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ABSTRACT

With the increasing need to evaluate health spending comes a need for frameworks that capture the multiple goals of hospitals. There is a need to rethink the application of theoretical approaches to investigating IS in light of the objectives of medical practitioners using practical technologies. The Balanced Score Card (BSC) has been successfully applied to hospital environments, but not to Picture Archiving Communication Systems (PACS) which are among the most important e-health implementations in hospital environments in the past decade or more. Therefore, this research investigates if the BSC adequately captures the multiple strategic goals of a hospital-wide PACS implementation. We conclude that the BSC is not adequate to capture the key features that need to be evaluated. An expanded model, the PACS-BSC model is proposed as a much more appropriate tool for examining such systems. This expanded model is developed as a resource for both researchers and practitioners.

KEYWORDS: Balanced Scorecard, Hospital Strategies, Model, Pacs, Workflow

INTRODUCTION

Since Strassman's (Strassman,1990) exposition of the 'productivity paradox' there has been increased attention paid to justification and evaluation of investments in information technologies and information systems (IT/IS). Observed outcomes from practice have called for theoretical explanations in order to construct a generalized view of IS. In the hospital environment we see that there is a pressing need for frameworks adequate to the tasks of evaluating increasingly expensive implementations. Because hospitals have multiple stakeholders and multiple strategic goals, to be adequate a framework needs to address these multiplicities. One promising framework is Kaplan and Norton's (Kaplan and Norton, 1992; Kaplan and Norton, 1996) Balance Score Card (BSC).

The BSC framework evaluates performance by translating key elements of strategy into performance measures such as financial and customer perspectives. As the selection of performance measures is determined by the context in which the evaluation is to take place, the BSC has the flexibility to apply to a range of organisations and to a range of IT/IS implementations.

BSC has been used to evaluate hospital performance and the implementations of IT/IS in hospital and medical contexts by several authors (Curtright, Stolp-Smith and Edell, 2000; Gordon and Geiger, 1999; Nathan and Pelphrey, 2004; Wachte, Hartford and Hughes, 1999). However, Picture Archiving and Communication Systems (PACS), which is one of the most important system implementations in the past few years in the area of e-health and the transmission of health data, have not been evaluated using BSC. Rather, most evaluations of PACS have tended to focus on single issues like clinical communication, quality improvement, image availability, speed of service and workflow simplification and automation and the associated gains that are important to the patient's overall journey (Peer, Peer, Walcher, Pohl, and Jaschke, 1999). The focus on single issues within PACS implementations has made it difficult to gain a clear understanding of the overall workflow impacts of a PACS implementation. Moreover, the literature does not relate well to the intangible value created for

the patient by the patient care benefits of PACS, which is an important component of the hospital's strategy overall and as it relates to IS strategy in particular.

Therefore, this paper investigates the adequacy of BSC for an holistic evaluation of the workflow impacts of a PACS implementation. It asks whether a theoretical model such as BSC adequately captures the reality of how such technology is used. The approach taken is radical in that it is built on a consideration of the fundamentals of hospital strategy. The BSC is then modified to incorporate qualitative themes rather than performance 'measures' to reflect the fundamentally qualitative nature of the clinical values of hospital strategy. In so doing, the paper develops a framework that is at once consistent with Kaplan and Norton's original intentions of assessing performance in terms of strategy while enabling an holistic evaluation of PACS that is relevant to hospital's not for profit and clinical strategies.

BSC & EVALUATION IN HOSPITALS

The BSC is a set of measures that provides managers with a comprehensive framework that translates a company's strategic objectives into a coherent set of performance measures that is a comprehensive view of the business. As originally developed by Kaplan and Norton, the BSC includes performance measures from four perspectives, supplementing the financial perspective with those of the internal business process, the customer, and learning and growth within the organisation. The four performance measures are:

- Financial perspective: "How should we appear to our shareholder?" Performance measures include operating income and return-on-investment.
- Internal Business Process perspective: "At which business processes must we excel?" Performance measures include rework rates, cycle-times and process costs.
- Customer perspective: "How should we appear to our customers?" Performance measures include customer satisfaction, and retention.
- Learning & Growth perspective: "How will we sustain our ability to change and improve?" Performance measures include employee skills, retention and satisfaction.

