

# A Longitudinal Cross-section Examination of the Implementation of Knowledge Management Systems and Firm Performance

Edward T. Chen  
James Monahan  
University of Massachusetts Lowell  
USA

David Feng  
Institute for Information Industry  
Taiwan, P.R.C.

## ABSTRACT

*Based on considerable anecdotal evidence, there is a growing belief that proprietary knowledge management systems (KMS) can significantly improve a firm's financial and operational performance. To date, however, there have been no scientifically based studies which empirically test the validity of such claims. In this paper, we report the results of a three year longitudinal study of 103 proprietary KMS adopting and corresponding non adopting firms. Using regression techniques, several different financial and operational measures are compared to determine whether KMS adoption provides a statistically significant incremental benefit or not. A secondary analysis of the same firms, conducted using the DuPont Analysis, is performed. In both instances the results generally support the contention that KMS adoption does provide statistically significant and measurable positive impacts on a firm's financial and operational performance.*

## INTRODUCTION

Many benefits are widely claimed for KMS even though these systems have not yet been widely adopted. Over the last decade, there has been growing *anecdotal* evidence offered that the implementation of KMS positively contributes to a firm's overall performance. But, objective empirical results, relating KMS investments to firm improvements have been scarce and often equivocal. Moreover, such studies have relied exclusively on traditional accounting-based measures of firm performance and tended to downplay the contributions of KMS to performance dimensions. In fact, a review of the literature reveals a dearth of empirical research on how to successfully develop and implement KMS to enhance firm performance. Instead, much of the existing KMS research has focused either on the use of various technologies to acquire or to store knowledge resources or on the conceptual nature of KM (Alavi & Leidner, 2001; Galup, Dattero & Quan, 2004; Kankanhalli & Tan, 2005; Sabherwal & Sabherwal, 2007). The more important question of whether KMS can and does actually improve firm performance has remained uninvestigated.

This study attempts to provide some objectively based empirical data relative to that void. Our methodology is statistically based and relies heavily on the identification of a set of representative firms who have made investments in proprietary KMS during the study period. Identification of such firms (called KMS Adopters) was completed only after an extensive search and verification process, described later. A corresponding group of otherwise similar non KMS

adopting firms was also studied. By statistically comparing these two groups in terms of a set of well recognized, financial and operational measures, we sought to see whether or not KMS adoption shows up as a statistically significant variable in our regression models.

The paper is organized in the following way. In **Section 2** we begin with a focused review of the KMS literature and the formulation of a set of hypotheses that are consistent with the belief that KMS does help. **Section 3** includes the list of financial metrics used in the study. **Section 4** describes in some detail the methodology employed to identify firms in the both the adopting and non-adopting groups. It also develops the rationale behind the mathematical regression model used in the study. In **Section 5** we present our statistical results and in **Section 6** we conclude with a discussion of the general conclusions reached in the study.

## REVIEW OF LITERATURE AND HYPOTHESIS DEVELOPMENT

### *The Potential Benefits of Knowledge Management Systems*

Knowledge management systems (KMS) are IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage, retrieval, transfer, and application (Alavi & Leidner, 2001). Not all KM initiatives involve an implementation of IT, but many KM initiatives rely on IT as an important enabler (Bhatt, Gupta & Sharma, 2007; Davenport & Prusak, 1998). The objective of KMS is to reveal three common applications: the coding and sharing of best practices; the creation of corporate knowledge directories; and the creation of knowledge networks (Alavi & Leidner, 2001). Critical to KMS, information technologies, customer relationship management (CRM) and business intelligence (BI) for example, assist in speeding up communications, eliciting tacit knowledge, and improving customer service (Housel & Bell, 2000; Galy & LeMaster, 2006). There is no single role of IT in knowledge management just as there is no single technology comprising KMS. The potential benefits of KMS include productivity and quality improvements in key areas such as product reliability, customer service, and productivity. KMS is thus expected to enhance firm performance through efficiency and effectiveness gains. Some organizations that have reaped the benefits of KMS are summarized in Table 1.

