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# Health information systems: Failure, success and improvisation

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**Summary**
*Background and purpose:* The generalised assumption of health information systems (HIS) success is questioned by a few commentators in the medical informatics field. They point to widespread HIS failure. The purpose of this paper was therefore to develop a better conceptual foundation for, and practical guidance on, health information systems failure (and success).
*Methods:* Literature and case analysis plus pilot testing of developed model.
*Results:* Defining HIS failure and success is complex, and the current evidence base on HIS success and failure rates was found to be weak. Nonetheless, the best current estimate is that HIS failure is an important problem. The paper therefore derives and explains the ''design—reality gap'' conceptual model. This is shown to be robust in explaining multiple cases of HIS success and failure, yet provides a contingency that encompasses the differences which exist in different HIS contexts. The design—reality gap model is piloted to demonstrate its value as a tool for risk assessment and mitigation on HIS projects. It also throws into question traditional, structured development methodologies, highlighting the importance of emergent change and improvisation in HIS.
*Conclusions:* The design—reality gap model can be used to address the problem of HIS failure, both as a post hoc evaluative tool and as a pre hoc risk assessment and mitigation tool. It also validates a set of methods, techniques, roles and competencies needed to support the dynamic improvisations that are found to underpin cases of HIS success.


## 1. Introduction

The medical informatics literature presents, by and large, a picture of successful health information systems (HIS): the modal form of journal article and conference paper is an implementation case study that is adjudged to be a success. There is a negative bias against publication of failures found in healthcare literature more broadly and in medical informatics literature specifically [1,2]. Hence, just a small handful of writings strike a discordant note, claiming there to be significant numbers of HIS failures.

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This paper — aligning itself with the minority literature — sets out to investigate HIS failure. Its initial task will be to review the nature and extent of this failure. If, as seems likely, there are significant problems with significant numbers of information technology (IT)-based systems in healthcare, this creates a major gap between the positive potential for informatics to contribute to the work of healthcare organisations and a more negative reality. This, in turn, means that increasingly large sums of money are being invested in new health information systems but that a substantial proportion of this will go to waste on unimplemented or ineffective systems.

Dissatisfied with the analyses of HIS failure offered to date, this paper develops a new model that may offer a better understanding of that failure (and, equally, of success). This, in turn, can highlight interventions that may help to reduce the risk of systems failure.

## 2. Defining and estimating HIS failure and success

Any discussion of HIS success and failure must begin with a definition of its terms. Such an attempt runs into some immediate difficulties that this paper, while recognising, cannot completely resolve. The first difficulty is the subjectivity of evaluation: viewed from different perspectives, one person's failure may be another's success [3,4].

This problem can be partly addressed through a three-way categorisation of HIS initiatives:

- The *total failure* of an initiative never implemented or in which a new system is implemented but immediately abandoned. Such an outcome can be defined relatively objectively.
- The *partial failure* of an initiative in which major goals are unattained or in which there are significant undesirable outcomes. In some cases — for example, where only a subset of initially stated objectives has been achieved — the notion of partial failure may be relatively straightforward. Other partial failures, though, are more difficult to identify because identification grapples with the issue of subjectivity. This requires evaluation to ask: ''Whose goals are unattained?'' and ''For whom are the outcomes undesirable?''.
- The *success* of an initiative in which most stakeholder groups attain their major goals and do not experience significant undesirable outcomes. Again, there will be subjectivity in identifying such outcomes.

Given this categorisation, one could then review literature data in order to produce estimates of success and failure.

