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CHARACTERISTICS OF ADOPTION AND USE OF B2B ENABLING TECHNOLOGIES IN AUSTRALIAN COMPANIES

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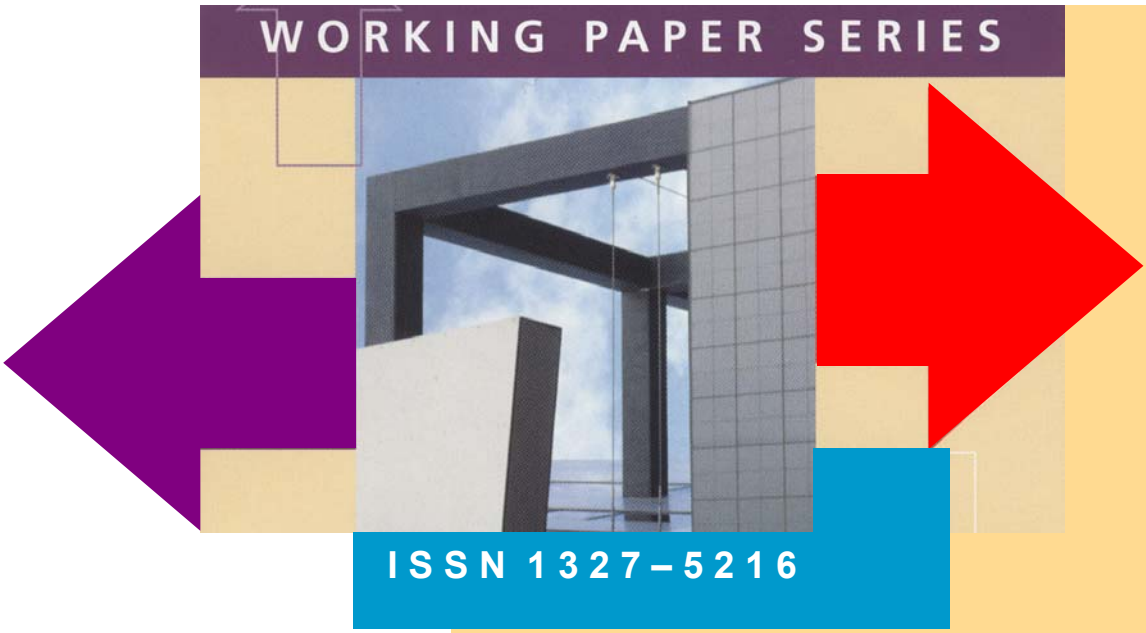
Working Paper 33/02
November 2002



Abstract

This paper uses data from Australian companies to compare and examine characteristics of adoption and use of emerging technologies such as the Internet. In order to achieve this the use of emerging technologies is compared to the use of established technologies (such as EDI) on the basis of company size, industry and ANZSIC code (an industry classification code similar to the International Standard Industrial Classification ISIC). The functions of current and planned websites are also compared on the basis of these demographic variables, and a causal model is used to examine the implications of implementation of Internet technologies. The results indicate that many of the same characteristics identified for the adoption and use of established technologies will not hold true for emerging technologies such as the Internet. It is, however, also noted that some critical characteristics for improving performance through the use of these enabling technologies appear unchanged, irrespective of their improved ease of implementation and use.

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DEPARTMENT OF MANAGEMENT

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INTRODUCTION

The adoption of technology to enable the more widespread application of business to business (B2B) methodologies has traditionally been slow, with some of this technology (e.g. EDI) having been available for over thirty years (Johnston and Mak, 2000). Burnell quotes KPMG research from 1998 in the US where it was found that although 92% of retailers surveyed were sharing information with customers and suppliers, 79% were using fax or other traditional paper based means to do this (Burnell, 1998). Carter et al also cite research conducted by the Centre for Advanced Purchasing Studies in the US who found in 1996 that only 13% of purchase orders across 25 industries (493 companies) were transmitted using EDI (Carter and Hendrick, 1997). This is despite other research indicating that the contribution of the cost of paperwork to the final price of a product can be significant, ranging from between 3.5% to 15% (Ojala and Suomi, 1992). Part of the explanation for the slow take up of this technology, and its restricted application in small / medium companies has been attributed to the cost and difficulty of implementation (Cash and Konsynski 1985; Bytheway and Braganza 1992; Iacovou, Benbasat et al. 1995; Barua and Lee 1997; Hart and Saunders 1997; Koloszyk 1998; Ramamurthy, Premkumar et al. 1999; Rassameethes and Kurokawa 2000). Recent rapid changes in technology have had both positive and negative impacts in this context. On the one hand they provide opportunities for more rapid adoption and improved levels of connectivity between trading partners. On the other hand, this increasing rate of change promotes obsolescence. Systems that were recently "state of the art" can become outdated legacy systems quite quickly. (Froehlich et al., 1999; Hewitt, 1999). The ability of the Internet to overcome problems common to previously used networks is seen by many to provide a significant opportunity to overcome many of these problems. This paper uses data collected from Australian companies to examine whether the adoption and use of Internet based technologies exhibits different characteristics from that of established technologies. It also uses a causal model to examine whether the promised benefits of more easily facilitated adoption are likely to be realised.

