been found to be beneficial though these tend to be research or trial projects (Chae et al. 1994; DeLuca & Enmark Cagan 1996; Sands et al. 1998; Halamka & Safran 1998). Clinical information systems are still rarities (Handler 1998a; Handler 1998b; Duncan 1999; Perreault & Metzger 1999).

It therefore appears there are divergent arguments about how observable the successful application of IT is in health organisations. Certainly IT is being implemented across all industries and both successes and failures are visible. The successes are most visible in banking and general administration areas. Health projects, particularly those addressing clinical areas, are less common and are generally seen as problematic. This, therefore, suggests that the observability of successful IT in health has only a weak to medium presence.

Trialability

Trialability is the ability to test out an innovation in part before committing to it in full. Innovations that can be easily trialed have been found to diffuse more rapidly than those that cannot (Rogers 1995).

Small, stand-alone IT systems are easily trialed. A greater challenge is in the implementation of major, cross-organisational systems. The achievement of benefits from such IT systems requires organisational changes (Davenport & Short 1990). This leads to non-linear innovation (revolution) rather than evolution (Zuboff 1988). Such significant levels of change, particularly in the social nature of the organisation, are difficult to trial on a limited basis. Also, implementation of IT projects frequently requires complex technical and management infrastructures (Nolan & Croson 1995; Weill & Broadbent 1998). Again, this makes trials of IT complex, multifaceted exercises.

When combined, the degree of change IT causes, the cross-organisational co-ordination required, the infrastructure that must be in place and the costs involved - all suggest that major, strategic systems are exceedingly difficult to trial. This will lead to the slow adoption of major IT systems.

Conclusions

This paper has reviewed the variables that have been found to be the key to innovation diffusion and has presented the likely state of the variables. Therefore, it is possible to draw conclusions about the way that IT has diffused in health. The findings are summarised in Table 1, which shows whether the variables in a health context are likely to speed up, be neutral to, or hinder diffusion.

Table 1: summary of innovation diffusion variables

	Expected impact on health IT diffusion rate			
	Rapid	Normal	Slow	Comment
Leader Characteristics		√		No conclusions can be drawn
Internal Organisational Characteristics				
Centralisation			√	Centralised management and control of IT slows innovation of major projects
Complexity	√			Health should create plenty of ideas for exploiting IT
Formalisation			√	Health organisations tend to have set rules and practices
Slack			√	Assume government policies have eliminated slack
Size	√			
External Characteristics of the Organisation				
Openness			√	Health tends to be open within professional groupings but closed to the world in general
Technological Variables				
Relative Advantage	√ For core business systems such as accounts and payroll where cost reduction is the objective		√ Particularly for clinical and strategic systems	Accepted methods for assessing relative advantage are not available
Compatibility	√ Point solutions for cost-reduction and operational efficiency		√ Particularly in clinical practice	
Complexity	√ Point solutions for cost-reduction and operational efficiency		√ Major strategic projects	
Trialability			√	
Observability	√ For core business systems such as accounts and payroll		√ Particularly for clinical and strategic systems	Based on major projects

This summary shows that the observed slow diffusion of major IT systems across health is predictable. Based on innovation diffusion theory, health organisations, whilst being able to be very innovative in many respects (eg in treatment regimes developed by professional groups) face challenges with major cross-organisational innovation. The formalisation which exists for patient safety, the reduction of organisational slack, strong professional alignment and the centralisation of control of major IT all act to reduce the rate of innovation. The impact of health leaders has not been determined and would be a valuable topic for future research.

The technological diffusion variables also give a clear indication about why IT has diffused in the way it has in health care. First, operational systems aimed at cost reduction, such as payroll and accounting systems, score well on all variables of innovation diffusion. This is supported by observation of hospital information technology where, over the years, these systems have been the first to be implemented and the ones to be updated most often. Strategic health systems, such as computerised patient records or systems for linking the continuum of care, score badly for their ability to diffuse. These types of systems are complex, not easily trialed, the benefits are not proven and the chance to observe them installed in similar organisations is limited.

This paper shows some of the areas that managers in both the health and IT industries need to focus on for the wider, more effective adoption of IT. Health organisations need to break down 'silos' and develop more flexible ways of working across organisational units without resorting to tight, centralised control. They also need to find ways of observing and learning about potential innovations from non-health organisations.