The comprehensive view drawn from these four performance measures can then be presented as a single management report that reflects many of the elements of a company's competitive agenda: becoming customer oriented, shortening response time, improving quality, emphasizing teamwork, reducing new product launch times, and managing for the long term (Kaplan and Norton, 1992). Not only does the BSC provide a measurement framework that improves alignment of actions to the strategic goals of an organisation, it also provides a platform for identifying priorities (Mooraj, Oyon, & Hostettler 1999). These priorities can then be used to guide management in the achievement of objectives.

However, the BSC is not a template that can be applied to business in general or even industry-wide. Rather, it is intended that different market situations, product strategies, and competitive environments employ different scorecards – differing in terms of performance measures. Each organisation's unique reason for an IT/IS implementation, and therefore different perspectives on measuring success, is reflected in the use of a BSC that includes appropriate performance measures. BSCs are particularly appropriate for organizations in industries such as healthcare where there is a more diverse set of performance measures than in the business and academic sectors (Voelker, Rakish and French, 2001). Therefore, the BSC's design flexibility makes it applicable to the evaluation of a broad range of organisations and implementations, and suitable to evaluation within the health sector. A range of perspectives have been used to generate performance measures used in BSC applications within the health sector such as patient satisfaction, clinical outcomes, functional health status and cost to evaluate outsourcing (Schriefer, Urden and Rogers , 1997) . Other studies cite growth, customer satisfaction, system integration, low-cost provision, clinical outcomes, financial goals, patient satisfaction and research and teaching (Voelker, Rakish and French, 2001).

We argue that these adaptations of the BSC to healthcare are successful because the modifications are in line with the organisational strategies of the health sector, consequently there is a value in a BSC which is specifically targeted towards PACS.

HOSPITAL STRATEGY

Healthcare systems today face strong pressure to improve clinical quality, enhance service, expand access, and reduce costs (Mooraj, Oyon, & Hostettler 1999) . Moreover, hospitals and other healthcare institutions are facing critical issues with respect to strategy formulation. These issues are different to those faced by commercial corporations largely because they reflect non-financial components of hospitals core business such as improvements in the effectiveness of clinical care, a streamlined patient journey and overall workflow (Liedtka, 1992).

'Strategy' in the corporate sense popularised by Porter is "the creation of a unique and valuable position, involving a different set of activities… different from rivals (Porter, 1996) . Following from Porter's earlier work, three fundamental strategies for competitive advantage are identified: low cost, product differentiation and niche market (McFarlan, McKenney and Pyburn ,1983). Willcocks, Petherbridge and Olson (2001) expand these to six strategic uses of IT: breakthrough unit costs for customers, service-based differentiation, micromarketing management, shorter time to market, transfer of experience; and new level of partnership. The idea of strategy as a way of positioning the organization so as to attract customers and compete with rivals is central to these approaches.

However, the relevance of corporate strategy to hospitals that have a commitment to clinical excellence and a commitment to public responsibility, has been questioned (Liedtka,1992). Where clinical and not-for-profit considerations are fundamental to organisational strategy, Liedtka suggests that Andrews concept of strategy is more relevant: *"a pattern of decision in a company that determines and reveals its objectives, purposes, or goals, produces the principal policies and plans for achieving those goals, and defines the range of business the company is to pursue, the kind of economic and human organization it is or intends to be, and the nature of the economic and non-economic contribution it intends to make to its shareholders, employees, customers, and communities (*Andrews, 1987, p.56*)."*

Given this richer concept of strategy, Andrews argues that there are four elements to be considered together to determine strategy, and that each of these suggests a question from the organisation's perspective:
What the market wants in terms of industry opportunities and threats – what might we do?
The organisation's competence – what can we do?
The aspirations and values of executives in charge of the organisation – what do we want to do?
The organisation's obligation to society – what should we do?