**Table 1: Potential Benefits of Adopting KMS.**

Company	Source	Potential Benefits
IBM	Massey, et al, 2001	Nearly two-thirds of customers find using Inside IBM to be beneficial. Customers identified key benefits including easy to access information for problem resolution and ease of purchasing. Essentially, Inside IBM assured that IBM would be available and ready to meet their needs.
General Motors	Alexander, Cafeo, Gibbons & Lesperance, (2002).	Develop the KMS seed system in key communities of practice and then encourage its customization and spread throughout the enterprise. This has the benefits of worker buy-in and adoption of the KMS to their workflows.

Buckman Laboratories	Zack (1998)	Transfer of knowledge and best practices system helped push new product-related revenues up 10 percentage points, a 50% increase since 1992.
Texas Instruments	Davenport & Prusak (1998)	TI generated US\$ 1.5 billion in annual free wafer fabrication capacity by comparing and transferring best practices among its existing 13 fabrication plants.
Dow Chemical	Davenport & Prusak (1998)	Early efforts to manage intellectual capital brought an immediate cut of US\$ 40 million in savings.
Chevron	Housel & Bell (2000)	Chevron's network of 100 people who share ideas on energy-use management has generated an initial US\$ 150 million savings in Chevron's annual power and fuel expense. The objective of the knowledge community is to share and implement ideas to reduce company-wide energy costs and waste.

### *Adoption of KMS and Firm Performance*

This study is based on examining empirically the argument that KMS play a central role in the creation and realization of knowledge-based synergies across different business functional units of KMS adopters. Previous research indicates that a successful adoption of Information Systems (IS) which support business strategies can help the firms gain a superior financial performance (Bharadwaj, 2000; Goran, 2005; Hayes, Hunton & Reck, 2001; Hitt, Wu & Zhou, 2002; Hunton, Lippincott & Reck, 2003). KMS, as a class of specific *IS* applied to manage organizational knowledge, can facilitate the efficient and effective sharing of a firm's intellectual resources (Poston & Speier, 2005), and as such may produce long-term sustainable competitive advantage (Alavi & Leidner, 2001; Evans & Neu, 2008; Spender & Grant, 1996; Teece, 1998).

KMS adopters generally believe that the value of KMS will exceed its cost. From the knowledge-based view, firms can devise strategies to create and sustain advantages from investments in IT (Duliba, Kauffman & Lucas, 2001). Researchers have shown that a firm's ability to effectively leverage its IT investments by developing the strong IT capability can result in a better firm performance (Bharadwaj, 2000; Santhanam & Hartono, 2003). Based on the knowledge-based view, this study hypothesizes that KMS adopters could add more business profits and decrease costs through creating knowledge-based synergies than non-adopters. KMS could increase KM capability and firm performance by facilitating exchange of knowledge resources and business intelligence across the business functional units.

This study examines the firm performance using a set of financial criteria. It is expected that, other things being equal, KMS adopters will outperform their counterparts who do not implement KMS. Differential measures have been used in former studies to examine the long-term performance pertaining to competitors (Bharadwaj, 2000; Santhanam & Hartono, 2003). The first hypothesis of the research is:

*H1: Firms that adopt KMS will have better financial performance ratios than those of non-adopters.*

### ***DuPont Analysis of the Firm Performance KMS Adopters***

A firm's value of creating historical performance and future potential can be monitored through the use of the DuPont Analysis. Developed by scientists at DuPont Company to track the firm's performance in its diversified investments about a century ago, this method looks at net profit margin (NPM) and asset turnover (ATO) as the building blocks to return on assets (ROA). The DuPont Analysis can help to identify and quantify value drivers and ultimately develop strategies to improve ROA (Evans & Bishop, 2002). Increased efficiency is likely to show up in efficiency measures such as inventory turnover and total asset turnover. In addition, increased efficiency will appear in profitability measures such as gross profit margin and net profit margin to the extent that fixed costs are a component of the cost of produced goods (Dehning & Stratopoulos, 2002). Fairfield and Yohn (2001) provide evidence that disaggregating ROA into ATO and NPM does not provide incremental information for forecasting the change in ROA one year ahead, but that disaggregating the change in ROA into the change in ATO and the change in NPM is useful in forecasting the change in return on assets one year ahead. DuPont Analysis makes a simultaneous analysis of efficiency and profitability possible. DuPont Analysis also shows that the NPM and ATO interact to determine ROA.

