



Issues in the Development of E-Marketplaces: A Public Sector Perspective

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ABSTRACT

The procurement environment is becoming more complex for practitioners with new e-marketplace developments. This paper explains the issues related to procurement decisions and benefits evaluation with a focus on the Government sector.

The evaluation of benefits literature in information systems needs updating as most of the models proposed were designed for systems that had an internal focus.

A case study of the adoption and use of an E-marketplace (GEM) in a Government Department illustrates the specific peculiarities and constraints on public sector e-marketplaces. The paper provides an evaluation framework that can be used by public sector organisations when examining the adoption and evaluation of e-marketplace procurement that emphasises the experimental nature of many e-commerce related projects. The paper contributes to the "evaluation of benefits" literature by identifying the importance of community impact as a dimension missing from current frameworks.

INTRODUCTION

In 1994 the European Logistics Association defined procurement as "the activities which ensure the availability of material in the desired quality, quantity, place and time to the requesting unit." (European Logistics Association, 1994) The intervening years have seen subtle change, in particular today we emphasise that procurement encompasses both materials and services, particularly with purchaser-provider models in the public sector. This paper evaluates current benefit frameworks in this context and identifies a deficiency in the use of these models when assessing e-marketplaces in the public sector.

The first section of the paper covers the main issues in relation to the procurement environment and benefits evaluation. The details of the case study are described with details of the research method. The usefulness and validity of the various benefits frameworks are then discussed.

Procurement Environment and the Rise of E-Marketplaces

There is ample evidence that in private sector procurement benefits, risks and opportunities may accrue to both purchasers and suppliers (Greenstein & Vasarhelyi, 2002). When e-marketplaces are established as an independent business, this brings a third party into the benefits equation. Even in this situation the assessment of benefits and costs is relatively straightforward. Public sector procurement is a more complex environment with its potential to impact on a variety of policy issues of interest to stakeholders, particularly the government and the bureaucracy. For example, in Western Australia the state government has a "Buy Local" policy that is expressly designed to further the government aims of regional development, rather than to achieve the most cost-effective procurement for the purchasing agency.

There has been a plethora of e-marketplaces developed in the last decade. These marketplaces come in many forms.

- Development of traditional markets into electronic marketplaces, for example the conversion from floor trading to electronic trading on major stock exchanges.
- Some markets have been established as vertical markets to service specific industry sectors including motor vehicle manufacture, mining, plastics and the pharmaceutical industry.

- Some markets appear to have been established simply on the basis that integrated software solutions enable them to be effective, for example www.Mysap.com.

On another dimension, markets have been established by:

- Buyers (typically where the buyers are in a position of power in the market)
- Sellers (typically where they have the power)
- Intermediaries (typically where there is threat of disintermediation in the market)

E-marketplaces may be seen to facilitate the stages in the life cycle of trade which cover *negotiation, execution and settlement* (Bytheway, 1995a).

(Nokkentved, 2000) provides a continuum of functionality for the development of marketplaces. He suggests four major categories of function can be provided by e-marketplaces. These range from the provision of information, through to facilitation, then transaction and finally integration.

Evaluation of Benefits Concepts

The benefits evaluation literature has three main themes or sets of issues. The first is the benefits evaluation classification as defined by DeLone and McLean (1992) and subsequently extended by other researchers. This framework has been in place for some time and referred to extensively by IS researchers. The extent to which this framework is useful as a way of classifying benefits, especially for electronic commerce systems such as e-marketplaces, is worthy of examination since the classification was developed as a tool for use

Table 1: Functionality of e-marketplaces (Nokkentved, 2000)

	Information	Facilitation	Transaction	Integration
Required Process	Industry directory	Product/Service posting	Registration of members	Collaborative planning
	Product database	RFP/RFQ posting	Authentication of members	Connectivity to back-end systems (i.e. ERP)
	Content rationalisation	Planning	Hold Account Receivable	Support for workflow
	Search Capability	Auction	Credit Ratings	Integration with back-end systems
	Online experts	Negotiation	Settlement Handling	OLAP
	Editorial content		Payment Handling	Support for Reverse flows
	Discussion forums		Bid/Ask markets	Integration with other trade exchanges
	Job market		Order status	
			Shipment Status	
			Links to other providers	

with information systems in the eighties and early nineties and has mainly a technical focus.