Liedtka argues that, in the health context, it is clinical as well as executive preferences that must be considered. Liedtka summarises these elements and questions in a diagram that emphasises the fact that the elements of strategy may be classified as either market-driven or non-market driven, and as internal or external (Figure 1). According to Liedtka, the incompatibility of Porter and his followers' concept of strategy for hospitals lies in Porter's exclusive focus on market driven elements of what the organisation can do and the threats and opportunities that the organisation faces.
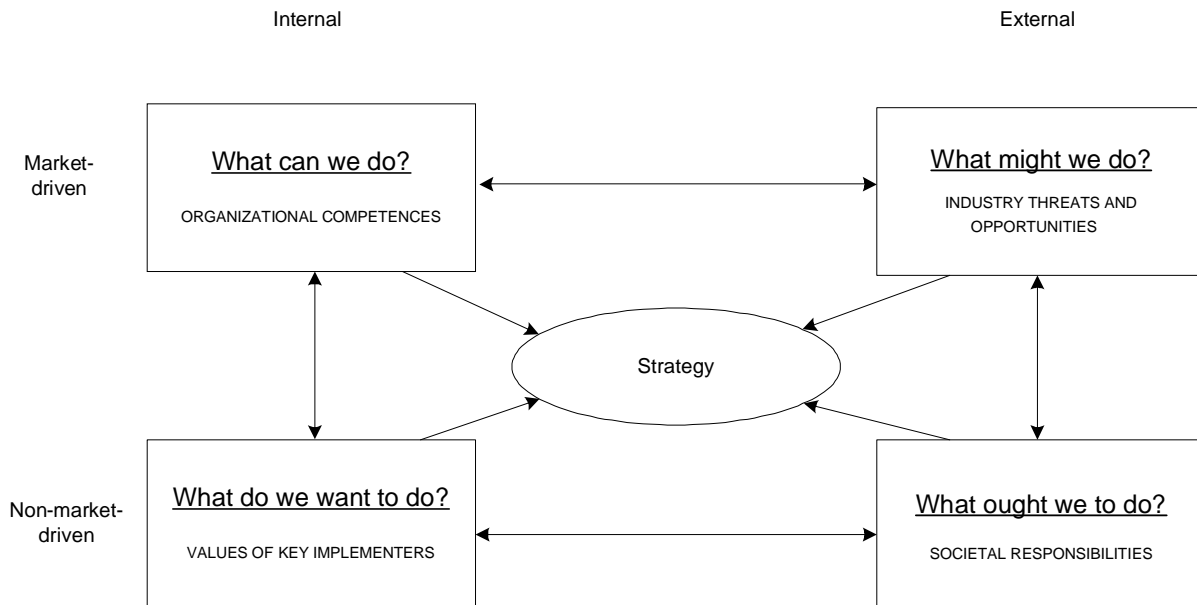

Figure 1: Andrew's model of the strategy formulation process, adapted from Liedtka

Clinical excellence and service to the community are key factors for public hospitals (Firth and Francis,2004). These factors are important determinants of clinicians' acceptance, use and 'ownership' of IT/IS in hospitals. Clinicians appropriate technologies to the extent that they support and enhance workflow in ways that improve the patient's clinical journey. Attempts to impose IT/IS that do not result in such positive workflow outcomes for patients lead to poor morale and resistance.

Consequently, BSC evaluations of IT/IS implementations in hospitals need to incorporate a wide range of non-market performance measures because they reflect the non-market elements of the hospital's strategic perspectives. Thus a model for the evaluation of health systems based on Andrews approach seems more appropriate.

THIS STUDY

Method

In order to develop an appropriate set of performance measures for the BSC in the PACS environment, and to understand those measures in a practical context, a study was undertaken of a PACS implementation in a large public hospital in Australia (identity withheld) offering the full suite of medical inpatient and outpatient services. Following a MiniPacs implementation in 1995, a hospital-wide implementation was undertaken in 2004.

