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Why Health Care Information Systems Succeed or Fail

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Table of Contents

Why Health Care Information Systems Succeed or Fail

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Abstract

Some health care information systems (HCIS) do succeed, but the majority are likely to fail in some way. To explain why this happens, and how failure rates may be reduced, this paper describes the 'ITPOSMO' model of conception—reality gaps. This argues that the greater the change gap between current realities and the design conceptions (i.e. requirements and assumptions) of a new health care information system, the greater the risk of failure.

Three archetypal large design—reality gaps affect the HCIS domain and are associated with an increased risk of failure:

- ***Rationality—reality gaps***: that arise from the formal, rational way in which many HCIS are conceived, which mismatches the behavioural realities of some health care organisations.
- ***Private—public sector gaps***: that arise from application in public sector contexts of HCIS developed for the private sector.
- ***Country gaps***: that arise from application in one country of HCIS developed in a different country.

Some generic conclusions can be drawn about successful approaches to HCIS development. Examples include the need for more reality-oriented techniques and applications, and greater use of participative approaches to HCIS. More specifically, techniques can be identified for each of the seven ITPOSMO dimensions that will help close the gap between conception and reality. This can include the freezing of one or more dimensions of change. Such techniques will help improve the contribution that information systems can make in health care organisations.

Overall, then, this paper will provide readers with an understanding and model of why health care information systems succeed or fail, and with general guidance on how to avoid HCIS failure.

[1] An amended version of this paper will appear in *Health Care Information Systems: Challenges of the Next Millennium*, A. Armoni (ed.), Idea Group Publishing: http://www.idea-group.com/

A. Background: Health Care Information System Success and Failure

New information systems have a powerful potential to improve the functioning of health care organisations (Neumann et al., 1996; Raghupathi, 1997). However, that potential can only be realised if health care information systems can be successfully developed and implemented.

There are a large number of reported HCIS success stories from around the world but these seem likely to be painting a falsely-positive picture. There is generic evidence that a significant majority of information systems initiatives are failures in both the private sector (Korac-Boisvert and Kouzmin, 1995; James, 1997) and the public sector (Heeks and Davies, 1999).

There is also plenty of specific evidence that many – even most – health care information systems are failures. Anderson's (1997:90) work on HCIS cites "studies that indicate half of all computer-based information systems fail". Keen (1994a:1) notes that, "For every documented success, there seems to be a clutch of failures." Likewise, Paré and Elam (1998:331) state: "Research shows that many health care institutions have consumed huge amounts of money and frustrated countless people in wasted efforts to implement information systems".

The same message of failure is also found in studies of particular health care applications. Many electronic patient record initiatives have failed (Dodd and Fortune, 1995) so that systems in the US "still consist largely of paper records." (Anderson, 1997:89). So, too, for hospital information systems (HIS): "It appears that the set of all successful HIS implementations is only slightly larger than the null set, and these have usually been developed at academic centers." (Rosenal et al., 1995:554).

In all, we can identify four main forms of HCIS failure:

- The *total failure* of a system never implemented or in which a new system is implemented but immediately abandoned. A much-reported example is that of the London Ambulance Service's new computerised despatching system. This suffered a catastrophic failure within hours of implementation, leaving paramedics unable to attend health care emergency victims in a timely manner (Health Committee, 1995).
- The *partial failure* of an initiative in which major goals are unattained or in which there are significant undesirable outcomes. Anderson (1997:87), for instance, cites the case of "An information system installed at the University of Virginia Medical Center [*which*] was implemented three years behind schedule at a cost that was three times the original estimate."
- The *sustainability failure* of an initiative that succeeds initially but then fails after a year or so. Some of the case mix systems installed under the UK National Health Service's Resource Management Initiative fall into this category. They were made fully operational and achieved some partial use but with limited enthusiasm from staff for using them. Ultimately, they were just switched off (HSMU, 1996).
- The *replication failure* of an initiative that succeeds in its pilot location but cannot be repeated elsewhere. Although presenters may not realise it at the time, every health informatics conference is jam-packed with replication failures about to

happen; with wonderful innovations that are tested once and then disappear without trace. As an audience, we hear all about the pilot, but we tend not to hear about the replication failure.

This all points to a yawning gap between the positive potential for information systems to contribute to the work of health care organisations and the largely negative reality. This, in turn, means that increasingly large sums of money are being invested in new health care information systems but that a substantial proportion of this will go to waste on unimplemented or ineffective systems.

Clearly, something must be done to try to reduce this wastage. To do this, we need to understand why failures occur and why, less frequently, there are successes.

A1. Understanding HCIS Success and Failure

Paré and Elam (1998:332) note that most past investigation into failure of HCIS has tended to be normative, focusing on "a set of managerial prescriptions which, taken as a whole, constitute the 'ideal' way to implement an information system. Yet, despite these normative principles, many organizations and health care institutions find their attempts to make use of computer-based information systems fraught with difficulty."

In seeking to understand HCIS failure, we must therefore take an alternative route forward rather than the standard prescriptive 'cookbook' approach. The starting point will be that of *contingency* that sees no single blueprint for success and failure in organisational change (Poulymenakou and Holmes, 1996; Paré and Elam, 1998). Instead, it must be recognised that there are situation-specific factors for each HCIS which will determine success and failure and, hence, strategies for success.

Inherent within most ideas of contingency is the idea of *adaptation*: of states of mismatch and match between and within factors and of the need to change in order to adapt systems so that there is more match than mismatch. In the context of overall organisational change, this is mainly described in terms of the need for adaptation of organisational structure to the organisational environment (Butler, 1991). In the context of HCIS, too, there is an 'environment' to which the information system can be adapted.