The second issue related to e-commerce benefits evaluation is the process of evaluation. A growing body of literature highlights that benefits evaluation cannot be disentangled from the method of evaluation. In particular whether a quantitative (rationally constructed) or qualitative analysis (socially constructed) is taken (Hirschheim & Smithson, 1988) & (Serafeimidis & Smithson, 1994).

The third, and often overlooked aspect of evaluation of benefits is that their perception of significance can change significantly through time. Only a relatively small percentage of studies take a longitudinal approach. There may even be a cycle of benefits that can be derived from e-marketplaces that cannot be brought out by one of data collection or a case study over a short period of analysis.

Bytheway's (Bytheway, 1995b) taxonomy of the strategic benefits of the application of IT to the supply chain may alternatively be described as a taxonomy of motivation. It is suggested that there are three core benefits provided:

- Efficiency: doing things right
- Effectiveness: doing the right thing
- Evolution: doing something else

In addition, he proposed two other "extreme reasons" for implementing innovation in technology. These are:

- Defensive: reacting to moves made by competitors
- Experimental: trying to understand your opportunities

Whilst these reasons may have seemed extreme when they were proposed in 1995, in the addition to the expected returns in the core categories, we think that it serves as a useful framework for analysing adoption and support for the introduction of e-marketplaces.

RESEARCH METHODOLOGY

In this section of the paper we explain the research questions, the research approach, the data gathering and data analysis methods. Based on our analysis of the literature on evaluation of benefits we argue that there are several issues worthy of investigation. For our main question we would like to determine the levels and types of benefits derived from engaging in e-marketplaces. There may, for instance be new types of benefits not previously identified or certain types of benefits may or may not be significant.

The study is shaped by existing benefits evaluation theory and so we also wish to determine the extent to which the evaluation frameworks developed in the past with information systems are relevant and appropriate for electronic commerce applications and in particular e-marketplaces.

The project involves an in-depth case study of a government department. The information gathering component of the research has involved face-to-face discussions and interviews, and e-mail and telephone communication, access to company documentation, and attending company meetings. Information has also been gathered from strategic plans, job descriptions, and company reports, and the Web site.

An interpretive approach was used to analyse the data. The main research themes are shaped by the research literature and questions were analysed and classified according to these and validated using a second researcher. However, the research interpretation is influenced by a number of research traditions. The paper takes the form of a participant-observer revelatory case study using an embedded, single case design. A dialectic hermeneutic approach suggests that the wider environment is an important issue for explaining organisational decisions. Hermeneutics is primarily concerned with the meaning of a text or text analogue (Myers, 1995). The data, which are interview transcripts, are analysed in terms of themes, motifs, and key words in the same way, as a literary text is (Bronsema & Keen, 1983). However, it provides few, if any, methods or techniques for identifying the wider issues. One of the main differences between pure and dialectical hermeneutics is that, in the latter, the researcher does not just accept the opinions of the participants, but tries to evaluate the totality of understandings in a given situation. The role and understanding of the par-

ticipants are interpreted historically, and in terms of social and political structures and includes the contribution of the researcher in the analysis process.

CASE STUDY DESCRIPTION

The Western Australian Government currently spends approximately \$A5 billion on goods and services and estimates of average transaction cost are estimated at an average for simple purchases of \$100 (DoIT, 2001b).

Early in 2000 the West Australian government agency responsible for management of government purchasing, the Department of Contract and Management Services (CAMS), embarked on the development of major project known as the Government Electronic Marketplace (GEM)(DoIT, 2001a). On the 1st July 2001, as a result of machinery of government changes the responsibility for the project moved to the replacement for CAMS, the Department of Industry and Technology (DoIT). This case study traces the development GEM from inception to pilot implementation within one major government agency. This process illustrates several of the major issues associated with marketplaces in general and highlights some special difficulties in implementing such a marketplace within the public sector.