The study involved indepth, semistructured interviews with users of PACS in several locations throughout the hospital. The interviews were loosely framed around a set of questions designed to encourage participants to talk about three interrelated issues:
the goals and strategies of the hospital;
the importance of workflow to those goals and strategies; and
how well they believed that the PACS implementation helped improve the workflow and subsequently to achieve those goals and strategies.

The interview data was supported by internal and publicly available documents that explored the vocation of the order of nuns running the hospital as well as the policy and mission of the public health system.

Interview data were entered on Nvivo and coded using the open and axial techniques recommended by Miles and Huberman (1994). The open coding enabled the large amount of text to be organised according to nodes and so to begin to understand its contents. The axial coding enabled the researchers to rethink their nodes and check that they had not forced data into pre-conceived patterns to suit the theory. In so doing, the researchers looked for causes and consequences and for natural clusters of the nodes (Neuman, 2002).

Findings and discussion

Four measurement perspectives were found. The four perspectives relate to one another, as do Kaplan and Norton's original perspectives. The first two are directly analogous to two of Kaplan and Norton's original perspectives (internal business processes and customers, respectively). The latter two are more radical modifications to reflect the non-market context of the hospital environment in which PACS is implemented:

- a clinical business process perspective that captures the major clinical impacts on workflow has been included because the outcome - speed of service – is of central importance to workflow analyses. The workflow implications of PACS impacting on clinical business processes not only relate to automation (Lundberg and Tellioglu, 1997), but also to the productivity of radiologist, technologist and the clerical staff (Hayt and Alexander, 2001), report-turnaround-times (Redfern and Langlotz et al, 2002) and changes in communication between radiologist and clinicians (Weatherburn, Bryan and Cousins, 2000; Fiedler and Haufe, 1996) . This perspective is consistent with the original BSC perspective: "At which business processes must we excel?"
- a patient perspective that captures the impact of PACS on the production of value for the patients along the workflow is included because queues and bottlenecks are symptoms of poor patient throughput. The workflow implications that are directly patient-related include reduction in delays, and an increase in timely care as well as throughput time of patients (Andriole, 2002; Ahovuo, Tolkki, Fyhr and Kujala, 2004; Tolkki et al, 2004) . This perspective is consistent with the original BSC perspective: "How should we appear to our customers?"
- a quality and transparency perspective that captures the level of monitoring and status checking possible in the system is included because the literature suggests that improved workflow quality and transparency give higher diagnostic value. Quality workflow would imply that variations in the workflow that may harm patients would be eliminated. While it has been found that automation leads to improvements in workflow quality (Laet, Naudts and Vandevivre, 2001), PACS can also eliminate steps in the workflow, making it more simple and transparent (Siegel and Reiner, 2003a, Siegel and Reiner, 2003b) . Given that bottlenecks can arise throughout the workflow , transparency can promote better outcomes by enabling status checking. This is aided by the impact of PACS on reducing rates at which images need to be retaken (Peer et al, 1999; Siegel, Protopapas et al, 1996) and the almost complete elimination of faulty exposures (Fiedler and Haufe, 1996) . This radical departure from Kaplan and Norton's original four perspectives reflects the fact that hospitals not only need rapid workflow, but they must have

quality checks that imply a quality and transparency of workflow. It reflects an emphasis on Andrews perspective of "what do we want to do" and "what should we do?" when hospitals are focussed on workflow as a way of enhancing patient care. This perspective asks "are we maintaining and enhancing the quality and transparency of our workflow?"

- an information systems perspective that captures the impact that PACS has on the enabling power of the information system is included. This is because the literature suggests that PACS impacts upon the information systems potential to contribute to workflow execution. PACS impacts on the overall contribution of IS to workflow by making images accessible and available, by providing new ways for radiology departments to cooperate , by eliminating paper work and through integration . An important aspect of workflow is the down-time of the system, and the associated loss of records . This is a somewhat radical departure from Kaplan and Norton's original four perspectives. This perspective provides an aggregated view of these issues and asks "Does the IS assist in the execution of the workflow?" This change was made to reflect the fact that PACS typically does not stand alone. Rather, in its relationship with existing systems it can be integrated to streamline processes, or can slow processes through parallel systems .