We will investigate this in greater detail in the following section but will note two key points here. First, that we are not just talking about matching the technological environment:

> "Past experience suggests that efforts to introduce clinical information systems into practice settings will result in failures and unanticipated consequences if their technical aspects are emphasized and their social and organizational factors are overlooked. … Several decades of experience with computer-based information systems make it clear the critical issues in the implementation of these systems are social and organizational, not solely technical." (Anderson 1997:89)

Second, that these 'social and organisational factors' are not just a question of relatively objective realities, such as work processes or organisational structures, but

also of relatively subjective perceptions. Dodd and Fortune (1995) and Dhillon (1998), for example, note the role of stakeholder assumptions, expectations and viewpoints in contributing to the failure of health care information systems. In particular, these authors and Roberts and Garnett (1998) note that problems arise when there is a difference (i.e. a mismatch) between the model assumed within construction of the HCIS and the perceptions of key stakeholder groups such as medical practitioners.

Thus far, we can therefore conclude that a successful HCIS will be one that tends to match its environment in relation to technical, social and organisational factors; these latter including the perceptions of key stakeholders.

However, there is a major problem here: if the HCIS were to exactly match its environment, it would not change that environment in any way. Yet the formal purpose of HCIS is to support and bring about organisational change in order to improve the functioning of health care organisations. There must therefore be some degree of change that an HCIS introduces. Indeed, a greater degree of change may bring greater organisational improvements (though there is no necessary link between size of change and size of benefits).

On the other hand, if HCIS try to change too much this brings with it a risk of failure and, the more you change, the greater this risk (Dodd and Fortune, 1995). In the London Ambulance case, for example, failure arose because "the speed and depth of change were simply too aggressive for the circumstances." (Page et al., 1993, cited in Beynon-Davies, 1995:181). Equally, success becomes more likely when change is limited. For example, a successful patient record system in a UK hospital was implemented with a design that deliberately minimised cultural, work process, information and financial change (Roberts and Garnett, 1998).

Overall, then, there is a trade-off between change and risk for HCIS. Reducing the size of change may increase the chance of system success but also reduce the organisational benefits of that system. Conversely, increasing the size of change may reduce the chance of system success but also increase the organisational benefits of that system.

B. Dimensions of Change: Conception—Reality Gaps

From the previous section, we saw that central to health care information system success and failure is the amount of change between 'where we are now' and 'where the HCIS wants to get us'.

The former will be represented by the current realities of the particular health care context (part of which may encompass subjective perceptions of reality). The latter will be represented by the model or conceptions and assumptions that have been incorporated into the new HCIS' design. Putting this a little more precisely, then, we can say that success and failure depend on the size of gap that exists between 'current realities' and 'design conceptions of the HCIS'.

Where do these 'design conceptions' come from? They derive largely from the worldview of those stakeholders who dominate the HCIS design process. We will discuss these in more detail later, but can note here that dominant stakeholders are typically drawn from technical or managerial or clinical groups. In this case, we should amend our earlier phrase from 'where the HCIS wants to get us' to 'where the dominant stakeholders want the HCIS to get them'.

B1. Dimensions of the Conception—Reality Gap

Using a couple of HCIS case studies, we will now map out the dimensions of this 'conception—reality gap'.

Case Study 1

A 'ComputerLink' scheme for 26 home-based AIDS patients was set up that put them in touch with each other individually and in groups, and with an encyclopaedia (Brennan and Ripich, 1994). The scheme was a qualitative success, as judged by participant ratings, and a quantitative success, as judged by the fact that:

- ComputerLink was used, on average, 300 times during the six-month evaluation period by each patient;
- its private email and public email forum components were used more than 10,000 times; and
- its electronic encyclopaedia of AIDS-related information was accessed nearly 800 times.

Its success can be attributed to the limited gaps that existed between the system's design conceptions (drawn largely from nurse and patient stakeholders) and contextual realities for the AIDS patients along seven dimensions:

- *An information dimension*: ComputerLink was designed in a way that offered great flexibility of information access either via the encyclopaedia or via queries in public/private email messages. Because of this conceptual flexibility, users were easily able to meet their real information needs through the system.
- *A technology dimension*: ComputerLink was designed around simple and straightforward technology using basic PCs, simple software and existing

networking links. This therefore demanded relatively limited change along the technology dimension.

- *A process dimension*. ComputerLink was designed so that it supported the pre-existing information-seeking and communication processes that AIDS patients undertook prior to computerisation. There was thus virtually no gap between conception and reality along the process dimension.
- *An objectives and values dimension*. ComputerLink's design met patients' real needs and provided something they said was valuable to them: the ability to interact with other AIDS patients and to have more information about their condition. It was also designed to meet very different individual objectives, from those who wanted to interact with a group on a daily basis to those who wanted occasional individual communication or anonymous 'support' (from the encyclopaedia).
- *A staffing and skills dimension*. ComputerLink was designed to require the input of only one project nurse on an irregular basis and to require only a limited number of new skills for system use. There was thus little gap between conceived and actual human capability requirements.
- *A management and structures dimension*. ComputerLink was designed to fit within the existing health structures and, as noted, required only the addition of a fairly simple management framework of one nurse to monitor the system.
- *An 'other resources' dimension*. ComputerLink was designed to have very low implementation and operation costs, with equipment costing only US$350 per patient. Its financial requirements were therefore well matched to the real finances available. It was also designed to meet the time resource realities of patients by providing 24-hour access. Participants were therefore able to match expenditure of time to their availability periods. For example, there were as many logins between 10pm and 3am as between 10am and 3pm.