METHODOLOGY

A survey instrument was designed using data gathered from a review of current literature combined with two separate sets of case studies (a total of 15 cases). The sample was drawn from the organizations who are members of EAN (European Article Numbering Association) Australia. This organization administers and manages the barcoding and product numbering standard used in Australian fast moving consumer goods supply chains. It also promotes a system for the management of supply chains using business to business e-commerce enabling technologies including EDI and Web based applications. There were 553 responses received, indicating an estimated response rate of 16.5%. The sample size was reduced to 335 companies for further analysis using the Structural Equation Modelling (SEM) technique. This was done in order to reduce the proportion of missing data for some constructs, as the AMOS package used for this model requires a complete data set. Exploratory factor analysis was carried out to determine whether underlying constructs or factors could be derived from the data set. As a result 15 separate factors were extracted (comprised of 116 individual survey items). These were subsequently reduced to factor variables for use as observed variables in the SEM model. In some cases two factors were combined to produce a single observed variable (where the theory justified this) to promote model simplicity. The survey also contained a number of questions relating to the use of established technologies (such as EDI, data capture technologies etc.), current uses of websites, and current / planned functions of websites. These groups of questions were analysed using a range of statistical techniques including ANOVA, T-Tests, Cross Tabulation and Chi-Square testing. Three major demographic variables were used for comparison of the results and to provide greater depth to the analysis. These were Company Size (based on the number of employees in Australia), Industry Sector (Manufacturing, Wholesale Distribution and Retail), and ANZSIC Code (an industrial classification system developed jointly by the Australian Bureau of Statistics and the New Zealand Department of Statistics – the international equivalent being the ISIC standard).

SEM MODEL: Six dimensions comprised the SEM model:

CAPABILITY – In the model this dimension is an unobserved variable comprised of two observed factor variables. These are made up of three separate factors, namely; Strategic Reengineering; Infrastructure Spending and Technology Spending combined. This construct captures the capability of the organization to reengineer processes and select appropriate technologies. The literature indicates that this has not traditionally been easily achieved (Akkermans et al., 1999; Bensaou, 1997; Croom, 2001; Crum and Allen, 1997; Fernie, 1995; Handfield et al., 2000; Min and Galle, 1999; Monczka et al., 1998). PROCESS – In the model this dimension is an unobserved variable comprised of three observed factor variables. These are made up of four separate factors, namely; Challenging Cognitive Frameworks Using External Resources; Environmental Scanning; along with Benchmarking and Stakeholder Involvement combined to create the construct Challenging Cognitive Frameworks Using Internal Resources. This construct draws on the proposition that organizations use a number of methods for determining environmental conditions in order to formulate technology strategies in dynamic environments (Sanchez 1993; Bowman 1997; Frye 1997; Hines and Rich 1997; Sanchez and Heene 1997; Sanchez and Heene 1997; Jutla, Bodorik et al. 1999; Chase 2000). KNOWLEDGE – In the model this dimension is an unobserved variable comprised of two observed factor variables. These are made up of three separate factors, namely; Knowledge of Implications and Options for Implementation of the EAN System; and Understanding of Potential Benefits of the EAN System combined with Understanding of a "Full Implementation" of the EAN System. This construct captures the idea that extensive knowledge of potential benefits, and of the technological options, is important in determining successful implementation. The reengineering literature provides support for the notion that understanding of the potential benefits of technology is a prerequisite for effective change management (Hammer 1990; Hammer and Champy 1994; Watson 1994; Edwards and Peppard 1996). CONTENT – In the model this dimension is an observed variable (factor variable) made up of 15 individual observed variables covering the stated objectives and expectations of the implementation strategy. This construct proposes that the planning processes, stated objectives and expectations of the organization will have an effect on the extent of implementation of B2B enabling technologies. The relationship between planning processes and implementation of B2B methodologies is also a theme that has some support in the literature (Thompson, 1999; Lummus et al., 1998; LaRoche, 1998; Abcede, 1997; Arntzen et al., 1995). EXTENT OF IMPLEMENTATION – This dimension comprises two constructs that are interchanged during the analysis in order to provide a comparison between the adoption and use of established and emerging technologies. *Established Technologies*: This construct is an observed variable measuring the degree to which implementation (i.e. of *established technologies*) has been extended to include customers and suppliers. *Emerging Technologies*: This construct is comprised of a single observed variable capturing the extent of use of current and planned websites to enable transactions between trading partners. PERFORMANCE – This dimension of the model is made up of one observed factor variable. As a result of exploratory factor analysis of 17 variables from the survey, two factors were extracted and named Operational Outcomes and Bottom Line Outcomes. These were combined to form a single factor variable capturing perceived contribution of the EAN system to organizational performance. Two SEM models are used for comparison – one using the Established Technologies construct representing Extent of Implementation, the other using the Emerging Technologies construct.