For IT to be adopted more rapidly there needs to be a number of new techniques cultivated, technologies developed or refinements made to existing ones. First, there needs to be a much clearer understanding of IT's relative value. Techniques for measuring benefits need to be improved and agreed. These should then be used to assess the benefits of proposed strategic systems. Secondly, implementation methods need to be used that facilitate trials, allowing low risk assessment of innovations before their full-scale adoption. Thirdly, there needs to be continuing developments in the design and use of information systems, particularly in the clinical setting, if higher levels of compatibility with health organisations are to be achieved.

This paper has focused its approach to innovation diffusion on traditional approaches developed by Rogers and others in areas such as mass communication theory over the past 30 years. It is recognised, however, that the models used here limit the consideration and evaluation of the policy framework and external environmental pressures that may also shape the way health organisations address innovation. Further research is planned to evaluate the relevance and impact of these factors on health and IT innovation adoption.

References

Attewell P 1992, 'Technology Diffusion & Organisational Learning: The Case of Business Computing', *Organization Science*, vol. 3, no. 1, pp. 1-19.

Braithwaite J, Lazarus L, Vining RF & Soar J 1995, 'Hospitals: to the next millennium', *International journal of health planning and management*, vol. 10, pp. 87-98.

Brynjolfsson E & Hitt L 1995, 'Information technology as a factor of production: the role of differences among firms', *Economics of Innovation and New Technology*, vol. 3, pp. 183-199.

Brynjolfsson E & Hitt L 1996, 'Paradox Lost? Firm-level evidence on the returns to information systems spending', *Management Science*, vol. 42, no. 4, pp. 541-558.

Brynjolfsson E & Yang S 1996, 'Information technology and productivity : a review of the literature', *Advances in Computers*, vol. 43, pp. 179-214.

Bullen CV 1995, 'Productivity CSFs for knowledge workers', Information Strategy: *The Executive's Journal*, vol. 1995, Fall, pp. 14-20.

Butler B & Gibbons DE 1998, 'Power Distribution as a Catalyst and Consequence of Decentralized Technology Diffusion', in *Information Systems Innovations and Diffusion: Issues and Directions*, T. J. Larsen & E. McGuire, eds., Idea Group, Hershey:PA, pp. 3-28.

Chae YM, Kim SI, Lee BH, Choi SH & Kim IS 1994, 'Implementing health management information systems: measuring success in Korea's health centers', *International journal of health planning and management*, vol. 9, pp. 341-348.

Chassin MR 1998, 'Is healthcare ready for sigma six quality', *Milbank Quarterly*, vol. 76, no. 4.

Cortada JW 1997, 'Economic preconditions that made possible application of commercial computing in the United States', *IEEE Annals of the history of computing*, vol. 19, no. 3, pp. 27-39.

CSC 1998, *Critical Issues of Information Systems Management 1998 CSC*, El Segundo.

CSC 1999, *Critical Issues of Information System Management 1999 CSC*, El Segundo.

Davenport TH & Short JE 1990, 'The new industrial engineering: information technology and business process redesign', *Sloan Management Review*, vol. 1990, Summer, pp. 11-27.

Degeling P, Kennedy J, Hill M, Carnegie M & Holt J 1998, *Professional sub-cultures and hospital reform* University of New South Wales, Sydney.

DeLuca JM & Enmark Cagan R 1996, *Investing for business value: how to maximise the strategic benefits of healthcare information technology* American Hospital Publishing, Chicago.

Dick RS, Steen EB & Detmer DE 1997, *The computer-based patient record: an essential technology for health care*, Revised edn, National Academy Press, Washington.

Dumont R, van der Loo R, van Merode F & Tange H 1998, 'User Needs and Demands of a Computer-Based Patient Record', in *Medinfo '98: 9th World Congress on Medical Informatics*, B. Chesnik, A. T. McCray, & J.R. Scherrer, eds., IOS Press, Amsterdam, pp. 64-69.

Duncan M 1999, *A simplified ROI for an ambulatory CPR*, Gartner Group, CS-06-0505.

Gates B & Hemingway C 1999, *Business @ the speed of thought* Viking, Ringwood.

Grindley K 1999, *The Compass International IT Strategy Censusßœ 1999*, Compass Publishing BV, Benelux.

Grove A 1996, *Only the paranoid survive* Doubleday, New York.

Halamka JD & Safran C 1998 'CareWeb, a Web-Based Medical Record for an Integrated Healthcare Delivery System', in *Medinfo 98:9th World Congress on Medical Informatics,* B. Chesnik, A.T. McCray, & J.R. Scherret eds., IOS Press, Amsterdam, pp. 64-69.

