Factors associated with health information system success: Results of a survey of hospitals in South Africa

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Abstract

A survey of computerised hospital information system (CHIS) use was conducted in two South African provinces, in order to test a conceptual model of CHIS use developed in previous phases of this study. Relationships between factors of the conceptual model and user assessment of CHIS success; and between pairs of conceptual model factors, were derived from the survey data.

The results confirmed that factors of the conceptual model were associated with CHIS success. Analysis of the relation-ships between factors yielded results which supported some of the conceptual model relationships, and were inconclusive for others. None of the conceptual model relationships was con-tradicted by the survey results. Further investigation is re-quired to demonstrate statistical relationships between factors of the conceptual model more conclusively.

The results to date support arguments for the applicability of the conceptual model of CHIS use beyond the study hospitals to other level 1 and level 2 hospitals in South Africa.

Keywords:

Hospital information system, South Africa, HIS evaluation, HIS success.

Introduction

Studies of factors associated with the success and/or failure of computerised health information systems have focussed on the factors themselves, and the relative weighting of the factors, rather than on the relationships between factors ([1] and [2] for example). In this study, factors associated with success; user assessment of success; and the relationships between factors associated with the success of computerised hospital informa-tion systems (CHISs) were examined.

In previous phases of this study, a conceptual model of CHIS use was developed based on case studies in four South African hospitals, as reported in [3] and [4]. A survey of CHIS use was conducted in level 1 and level 2 hospitals in two South African provinces, in order to test this conceptual model of CHIS use. The model is shown in Figure 1.
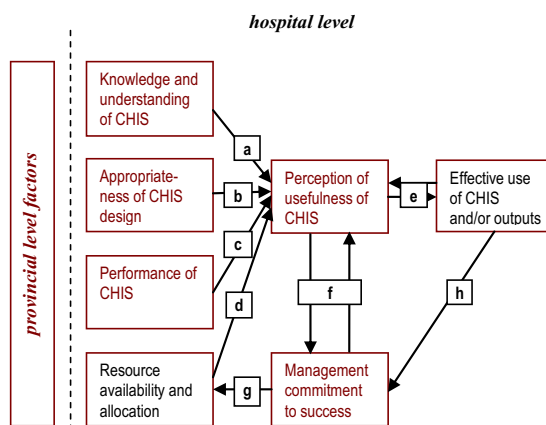

Figure 1- Conceptual model of CHIS use, identifying relationships between model factors for analysis

Methods

A survey of CHIS use was conducted in level 1 and level 2 hospitals in two provinces in South Africa. The objectives of the survey were

- To review the factors of the conceptual model of CHIS use;

- To further investigate relationships between factors of the conceptual model of CHIS use;

- To identify differences between groups of hospitals us-ing the same CHIS in respect of factors associated with CHIS success or lack of success;

- To provide further data for identifying factors which could help to explain CHIS success or lack of success.

Two sets of questionnaires were used: hospital questionnaires were designed to obtain information about the CHIS implementation for the hospital as a whole, and user questionnaires were designed to obtain the opinions of individual users. Questions in the questionnaires were designed to reflect various aspects of the conceptual model. Extensive provision was made in the questionnaires for user comments. Quantitative data took the form of weighting on a 5-point scale (strongly disagree, disagree, neutral, agree, strongly agree) or presence or absence of a factor (yes, no, neutral). Provision was made for recording 'no response' to questions.

Data were collected from a wide range of CHIS users, including heads of hospitals, information officers, case managers, and supervisors of end users. Interviews were conducted in person or telephonically by arrangement, and the questionnaires completed by the interviewer; or questionnaires were self-completed by the respondents.

Results

Overview of the CHIS implementations

Data were obtained from 70 respondents at 30 hospitals in the two study provinces. The CHIS implementations in the study hospitals supported patient administration and billing, and included provision for recording limited clinical data. The study hospitals in Province 1 were using one of two CHISs (SystemA or SystemB) and all the study hospitals in Province 2 were using SystemC.

Data analysis approach

A major aim of the survey was to build on the results from the case studies, in order to further refine the conceptual model of CHIS use as a framework for analysing CHIS success. The analysis of the survey results was aimed at investigating the validity of the conceptual model in the survey hospitals (i.e. in additional level 2 hospitals in Province 1; in level 1 hospitals in Province 1; and in level 2 and level 1 hospitals in Province 2), and assessing whether changes in the model would be required (based on the survey results).

In general, data analysis was done by treating all respondents using the same CHIS as a single group, in order to work with a reasonable sample size (maximum 33 respondents for SystemA, 15 for SystemB and 24 for SystemC). Hospital data were combined in such a way as to reflect the overall view of the data from a hospital perspective.

