Hospital Information Systems Quality: A Customer Satisfaction Assessment Tool

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Abstract

Hospital Information Systems (HIS) play a significant role in providing quality healthcare services. However, HIS lag behind their industrial counterparts in providing quality (i.e., timely, accurate, complete) information and have been the target of many criticisms for alleged shortcomings. The aim of this research is to identify the requirements for HIS to assist in providing quality healthcare service. To this end, questionnaires were designed to assess the level of satisfaction of different HIS users. In addition, this research introduces the concept of loss function and relates it to repercussions of HIS customer dissatisfaction.

Background

Hospital Information Systems (HIS) have lagged business and industrial information systems in the use of information technology [1] and in the application of quality standards to customer satisfaction. The gap in attention to quality can be seen in statistics published by the US agency - National Institute of Standards and Technology (NIST). NIST oversees the Malcom Baldrige National Quality Award to promote awareness of quality excellence, to recognize quality achievements of U.S. companies, and to publicize successful quality strategies. Awards may be given each year in each of three categories: Manufacturing companies or subunits - Service companies or subunits and Small businesses.

In 1995, the National Malcolm Baldrige Quality Award created two new pilot test categories: Education and Health Care. Forty-six American organizations in Health Care submitted their applications and nineteen in Education. The results of the quality assessments for health care and education are shown in Figure 1. It is interesting to note that both education and health care lag manufacturing & service in attention to quality (health care having the lowest scores). In particular, health care scored 30% or less in percent of score for “Information and Analysis.”

"Strategic Planning" and "Process Management." All three areas directly impact on or are impacted by quality of information systems.

These results reinforce the need to develop measurement tools to assess, understand and improve the quality of Information Systems and, more specifically, the quality of Hospital Information Systems. Quality HIS are needed to sustain high quality health service delivery that meets the needs of the people it serves [2].

Figure 1. 1995 health care and educational pilot programs average category scores [3].

The focus of our research is to develop a tool and a methodology to assess the quality of Hospital Information Systems (HIS). This assessment methodology is driven by “customer voices.” We can classify HIS customers as being internal or external. Internal customers are Physicians, Nurses, Laboratory technologists, Pharmacists, Quality department, and others within a healthcare facility who interact with the essential processes. External customers are: Patients, Patients’ families, Insurance Providers, Suppliers, Health Services Researchers, etc. This research focuses on internal HIS users only. Commonly called users, they are more than simple users, they are customers of a system, a service, and information. These customers evaluate the quality of a system, in everyday use. If they are not satisfied by the quality of a system, by the quality of the service integrated in the
system and by the quality of information delivered by the system, they will not use it, or will not use it correctly and efficiently. This is particularly true in hospital environments where health personnel may be distrustful and even reject new technologies. Paper records are critical elements of health care. If the HIS is not adapted to common tasks, if it is too complex to use or to understand, if it is not user-friendly and does not meet their expectations, it will be ignored and even sabotaged [4].

It is important to measure how customers perceive their HIS and quantify their satisfaction rather than evaluate technical aspects of the systems and to listen to the voice of customers rather than developers voices. A “good” information system, perceived by its users as a “poor” system, is a poor system [5]. What are the repercussions of a low quality HIS? HIS can be categorized by their complexity and their integrity. Complexity, because HIS integrate a large variety of Medical and Administrative information and Integrity, because low quality information can have dramatic repercussions on patient healthcare.

To illustrate the repercussions that customer dissatisfaction can have on costs and health care quality, we use a quality tool called “Loss Function.” The Loss Function method was developed by Dr. Genichi Taguchi, a Japanese statistician and Deming prizewinner. Taguchi’s methods were originally developed for product design. We adapted the “loss function” concept to illustrate HIS quality.

The Loss Function concept is based on the idea that loss to society occurs whenever there is a deviation from the most desirable target for the quality of a product or activity. The losses may be due to reduced levels of performance, marginal customer service, a slightly shorter product life, low product reliability, or a greater number of repairs. In short, losses occur when the customer has a less-than-optimal experience with the product or service. The larger the deviation from the desired value, the greater the loss to society [6]. The basis of Taguchi’s words is that the smaller the loss, the better the product’s quality [7]. This concept though initially used in manufacturing, can easily be applied to service industry. In particular, the quality of healthcare services can also be measured in term of loss to society.