To sum up, the assumptions or conceptions underlying ComputerLink's design were either matched to existing realities or required only very limited change along seven possible dimensions. It was therefore successful because of its limited conception—reality gaps.

We can use this example to create a model of HCIS conception—reality gaps, which we will call the 'ITPOSMO' model because of its seven dimensions:

- **I**nformation
- **T**echnology
- **P**rocesses
- **O**bjectives and values
- **S**taffing and skills
- **M**anagement and structures
- **O**ther resources: money and time

Analysis of other information systems cases from both the health care sector (see below) and beyond (Heeks and Bhatnagar, 1999) indicates that these seven dimensions are necessary and sufficient to provide an understanding of conception—reality gaps.

Case Study 2

We can use the ITPOSMO model to explain HCIS failure as well as success. A UK hospital attempted to introduce an expert system for computerised coloscopy (Guah, 1998). However, the system design was conceived mainly by technical staff, and there were significant conception—reality gaps along a number of the ITPOSMO dimensions:

- *Information*: the expert system was designed to produce a set of statistical information on coloscopy, but it emerged that there was no significant demand for this information. There was thus a large gap between the information conceptions underlying the system and the information realities of existing hospital practice.
- *Technology*: the expert system required a relatively powerful technological infrastructure, which differed markedly from the hospital's current technological realities.
- *Processes*: the expert system was designed to automate many of the currently human decision-making processes around coloscopy. This created a significant gap between the new processes conceived within the system design and the current process reality.
- *Objectives and values*: because of the process automation, the system's design did not match well with the objectives and values of medical staff who feared automation and who believed that human inputs remained critical. Nor did the expert system's objectives match well with the priorities of senior hospital managers, leading to their providing little, if any, support for the project.
- *Staffing and skills*: the expert system was relatively difficult to use and there was thus a significant gap between the requirements of its design conceptions and the reality of availability and expertise of hospital staff.
- *Management and structures*: there was little conception—reality gap along this dimension.
- *Other resources*: the expert system was both time-consuming and costly to operate. This created a serious gap between the system's design requirements and the realities of resource availability within the hospital.

Overall, there was too great a gap between the design conceptions of the expert system and the realities of the hospital context into which it was being introduced. The result was that the pilot project was abandoned, having failed because of its outsize conception—reality gap.

C. Archetypes of Health Care Information System Failure

Conception—reality gaps can arise in any situation, but we will highlight some archetypes that can make HCIS failure more likely.

C1. Gaps Between Formal Rationality and Behavioural Reality

'Hard' rational models assume logic, formality and objectivity to underlie the workings of organisations. Alternative 'soft' behavioural models of organisations have subsequently been developed. They assume factors such as human limitations, social objectives and subjectivity underlie the workings of organisations.

Difficulties occur in HCIS implementation where a hard rational design meets a soft behavioural reality. The design component can arise in a number of ways depending on which stakeholder group's worldview dominates the HCIS design. Three archetypal examples will be provided here:

- *Technical rationality*. Technology is typically conceived as an objective and rational entity, not as something that incorporates particular cultural and political values. When information technology (IT) is seen to play a central role in HCIS, those information systems are therefore themselves likely to be conceived according to an objective and rational model. This may occur particularly, though not exclusively, where IT professionals dominate the design process, allowing a technology-based worldview to dominate design conceptions. Isaacs (1995), Coiera (1997) and Dhillon (1998) report the tendency of IT personnel in health care to hold a rational, technology-focused worldview:

  > "Since the nature of IT exploitation within organizations is based on formal-rational models, analysts tend to study only the defined and official roles specified through job descriptions, etc. They do not consider the informal social relations, for example through coalition formulation, which are common in complex organizations" (Dhillon, 1998:10)

- *Managerial rationality*. Managers have their own objectives, but are also the conduit for the objectives of external stakeholder groups such as shareholders or governments. Such objectives can relate to legal or bureaucratic rationalities, but they frequently relate to money. Like technology, money is typically conceived as an objective and rational entity. When financial information is seen to play a central role in HCIS, those information systems are therefore themselves likely to be conceived according to an objective and rational model. This may occur particularly, though not exclusively, where health care managers dominate the design process, allowing a finance-based worldview to dominate design conceptions. Both Ennals et al. (1996) and Dhillon (1998) report the increasing imposition of rational financial management models via information systems as part of the health care reform process.
- *Medical rationality*. Although it deals with people, medicine is also frequently conceived in an objective and rational manner where diseases and injuries, not patients, are the focal entity (Keen 1994a). When medical information is seen to play a central role in HCIS, those information systems are therefore themselves likely to be conceived according to an objective and rational model. This may occur

particularly, though not exclusively, where doctors dominate the design process, allowing a medicine-based worldview to dominate design conceptions.

The technical or managerial or medical worldview incorporated into the HCIS' design conceptions may come into conflict with the actual and perceived realities of other health care stakeholders, especially practitioners, or it may not. Where it does conflict, there will be a large gap between the HCIS' formal, rational design conceptions and the more informal, behavioural realities of health care practitioners.

When there is such a gap, these behavioural realities should not simply be labelled 'irrational' since they may derive from logically-consistent viewpoints such as:

- *care rationality*: a viewpoint that sees the patient's needs as paramount; or
- *personal/political rationality*: a viewpoint that sees the stakeholder's own needs (or those of his/her group) as paramount.

Behavioural realities may equally derive from individual differences, human cognitive or other limitations, and from further viewpoints (including those others would label 'irrational').

