The Effect of Information Quality on Surgery Process Variation

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ABSTRACT

This paper discusses the relationship between quality of care and information quality (IQ). The focus of the paper is on surgery process variation. The paper aims to identify the IQ dimensions that considerably affect surgery process variation. The research uses a case study approach and employs gap analysis and Delphi technique. Results indicate that accuracy, accessibility, completeness and timeliness are the most critical IQ dimensions that are affecting process variation.

Keywords: Delphi technique, gap analysis, information quality, process variation.

QUALITY OF CARE AND INFORMATION QUALITY

Quality of care is about meeting the physical, psychological and social expectations of the patients who search for care. According to the American Institute of Medicine, quality of care is "the degree to which health services for individuals and populations increase the likelihood of desired health outcome consistent with current professional knowledge" (Kupersmith 2003). The Advisory Commission on Consumer Protection and Quality in the Health Care Industry notes that there is a continuing pattern of variation in health care services, including regional variations and small-area variations (Advisory Commission, 1998).

Deming, who has developed a profound knowledge of quality, considers 'variation' as "the chief culprit of poor quality" (Evans and Lindsay 2005, p. 94). Deming observes that variation in quality characteristics exists in every process. Variation makes the process unstable and its outcome unpredictable because the variation that exists from one time period to the next is also unpredictable (Miller, 2005). Healthcare service is an information based service (McLaughlin 1996). Understanding the variation in information is the first step in reducing healthcare service variation and then stabilising the healthcare process. There are major variations in the conclusions of clinical observations and their interpretation (James et al. 1994). In fact, most healthcare quality problems can be attributed to variation or what is referred to as 'unwarranted variation" in healthcare delivery (Wennberg 2002). The term 'unwarranted' in relation to variation reflects a lack of necessary or quality information to conduct healthcare processes. This suggests that information quality is a critical factor in decreasing variations in the healthcare industry. Recognition the importance of data and information quality becomes a key area of both strategic and operations management in the healthcare industry (Lorence and Jameson 2002). The Lorence and Jameson study also emphasises that there is a shift from the traditional error-based approach to evidence-based data driven medicine. This allows the measurement of quality of care to be based on data rather than intensive, personal interaction with patients. As such, "the quality of data maintained by organisations becomes a critical factor in the ultimate delivery of care" (Lorence and Jameson 2002).

This paper discusses the information quality (IQ) dimensions and aims to identify the critical and decisive IQ dimensions affecting surgery process variation. The paper employs a case study approach. The paper uses gap analysis and Delphi technique (Linstone and Turoff, 2002) in order to define the critical dimensions affecting the process variation. The following section identifies the dimensions of information quality.

DIMENSIONS OF INFORMATION QUALITY

Evans and Lindsay (2005) stress that quality can be a confusing concept. They provide two main reasons for this assertion; (1) people view quality using different perspectives and dimensions based on their individual roles, and (2) the meaning of quality continues to evolve as the quality profession grows and matures. Similarly to product quality, IQ has no universal definition. To define IQ, it is important to comprehend both the perspective from which IQ is viewed and its dimensions. The Cambridge Dictionaries Online (2005) defines perspective as "a particular way of considering something" and dimension as "a measurement of something".

Individuals have different ways of considering the quality of information as they have different wants and needs and, hence, different quality standards which lead to a user-based quality perspective (Evans & Lindsey, 2005). This perspective is based on the Juran definition of quality which defines quality as 'fitness for intended use' (Juran and Godfrey, 1999). Thus, information and data can be regarded as being of high quality if they are fit for their intended use in operations, decision making and planning (Redman, 2004). Other related IQ perspectives are 'conformance to specifications' and 'meeting and exceeding consumer expectations' (Evans & Lindsay, 2005). While these perspectives capture the essence of IQ, they are very broad definitions and are difficult to use in the measurement of quality. There is a need to identify the dimensions that can be used to measure IQ.