The published objectives and benefits of the system listed on the DoIT web site (DoIT, 2001b) are:

Project objectives

1. To provide an end-to-end online buying solution using web browser technology.
2. To enable supplier created and maintained catalogues.
3. To enable distributed requisitioning and work flows.
4. To satisfy Government buying and policy compliance. *
5. To enable buyer-to-buyer (sic) procurement efficiencies.
6. To integrate Financial Management Information Systems (FMIS) with Gem.
7. To support the Open Buying on the Internet (OBI) standard and Australian Procurement and Construction Council (APCC) Guidelines. *
8. To provide a confidential and secure infrastructure.
9. To provide a vehicle for procurement reform. *

Expected benefits

- A. Reduced time to perform searches, secure approvals, place orders, make payments and acknowledge receipts.
- B. Reduced 'real' cost of procurement and processing times.
- C. Reduced duplicate payments.
- D. Minimised data entry and streamlined data collection.
- E. Improved data quality for management reporting.
- F. Open trading model for transacting on a many-to-many basis.
- G. Added value to supply chain management.
- H. Supplier maintained catalogues. "

Note: line numbering has been added to assist later analysis

The items marked with an * are those which differentiate this e-marketplace from those in the private sector. Note that on further discussion with the Project Sponsor we established that objective 5 should read "project-to-buyer procurement efficiencies". The establishment of GEM is not just a tool for implementing market efficiencies, but also for implementing a variety of policies as discussed above.

As addressed earlier, there are many stakeholders in any marketplace, typically all markets must have both buyers and sellers in order to exist. Additionally, the market may be owned and controlled by a third party whose business is the delivery from effective and efficient market to the both buyers and sellers. In the case of GEM the government owns most of the buyers, some of the sellers and the operator of the market. To further complicate matters, it also owns the policy-making body that sets the rules for open and effective competition for all government purchasers. This separate body is known as the State Supply Commission.

In identifying potential leading-edge buyers for the market the selected agency was selected for a variety of reasons. It had already

commenced the process of reviewing supply chain management with a view to outsourcing the management of its supply chain. The chief executive officer had been the chief executive officer of CAMS in his previous position and was known to be a strong supporter of the implementation of strategic procurement initiatives. A solution value assessment conducted as part of the process of implementation of a new financial system had indicated in the transaction costs within the supply chain could be significantly reduced by the application of current information technology.

In early 2000, CAMS held a series of briefings for agencies. Initial proposals established that GEM was more than simply an e-marketplace. It was in fact a front-end procurement system and marketplace combined. GEM was designed to provide a complete service from the time a need was identified (purchase requisition) through purchasing to the receipt of goods.

As mentioned earlier, the agency was, at this time, in the process of re-implementing its Financial Management Information System (FMIS) and upgrading the application software to an ERP system (Oracle Financials, Version 11). A significant feature of this implementation was the implementation of the procurement module of Oracle Financials that included provision for self-service purchasing (SSP).

At these meetings, it was established that there was considerable overlap between the proposed functions for GEM and the functionality of the ERP solution in situ. As GEM was at the time, an unproven concept, it was decided to run parallel implementation of GEM and SSP, with the split along functional lines.

- Major function: GEM
- Rest of agency: SSP

It was considered that the introduction of e-procurement systems was in its infancy and that the organisation would be prudent to “hedge its bets” by this method.

The GEM solution proposed at this stage addressed only the negotiation and execution phases of the trade lifecycle and did not address the settlement (and costing) requirements of the agency. The concept appeared to be conceived from the procurement perspective, rather than from an integrated accounting information systems perspective, thus the issues associated with payment and distribution of costs had not been addressed.

To address this problem, the first step was to decide on the point of integration between the FMIS and GEM. This was particularly difficult as the project was of a scale which would require a phased implementation over an extended period of time. The need to run two systems in parallel also influenced the decision.