Due to the limited sample size in relation to the number of variables being considered, it was not possible to use analytical statistical techniques for data analysis. Therefore, a descriptive statistical approach was followed to describe the results related to the factors in the extended conceptual model of CHIS use; and to compare and discuss the relationships between model factors as reflected in the survey results.

Conceptual model factors associated with CHIS success: User responses

Some of the survey questions were designed to obtain the respondents' opinions about the association between the **hospital-level** factors in the conceptual model and CHIS success; and between these conceptual model factors and lack of CHIS success. The factors associated with lack of CHIS success were conceptualised as being the opposite of those associated with success (i.e., lack of knowledge and understanding, inappropriate design, poor performance, etc.). A summary of user responses to questions related to the factors in the extended conceptual model of CHIS use, from users in Provinces 1 and 2, is given in Table 1.

Respondents appeared to find difficulty dealing with these questions relating to factors associated with success and lack of success, and particular difficulty with factors associated with lack of success. On average, there were 32% nil or neutral user responses to the questions related to CHIS success (see Table 1) and 42% nil or neutral response to questions related to **lack of** CHIS success. Possible explanations for the difficulties experienced with these questions include the phrasing of the questions, and a lack of general knowledge and experience of CHISs among some of the survey respondents, although conclusive evidence was not obtainable.

Table 1 - Rating values for factors associated with CHIS success – all users all hospitals

Conceptual Model Factor	Total users	Users no response/ neutral	-ve user response	+ve user response	% +ve user response
knowledge	72	23	1	48	98%
design	72	23	3	46	94%
performance	72	23		49	100%
resources	72	22	5	45	90%
usefulness	72	23		49	100%
commitment	72	24	3	45	94%
use effectively	72	23		49	100%
Average		**32%**		**68%**	**97%**

Taking into account the limitations in this data set, those respondents who did express opinions about the association between the (hospital-level) conceptual model factors and CHIS success in their environments agreed that there was an association between the conceptual model factors and CHIS success: Overall, approximately 97% of the respondents to these questions agreed that the factors in the extended conceptual model of CHIS use are associated with CHIS success. A few respondents indicated that these factors are not associated with CHIS success. These negative responses could be interpreted as meaning that, in the respondents' environments, these factors were not associated with CHIS success due to their absence or weakness (limited resources, or limited management commitment, for example). On average, 65% of the respondents strongly agreed or agreed that **lack of** each of the factors of the

conceptual model could be associated with lack of CHIS success in the hospitals in which they were working. Therefore, the available data do support the inclusion of the hospital-level factors in the conceptual model of CHIS use developed in this study as being factors associated with CHIS success. The converse, i.e. that lack of these factors is associated with lack of CHIS success, is less strongly supported by the data.

Although the number of respondents for which data are available is limited (average 47 respondents about factors associated with CHIS success and average 42 respondents about factors associated with lack of CHIS success), this is also true of other studies examining the factors associated with CHIS success or failure, such as those in [1], [2] and [5]. Future studies which include more respondents would enable stronger conclusions to be drawn.

Conceptual model factors and user perception of CHIS success

The variable 'successful?' reflects the responses of users to the statement 'Overall, in terms of my job, the CHIS is a success'. The rating values of this variable therefore provide the most direct reflection from the survey of the respondents' overall opinions of the CHIS which they were using.

One of the assumptions in this study (also supported by results from the literature) is that effective CHIS use is related to CHIS success. Therefore, if the conceptual model is valid, the rating values (and other measures) of the factors of the conceptual model of CHIS use, should be consistent with user perceptions of CHIS success in their working environments. The analysis of cross correlations between the variable reflecting CHIS success ('successful?'), and the variables reflecting factors of the extended conceptual model of CHIS use, was therefore aimed at exploring these relationships, based on the available numeric data from the study survey.

At hospital level, there were statistically significant correlations between 'successful?' and the variables linked to the conceptual model factors 'quality of data' (sub-factor of 'knowledge and understanding of CHIS'); 'performance of CHIS'; 'perception of usefulness of CHIS'; and 'effective use of CHIS and/or outputs'; respectively for some categories of users. At user level, there were statistically significant correlations between 'successful?' and the variables representing each of the model factors, for some categories of users.

