

# Evaluating Large Scale Health Information Systems: From Practice Towards Theory

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*With the introduction of large scale health information systems which are incrementally developed from legacy systems, evaluators are faced with difficult methodological and practical problems. Some of the problems involved in multi-disciplinary multi-method evaluations are discussed. It is argued that the development of a framework for evaluation is necessary in order to successfully plan an evaluation, understand the implications of the results and make future predictions based upon them. Some suggestions for arriving at such a framework are put forward.*

## INTRODUCTION

Two major approaches to the evaluation of health care Information Systems (IS) have been identified by Friedman and Wyatt as objectivist and subjectivist[1]. The objectivist position starts with the assumption that rational persons can agree on what attributes of a system are important to measure, and that the results of these measurements can be interpreted as desirable, correct or positive (i.e. a "Gold standard"). Objectivists believe that these chosen attributes are capable of measurement, that measurement can be repeated by others yielding the same result, and that the measuring process does not affect the resource under study. Numerical measurement is seen as superior because it enables precise statistical analysis.

Subjectivists believe that the results obtained from observation are dependant upon the context and the observer and that different results are a legitimate

conclusion. They refute the idea of a "gold standard" arguing that individuals and groups hold different opinions on an issue, and that understanding and documenting their differences of opinion is an important aspect of evaluation. Subjectivists favour qualitative data for its richness and expressiveness compared to numerical data.

Many Medical Informatics (MI) practitioners subscribe to the medical community's objectivist perspective, viewing the most important system attribute as financial savings and the preferred study design as a randomised controlled clinical trial (RCT)[2]. A review carried out by Van der Loo, examined the types of study design employed in the evaluation of health care IS (1974-1995) . This study set out a "gold standard" of evaluation which comprises an economic analysis coupled with a RCT, and scored the evaluation studies examined against this standard. Of the 108 studies found, only 6 met this standard. The author was highly critical of the majority of evaluations and called for a more robust approach to be taken[3].

Recently, the subjectivist viewpoint has received attention as those involved in the development and implementation of clinical systems realise the significance of social and organisational issues[4]. If we are to examine social and organisational issues we must employ qualitative methods from social science. The goal of qualitative research is the development of concepts which assist us in understanding social phenomena in natural (rather than experimental) settings, giving due emphasis to the meanings, experiences, and views of all the participants[5].

The objectivist and subjectivist approaches both have important roles to play in the evaluation of clinical systems. A recent paper reports on the negative findings of a RCT of a computer-based physician workstation. Without the inclusion of qualitative methods in the study design, it was not possible to interpret these negative findings[6]. Von Gennip analysed a wide range of European evaluations and other studies and argues strongly for formative and multi-method evaluations[7]. A paper by Kaplan also advocates a multi-method approach to evaluation, which includes qualitative analysis, and defines several criteria of evaluation. However, this proposal does not address multiple site evaluations and does not set down any detailed methodology[8].

In the past, evaluations of health care IS have been concerned with relatively small scale initiatives, which replace or augment conventional paper-based systems, and are piloted on one or more departments or wards rather than hospital wide. However, with the introduction of large scale health IS which are incrementally developed from legacy systems, evaluators are faced with difficult methodological and practical problems.

This paper highlights some of the problems involved in the multi-disciplinary assessment of large scale health care IS. It describes an evaluation project which combines both objectivist and subjectivist perspectives. The knowledge and understanding gained during this evaluation identifies the need for, and helps to develop, an evaluation framework for health care IS. Such a framework would enable MI practitioners to plan an evaluation study, understand the implications of the results and make future predictions based upon them. Some suggestions for arriving at an evaluation framework are put forward.

### **FROM PRACTICE**

The evaluation project described here concerns two UK National Health Service (NHS) initiatives, which began in 1994. The Electronic Patient Record (EPR) project is a three year research and development programme to assist clinicians in acute hospitals to provide better care to patients through the use of electronic patient record systems[9]. The Integrated Clinical Workstation (ICWS) project[10] is concerned with providing interface facilities to an EPR. Two hospitals are

demonstrator sites for the EPR project and three for the ICWS project.