Statistical distributions representing IS customer satisfaction can have different shapes depending on the quality of the IS evaluated. We may obtain a normal distribution (Figure 2a), a distribution of values which are positively skewed (Figure 2b) illustrating a majority of customers are satisfied with their HIS, or negatively skewed (Figure 2c) illustrating a majority of customers are dissatisfied with their HIS, or a bimodal distribution (Figure 2d) illustrating two distinct groups of customers satisfied/dissatisfied. The loss function represents the loss engendered by the customers’ dissatisfaction due to low HIS quality. The loss function consists (in our case) of half of a quadratic function instead of a quadratic function, because we can only obtain a “positive” deviation from our target (maximally satisfied customers). According to Taguchi methods, the loss function of deviating from the target can be measured by: \( L = C \cdot D^2 \) where \( C \) is the cost of unit deviation and \( D \) is the amount of deviation from the target.

![Figure 2. Loss function of HIS customer satisfaction](image)

In industrial and business environments, the loss function is typically expressed in dollars. This is also true for health care organizations, except the loss has an important quality-of-care aspect which is equally or more important than the financial loss aspect.

HIS quality influences the quality of care by capturing, transferring, storing, managing and displaying medical information. In improving the quality of these processes, the system should provide higher quality (i.e., accurate, complete, timely) information which in turn can increase the quality, effectiveness and efficiency of medical decision making, resulting in improved customer satisfaction while reducing health related risks.

In health care, the customer (patient) has a direct and permanent contact with the medical personnel who must provide quality service **at the first attempt**. Depending on the satisfaction distribution obtained, the loss (shaded part) increases or decreases (Figure 2). By capturing the factors of HIS customer dissatisfaction and analyzing them, we can modify and improve the quality of an HIS, thus making the users more satisfied, and reduce the loss. After improvement, we want to obtain a customer satisfaction distribution which looks like Figure 3, where the major part of the satisfaction distribution is approaching the target value (Maximally Satisfied). The loss engendered by this new function is considerably lower compared to the initial one (Figure 2).

Do the quality-of-care improvements and cost reduction repercussions of “shifting” or “modifying” this customer satisfaction distribution justify the investments required to
improve the quality of the HIS? There are no simple answers. However, the application of Pareto analysis provides insights. By improving 20% of the primary dissatisfaction aspects, we can substantially shift the satisfaction curve. Based on our experience, we found that some simple and inexpensive HIS modifications can improve customer satisfaction, improve patient health care, and reduce costs. Concerning modifications judged “expensive”, a detailed analysis of repercussions on patient health care and on cost (lost and waste) is called for. In doing this evaluation it is important to reveal dependencies on critical factors.

To understand how to assess quality, we must first understand what the term “I.S. Quality” means. The term “quality” of information systems has been categorized by six major dimensions of IS success [8]: System Quality, Information Quality, Use, User Satisfaction, Individual Impact and Organizational Impact. But HIS now incorporate a significant service component which should be added to the six dimensions. Indeed, HIS customers expect the HIS department to assist them with a myriad of tasks, such as hardware and software selection, installation, problem resolution, integration with other networks, system modifications or development, education, conversion of data to information meaningful for decision making, etc. [9]. Figure 4 capture some of these I.S. quality factors and their interactions.

Measuring the quality of HIS is a complex task. On-site interviews may permit evaluators to ‘mine’ for areas of dissatisfaction but users with high-pressure workloads may be reluctant to engage in a lengthy interview process. Also, interview responses are difficult to normalize and generalize. Other means of information gathering, such as observation, are useful but each has its own advantages and shortcomings. This study promotes the use of questionnaires for many practical reasons. Questionnaires permit us to survey more participants, eliminate geographical barriers and permit respondents to have sufficient time to think about the questions. Newsted P., Huff S. and Munro M. [10] explain and illustrate in their MIS survey research web site the strengths and weakness of IS survey research. This web site presents an incredible source of information concerning survey instruments in IS.