It should be noted that gaps between formal, rational design and informal, behavioural reality are not always a case of disagreement between different stakeholder groups. They can also confuse individuals, making it difficult for them to 'get in touch with reality'; for example, when trying to distinguish the information they think they ought to need from the information they actually need. Westrup (1998:84) similarly reports the difficulty health practitioners have in detaching themselves from dominant rational paradigms and recognising what goes on in reality when describing processes:

> "Nurses had problems in differentiating between what they actually did and what they said they did. So, for example, it is recognised that nursing as a profession should plan nursing care using a process of care planning. This is what nurses in the hospital I studied said they did and made a requirement of the [*new information*] system. In practice, care planning was seen as time-consuming and unnecessary for most nursing care … As a consequence care planning was not done in practice. When the nursing system was implemented, care planning … was embodied in the system and nurses had to create care plans if the system was to work properly. The upshot was that the computerised system was more time-consuming than previous practice."

Impacts of Imposing Rational Information Systems

Taking a patient perspective, we can classify three main impacts of imposing rational information systems on behavioural realities:

Potential benefits. There may be benefits in imposing more rational information systems on health care staff, where this suppresses behaviours based on selfish motives or on negative idiosyncracies and human limitations. For example, research shows that that 20-50% of major therapeutic intervention decisions, and perhaps a higher proportion of minor interventions, involve little or no use of the evidence base. As a result "proven useless and even frankly harmful therapies linger in practice long after the evidence is clear" (Davies and Nutley, 1999:12). Hence, there is a demonstrable

need for – and value of – use of more rigorous and medically-rational evidence-based information about the efficacy of health care interventions by health care practitioners.

Health care practitioners tend to resist change in this context because of a concern with preserving "long-standing practice patterns" (Anderson, 1997:84) and "their professional autonomy" (Beynon-Davies, 1995:181). We can view these as rather defensive reactions to the conception—reality gap.

Damaging impacts. There may be dangers in imposing more rational information systems on health care staff, where this suppresses patient-centred behaviours. For example, imposing rational information systems (IS) can suppress two important types of informal patient-centred information system. First, those that operate between health care professionals as an essential part of patient care (Davies, 1997). Second, those that operate between practitioners and patients, again as an essential part of patient care. As an example, problems often emerge when technically-rational computerised knowledge-based systems are introduced into the patient consultation and diagnosis process (Steimann, 1995). The rational bias of one such system was evaluated:

> "This was found to have at least two implications: the patient did not get the opportunity to air his [*sic*] own feelings and thoughts, and the dialogue switched back into past tense, focusing on the patient's problem history instead of the present situation." (Alendahl et al., 1995:919)

Health care practitioners tend to resist change in this context because of a concern about damaging health care outcomes (IMG, 1996; Greaves, 1998). From a patient perspective, we can view these as rather objectively-justifiable reactions to the conception—reality gap.

Equivocal impacts. As well as imposing rationality, rationally-conceived HCIS also tend to impose uniformity by allowing one particular way of doing things. This will suppress flexibility and diversity in the health care context, overriding the typical reality of individual work styles, needs and approaches (Lincoln and Essin, 1995). We term this an equivocal outcome since it may either help or hinder patient care. It may help in situations where flexibility and diversity are equated with corruption or with poor or uneven work quality. It may hinder in situations where flexibility and diversity are necessary reactions to individual patient and staff differences. Universal codes, for example, may improve the work of a poor medical practitioner but hinder the work of a good one (Ireland and Regan, 1995).

Outcomes of Imposing Rational Information Systems

A large gap between rational HCIS design conceptions and behavioural health care realities leads to the inevitable risks of failure.

Dhillon (1998), for example, reports the failure of a clinical information system in a UK hospital. The failure arose when the information system, based by its analysts on a formal, technically-rational model of hospital functioning, was introduced into a much 'messier' informal reality, leading to "a clear mismatch between the formal models

[*within the IS*] and the perceptions of system users who inevitably reflect a more informal and pragmatic approach to their own organizational realities." (Dhillon, 1998:2). There was a mismatch particularly along the process, objectives and structures dimensions of the ITPOSMO model. The "prescriptive and utterly inflexible" information system that resulted was of little use to health practitioners.

A patient assessment information system in the intensive care unit of a North American health centre failed for similar reasons (Paré and Elam, 1998). It was designed according to a formal, managerially-rational model of nursing that did not match realities. In particular, there was a conception—reality gap along the process and objectives dimensions of the ITPOSMO model:

- The computer system captured the time nurses made their system inputs and logged this as part of the legally-submissible document that the system produced, since nurses "are requested by law to perform and document a complete assessment of each patient in the first 90 minutes of their shift." In reality, nurses sometimes found themselves needing to provide care to a critically-ill patient immediately they came on shift. They were thus only able to document their assessments much later in the shift. It was easy to 'work around' manual recording systems to incorporate this technically-illegal but morally- and clinically-sound practice; but not so with the computerised system. Nurses adopted various means of coping with this conception—reality gap, including non-use of the computerised system.
- The computer system produced standardised reports. These demotivated the more experienced nurses who felt there was no way to demonstrate their additional value and expertise. The system's rational conception therefore failed to meet the reality of some nurse objectives and values, leading to their avoiding system use.

C2. Gaps Between the Context of Design and of Implementation

As noted above, those who design health care information systems make certain assumptions that are then incorporated into the design. These assumptions will be at least partly determined by the context in which the HCIS was designed. For example, an HCIS designed in a context where preventive health care models are the norm may well incorporate certain preventive health model conceptions within it. This may not be problematic where the HCIS is then implemented within the same context in which it was designed. However, problems will arise if the design and implementation contexts are different.

We have already described intra-organisational examples of this in the previous section, where problems arose particularly due to the different contexts in which IT professionals, health care managers, and health care practitioners work. We can provide two further inter-organisational examples of this problem.