It is important to note that many state government agencies in Western Australia have implemented Enterprise Resource Planning (ERP) systems. Each agency has selected the system that it considers most appropriate for itself resulting in a heterogeneous collection of Oracle, SAP, Peoplesoft and other systems across the sector. It is clear that Western Australia has chosen to consider the agency as the “enterprise” for these systems, rather than take a whole of government approach such as that adopted in the state of Victoria. This results in some difficulties for the integration of GEM into the FMIS of buyer agencies.

After due consideration of many integration points, it was agreed that the most feasible point at which to integrate would be after the settlement (payment) phase of the transaction had been completed. These issues were crucial to the success of the implementation from the point of view of the agency. DoIT agreed to modify the system to handle the complete cycle from Procurement to Payment.

With the widened scope, GEM was implemented at a single pilot site in July 2001. At October 2001,

GEM is operational at limited purchasing sites with several hundred suppliers actively participating in the market.

DISCUSSION

The evolution of GEM from a procurement system to a market that fulfils almost all of the criteria presented by both Bytheway and Nokkterved is of some significance in providing a degree of support for the validity of these models. It became clear early in the project that to achieve a real benefit from the implementation of the e-marketplace at the integration level, the transaction level must be satisfied first.

In this section of the paper we examine and classify the declared project objectives and benefits listed earlier by DoIT in using e-marketplaces in the government sector.

The established benefits evaluation frameworks are used to structure the examination of benefits. We also highlight a number of issues that are still to be resolved as a result of the strategy adopted in relation to e-marketplaces with some suggestions for organisations on how to deal with these.

Analysis within the DeLone & McLean Framework

We did not find it surprising that most of the declared objectives and benefits fit this well accepted model, nor did we find it unusual that many of the benefits postulated by the model were not enunciated in the statement. The list obviously was not intended to be an exhaustive model of the benefits to be gained by the introduction of the GEM system, but specifically to address the perceived benefits from procurement perspective. We believe that each of the aspects of the DeLone and McLean model should be included in the evaluation of the benefits of GEM. The measurement of these constructs from each perspective (supplier, seller and policy maker) could be incorporated into a balanced score card for the long term evaluation of the project.

Table 1: Objectives and benefits of electronic marketplaces categorised under MIS success measures (DeLone & McLean, 1992)

System quality	Information quality	Information use
Ease of use, Convenience of access System flexibility, Usefulness of features and functions, response time, Integration of systems <i>Objectives:</i> 6. Integration with FMIS 8. Confidential and Secure infrastructure <i>Benefits:</i> None recorded	Current, Timely, Reliable, Useable Complete, Accurate, Free from bias <i>Objectives:</i> None recorded <i>Benefits:</i> A. Reduced time..... C. Reduced Duplicate payments E. Improved Mgt. Reporting	Purpose of use Recurring use Motivation to use <i>Objectives:</i> 1. end-to-end buying solution <i>Benefits:</i> None recorded
User satisfaction	Individual impact	Organisational impact
Overall satisfaction Information satisfaction Full information required Enjoyment Decision-making satisfaction <i>Objectives:</i> None recorded <i>Benefits:</i> E. Improved Mgt. Reporting	Problem identification, information awareness and decision effectiveness through provision of : i. Analytical capabilities for business analysis ii. Market intelligence iii. Forecasting iv. Greater visibility of supply chain v. Project management collaboration vi. Information sharing vii. Interorganisation connections viii. Instant communications ix. Mediated business processes <i>Objectives:</i> 2. supplier maintained catalogues 5. buyer-to-supplier efficiencies (through automated communication technologies) <i>Benefits:</i> G. Added value to supply chain management H. Supplier Maintained Catalogues	Operating cost reductions. <i>Objectives:</i> 6. integration with FMIS <i>Benefits:</i> A. reduced time B. Reduced real cost Overall productivity gains. Staff reductions <i>Benefits:</i> D. minimise data collection H. Supplier Maintained catalogues Contribution to achieving goals through improved management of data and ‘near perfect’ information flow . <i>Objectives:</i> 3. work flow management 5. buyer to supplier efficiencies

What we consider of most interest are the perceived objectives and benefits which do not fit the model, viz:

Objectives:

4. To satisfy government buying and policy compliance
7. To support the Open Buying on the Internet (OBI) standard and Australian Procurement and Construction Council (APCC) Guidelines. *
9. To provide a vehicle for procurement reform. *

Benefits:

- F. Open trading model for transacting on a many-to-many basis.