In attempting this, one runs into a further difficulty. Despite the fact that evaluation as a topic offers a higher profile within the medical informatics literature than within the broader information systems (IS) literature, the base of evaluative case study data from which one could estimate success and failure rates is weak: ''most of the available literature refers only to pilot projects and short-term outcomes, and in many cases the efficacy of the application was being considered, rather than its effectiveness'' [5]. These weaknesses can be teased out:

- *Timing*: Reporting pilots and prototypes rather than fully operational systems is problematic in itself. It also highlights the problem of timing in the determination of success and failure, where today's HIS success may be tomorrow's HIS failure, and vice versa [6]. This issue remains largely unrecognised within the medical informatics literature, where data is almost universally cross-sectional rather than longitudinal. It is thus blind to the *sustainability failure* of HIS that succeed initially but are then abandoned after a relatively short period of time. It is also blind to the abandoned failure that is then revived at some later stage. Yet both exist in practice: a point discussed later in this paper.
- *Objectivity of categorisation*: The definitions of partial failure and of success are only operationalisable where evaluation methods recognise subjectivity, and recognise and interact with multiple stakeholder groups. Yet most reported case studies take a positivist approach to evaluation that assumes an objectivity to success and failure [7].
- *Objectivity of data*: More contentiously, one may reflect that many HIS paper authors are the developers of the system they seek to report due, in part, to the strong historical practice-orientation of academic groups within medical informatics [8]. They therefore lack the distancing and independence from the object of study that are norms of methodological rigour in referent medical or information systems disciplines.

Given that case study material forms a poor basis for estimation, we must turn instead to the few instances of cross-case data. Some of this data relates to specific types of application, for example:

- *Clinical decision making systems*: ''Currently prevalent systems . . . have high failure rates'' [9].

- *Computer-assisted learning in medicine*: ''Many of these programmes failed'' [10].
- *Mobile computing healthcare systems*: ''Studies evaluating prototypes have revealed that acceptance of such tools was rather low'' [11].
- *Shared decision making* (*SDM*) *systems*: ''Studies examining the adoption of SDM tools to support patients in treatment or screening decisions have reported clinicians' reluctance to use such tools'' [12].

Some data relates to particular countries and health systems, for example:

- ''People within the NHS [*UK National Health Service*] and without appear to believe that this organization has experienced relatively high rates of IS failure'' [13].
- ''Doctors in Norwegian hospitals reported a low level of use of all electronic medical records systems'' [14].

Other data is generic:

- ''Seventy percent of the systems either fail or do not provide end-user satisfaction'' [15].
- ''There are many more failure stories to tell than there are success stories'' [16].
- ''Even in today's health care organizations, more than 25 years after the inception of the field, truly successful HIS stories are not common. On the other hand, failures are highly visible, widespread, and costly'' [17].
- ''Most healthcare informatics professionals today have experienced or are familiar with one or more system failures. Many healthcare institutions have consumed huge amounts of money and frustrated countless people in unsuccessful IS efforts.'' [18].

Unfortunately, in almost all cases, the source of this data is either one or two individual case studies, or uncited. The Anderson figure [15] appears to derive from a survey, though the source is not entirely clear. One is left with estimates that appear more like assertions, or generalisations from personal or very limited experience.

To conclude, then, both the conceptualisation and the evidence base for HIS success and failure are weak. Both need strengthening. All one can say is that the data is at least suggestive that success and failure rates for HIS are not significantly out of line with rates reported from general IS surveys. Leaving aside the challenging issue of success and failure's evolutionary nature, these latter report that something like one-fifth to one quarter of IS projects fall into the total failure category; something like one-third to three-fifths fall into the partial failure category; and only a minority fall into the success category.

## 3. Understanding HIS failure and success

The best estimate, from an admittedly poor evidence base, is that most HIS fail in some way. In this section, we seek to understand why this should be.

Interest in HIS failure is not new but analysis of the limited past literature suggests it has tended to fall into one of two related traps. One trap relates to generalisability. Some studies are overly specific; focusing on a single case study of failure from which it is hard to legitimately generalise conclusions (e.g. [19,20]). Other studies are overly generic, providing prescriptive ''cookbook'' guidance that is intended to apply in all circumstances (e.g. [18]). In both cases, the studies fail to recognise the situation-specific factors that determine success and failure for each particular HIS [21].

The other trap relates to conceptualisation. Some HIS studies provide a useful practical technique but provide no clear conceptual model as a foundation (thus limiting the confidence with which one can generalise from the initial study) (e.g. [22]). Others provide strong conceptual foundations but can offer limited practical guidance (e.g. [23]).