The research described in this paper focuses on the design of a quality measurement questionnaire for HIS. The methodology is based on an instrument developed by Bailey and Pearson [11] that was used and validated intensively during the past fifteen years.

**Theoretical Foundations**

The Bailey and Pearson satisfaction measurement instrument is based on the weighted sum of users' positive and negative reactions to a set of factors concerning the information system. The weight for a specific factor is based on its importance to the user, presented as follows:

\[ S_i = \sum_{j=1}^{n} R_{ij} W_{ij} \]

Where \( R_{ij} \) = The reaction to factor \( j \) by individual \( i \).

\( W_{ij} \) = The importance of factor \( j \) to individual \( i \).

by 39 factors affecting IS user satisfaction (Appendix 1). A semantic differential technique based on the use of adjectives to describe the characteristics of concepts and objects was used. Since people use adjectives to explain their perception of things, adjectives can be used to measure those perceptions [12,13]. Measurement of one’s perception involves the rating of four bipolar adjective pairs ranging from a negative to a positive feeling [11]. A sample item is shown in Figure 5.
Time required for new development: The elapsed time between the user's request for new applications and the design and development of the application systems by the HIS personnel.

<table>
<thead>
<tr>
<th>Short</th>
<th>Reasonable</th>
<th>Acceptable</th>
<th>Long</th>
<th>Undependable</th>
<th>Unreasonable</th>
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<td>Acceptable</td>
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<tr>
<td>Long</td>
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</table>

To me this factor is:

Important Unimportant

Figure 5. Sample factor used in the Bailey and Pearson questionnaire [14].

If customers are asked if they are satisfied with "the time required for new development" and told to rank their level of satisfaction between "Extremely dissatisfied" and "Extremely satisfied", a result will be obtained which may or may not reflect what the customer really thinks. For example, the customer can express dissatisfaction by focusing only on the waiting time aspect. Although it is long, the time might be quite reasonable for the project complexity. Different adjectives may enable a better interpretation of the level of satisfaction and on the different causes of dissatisfaction concerning a specific factor. Consequently, seven response categories are used for the user satisfaction measurement instrument (shown in Figure 6.). It was felt that the seven response categories labeled with the polar adverbs: Extremely, Quite and Slightly on both sides of the neutral response category did form natural groups that reflected typical communication patterns describing user satisfaction [14].

Figure 6. Seven possible response categories used in the B&P questionnaire [14]

The final and global user's satisfaction result is normalized between (+1) maximally satisfied and (-1) maximally dissatisfied. The reliability and different validity (content, predictive, construct) of this questionnaire have been rigorously demonstrated by Pearson [14].

Extending Quality Instruments

Ives, Olson and Baroudi [5] carried out investigations to reinforce the validity and to reduce the length of the Bailey and Pearson (B&P) instrument. A “short form” of the original B&P questionnaire was developed. The original 39 B&P factors were reduced to 13 (Appendix 1), two adjective pairs of scales were used instead of four, and the “importance” scale was removed. These modifications were done while maintaining reasonable levels of validity and reliability and the existing structure of scales. A large number of studies were published concerning the utilization of this short form questionnaire [15,16,17,18,19]. The original and the short form questionnaire have essentially been used in business environments. An interesting application of the short form questionnaire was done by Zviran [20] in a navy hospital. While previous assessment tools made valuable contributions to the body of knowledge about IS assessment, they have some drawbacks. In the research described in this paper, previous questionnaires were modified for the following reasons:

♦ The original B&P satisfaction factors were developed twenty years ago (1977). Some of them are still current but revolutionary changes in management methods and of computer technologies invalidate some aspects.
♦ The medical environment is different from business. Factors and vocabulary have to be adapted.
♦ There is no opportunity for customers to make comments and contribute ideas.
♦ No information is asked about the customer profile.
♦ No questions are asked about priority of improvement directions.