Public—Private Sector Gaps

We will focus the discussion here on hospitals, but the same issues arise for other public and private health care organisations.

Every hospital is different from every other hospital, creating a universal design—implementation context gap – and, hence, problems – if one attempts to transfer an information system created in one hospital to another one (Gowing, 1994; McDaniel et al., 1995). However, this gap is archetypally large between – depending on the national health system – public sector and private sector hospitals or non-profit and for-profit hospitals. Differences exist between these two along all seven of the ITPOSMO dimensions. We will just provide a few illustrative gaps here, based on Vogt et al. (1996). These are stereotypes, and examples of reversals do exist, but they nonetheless represent typical gaps:

- *Information*: public hospitals tend to place less emphasis on financial cost information and more emphasis on broader performance indicator information than private hospitals due to different regulatory requirements.
- *Technology*: public hospitals tend to have a more limited and older technological infrastructure than that found in private hospitals.
- *Processes*: public hospitals tend to treat a different case mix to private hospitals, typically treating far more illness of the poor, and thus requiring a rather different set of health intervention processes. Both administrative and clinical processes are also different because of the different funding arrangements for patients.
- *Objectives and values*: in the public sector, "such things as budget maximization or output maximization have been posited as more plausible objectives … By contrast, for-profit institutions hold profitability (and thus efficiency) as a primary goal." (Vogt et al., 1996:94).
- *Staffing and skills*: public hospitals tend to have fewer nursing staff and fewer technology-related staff than private hospitals.
- *Management and structures*: public hospitals tend to have weaker non-clinical management and administration structures than private hospitals, partly due to different financing arrangements.
- *Other resources*: public hospitals tend to have less money than private hospitals.

Given these differences, information systems or techniques developed for private sector hospital use can easily be based on conceptions that do not match public sector hospital realities. They will therefore be more prone to failure if introduced into a public sector hospital.

We will illustrate this not with a specific information system, but with a particular information systems technique: strategic information systems planning (SISP). SISP was designed within and for the private sector, and is based on conceptions of unitary organisational objectives, apolitical decision making, and the presence of skilled support for implementation that do not apply in many public sector health care organisations (Ballantine and Cunningham, 1999). This conception—reality mismatch has made traditional SISP risky and/or impractical in the public sector. This was epitomised in the UK public sector by cancellation of the Wessex Regional Health

Authority's Regional Information Systems Plan, causing an estimated £20 million (c.US$33m) to be wasted (Beynon-Davies, 1995).

Country Gaps

Health care information systems developed in the context of one particular country will incorporate common assumptions of that context, but:

> "Apart from the existence of a patient, a disease, and a doctor, one can sometimes question what is really common among the different health services and social welfare public systems existing throughout the world." (Dusserre et al., 1995:1476)

Every country is therefore different from every other country, creating a universal design—implementation context gap – and, hence, problems – if one attempts to transfer an information system created in one country to another country. These gaps and HCIS transfer problems certainly exist between Western nations (Keen, 1994b; Curry, 1998) However, this gap and transfer problems are archetypally large between developing and industrialised countries (Vian et al., 1993). Differences exist between these two along all seven of the ITPOSMO dimensions. We will just provide a few illustrative gaps here, based on Heeks and Bhatnagar (1999):

- *Information*: formal, quantitative information stored outside the human mind is valued less in developing countries.
- *Technology*: the technological infrastructure (telecommunications, networks, electricity, etc.) is more limited and/or older in developing countries.
- *Processes*: work processes are more contingent in developing countries because of the more politicised and inconstant environment.
- *Objectives and values*: developing countries are reportedly more likely to have cultures that value kin loyalty, authority, holism, secrecy, and risk aversion.
- *Staffing and skills*: developing countries have a more limited local skills base in a wide range of skills. This includes IS skills of systems analysis and design, implementation skills, and operation-related skills including computer literacy and familiarity with the Western languages that dominate health care computing. It also includes a set of broader skills covering the planning, implementation and management of HCIS initiatives, and health care management.
- *Management and structures*: developing country health care organisations tend to be more hierarchical and more centralised.
- *Other resources*: developing countries have less money. In addition, the cost of IT is higher than in industrialised countries whereas the cost of labour is less.

Perhaps even more than with the public—private gaps, it is important to recognise these as stereotypes and to remember that the Third World is not some computer-free wasteland. Countries like Iran, India and Morocco first introduced computers in the mid-1950s; computers are used today in many developing country hospitals; and some countries produce their own health care information systems. Vast gulfs also exist within industrialised countries: compare health care in Beverly Hills with that provided in South Central in Los Angeles for instance.

Nonetheless, there is a major problem with the 'If it works for us, it'll work for you' mentality being peddled round the Third World by IT and health care multinationals,

by international consultants, and by aid donor agencies. Given the differences described, HCIS designed for use in an industrialised country can easily be based on conceptions that do not match realities in a developing country. They will therefore be more prone to failure if introduced into that developing country.

In the Philippines, an aid-funded project to introduce a field health information system was conceived according to a Western model that assumed the presence of skilled programmers, skilled project managers, a sound technological infrastructure, and a need for information outputs like those used in an American health care organisation (Jayasuriya, 1995). In reality, none of these was present in the Philippine context and the information system failed. Jayasuriya (1995:1604) concludes:

> "The alignment of IT to the organizational systems in developing countries tends to suffer from the assumption that models developed for developed countries are appropriate: this does not recognize the idiosyncracies of these systems."

Combining the Gaps

Where both sectoral and country gaps are combined, as occurred during the UK's Resource Management Initiative, trouble is almost guaranteed. Because RMI timescales were very short, most of the required nursing information systems were not home-grown. Instead, systems designed for the US private sector were transferred to the UK public sector with some limited adaptation.