DATA ANALYSIS

Trends in Internet Usage

The survey contained six questions relating to the extent to which the Internet is used for a range of business related activities. There was little difference found in use of the internet (using these six variables) based on either company size or industry, except for the use of e-mail. In this case smaller organizations and manufacturers were found to be significantly correlated with lower uses of e-mail, and larger organizations from retailing with higher levels of use (.167 at $p<.01$ and .108 at $p<.05$ respectively). On the other hand, extent of implementation of established technologies (e.g. EDI) was found to be significantly (all at $p<.01$) correlated with use of the internet on all six dimensions tested. These results indicate that organizations currently using the established technologies are also using the emerging technologies to a higher degree. The study also found that the use of established technologies (particularly EDI) was significantly associated with

both company size (0.309 at p<.01) and industry sector (differences significant at p<.05 recorded between groups). There is also an indication that these relationships do not hold for the use of the Internet. Of the 46% of respondents stating that they did have websites, larger organizations indicate a higher likelihood than do smaller ones with the correlation being .246 at p<.001. By way of contrast, there is no significant relationship recorded between industry sector and the operation of a current website, indicating that organizations in all sectors are using the Internet, at least to provide an on line presence. However, for plans to implement websites, there is a universal bias toward developing and implementing an Internet presence across all groups. In fact, the data indicates that although a higher proportion of larger organizations are planning to implement within the next 12 months, there is little difference between the micro (1-4 employees) and Macro (>200 employees) sectors in terms of implementation intentions over the longer term. Only 17% of the micro group indicated they will never establish a website, compared to 14% of the macro group. Significance testing of this data also indicated no relationship between company size and plans to implement websites. Examination by ANZSIC code further highlights this trend toward website implementation. When a comparison between ANZSIC code groups was made on the basis of both existence of current websites, and intention to implement in the future, it was apparent that there was a common intention to further adopt Internet technologies. The group showing the lowest level of intention for future implementation was the Agriculture sector, but even in this case 60% of respondents indicated an intention to implement a website some time in the future. The results also indicated that organizations with current websites have tended to use them more for establishing a presence, providing product information, general company information and public relations. This was contrasted with organizations planning to implement websites, who indicated they were placing an equal (or in some cases greater emphasis) on commercial transactions. To illustrate this, 61% of manufacturers, and up to 80% of micro (employing 1-4 people) organizations reported the intention to use the internet for direct transactions with trading partners in the near future. Both of these groups reported significantly lower comparative use of EDI for this purpose.