To overcome these problems, a new questionnaire was developed that incorporated fundamental B&P instrument aspects. Developing a new instrument is a difficult, time-consuming and costly activity [21]. However, given the rapid changes in healthcare management, revolutionary changes in computing technology, and the expansion of the HIS user populations, it is necessary to re-cast prior work to enable its application to this new context (i.e., HIS).

A New-HIS Quality Measurement Tool

As shown in Appendix 1, after a review of IS survey research, 24 final factors were retained. B&P used four pairs of adjectives to describe each factor, but some were too similar and did not provide new information. The short form questionnaire was composed of only two pairs of adjectives which left the possibility that some satisfaction aspects might be missed. Depending on each factor, it was decided to use a variable number of adjectives that seemed appropriate to globally describe the associated satisfaction factors. In addition, features were added to compensate for other shortcomings of previous tools. The new questionnaire is composed of five sections:
Appendix 2 includes a small selection of questions from each part of the assessment questionnaire. The first part of the questionnaire is composed of questions to define the customer profile. Customers define their HIS task, experience profile, usage during a typical day and the importance of the HIS in doing their job. These kinds of questions define categories of customers (segmentation) and take into consideration some specific aspects that are the most important for their job. Some factors might have no importance for customers who use the HIS fifteen minutes per day and yet be essential for customers who use it many hours.

To make the questionnaire understandable and as unambiguous as possible, short phrases are used including the factor descriptive adjective, instead of the adjective alone (see Figure 7).

| Information availability: The data and information I use/need for my job are: |
|-----------------------------|-----------------|-----------------|-----------------|-----------------|
| Available at convenient places | 3.2.1.0.1.2.3     | Unavailable    |
| Available every time         | 3.2.1.0.1.2.3     | Unavailable    |
| Accessible ( procurable) from different HIS ( sources) | 3.2.1.0.1.2.3 | Inaccessible |
| Data retrieval is Easy       | 3.2.1.0.1.2.3     | Complex   |
| The information availability is: | Important to me | 3.2.1.0.1.2.3 | Unimportant |

Figure 7. Illustration of questionnaire form.

In the second part of the questionnaire, we are looking at the customer satisfaction with different services delivered by the HIS, and how HIS personnel interact with the customer. This part includes the five following HIS satisfaction factors: HIS Personnel service/orientation – Processing of change requests – Maintenance (internal/external) – Degree of training – HIS Hot-line assistance.

In the third part of the questionnaire, we are looking at the customer satisfaction with the User-Interface, Functions available and Performances of the HIS. Eight factors are used to assess the interface quality: Data entry – Printer utilization – Format of printed output – Screen interface – Usability – Language – Documentation – Online assistance.

Four questions are used to assess the functions quality: Reversibility - Integration of new functions – integration of new process and a last question concerning the functions that the user found particularly well and poorly designed.

Four factors are used to describe the customer level of satisfaction with the HIS performance: Response time – System reliability – Flexibility of the system and integration of the system.

In the fourth section of the questionnaire, we are looking at the customer satisfaction with the information quality. Three factors are used: Quality of Information and causes of Non-quality – Information availability-Integration of new information.

The last part of the questionnaire focuses on the global customer’s feeling of satisfaction with the HIS to define which are the most important factors for the customer and which ones should be improved or modified by priority. Customer feeling of relevancy and perceived utility of the HIS are also solicited. Another question asks the customer to describe payoffs that might be realized if the HIS were modified. This activity requires customers to reflect on the medical and financial repercussions of HIS improvement; are customers aware and confident that improvement of their HIS can be profitable for them and for their organization?

Finally, customers are asked to evaluate the quality of the questionnaire according to the “agreeable, suitable and meaningful” adjectives. The last page of the questionnaire is reserved for general comments. The questionnaire is accompanied by a page of instructions illustrated with an example of responses. A cover letter from the hospital encourages participation and confirms the confidentiality of the results.