Apart from counter-intuitive results for SystemB users, the results of the cross correlations at user level between 'successful?', and the variables representing the following model factors supported the corresponding relationships in the extended conceptual model of CHIS use: 'knowledge and understanding of CHIS'; 'appropriateness of CHIS design'; 'perception of usefulness of CHIS'; and 'management commitment to CHIS success'. The correlations between 'successful' and 'effective use of CHIS and/or outputs' were counter-intuitive or weak, in contrast to the strong correlations between these variables at hospital level. As for the hospital-level analyses, the results at user level did not support a relationship between 'successful?'

and the variable representing the factor 'resource availability and allocation' in the conceptual model.

The hypotheses that the factors of the conceptual model are associated with CHIS success are thus largely supported by these cross correlations.

CHIS success: variables associated with factors of the extended conceptual model of CHIS use

Following the argument that the factors in the conceptual model are associated with CHIS success, the percentage of positive rating values for the variables representing these factors provides an indication of level of success. Therefore, the rating values were analysed, mainly at user level, for each of the variables used to reflect the hospital-level factors of the conceptual model. For the variable which reflects the resource allocation for ICD-10 coding from patient records, rating values were analysed at hospital level. A summary of the percentage positive rating values for the variables used to represent hospital-level factors in the extended conceptual model of CHIS use is presented in Table 2.

Table 2 - Summary of % positive responses for measures of conceptual model factors

Conceptual model factor	Sys-temA Prov 1	Sys-temB Prov 1	Sys-temC Prov 2
Knowledge and understanding of CHIS - training	92%	85%	65%
Knowledge and understanding of CHIS – quality of data	68%	46%	47%
Appropriateness of CHIS design	84%	69%	33%
Performance of CHIS	100%	68%	41%
Availability and allocation of resources (per hospital)	*38%*	*20%*	*71%*
Perception of usefulness of CHIS	89%	60%	64%
Management commitment to CHIS success	93%	80%	42%
Effective use of CHIS and/or outputs	75%	43%	33%
Respondents' perceptions of CHIS success	*95%*	*100%*	*37%*

For the purposes of comparison, the 'percentage of positive responses' was calculated for each variable, for each category of users. The 'positive responses' reflect all responses which reflect a positive response in terms of CHIS use. The percentage of positive responses was calculated using the total number of responses to the question as the denominator (i.e., excluding the number of 'no response's (rating value = 9)).

Apart from the data for 'availability and allocation of resources', these data for percentage positive rating values show that the survey respondents regarded SystemA as being more successful than either SystemB or SystemC, and that the two Province 1 implementations (SystemA and SystemB) were viewed as being more successful than the SystemC implementations in Province 2. This pattern is repeated in respondents'

perceptions of CHIS success, as reflected in the user responses to the question 'Overall, in terms of my job, the CHIS is a success', as shown in Table 2. All but one of the respondents among the SystemA users, and all the SystemB users, who responded to this question agreed or strongly agreed that the CHIS was a success in their jobs, while only 37% of SystemC user respondents shared this opinion.

Statistical analysis: relationships in the conceptual model

Eight relationships between factors in the extended conceptual model of CHIS use were analysed, reflecting the relationships between factors in the extended conceptual model of CHIS use, as shown in Figure 1.

The relationships between the characteristics of users and the CHIS and perception of usefulness of the CHIS (relationships (a) to (c)) were generally not strongly supported by the results of the cross correlations. However, the data from cross tabulations between the rating values of these variables did support these relationships.

Positive, but not statistically significant, cross correlations were shown between 'all patients' (reflecting resource availability for ICD-10 coding) and 'management commitment to CHIS success' (relationship (g)). A weak cross correlation was demonstrated between 'all patients' and 'perception of usefulness of CHIS' (relationship (d)).

Strong, but not necessarily statistically significant, relationships were demonstrated for most groups of respondents for the measures for the relationships involving 'management commitment to CHIS success', 'effective use of CHIS and/or outputs' and 'perception of usefulness of CHIS' (relationships (e), (f) and (h)). Where cross correlations were counterintuitive, cross tabulations did reflect positive relationships between these variables, as expected in terms of the conceptual model. The measures used for these conceptual model factors at hospital level all related to the respondents' perceptions of hospital management attitudes to and use of the CHIS at a hospital. The cross correlations between these variables were generally stronger than those for other conceptual model relationships, reflecting support for the relationships in the model. In a future study, more detailed comparisons between the answers to these questions by different groups of respondents could provide interesting insights into differences in perception of the CHIS between groups of hospital personnel.

Discussion

The aim of this survey was to test and refine the extended conceptual model of CHIS use developed following the case study phase of the study. The data from the survey were analysed from two perspectives: testing of hypotheses related to the relationships between the factors in the extended conceptual model of CHIS use, and CHIS success; and testing of hypotheses related to the relationships among factors in the conceptual model. The presentation and analysis of results in the previous Sections focussed largely on the results of analysis of the numeric data from the survey. In this Section, some of the avail-

able numeric and non-numeric data from the survey are discussed in combination.