These perspectives indicate another radical deviation from Kaplan and Norton's original BSC in which the perspectives indicated performance measures. While performance measures, with their essentially quantitative implications, are relevant to financial and corporate internal business process perspectives, it has been found that they may not be adequate for some enterprise-wide applications (Goldszal, Bleshman, & Bryan, 2004) . When it comes to hospital goals of clinical excellence the outcomes may be difficult to quantify because they have aspects that are essentially qualitative. It is hard to measure the intangible value created by PACS to patients, radiologist, clinicians in terms of quantitative measures. It requires a broader understanding.

Therefore, the perspectives outlined here should be considered as incorporating qualitative themes rather than performance 'measures'. This makes it necessary to have a qualitative method for understanding the values of the outcomes associated with many elements of the perspectives.

PACS-BSC MODEL

Given the four perspectives that were found to capture the strategy in the particular case at hand, the proposed BSC to evaluate the impact of a PACS implementation on workflow in a hospital are:
Clinical business process perspective
Patient perspective
Quality & transparency perspective
Information system perspective

These have been identified as consistent with the hospital strategy as indicated by the users of PACS, other hospital officials, and the documents reviewed. These measures are consistent with the literature on workflow associated with the patient's clinical journey. Taken together, these perspectives give the following framework: the PACS-BSC model as seen in Figure 2. The PACS-BSC model enables the holistic investigation of PACS impacts in that it captures the essential impacts on workflow.

The model demonstrates interdependency of the four perspectives and the relationship with the vision and strategy of a hospital. This is in accordance with Norton and Kaplan's original intentions in that the four perspectives complement each other, and there is not one perspective that alone represents strategy - yet it is a significantly improved approach for specifically evaluating PACS. Moreover, the PACS-BSC invites qualitative assessment that reflects the qualitative nature of not only the perspectives, but also of the strategy and vision of hospitals.