Pilot Survey Testing

The B&P and the “short form” questionnaires have been shown to be valid and reliable. In modifying these questionnaires, it is necessary to demonstrate the validity and the reliability of the new instrument. It is difficult to assess the quality of the data a survey collects. It is easier to assess the accuracy of the survey instrument used to collect data. This assessment consists primarily of looking at the validity and the reliability [22]. The current version of the questionnaire (May 98) is too long to be administered as is (18 pages). The goal is to decompose the current instrument to create shorter questionnaires adapted to each category of customer. Each category of customer has expectations and feelings of satisfactions about the quality of information, service and functions offered.

In the first part of our pilot test, we plan to ask customers to rank by importance (1 to 5) the list of factors essential for their job. Using these priorities the initial 24 general factors will be reduced to 10 that are essential for each category of customer. With this approach we will focus on the most important factors that generated the highest levels of dissatisfaction and have the biggest
repercussions concerning quality of patient healthcare and costs (Pareto rule).

When we have obtained these factors for each category of customers, a sample of representative customers of each category will be interviewed and asked to fill out the new short-form questionnaire. This pilot survey will measure how appropriate, complete and comprehensible the questions seem to a set of reviewers who have some knowledge of the subject matter. This second phase will contribute to demonstrating the content validity of the questionnaires.

To evaluate the reliability level of the questionnaires, different methods can be used (test-retest method, split halves method). The internal consistency reliability of adjectives used to define a factor will be measured in calculating a Cronbach’s coefficient alpha [22]. An additional scale will be included to measure the internal consistency of the instrument. The scale is defined by “Satisfied / Dissatisfied” and will be included with the evaluation scale of each factor. This “direct” assessment should correlate highly with the factor score determined by the adjective scales. The same scale is included at the end of the three main parts of the questionnaire to obtain an evaluation of the global satisfaction of the customer with the System, Service and Information quality aspects. Finally, a “Satisfied / Dissatisfied” scale will be used to evaluate the overall satisfaction of the customers with their actual HIS. These scales will permit the choice and the representativeness of the factors and adjectives chosen to assess the HIS customer satisfaction to be validated. These added scales will be used only during the pilot survey to validate the internal consistency of the questionnaire.

Conclusions

Measuring IS customer satisfaction is a complex task and a large number of HIS quality facets need to be analyzed. However, the questionnaire developed could help HIS managers and developers to better understand requirements and dissatisfaction aspects of HIS customers. This instrument could be used before IS reengineering processes in order to identify some problem areas for more detailed investigations. It can also be used to avoid pit-falls for new HIS implementations.

It is important to keep in mind that the best way to serve HIS customers is not by giving them what developers think they want, but rather what customers want. This type of survey makes visible some unexpected dissatisfaction problems that will not be easily detected otherwise. The questionnaire is being refined and tested in different hospitals to reinforce its validity and reliability aspects. HIS developers can use it as a tool for existing system evaluation and for continuous improvement of evolving systems. With few adaptations, it could be equally applied to other environments.

References


Appendix 1

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<tr>
<td>Top management involvement</td>
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<td>Communication with the EDP Staff *</td>
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<td>Feeling of participation *</td>
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<td>Completeness *</td>
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<td>满意度 /满意度问题的整合与新功能的整合</td>
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</table>

Appendix 2: Samples of the revised questionnaire

SECTION A: USER PROFILE

For which tasks do you use Hospital Information Systems (H.I.S.) in doing your job? (Please choose all that apply)

- To enter Medical data concerning the patient.
- To enter Administrative data concerning the patient.
- To display Medical data concerning the patient.
- To display Administrative data concerning the patient.
- To obtain and analyze statistical information about the hospital and individual units.
- To display clinical practice guidelines.
- To conduct clinical research.
- To communicate between department.
- To analyze trends and develop budget forecast.
- For medical decision support about diagnosis and treatment of patients.
- To consult information from external information Systems (Insurance, Medical database,…)
- Other tasks (specify) : __________

SECTION B: QUALITY OF H.I.S. DELIVER SERVICES / ORGANIZATION PROCESSES

H.I.S Personnel Service / Orientation: Indicate which description best fits your interactions with H.I.S. personnel:

They usually solicit my ideas 3.2.1.0.1.2.3 They never solicit my ideas
Personnel are open to new ideas 3.2.1.0.1.2.3 Their opinions seem pre-determined
Our interactions are professional 3.2.1.0.1.2.3 Unprofessional

Interaction with H.I.S. Personnel is1:

Important to me 3.2.1.0.1.2.3. Unimportant to me

Your overall sense of satisfaction with the H.I.S. Personnel interaction is2:

Satisfied 3.2.1.0.1.2.3. Dissatisfied

SECTION C: QUALITY OF THE H.I.S.

A/ INTERFACE

Screen Interface: What do you think about the screen interface you use to display and enter data in the H.I.S.?

Screen layout are: Well designed 3.2.1.0.1.2.3. Poorly designed
Screen colors are: Pleasant 3.2.1.0.1.2.3. Unpleasant
Information is: Readable 3.2.1.0.1.2.3. Confusing
Menus are: Easy 3.2.1.0.1.2.3. Complex
Volume of output per screen is: Suitable 3.2.1.0.1.2.3. Unsuitable
Graphics are: Pertinent 3.2.1.0.1.2.3. Uninteresting
Charts are: Concise 3.2.1.0.1.2.3. Diffused
Screen interface is: Easy to customize 3.2.1.0.1.2.3. Rigid

B/ FUNCTIONS

Reversibility: The ability of the system to offer you a chance to reverse and correct a mistake (incorrect information). This function is:

Simple 3.2.1.0.1.2.3 Complex
Secure 3.2.1.0.1.2.3. Unsecure
Fast 3.2.1.0.1.2.3. Slow

C/ PERFORMANCE

Integration of systems: The ability of H.I.S. to communicate, transmit and exchange data between internal hospital systems (Computers, Software, Measure automation,...) servicing different functional areas. This integration is:

Complete 3.2.1.0.1.2.3. Incomplete
Sufficient 3.2.1.0.1.2.3. Insufficient
Successful 3.2.1.0.1.2.3. Unsuccessful

SECTION D: INFORMATION QUALITY

The quality of the H.I.S. information you use are:

Accurate 3.2.1.0.1.2.3. Inaccurate
Complete 3.2.1.0.1.2.3. Incomplete
Current 3.2.1.0.1.2.3. Obsolete
Sufficient 3.2.1.0.1.2.3. Insufficient
Understandable 3.2.1.0.1.2.3. Incomprehensible
Secure (ensure confidentiality) 3.2.1.0.1.2.3. Unsecure
Uniformly defined (standardized) 3.2.1.0.1.2.3. Irregularly define
Timely (available as it has been collected) 3.2.1.0.1.2.3. Untimely

1 This question (Important/Unimportant) will be asked for each factor.
2 This question (Satisfied/Dissatisfied) will be asked for each factor. It will only be used during the pilot survey to validate the internal consistency of the questionnaire.
SECTION E: GLOBAL SENSE OF SATISFACTION

Perceived Utility: Your judgment about the usefulness of the H.I.S. information products and services that are provided. The utilization of the H.I.S. enable me to:

- Improve the quality of the work I do
- Be more efficient in my work
- Have a greater control over my work
- Assist me in performing my work
- Increase the safety of care
- Makes it easier to do my work

3.2.1.0.1.2.3. Reduce the quality
3.2.1.0.1.2.3. Less efficient
3.2.1.0.1.2.3. Less control
3.2.1.0.1.2.3. Disturb me
3.2.1.0.1.2.3. Decrease it
3.2.1.0.1.2.3. Makes it more difficult

In your opinion, what results could be obtained in modifying / improving the present HIS you use?

- Quality of patient care may be enhanced
- Cost of care may be reduced
- Efficiency can be increased
- Risks may be decreased

3.2.1.0.1.2.3. May be reduced
3.2.1.0.1.2.3. May be increased
3.2.1.0.1.2.3. May be decreased
3.2.1.0.1.2.3. May have increased