SEM Model

The path parameters for the SEM model are presented in Figure 1 below:

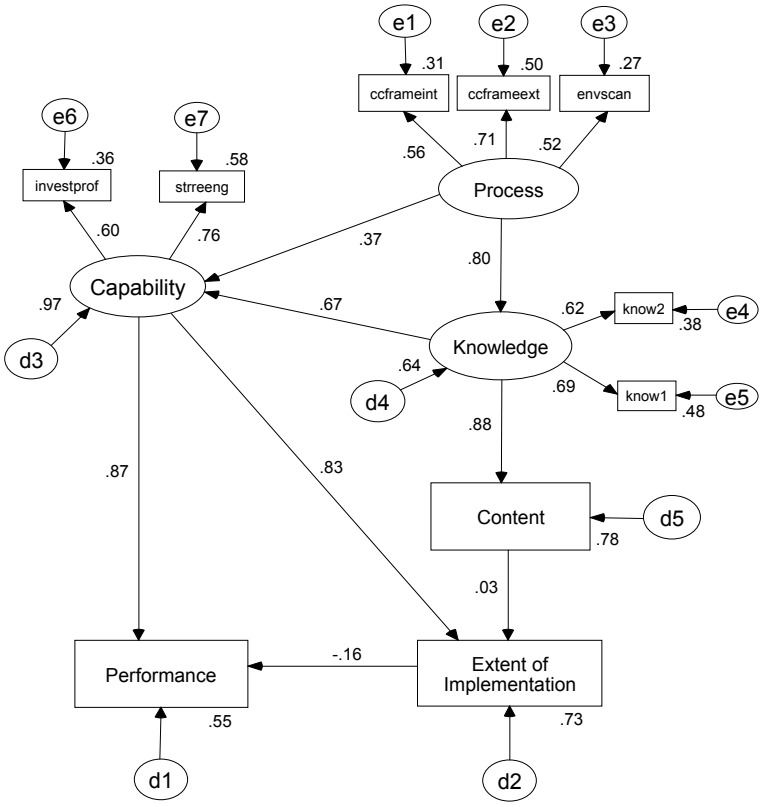

Figure 1: Path parameters of the SEM model

Table 1: Goodness of fit statistics for the SEM model

The model produced the following goodness of fit statistics:

GFI	AGFI	RMSR	RMSEA	TLI	NFI	CHI^2	DF	SIG.	N	CHI^2/DF
0.948	0.905	0.035	0.077	0.940	0.942	89.570	30	0.000	335	2.986

The indices reported above (e.g. GFI = .948) indicated that the model was a plausible representation of the constructs and relationships proposed. The high CHI^2/DF value was not seen to be a problem due to the comparatively large sample size. The path parameter values indicate that the constructs Process, Capability and Knowledge have a strong and significant determining effect on both Extent of Implementation (i.e. of the established technologies), and on Performance. This is further borne out by the direct and indirect effects found through this analysis. These are reported in Table 2 below:

Table 2: Direct and Indirect Effects (* denotes non-significant value effect)

IV	DV	DIRECT	INDIRECT	TOTAL
PROCESS	KNOWLEDGE	.80		.80
	CAPABILITY	.37	.54	.90
	CONTENT		.71	.71
	EXTENT of IMPLEMENTATION		.77	.77
	PERFORMANCE		.67	.67
KNOWLEDGE	CAPABILITY	.67		.67
	CONTENT	.88		.88
	EXTENT of IMPLEMENTATION		.58	.58
	PERFORMANCE		.49	.49
CAPABILITY	EXTENT of IMPLEMENTATION	.83		.83
	PERFORMANCE	.87	-.130	.74
CONTENT	EXTENT of IMPLEMENTATION		.03*	.03*
	PERFORMANCE		-.004*	-.004*
EXTENT of IMPLEMENTATION	PERFORMANCE	-.16*		-.16*

The model also shows that Extent of implementation of the established technologies has no apparent significant effect on Performance, despite the strong effect that Process, Knowledge and Capability all exert on both these variables.

Comparison Using the SEM Model

In order to further test the implications of these results the causal model was used to compare changes in the nature of the model when the Extent of Implementation construct (i.e. of existing technologies) is substituted with Extent of Implementation of Internet based technologies. In order to capture the extent of implementation of Internet technologies, and their use for enabling business to business trading with customers and suppliers, four variables from the survey dealing with these issues were recoded. When the variable created was substituted into the causal model under the new observed variable name of "Extent of Implementation of B2B Using the Web", the most obvious effect was is to weaken the relationship between Capability and the new Extent of Implementation construct. Figure 2 below shows a comparison between the two models with the major path values detailed.