Such a characterisation is echoed in analyses of the broader literature on IS failure and risk, which adds one further trap [24]. This is the contrast between IS studies that are static, concerned solely with factors underlying success/failure, and those which are dynamic, concerned solely with the process of IS implementation that ends in success or failure.

We thus have three pairs of Scylla and Charybdis that — not without difficulty — must be steered between. Dealing with these in reverse order, this paper takes a route that attempts to encompass both static factors and dynamic process; that provides a conceptual foundation to its practical guidance; and that draws from multiple case studies in order to offer some confidence of generalisability, but also draws centrally on the notion of contingency in order to deliver a model that can be shaped to the differing circumstances of differing health information systems.

Inherent within most ideas of contingency is the idea of *fit* or *congruence*: 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. There are different variants of contingency models but one main concept has been that of fit between an organisational system — an information system, a management system, etc. — and its environment [25]. Within the information systems literature, there is variation in the environmental factor or factors that an information system is supposed to fit with. One important strand has been work looking at the fit between technology and the task it is intended to support [26,27]. Another has been writings on fit between IS and organisational strategy [28,29].

There are two problems, though, with these earlier contingent approaches. First, they tend to be narrow: picking on just one or two factors despite the fact that IS success and failure are seen to be multi-factoral [24]. Second, in seeking to match an IS to its environment, they produce a logical challenge: if, for example, a health information system were to exactly match its environment, it would not change that environment in any way. Yet the formal purpose of HIS is to support and bring about organisational change in order to improve the functioning of healthcare organisations. There must therefore be some degree of change that an HIS introduces.

On the other hand, if a health information system tries to change too much this brings with it a risk of failure and, the more you change, the greater this risk [16]. In the much-cited London Ambulance Service case, for example, failure arose because ''the speed and depth of change were simply too aggressive for the circumstances'' [30].

### 3.1. Dimensions of change: design—reality gaps

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

The former will be represented by the current realities of the particular healthcare context. The latter will be represented by the model of conceptions and assumptions that have been inscribed into the new HIS design. Putting this a little more precisely, then, the model proposed here would state that success and failure depend on the size of gap that exists between ''current realities'' and ''design conceptions of the HIS''. More plainly, this can be referred to as the ''design—reality gap''.

In practice, because of subjective expectations about the future and subjective perceptions of reality, it could be argued that every individual HIS stakeholder has their own design and their own version of reality. Among these myriad design—reality gaps, we must necessarily simplify the model. Drawing on a thread within the IS failure literature [3,31], the two key homogenised stakeholders in the model presented here will be the designers who create the dominant HIS design, and the users who populate the local reality.

These groups are especially valuable to an understanding of failure given their dislocation, in both psychological and even physical terms, as part of the HIS implementation process. However, this simplification does impose limits; for example, limiting subjective partial failures to a consideration of the objectives of these two stakeholder groups alone.

What could be relevant dimensions of this ''design—reality gap'' between the designers' dominant design and the local actuality of the users? The dimensions could be built up in a number of ways: theoretically on the basis of literature; descriptively on the basis of a straightforward delineation of components of an information system; and analytically on the basis of case studies. An amalgam of all three approaches is presented here.

In all, as noted above, the design is a representation of an intentional future. It is a world-in-miniature that contains elements that have been inscribed either explicitly or implicitly. These elements include:

- *Components from the designers' own context*: Health information system design is a situated action—an action ''taken in the context of particular, concrete circumstances'' [32]. This action draws elements of that context into the design:

  ''Our technologies mirror our societies. They reproduce and embody the complex interplay of professional, technical, economic and political factors.'' [33]

  Designers themselves are part of and shaped by that context, and so their own cultural values, objectives, etc. will be found inscribed in the design [34,35].
- *Conceived assumptions about the situation of the user*: This includes assumptions about the users' activities, skills, culture and objectives, and assumptions about the user organisation's structure, hardware and software infrastructure, etc. [32,36,37].

This literature therefore suggested a need to encompass issues of objectives and values, activities, human skills, organisational structure, and technical infrastructure. This was combined with more descriptive material on key factors that underlie IS implementation such as data, financial resources, and their coordination through managerial systems (e.g. [24,38]

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