Relationships among factors in the extended conceptual model of CHIS use

Results of analyses of data related to factors, and relationships between factors, in the extended conceptual model of CHIS use have been presented. Relationships between 'perception of usefulness of the CHIS' and other factors of the conceptual model; and data related to 'resource availability and allocation' are discussed further in this Section.

Perception of usefulness of CHIS

This factor of the extended conceptual model of CHIS use is linked to all other hospital-level factors in the model, reflecting the strong influence of perceptions on users' attitudes to CHISs. As discussed previously, there were few statistically significant cross correlations between the variable used to represent 'perception of usefulness of CHIS' and measures of other factors in the conceptual model.

Respondents were also asked a series of questions about the CHIS which they were using. The responses to these questions were coded in terms of factors of the conceptual model, yielding a set of approximately 300 coded comments from all the users who responded to these questions.

The coded comments linked to positive perceptions of usefulness of the CHIS related mainly to the model factors 'appropriateness of CHIS design' (approximately 50% of coded comments); 'knowledge and understanding of the CHIS'; 'CHIS performance'; and CHIS outputs (a sub-factor of 'effective use of CHIS and/or outputs'), and confirmed relationships between these factors and 'perception of usefulness'. For the coded comments linked to negative perceptions of usefulness of the CHIS (fewer than 100 coded comments), the majority of comments were related to 'CHIS performance' and 'appropriateness of CHIS design', thus supporting a relationship between poor CHIS performance and/or design, and a perception that the CHIS is not useful.

Combining all available data related to 'perception of usefulness of CHIS', it can be claimed that the relationships between this factor and factors related to the CHIS implementation ('knowledge and understanding of the CHIS' by users; 'CHIS performance' and 'appropriateness of CHIS design'), **are** supported by the available data from the survey.

Resource availability and allocation

Statistical analyses for the relationship between 'resource availability and allocation', and 'perception of usefulness'; and between 'resource availability and allocation' and 'management commitment to CHIS success' resulted in weak or counter-intuitive cross correlations, although the cross tabulations between these measures were generally positive. The comparison of the rating values for 'resource availability and allocation' for the different CHISs indicated that the system which performed most poorly in terms of most other measures (SystemC) had 71% positive ratings, compared with an average of 33% positive ratings for the Province 1 CHISs (Sys-

temA and SystemB). These statistical analyses therefore were considered in combination with other data related to the conceptual model factor 'resource availability and allocation'.

An important component of the conceptual model factor 'resource availability and allocation' is the availability of the required human resources to support the CHIS implementation at hospital level. The personnel arrangements for information management at hospital level in the two study provinces were rather different: The organogram for posts related to the CHIS at Province 1 hospitals makes provision for Information Officers at each hospital, and a case management function (full- or part time), which includes responsibility for ICD-10 coding for fee-paying patients. For Province 2 hospitals, the organogram includes an information management function at management level, as well as software and hardware support staff. Respondents reported that clinical and/or senior ward administrative staff were responsible for ICD-10 coding. There were no case managers at any of the study hospitals.

Although there were major differences in the organograms in the two provinces, the arrangements for system support appeared to be similar: during office hours, queries were referred to the information officer, a superuser in the section (for example, admissions or fees) or to external personnel responsible for application software or hardware support. After hours, calls were logged at call centres in both provinces, although in some cases, application software support staff were contacted directly. As was found at the case study hospitals, limited CHIS support available at hospital level and from external personnel was not highlighted by most users as a major problem.

Conclusion

Results of this study have shown that the factors of the conceptual model of CHIS use are associated with CHIS success, and that the relationships between factors of the model could be demonstrated.

This study makes a significant contribution to the literature on HIS success and failure on several counts:

- there have been few reported surveys to obtain data on HIS success and failure – data were obtained from approximately 70 users at 30 hospitals, across two provinces, each using one of three CHISs;
- this study was conducted in level 1 and level 2 hospitals using commercially-supplied CHISs, and in environments of limited resources for CHIS support;
- data were obtained from the perspective of CHIS users and hospital managers, rather than from HIS experts as in other reported studies.

Issues to be addressed in future studies include:

- Further refinement of proxy measures for conceptual model factors;

- Obtaining larger and more representative samples of different categories of users, to enable comparison of data from different perspectives;

- Combining data obtained from a CHIS user and user support perspective with data obtained from CHIS experts in the study environment;

- Comparisons between data obtained from public sector level 1 and level 2 hospitals in South Africa with data obtained from similar hospitals in other settings.

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