IQ is a multidimensional concept. This means that organisations must use multiple dimensions and measures to evaluate the quality of their information or data. Several researchers have attempted to identify the IQ dimensions. Wang et al. (1995) list twenty six IQ dimensions, which in turn are classified into either internal view (design operation) or external view (use and value). Each of these classifications is divided into two subcategories; data-related and system-related (Wand & Wang, 1996). Wang and Strong (1996) conducted an empirical two-phase sorting study and provide the most comprehensive list of IQ attributes. Their list comprises 118 attributes. The 118 attributes are reduced to 20 dimensions, which in turn are grouped into four categories: accuracy, relevancy, representation and accessibility. Wang and Strong (1996) re-examine their four initial categories and relabelled the first two categories and the four categories become: intrinsic, contextual, representation, and accessibility. It should be noted here that Wang and Strong use the term DQ (rather than IQ) to represent both DQ and IQ. Recently, Lee et. al (2002) developed a two-by-two conceptual model for describing IQ. The model comprises 16 dimensions, which are classified into four categories; sound information, dependable information, useful information and usable information. Table 1 provides definitions of the most common IQ dimensions used in the literature and illustrates their categories.

RESEARCH METHODOLOGY

Case study approach can be used to provide a detailed description of a phenomenon (Yin, 1994). The finding of this research is based on a single case study which is used to explore the role of data quality dimensions in process variation. This case is also revelatory in nature. According to Yin (1994; 1998), the revelatory case approach is a single case study conducted under difficult circumstances not normally open for in-depth study.

The case study is part of a project initiated by the author and has been funded by the Faculty of Business at the University of Southern Queensland, Australia. The project includes two postgraduate students - an Honours Degree student and a Masters Degree student. The selected case is an Australian rural public hospital. The hospital comprises thirteen departments including; Surgical, Anaesthetic, Orthopaedic, Obstetric & Gynaecology, Paediatrics, Emergency, Critical Care, Medical Imaging, Medical, Renal, Public Health, Oncology, and Rehabilitation.

Table 1. Definitions of the common IQ dimensions used in literature and their categories. Adapted from several research works (Al-Hakim, 2006, p xiv-xv)

Dimension	**Definition**	**Category**		
		Wang and Strong (1996)	Wang et al. (1995)	Lee et. al (2002)
Accessibility	The degree to which information is available, easy obtainable or quickly retrievable when needed. Accessibility depends on the customer's circumstances.	Accessibility	Internal + External - Data / system related	Usable
Accuracy	The degree to which information represents real world state.	Intrinsic	Internal -Data related	Sound
Amount of Information	This dimension measures the appropriateness of volume of information to the user or task at hand	Contextual	Internal / External -Data related	Useful
Believability	This dimension measures the user assessment of trueness and credibility of information.	Intrinsic	Internal / External - Data / system related	Usable
Coherency	This measures how information "hangs together" and provides one meaning to different users.	Intrinsic + contextual	Internal -Data related	Sound
Compatibility	The level to which information can be combined with other information to form certain knowledge.	Intrinsic + Contextual	Internal -Data related	Useful
Completeness	The degree to which information is sufficient enough to depict every state of the task at hand or the represented system, that is, assesses the degree of missing information.	Contextual	Internal -Data related	Sound
Conciseness of representation	The compactness of information representation.	Representation	External -Data related	Sound
Consistency of representation	The degree of similarity and compatibility of information representation format.	Representation	Internal -Data related	Sound
Ease of manipulation	The applicability of information to different tasks.	Intrinsic	Internal - Data related	Useful
Ease of understanding	The degree of comprehension of information	Representation	Internal - Data/ system related	Useful
Free-of-error	The degree to which information is correct. This dimension measures the number, percentage or ratio of incorrect or unreliable information.	Intrinsic	Internal- Data / system related	Sound
Interpretability	The appropriateness and clarity of information language and symbols to the user.	Representation	Internal -Data related	Useful
Objectivity	This dimension measures information impartiality including whether information is unbiased and unprejudiced.	Intrinsic	External -Data related	Useful
Relevancy	Relevancy indicates whether information addresses the customer's needs. It reflects the level of appropriateness of information to the task under consideration.	Contextual	External -Data related	Useful
Reputation	The degree of respect and admiration of both information source and information content.	Intrinsic	External - Data related	Usable
Security	It indicates the level of either restriction on access of information or appropriateness of information back-up - protecting information from disasters.	Accessibility	Internal / External - System related	Dependable
Timeliness	This dimension measures how up-to-date information is with respect to customers' needs or the task at hand. It reflects also how fast the information system is updated after the state of the represented real-world system changes.	Contextual	Internal/ External - Data / system related	Dependable