Conceptually, these items may be grouped as extra-organisational impact (within the public sector, we would suggest the title of *impact on society*). This reflects the significant swing in emphasis from the internal focus of information technology in the early 1990s to a much wider approach a decade later as the introduction of technology and the consequent changes in process cross organisational boundaries. This seventh dimension may be particularly important for the evaluation and measurement of large IT projects in the public sector as they impact on the society which they serve in a way which may be separate from the public sector outcomes which they are initially designed to support.

Analysis within the Bytheway evaluation framework

In this case we have been able to categorise all of the published, perceived objectives and benefits within the framework. One category, the “defensive” is hardly used and this can be attributed to the dominant role of the government within the market of Western Australia. The framework is not as detailed as that proposed by DeLone and McLean and is not a substitute, yet they appear to be complementary, allowing for the categorisation along different important dimensions.

- Efficiency: doing things right
 - Objectives
 - 1. End-to-end buying solution,
 - 2. Supplier maintained catalogues.
 - 5. Buyer-to-supplier efficiencies
 - Benefits:
 - A. Reduced time
 - B. Reduced real cost
 - D. Minimise data collection
 - H. Supplier maintained catalogues
- Effectiveness: doing the right thing
 - Objectives
 - 6. Integration with FMIS
 - 8. Confidential and secure
 - Benefits: A, C & G
 - A. Reduced time
 - C. Reduced duplicate payments
 - G. Added value to supply chain management
- Evolution: doing things different
 - Objectives
 - 3. Work flow management
 - 7. OBI/APCC
 - Benefits:
 - E. Improved mgt. reporting
- Defensive: reacting to moves made by competitors
 - Objectives
 - 7. OBI/APCC (possibly)
 - Benefits:
 - None recorded
- Experimental: trying to understand you opportunities
 - Objectives
 - 4. Policy compliance

- 7. OBI/APCC
- 9. Vehicle for procurement reform
- Benefits:
 - F. Open trading model

Limitations of Benefits Evaluation Frameworks

This study shows that the DeLone & McLean framework is robust from an internal perspective but is incomplete in that this internal focus is a limitation where the effect of the introduction of a new IT system is such that is designed to have an impact on the whole society in which it operates. This can be addressed by the extra dimension proposed as “impact on society”, with the development of measurable constructs to reflect this dimension required as a matter of urgency.

The extended Bytheway framework proved robust within its limitations, and the case study provides evidence to support a significant investment by the Western Australian government on an experimental basis. It must be noted that as this framework addresses mainly organisational benefits, it does not stand alone as well as the extended DeLone and McLean framework. It assumes the realisation of other benefits such as the technical integration in order to obtain the organisational benefits.

Whilst the Bytheway framework is organisational and should be used with a traditional framework such as DeLone and Mclean, the constructs are sufficiently broad to be applied to benefits accruing to the community in general as well as the parties to the transaction.

Again, the Bytheway framework does not address the issues of measurement and evaluation of benefit when it has a community focus. These too, require urgent attention.

This case study and analysis highlights several issues of importance:

Accounting Information Systems texts generally (Bodnar & Hopwood, 1998; Gelinas Jr, Sutton, & Oram, 1999; Hall, 1998; Hollander, Denna, & Cherrington, 2000; Romney & Steinbart, 2000; Wilkinson & Cerullo, 1997) and established frameworks for e-marketplaces address the corporate AIS needs in the context of the major business cycles:

- Revenue & Collection
- Acquisition and payment

This case study shows that the implementation of a system to achieve only a portion of a cycle was not acceptable to the users of the system and that the proponents of the system modified the scope to meet this requirement. In planning IT initiatives proponents need to address integration issues early in the process.

The case also provides strong evidence that the implementation of e-marketplaces by the Western Australian government has objectives and perceived benefits which fall outside of the traditional, internally focussed IT benefits framework dating from the early 1990s. A seventh dimension to the DeLone and Mclean framework “Impact on Society” is proposed to address this issue.