> "The US systems were designed on the basis of assigning costs to individual patients based on the care given and the interventions undertaken and, as a consequence, this model was already encoded in the potential British systems." (Westrup, 1998:82)

As a result, "the nurses using (being used by) the system would have to follow the patterns of nursing care embodied in the system and based on the rather different US health environment."

Because of their US private sector origins, the transferred systems incorporated conceptions – of nursing information needs, of links to other IT systems, of nursing processes, of nursing objectives and values, of nurse and health managers skills and knowledge, of nursing management approaches – that were very different to the UK public sector reality.

For example, although the system incorporated rostering, "after nursing systems were implemented it was still common for nursing sisters to do the nursing roster at home as the computer system was found not to cater for the complexity of rostering in practice." As noted above, the system also fell down in the gap between the US-based conception of care planning as integral to nursing care and the UK reality that care planning was not generally done.

The result was widespread total or partial failure of these systems:

> "Hundreds of millions of pounds (and countless hours of people's time) were spent on information technology and systems introduced in virtually every hospital in Britain but it appears that few of them were successful by any

> criteria: complete implementation; actual use; or cost effectiveness” (Westrup, 1998:85)

Less than 30% of hospitals ever got their nursing information systems fully operational, and many of these were never fully used (HSMU, 1996).

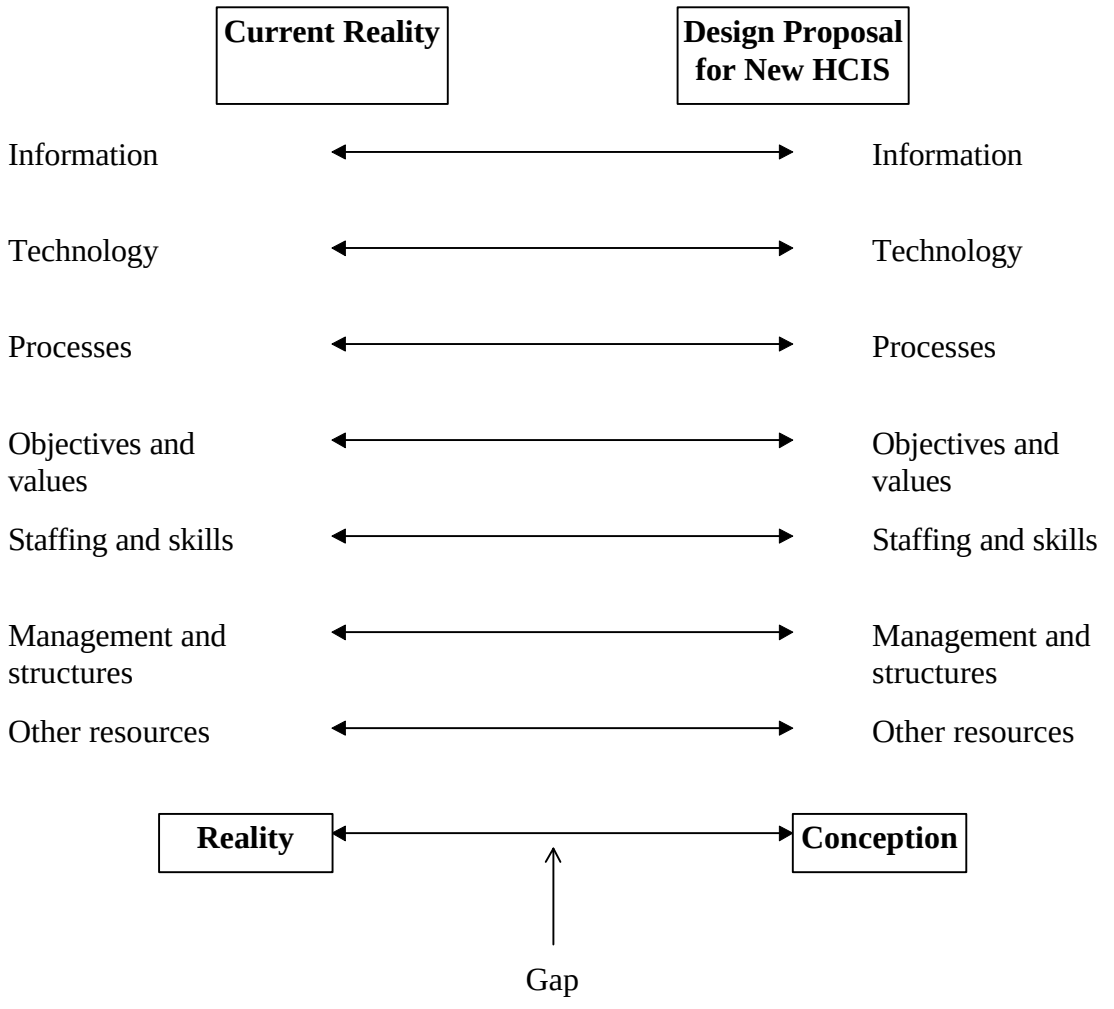
D. Conclusions

A health care information system succeeds or fails – it is argued here – dependent on the degree of mismatch between the conceptions in that system's design and the realities into which it is introduced. We can assess that mismatch along seven main dimensions, described above in the ITPOSMO model. Given that failure is naturally more of a concern than success, and given that HCIS will fail more often than they succeed, three archetypal conception—reality gaps were presented which make failure more likely to occur:

- when health care information systems derived from hard rational models of organisation meet a different behavioural reality;
- when HCIS derived from the private sector are transferred to public sector health care organisations;
- when HCIS derived from one country are transferred to another country, especially from an industrialised to a developing country.