The project is concerned with the surgical department. The department includes an operating theatre suite comprising six operating theatres. Four are used for elective lists that are run for two sessions per day. The two other theatres are dedicated to 24 hour emergency surgery services. There are eight recovery wards catering to the theatre patients.

A Delphi approach is used to collect, amend and reshape information regarding IQ dimensions affecting surgical process variation. The Delphi approach is characterised as a method for structuring a group of communication processes in a way that allows a group of individuals, as a whole, to deal with a complex problem (Linstone and Turoff, 2002). Semi-structured interviews were conducted with hospital officials including a senior registrar, senior nurse and elective surgery coordinator and other related officials and medical professionals. The officials were given an opportunity to provide feedback after initial assessment of the results.

The interviews are based on a questionnaire which aims to rate the expectation of the interviewee in relation to dimensions of IQ affecting process variation and the perceptions of the interviewee about the performance of the dimension. Each

question has two fields named as importance and performance. For the first field, the interviewee is asked to rate the expectation about critically or importance of the dimension on process variation. The second field considers the interviewee's perception of the performance of the dimension. If a dimension is not applicable to the process variation, the interviewee's is asked to tick N/A.

The Likert scale is used in the questionnaires to rate the importance and performance of IQ dimensions because it is the most popular method to measure attitudes and easy to administer (Sekaran, 1992). The Likert scales give the researcher a clearer understanding of the interviewees' perceptions on the key issues in the interviews (Yin, 1998). In this research a 7-point Likert scale is chosen to for two reasons. This scale can provide more accurate comparisons between different respondents as compare to the 5-point scale that is commonly used. Also, the odd scale is to allow the respondents to choose the neutral answer (point 3) if they are not sure of the answers. If the interviewee strongly agrees that a dimension under consideration is critical or performed well, he / she ticks '7'. The interviewee ticks "1" if he / she strongly disagrees.

IMPORTANCE-PERFORMANCE ANALYSIS

Healthcare officers dealing with a healthcare process may have different expectation about various IQ dimensions affecting process variation. The expectation from each dimension may also depend on the employee's performance and behaviour. They can also perceive or interpret the performance of an IQ dimension in their organisation. The expectation from a factor is referred to as "expected importance" and the interpretation of performance forms the "perceived performance" of a factor. A grid similar to the one shown in Figure 1 can be used to evaluate and analyse the importance-performance data (Evans & Lindsay, 2005; Keyt et al., 1994). An organisation should make a great effort to achieve high performance on factors of high importance and not to waste effort on factors of low importance.

Importance-performance analysis was first introduced by Martilla and James (1977). A gap between the perceived performance and the expected importance of a dimension may provide some indication as to whether the dimension is effectively implemented.

A gap between the importance and performance of each dimension is calculated. An IQ dimension is critical when the expectation is that the dimension is very important. However, when a dimension is critical and performed very well, that is, the importance-performance gap is insignificant, the dimension is not decisive.. A dimension is decisive only if it is satisfied the following two conditions:

1. It has a strong importance rate, that is, it is critical.
2. It has a significant importance-performance gap.

If an IQ dimension affecting the process is critical and has a positive value of importance-performance gap (expectation is higher than perception), then we have a potential problem in information flow and then with process variation. A negative value (expectation is less than perception) indicates an overestimation, which may result in wasting effort to increase performance in less critical factors (Al-Hakim and Xu, 2005).