External evaluation was a required part of both the EPR and ICWS projects. Several stake-holder groups, at both national and local levels, are interested in the results of this evaluation. These include the EPR and ICWS sites themselves, other sites involved or about to embark on EPR/ICWS development, manufacturers of clinical systems, the Information Management Group (IMG) and Research and Development Directorate (RDD) of the NHS, as well as practising clinicians and researchers.

The evaluation team includes clinicians, social scientists, computer scientists, health service management experts and economists. They provide a combination of experience of the clinical environment, health care organisation, medical Informatics technologies, patient records and the NHS organisation. They also have experience of a wide range of research and evaluation methods.

Some of the methodological and practical problems encountered during this project are briefly discussed below (a more detailed account can be found in [11]):

- The application of RCTs to EPR/ICWS evaluations is impractical. In particular there is the difficulty of introducing randomness into the study design. Whilst this is feasible for therapeutic interventions, where there are large numbers of recipients from which to randomise, introducing randomness into the implementation of whole or part of hospital systems is infeasible. Technology is generally taken up incrementally and there is no obvious "before" and "after" situation to enable comparison.

- Evaluation against objectives is not straightforward. Many health care IS are initiated without clear or realistic objectives. The various stake holders in a project will have conflicting objectives which evolve as their knowledge and understanding of the issues involved changes.

- A recent report by the Computer-based Patient Record Institute of the US defined 96 possible evaluation questions[12]. Given limited time and resources, and multiple stake holders, how can the most important questions to address and the most appropriate methods to employ be determined?

- Economic benefits are not the sole motivation of health care IS, and are generally difficult to measure. There are severe difficulties in applying the results of such analyses to other contexts.

- The provision of quantitative data is prime objective of many health care IS. The paucity of any analysable data prior to implementation fails to provide a baseline for comparison.

- In a multi-disciplinary multi-method evaluation, the problem arises of how to devise an integrated approach to the evaluation process, and to the assessment and presentation of results. It is important to avoid duplication of work and unnecessary disruption to sites which may distort results. The potential richness of understanding that could be achieved through the integration of results, may be prohibitively time consuming and presents many practical and ethical dilemmas.

- Logistical difficulties arise, with team members spread across the country. Meetings are difficult to arrange which hinders the sharing of ideas or arrival at any consensus concerning the evaluation approach.

- The different team members perspectives, knowledge and experiences of EPRs and ICWSs were very diverse. This can provide a richness of understanding given sufficient opportunity and inclination to share knowledge and assimilate new perspectives.

- Given the teams initial unfamiliarity with the specific EPR/ICWS sites and sub-projects, it was impossible to make specific proposals concerning the study design and methods at the beginning of the evaluation. The sites themselves are primary recipients of the evaluation results. Furthermore, any evaluation activities are potentially disruptive to the sites. Therefore, it was not possible to define research topics and methods without considerable prior negotiation with the sites.

- As the evaluation project progressed new hypotheses emerged which caused us to constantly reconsider our focus of attention and use of methods. Furthermore, as time progressed, the site's understanding of health care IS and the implementation process deepened and so their objectives changed.

## TOWARDS THEORY

The problems our team have encountered whilst engaged on the EPR/ICWS evaluation project have led us to believe that the development of an evaluation framework for health care IS is an important step towards realising the benefits of such systems. Without such a framework, it is not possible to identify those factors which are the most important determinants of success, understand the relationships between these factors, or make predictions based upon the assessment of these factors. Given the large amounts of resources that are being invested in health care IS, it is important that those who fund such initiatives can make informed choices on the likely success of proposals, and those involved in system development can monitor and refine their plans based upon accepted knowledge.

During the first phase (scoping study) of the EPR/ICWS evaluation project, our team agreed some fundamental assumptions about the process (drawing on the work of Kaplan [8]):

- Focus on a variety of technical, economic and organisational concerns.

- Use multiple methods including measurement, experimental techniques, and observational approaches to strengthen the robustness of results.

- Be formative and summative, providing regular feed-back to relevant individuals.

- Be longitudinal to capture process.

- Be modifiable to adapt to changing circumstances.

We also performed a literature review of health care IS evaluation performed to date. This enabled us to compile a list of the evaluation questions and topics seen as most important by the various authors. We then identified the six questions that our team and the stake holder involved viewed as most important:

- What is the impact of the technology on clinical management? This will be considered at three levels: individual patient care, management of services and resource management.