Having provided an explanation for failure, the obvious question is: 'OK, so what do we do about it?'.

Figure 1. The ITPOSMO Dimensions of Change for Health Care Information System Proposals



Our starting point for any process of HCIS implementation must be analysis of the conception—reality gap. There is no straightforward method for analysing the gap between current reality and the conceptions assumed within a proposed new health care information system. One approach – arising from Checkland's Soft Systems Methodology (Checkland and Scholes 1990) – is to undertake a) analysis of current reality and b) design of the new HCIS. In the case of both analysis and design, the seven ITPOSMO dimensions of change can be incorporated. Design can be used to expose inherent conceptions, so comparing reality and the design proposal along these dimensions will give an idea of the extent of change gaps (see Figure 1).

Soft systems methods often advocate recognition of gaps as potential changes, which can then be discussed in participative fora to identify those which are desirable and feasible. Where gaps are identified by participating stakeholder groups as both desirable and feasible changes to current reality, it may well be that they will be successfully implemented.

D1. Gap Closure Techniques for Greater HCIS Success

In tandem, though, it will be valuable to make use of techniques which either a) prevent large gaps arising in the first place, or b) reduce those gaps once they have been identified. There are many ways in which gap prevention or gap reduction can be achieved. We present here just a sample of techniques that may help improve the success rate of HCIS initiatives.

Legitimising and mapping organisational reality. An integral part of successful HCIS must be a proper understanding of current realities. This may often be difficult; for example, where rational paradigms dominate. In such situations, HCIS project leaders can help by 'legitimising reality': by encouraging participants to articulate the difference between rational, prescriptive models of what they should be doing and real depictions of what they are actually doing. Techniques for exposing and mapping organisational realities play a role here. Self- and third party observation helps expose realities. Use of soft systems tools such as 'rich pictures' helps map realities. Prototyping of HCIS helps both, particularly helping users to understand their real information needs. All of these techniques have been successfully applied to HCIS (Gillis et al., 1994; Checkland and Holwell, 1998; Paré and Elam, 1998; Ballantine and Cunningham, 1999).

Reality-supporting not rationality-imposing applications. We can distinguish a continuum of health care applications, as illustrated in figure 2. At one extreme, there are 'rationality-imposing applications' such as decision support systems. These incorporate a whole series of assumptions about the presence of rational information, processes, objectives and values, management structures, etc. These rationalities must either be present in the organisation as a pre-condition for successful implementation of this application, or they must be imposed. In many organisations, the introduction of such applications will not succeed because of the large gap between the application's required rationalities and current organisational realities. Hence, the problems found in introducing applications like DSS into many health care organisations (Vian et al., 1993; Blake et al., 1995; Edwards and Bushko, 1995; Ennals et al., 1996).

At the other extreme, there are 'reality-supporting applications' such as word processing. By comparison with rationality-imposing applications, reality-supporting applications require fewer conceptions to be met as pre-conditions or to be imposed. They can therefore work successfully in a wider variety of organisational environments. Hence, far from the gaze of those besotted by the 'leading edge', the domination of word processing and email as applications in health care settings (Young and Beswick, 1995; Smith and Harding, 1998).

Because they involve small conception—reality gaps, reality-supporting applications seem more likely to be successful and are therefore to be encouraged. Indeed, the importance of making health care applications as 'reality-supporting' as possible explains the interest in HCIS features that more closely imitate reality, such as free text-based recording and search systems, pen and audio input, mobile computing, and integration of images into computerised medical records (Dayhoff, 1995; Laukkanen and Maier, 1995; Lincoln and Essin, 1995; Verhoosel et al., 1998). Many HCIS may therefore have to become more technically sophisticated in order to become more reality-supporting and, hence, to integrate more easily into health care practice.

Figure 2. Continuum of Health Care Applications

Customisation to match realities. One general message is that whole health care sectors, organisations, and even individuals must continue to recognise, express and have satisfied their unique requirements. 'Customised' must therefore take precedence over 'ready made', as has been found for a number of successful HCIS (Keijzer and Rodrigo, 1995; Miller et al., 1995; Paré and Elam, 1998). In many cases, this will require national and/or sectoral and/or in-house HCIS capacities to be strengthened.

This will also affect selection of software vendors and developers. One key criterion will be their demonstrable willingness and ability to understand client contextual realities and to customise information systems accordingly. This finally has implications for the viability of health care organisation client consortia, suggesting they will be relatively difficult to sustain (Gowing, 1994).

Change agents. The ITPOSMO model is a reminder that a focus on technology is too narrow and that HCIS must be seen as part of a multi-dimensional process of change. Health care IT professionals must therefore see themselves more as change agents (Markus and Benjamin, 1996). They may become facilitators by increasing the capacity of others to change, or they may become advocates who take responsibility for implementing change along the identified dimensions. In either case, their technology

skills will be complemented by those of change management and of communication, negotiation and advocacy. To support this, there must be a change in the health care organisation structures and management processes that deal with information systems, away from the old 'central IT unit' model.

End-user development. Many of the gaps described in this paper are gaps between the context and assumptions of HCIS design and the context and assumptions of HCIS operation; that is, they are gaps between developers and users. One way to close these gaps almost entirely is through end-user development which vests all – or almost all – systems development roles in a single person. This will close the design—reality gaps of information needs, and of objectives and values. It can significantly reduce the money and time resource requirement, and end users are most unlikely to create unmanageable levels of change for themselves on the other ITPOSMO dimensions. As such, end-user development should greatly increase the chance of producing a successful health care information system, as has been found in practice (Edwards and Bushko, 1995).