FINDINGS

The initial round of interviews revealed that a considerable number of dimensions are considered critical dimensions with rating equal or higher than six (out of 7). These dimensions are accessibility, accuracy, believability, coherency, compatibility, completeness, free-of-error, interpretability, objectivity, relevancy, and timeliness. The meeting with the officers raised the question of whether the dimensions should be considered before or after the final decision to admit a patient to the operating theatre. The answer is that the research is concerned about process variability after the decision has been made to admit a patient to operating theatre. The officers emphasised the following issues:

- The dimensions accessibility, accuracy, believability, coherency, compatibility, completeness, free-of-error, interpretability, objectivity, relevancy, and timeliness are proposed to be analysed, verified or settled before the decision of admission of a patient to an operating theatre. However, except for the free-of-error dimension, there is no objective viable scale or metric that measures these dimensions. An IQ problem may happen regardless of the depth and level of effort.
- The surgeon who makes the decision to admit a patient is usually the surgeon who performs or supervises the surgery. Surgeons make decisions based on their assessment of trueness and credibility of information. Accordingly, the dimensions believability is not a decisive dimension. This assertion is true when more than one surgeon deals with the decision to admit a patient to the operating theatre.
- A supporting argument was that having doubts about source of information or on the trueness of information may unnecessarily disturb the surgery process and may considerably and unnecessarily increase costs.
- There are several recorded instances of a surgeon asking for information which he/she believed existed but no information actually existed. Such an event considerably affects surgery process variation. This makes the performance of completeness is relatively low.
- The officers emphasises that there are no problem in the performance of interpretability, objectivity and relevancy of information. However, with the high performance of these dimensions, surgeons may provide different meaning to the same information when they added to each others.

Based on the above discussion, the officers revised the importance-performance analysis as shown in Table 2.

Results (Table 2) indicate that accuracy and believability are extremely critical dimensions. Though the gap of importance-performance for accuracy is relatively small (0.43), there is a need to take further measures to ensure the accuracy of information received. The performance gaps for accessibility and timeliness and completeness are relatively high (1.29 and 1.00, respectively). This indicates the necessity to reengineer the information technology system in a way that allows real-time accessibility to the required data and information as well as timely and regularly updating data and information. There is also a considerable need to ensure the completeness of information.

CONCLUSION

The paper discusses the relationships between quality of care and information quality (IQ). It emphasises that the process variation is the main source of poor quality of care. The paper aims to identify the IQ dimensions that affecting the

Figure 1. Importance-performance comparison (Evan & Lindsay, 2005)

		PERFORMANCE	
		LOW	HIGH
IMPORTANCE	LOW	Who Care	Overkill
	HIGH	Vulnerable	Strength

Table 2. Gap analysis for some IQ dimensions

Dimension	Importance	Performance	Gap
Accessibility	6.14	4.85	1.29
Accuracy	6.71	6.57	0.43
Believability	6.85	*	*
Coherency	6.20	5.67	0.53
Compatibility	6.00	5.83	0.27
Completeness	6.43	5.83	0.60
Free-of-error	5.33		#
Interpretability	6.00	*	*
Objectivity	6.20	*	*
Relevancy	6.20	*	*
Timeliness	6.43	5.43	1.00

** The performance of these measures is considered up to the required standard and the importance-performance gap is insignificant.*

 # Non-critical factor

variation of the surgery process. It employs importance-performance gap and Delphi approach in order to identify the decisive IQ dimensions affecting surgery process variation. A dimension is a decisive dimension where it is critical (with high importance level) and does not perform well, that is, has a significant importance-performance gap. Results indicate that surgeons make decisions based on their assessment of trueness and credibility of information. However, surgeons may provide different meaning to the same information. In addition, there are several recorded instances of a surgeon asking for information which he/she believed existed but no information actually existed. Such events considerably affect surgery process variation. The analysis shows that the following IQ dimensions are decisive dimensions affecting the surgery process variation; accessibility, accuracy, coherency, compatibility, completeness, and timeliness.

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