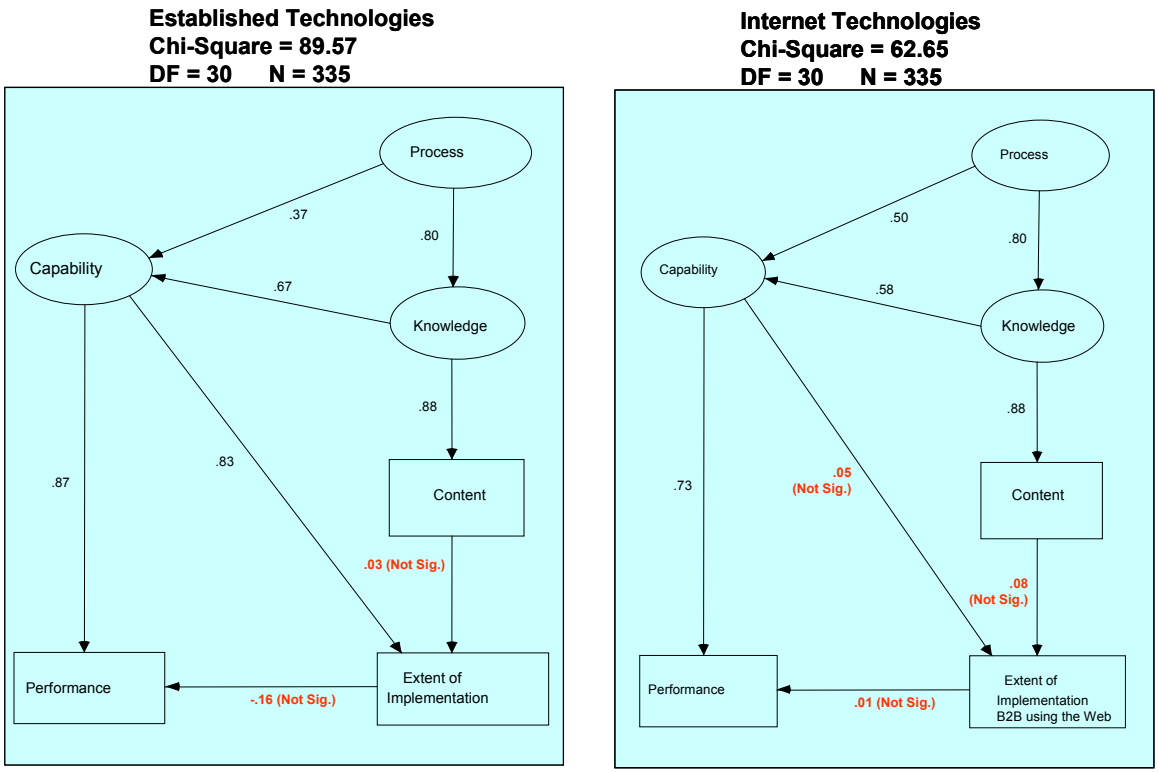

Figure 2: Comparison of models for extent of implementation of established and emerging technologies

The path from Capability to Extent of Implementation in the "Established Technologies" model is both strong and significant, and represents the need for organizations to have the necessary levels of infrastructure and ability in order to implement extensively. For the "Internet Technologies" model, however, this relationship no longer holds. In fact, the relationship is not just weakened, but it is both very weak and no longer significant. This effect captures the ease with which organizations are now able to start using the Internet based solutions, and supports the results reported above indicating that the adoption of Internet technologies will perhaps not be subject to many of the impediments of other technologies (such as EDI). What is also important to note is that the path from Capability to Performance is still strong and significant, while (as with the established technologies) that from extent of Implementation of B2B Using the Web is weak and non-significant. The implication is that though many more organizations will find the new technologies easier to implement, they will still be faced with the same need for significant levels of Capability in order to extract significant benefit through improved performance. This finding provides further support for the proposition that that the Internet does not of itself offer a "technological silver bullet", and has some support in the recent literature (Barber 1997; Puttre 1997; Jutla, Bodorik et al. 1999; Jutla, Bodorik et al. 1999; Goodman 2000; Jhingran 2000).

CONCLUSIONS

These results indicate that many of the same characteristics identified for the adoption and use of existing technologies will not hold true for emerging technologies such as the Internet. It is, however, important to note that some critical characteristics for improving performance through the use of these enabling technologies appear unchanged. The requirement for organisations to develop strategy using appropriate processes, and to be capable of transferring these into action, is highlighted as being a factor critical for success. Irrespective of the technology being adopted, it's ease of use, simplicity of operation, or basis in open and easily transferable standards, the need for organizations to have sound processes for strategy formulation and implementation appears to remain undiminished.

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