Participation. Where end-user development is not feasible, conception—reality gaps can be reduced through participatory approaches that allow the worldviews of a range of stakeholders to be incorporated into HCIS design. This can particularly be used to close gaps along the objectives and values dimension. It can be difficult to combine or compromise between different hard, rational worldviews because such worldviews tend to be resistant to change. Nevertheless, participative approaches have proven to be the bedrock of successful HCIS projects in a wide variety of settings (Foltz, 1993; Rosenal et al., 1995; Curry, 1998).

Hybridisation. The previous three techniques all require some form of 'hybridisation'. Current IT professionals need to be hybridised into broader change agents who combine IS and IT skills with an understanding of the health care context and of change management. Current health care professionals need to be hybridised towards a broader skill set that includes an understanding of information systems and information technology (especially the latter for end-user developers). For example, training must aim to create 'the informatics nurse' who can fully participate in HCIS initiatives (van Aulst and Springer, 1995).

Incrementalism. Where a major set of changes is planned as part of a new HCIS, breaking these down and introducing them only slowly and in an incremental manner will help to reduce the extent of any given change. This, in turn, will increase the likelihood of successful system introduction, as found in practice (Slater, 1996; Hoogewerf and Lowe, 1998).

Closing specific conception—reality gaps. The techniques already described are relatively generic to all ITPOSMO dimensions. However, techniques can also be employed to help close specific dimensional gaps. There are two main ways in which a gap between reality and proposal can be reduced: a) change current reality to make it closer to the HCIS design proposal, or b) change the HCIS design proposal to make it closer to reality. As an example of the former, staffing and skill realities can be brought closer to HCIS conceptions by hiring new temporary or permanent staff or through training schemes. Likewise, financial realities can be brought closer to HCIS

conceptions by seeking new funding sources. Many public sector organisations are doing this through 'private finance initiatives' under which private firms develop, own and operate the HCIS and are paid an annual fee over an agreed period for this service only if the service meets agreed criteria. Alternatively, HCIS conceptions can be brought closer to reality in both cases by reducing either the scale or scope of the HCIS design so that it requires fewer skilled staff or costs less to operate.

Freezing dimensions of change. Any dimension of the HCIS design proposal can be altered to make it smaller or simpler and thus closer to reality. This design alteration could go as far as making the new proposed design conceptions exactly match current reality along one particular dimension, by 'freezing' that dimension. Going further, the proposal could match reality along several of the ITPOSMO dimensions. An example of the first would be freezing the technology dimension of change by not altering the IT but, instead, focusing change on the redesign of health care processes.

A Caveat on Techniques

Finally, though, we must issue a caveat about the techniques described above. We began by saying that a contingent approach to HCIS is required but our focus in this paper has been about contingency of information system content (the 'what') rather than information system process (the 'how'). In other words, we have focused on matching the final information system to its context but have not thought about matching IS implementation techniques to their context.

We must now do the latter in order avoid presenting the listed techniques in a prescriptive, 'cookbook' manner. We must therefore not say 'participative approaches will always be part of successful HCIS implementation'. Instead, we must say 'first analyse the situation to see if these particular conditions hold; if they do, then participation is more likely to be of value; if they do not, then participation is less likely to be of value.'

For example, user-participation techniques are unlikely to work well where:

- users lack information about participative techniques and about the new information system (information dimension);
- the objectives of senior staff are not to share power and the values of the organisation are authoritarian and hierarchical (objectives and values dimension);
- users lack the skills and confidence necessary to engage in participative processes (staffing and skills dimension);
- the management style and organisational structures of the organisation are highly centralised (management and structures dimension);
- the organisation lacks the time and money to invest in participative approaches (other resources dimension).

From this example, it can be seen that we can apply the ITPOSMO model to the process of HCIS implementation. We can say that implementation techniques are less likely to work where there is a large gap between the conceptions inherent within those techniques and the realities of the organisation in which you try to apply them. We can therefore use the conception—reality gap model to assess not just the feasibility of a

particular HCIS design, but also the feasibility of particular HCIS implementation techniques.

D2. Questions for Future Research

From the analysis above, three key questions arise for future research.

- ***How and Why are Health Care Managers Pressurised into High-Gain, High-Risk HCIS Initiatives?*** Health care information systems with a larger conception—reality gap bring greater risks of failure, but they also typically promise greater organisational benefits from greater organisational change. Health care managers often find themselves in a dilemma, torn between one HCIS proposal that is revolutionary, high benefit and high risk, and another that is incremental, limited benefit and low risk. Future research can help understand the contextual – typically political – pressures that so often push managers to choose the former, leading to large, spectacular and very costly HCIS failures. Research is also needed to help managers identify options for modifying the political context, or – where modification is not possible – for reacting to that context in a lower-risk manner.

- ***What Barriers Exist to Adoption of Common Best Practice Techniques?*** The common 'gap-closing' techniques described above, and their positive impact, are no secret. Future research should therefore focus not so much on describing common best practice techniques, but on analysing the barriers to their adoption in health care organisations and on helping health care managers overcome those barriers. The question about hybridisation, for example, is not 'Does it deliver as a technique?' but 'Why can't or don't HCIS projects use it more often?'.

- ***What Innovative Techniques Can be Adopted to Support HCIS Initiatives?*** Common best practice techniques have been described, but a host of less well-known or less well-tried techniques exist that can close conception—reality gaps and can improve the success rate of health care information systems. Further research is required to identify, assess and disseminate such techniques. One example might be a tacit knowledge/informal information systems approach that seeks to expose and support the tacit knowledge that is key to many health care organisation functions, as used in the 'soft network' approach of Yorkshire Health Associates in the UK (Hastings 1996).

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