- What is the impact on the roles, the organisation of work and work satisfaction of staff? What is the experience of living and working at the implementation sites?

- Can the costs and benefits of such developments/technologies be valued?
- Patient record systems and technologies: How useful and useable are they?
- What is the relationship between electronic and paper records for the EPR/ICWS sites in respect of: availability of data, integrity, compliance with standards, volume of paper generated, and reduction in clerical activity.
- What is the relationship between the technology and the general management of the Trust?

Another important function of the scoping study was to determine who should be primarily responsible for addressing each of the above questions. Some questions naturally became the responsibility of a particular group, e.g. issues concerning the roles, the organisation of work and work satisfaction of staff became the responsibility of the social scientists. Other questions involved joint work, and the team members had to negotiate and agree upon their work areas.

The main phase of the project is currently underway. However, during this period, there has been continual shifts in the nature of the EPR/ICWS projects, the timetables projected, the hypotheses and questions seen as most important and the allocation of resources and perspectives of team members and stakeholders. The evaluation has been adapted and refined throughout this process and can be viewed as a learning exercise for all those involved.

An important aspect of this work is the emergence of an evaluation framework. Through practical experience and empirically derived data it will be possible to abstract general principles and guidelines for evaluation. In particular, work such as the EPR/ICWS evaluation contributes towards identification of the following:

1. What a successful implementation of a health care IS actually is.
2. The factors that influence the above defined success.
3. Appropriate tools and techniques to measure these success factors.

In terms of the EPR/ICWS evaluation, we have gained some important insights which can contribute towards the achieving these three steps.

We have identified several of the success criteria used by various stake-holders and begun to tentatively distinguish the factors which influence these success criteria. It is also becoming apparent that the tools and techniques we have used to investigate various factors are not all equally useful, and some need to be abandoned whilst others need to be adapted and supplemented in future studies.

In order to test our framework knowledge, we need to conduct steps four and five given below:

4. Use the tools and techniques to measure the identified success factors in system implementations and make predictions based upon these measurements
5. Refine these factors and measurements based upon the accuracy of these prediction and re-test the framework on new IS implementations.

## CONCLUSIONS

It is important to recognise that any framework developed will at best provide only guidance to evaluation. Health care IS cannot be treated purely from the objectivist perspective. Health care IS are essentially software artefacts. Whilst they have a functional objective, like other forms of artefact design, the perception of health care IS will always involve an element of aesthetics, politics and sociology. Thus, perceptions will always be filtered through a these factors. The provision of an evaluation framework which takes account of these factors is important in the move towards professionalism in MI[12].

A number of important points have become apparent during this work:

- Projects such as these operate in the real world: we cannot evaluate against theoretical or academic standards, or use pure methods. There are numerous constraints which exist (e.g. limited time and resources, logistics, conflicting cultural, social and political forces), therefore, we have to adapt as best possible, i.e. to be reactive. However, many of these problems can be eliminated or reduced by a planned evaluation, devised as part of the project specification, rather than added as an after thought.
- The majority of what we have learnt is about the process as opposed to hard facts about

outcomes. This knowledge is valuable but requires care in applying elsewhere.

- Team members have spent much time involved in debate and negotiation, with commissioning bodies, sites, and other team members. The process of sharing views and understandings is difficult at times, but can be enriching.

- Team members have a special understanding. This is richer than before they started work on the project and has come about through a process of mutual learning and development. Sharing knowledge about the subjects and method of research, as well as results has been an important aspect of the work. Negotiations and discussions often seem unproductive at the time they occur, but in retrospect have been invaluable.

- The evaluation of large-scale IS projects is a difficult task. Each project and its context will be unique, therefore learning will always be an important part of the process. One single discipline can never fully evaluate the impact of large systems, thus the ability of team members to work together co-operatively and share knowledge and ideas becomes paramount.

This paper has attempted to provide an account of some of the social, organisational and political factors which are inherent in most, if not all, research enterprises, particularly in those projects which venture outside the laboratory into the real world. The difference is that in most research such factors are not considered to be part of the data. However, such data is important if we are to facilitate multi-disciplinary evaluation work of complex systems involving both IT and people.

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