CONCLUSION

The Balanced Scorecard allows adaptation to the specific needs of hospitals in order to evaluate organisational performance and IT/IS implementations. Because the implementation process is undertaken for reasons consistent with IS and organisational strategy that is largely non-market, it should be evaluated in non-market terms. Clinical goals and not-for-profit components should therefore be primary when evaluating IT/IS implementations in hospitals.
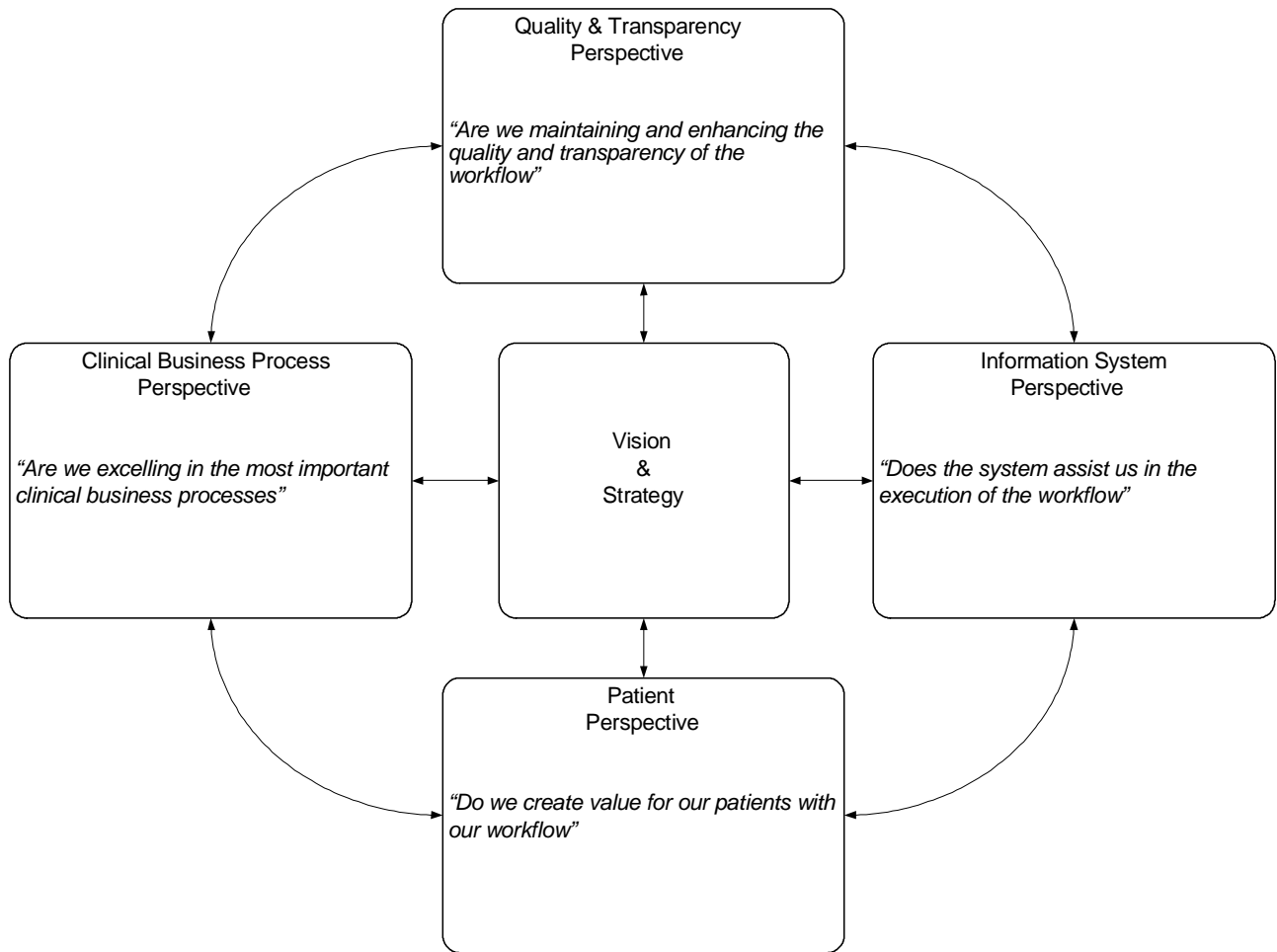
Figure 2: PACS-BSC model

Our approach is radical in that it is built on a consideration of the fundamentals of the hospital strategy, and valuable in that it results in the PACS-BSC model. Consistent with the qualitative nature of major aspects of hospital strategy, the new model incorporates qualitative themes rather than quantitative performance measures. While changing the perspectives to fit the hospital context, and changing the quantitative focus of the performance measures to qualitative themes may be radical, there is no change to the essential nature of the BSC model. Rather, the new model retains Kaplan and Norton's intention to evaluate outcomes from the perspective of the organisation's strategy and to be flexible to whatever those outcomes and strategy may be. Thus the PACS-BSC model is a holistic method to evaluate PACS impact on workflow that is relevant to hospital's not-for-profit and clinical strategies.

Retaining the original robustness of the BSC with regard to a radical review of organisational strategy and to the evaluation of qualitative outcomes, the PACS-BSC will be used to evaluate the impacts of PACS on workflow within hospitals. The authors argue that valid outcomes require a radical review of models in terms of purpose, concepts and structure and are currently undertaking empirical research to test the new model.

The application of the BSC framework and theories of strategy to PACS within the hospital environment has enabled both a richer understanding of the workflow outcomes, and a refinement of the BSC. The PACS-BSC, as developed, has enabled a more diverse understanding of outcomes from the staff's various perspectives. The use of qualitative interview methods in conjunction with quantitative survey methods has enabled an unearthing of outcomes as observed by the staff. Therefore, it is concluded that the academic tool kit with various theories and methods enables a clearer view of reality, while reality enables the appropriate refinement of theory.

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