Hamel G 1998, 'The challenge today: changing the rules of the game', *Business Strategy Review*, vol. 9, no. 2, pp. 19-26.

Handler T 1998a, Stalking the elusive computer based patient record system, Gartner group, R-06-1129.

Handler T 1998b, *Understanding how CPRs will evolve*, Gartner Group, COM-06-6400.

Heeks R, Mundy D & Salazar A 1999, *Why Health Care Information Systems Succeed or Fail*, Institute for Development Policy and Management, Manchester.

Keen PGW 1991, *Shaping the future: business design through information technology* Harvard Business School Press, Boston : MA.

Kotha S 1998, 'Competing on the internet: how Amazon.com is rewriting the rules of competition', *Advanced in Strategic Management*, vol. 15, pp. 239-265.

Mahajan V & Peterson RA 1985, *Models for Innovation Diffusion Sage*, Newbury Park: CA.

Mansell R & Silverstone R 1996, 'Politics of technologies', in *Communication by design: the politics of information and communication technologies*, R. Mansell & R. Silverstone, eds., Oxford University Press, Oxford, pp. 213-227.

Martin AL 1987, 'Information systems and physician practice patterns: England and America compared', *International journal of health planning and management*, vol. 2, pp. 25-36.

Meyer AD & Goes JB 1988, 'Organizational Assimilation of Innovations: A Multilevel Contextual Analysis', *Academy of Management Journal*, vol. 31,no. 4, pp. 897-923.

Minoli D 1994, *Analyzing Outsourcing* McGraw Hill.

Mytinger RE 1968, *Innovation in Local Health Services: A Study of the Adoption of New Programs by Local Health Departments with Particular Reference to New Health Practices*, U.S. Department of Health Education and Welfare, Public Health Service, Division of Medical Care Administration, Washington, D.C..

Nolan RL & Croson DC 1995, *Creative Destruction* Harvard Business School Press, Boston Ma.

Perreault LE & Metzger JB 1999, 'A pragmatic framework for understanding clinical decision support', *Journal of Healthcare Information Management*, vol. 13,no. 2, pp. 5-22.

Quinn J & Baily M 1994, 'Information Technology: Increasing Productivity in Services', *Academy of Management Executive*, vol. 8,no. 3, pp. 28-47.

Rogers EM 1995, *Diffusion of Innovations*, Fourth edn, The Free Press, New York.

Rosegger G 1991, 'Advances in information technology and the innovation strategies of firms', *Prometheus*, vol. 9, no. 1, pp. 5-20.

Sands DZ, Rind DM, Vieira C & Safran C 1998, 'Can a Large Institution Go Paperless?', in *Medinfo '98: 9th World Congress on Medical Informatics*, vol. 1 B. Cesnik, A. T. McCray, & J.R. Scherrer, eds., IOS Press, Amsterdam, pp. 60-63.

Schneider B & Bowen DE 1995, *Winning the service game* Harvard Business School Press, Boston.

Schwartz AP 1992, 'The economics of a strategy for advanced information technology', *Information Strategy: The Executive's Journal*, vol. 1992,no. Fall, pp. 11-17.

Shortliffe EH 1998, 'The Evolution of Health-Care Records in the Era of the Internet', in *Medinfo '98: 9th World Congress on Medical Informatics*, B. Chesnik, A. T. McCray, & J.R. Scherrer, eds., IOS Press, Amsterdam.

Smits MT, van der Poel KG & Ribbers PMA 1997, 'Assessment of information strategies in insurance companies in the Netherlands", *Journal of Strategic Information Systems*, vol. 1997,no. 6, pp. 129-148.

Stewart B 1995, *The second stage of IT: Increasing the return on technology*, Gartner Group.

Strassmann PA 1997, *The squandered computer* The Information Economics Press, New Canaan.

Thorp J 1998, *The information paradox: realizing the business benefits of information technology* McGraw-Hill Ryerson, Toronto.

van Bemmel JH & Musen MA 1997, *Handbook of medical informatics* Springer-Verlag, Heidelberg.

Weill P & Broadbent M 1998, *Leveraging the new infrastructure* Harvard Business School Press, Boston MA.

Whaling C 1996, 'Technological innovation and the US banking industry: innovation in the US retail and wholesale banking sectors', *Technology in society*, vol. 18,no. 4, pp. 477-501.

Zuboff S 1988, *In the age of the smart machine* Basic Books, New York.