It is clear from the case that the implementation of e-procurement systems is still largely at an experimental stage and that the concept of running parallel systems within different organisational units is still a useful tool when technology is either unproven or immature.

FUTURE RESEARCH

The case illustrates that the measurement of benefits from major IT projects such as an e-marketplace (GEM) is a complex task. There is a need to design valid and reliable measures for each perceived benefit, measure their achievement and rank their importance in order to develop an appropriate “balanced scorecard” by which to measure the project.

We have noted that the development of measurable constructs to reflect “impact on society” is required as a matter of urgency. Further investigation of the use and sponsorship of e-marketplaces by other public sector jurisdictions would be useful in order to further refine this dimension.

This in turn begs the wider question of the “impact on society” of e-marketplaces in the private sector, and of the implications and application of extra-territoriality for the regulatory environment.

REFERENCES

- Bodnar, G. H., & Hopwood, W. S. (1998). *Accounting Information Systems (7 ed.)*. New Jersey: Prentice Hall.
- Bronsema, G. S., & Keen, P. W. G. (1983). *Education intervention and implementation in MIS*. *Sloan Management Review*, 24(4), 35-44.
- Bytheway, A. (1995a). *Electronic Markets: A Framework for the analysis of trade and its potential for development*. MCB University Press. Retrieved 16 December 1996, from the World Wide Web:
- Bytheway, A. (1995b). *Information in The Supply Chain: Measuring Supply Chain Performance*. Cranfield Working Paper: Cranfield School of Management, Cranfield University.
- DeLone, W. H., & McLean, E. R. (1992). *Information Systems Success: The quest for the dependant variable*. *Information Systems Research*, 3(1), 60-95.
- DoIT. (2001a). *GEM*. Retrieved 24 September 2001, from the World Wide Web: <http://www.gem.wa.gov.au/default.jsp>
- DoIT. (2001b). *What Is Gem*. Retrieved 22 September 2001, from the World Wide Web: http://opal.gem.wa.gov.au/aboutgem/what_is_gem.jsp
- European Logistics Association. (1994). *Terminology in Logistics*.
- Gelinas Jr, U. J., Sutton, S. G., & Oram, A. E. (1999). *Accounting Information Systems (4 ed.)*. Cincinnati, Ohio: South-Western College Publishing.
- Greenstein, M., & Vasarhelyi, M. (2002). *Electronic Commerce: Security, Risk Management, and Control (2 ed.)*. New York: McGraw-Hill Irwin.
- Hall, J. A. (1998). *Accounting Information Systems (2 ed.)*. Cincinnati, Ohio: South-Western College Publishing.
- Hirschheim, R., & Smithson, S. (1988). *A critical analysis of information systems evaluation*. In N. Bjorn-Andersen & G. B. Davis (Eds.), *Information Systems Assessment: issues and challenges* (pp. 17-37). Amsterdam: Elsevier Sciences.
- Hollander, A. S., Denna, E. L., & Cherrington, J. O. (2000). *Accounting Information Technology and Business Solutions (2 ed.)*. Boston: Irwin McGraw Hill.
- Myers, M. D. (1995). *Dialectical hermeneutics: a theoretical framework for the interpretation for the implementation of information systems*. *Information Systems Journal*, 5, 51-70.
- Nokkentved, C. (2000). *Collaborative planning in e-supply networks*, Business Briefing: Global Purchasing and Supply Chain Strategies.: World Markets Research Centre.
- Romney, M. B., & Steinbart, P. J. (2000). *Accounting Information Systems (8 ed.)*. New Jersey: Prentice-Hall.
- Serafeimidis, V., & Smithson, S. (1994, 13-14 September). *Evaluation of IS/IT investments: Understanding and Support*. Paper presented at the First European Conference on Information Technology Investment Evaluation, Henley on Thames, UK.
- Wilkinson, J. W., & Cerullo, M. J. (1997). *Accounting Information Systems: Essential Concepts and Applications (3 ed.)*. New York: John Wiley & Sons, Inc.

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