A practical reason for employing ROA to evaluate IT investment is the extent of ROA as a measure of firm performance. ROA measures the accounting income return to a company for each dollar of assets employed in the business. As shown in equation (1), this can be expressed as a mathematical formula, consisting of a profitability measure (NPM) and efficiency measure (ATO). NPM measures income from ongoing operations per dollar of sales, while ATO measures how many dollars in sales of the firm is able to produce for each dollar invested in total assets. In other words, how efficiently does management utilize corporate assets to generate sales (Dehning & Stratopoulos, 2002; Evans & Morton, 2004)? This study proposes the use of the DuPont framework to address the following research question: "Where do we expect to see the performance payoff for firms adopting KMS?" The answer to this question will come from the DuPont analysis of the differences in ROA, NPM, and ATO between KMS adopters and non-adopters.

$$\text{Return on Assets (ROA)} = \text{Net Profit Margin (NPM)} \times \text{Total Asset Turnover (ATO)} \quad (1)$$

Based on the above discussion, this study proposes the second research hypothesis:

*H2: Firms that adopt KMS will have improved profitability and efficiency in firm performance than non-adopters.*

### **PERFORMANCE MEASUREMENT**

Firms that adopt KMS might have increased revenues or decreased costs a few years after the implementation of KMS. Researchers have examined the potential performance benefits from information systems at the level of the economy, industry, business, and individual (Alexander, Cafeo, Gibbons & Lesperance, 2002; Javier & Oscar, 2005; Liu, Olfman & Ryan, 2005; Poston & Speier, 2005; Shin, 2004). Although inconclusive, this body of research suggests that adopting KMS can in some circumstances provide significant individual and organizational benefits. Traditional financial variables are most likely to capture the impacts of this adoption over a period of time. Hence, this study uses a set of well-established financial measures of firm performance.

Studies examining a firm's financial performance due to IT adoption have employed a number of profit and cost ratios (Bharadwaj, 2000; Biggart & Gargeya, 2002; Boyd, Kronk & Skinner, 2002; Goran, 2005; Santhanam & Hartono, 2003). As a result, this study measures financial performance using a set of six commonly-used financial indicators, including return on assets (ROA), return on sales (ROS), operating income to assets (OPINA), selling, general and administrative expenses to sales (SGAS), total operating expenses to sales (OEXPS), and total number of employees to sales (EMPREV). The first two ratios, return on assets (ROA) and return on sales (ROS) have been widely used in the IS literature as measures of IS investment on the firm performance and enterprise value (Bharadwaj, 2000; Hitt & Brynjolfsson, 1996; Rai & Patnayakuni, 1997; Santhanam & Hartono, 2003; Tam, 1998). ROA has been shown related to several other measures of financial performance and as the best overall measure of firm performance because ROA incorporates both business profitability and enterprise efficiency (Bharadwaj, 2000). The ROS measure, which is the ratio of net income to sales, serves as another indicator of a firm's net profit margin (Bharadwaj, 2000; Dehning & Stratopoulos, 2002). The operating income to assets (OPINA) focuses on operating returns only and excludes incomes earned by the business from other sources such as interest income and income from other extraordinary sources. The operating income is regarded as a more appropriate measure of the direct value of IT investment (Bharadwaj, 2000; Santhanam & Hartono, 2003).

Selling, general, and administrative (SG&A) expenses are periodical overhead costs, not directly related to the acquisition or production of goods. Selling expenses result from the company's efforts to make sales, while general and administrative expenses result from the general administration of company's operations (Amir & Lev, 1996; Bharadwaj, 2000; Poston & Grabski, 2001). The operating expense and SG&A expenses are the generally accepted accounting measures for the production and overhead costs of a firm (Bharadwaj, 2000; Santhanam & Hartono, 2003). The number of employees to sales (EMPREV) is used as a measure of the productivity per employee (Henderson, Swamidass & Byrd, 2004; Hitt, Wu & Zhou, 2002; Poston & Grabski, 2001). Though the literature review turns out six commonly-used financial measures, Table 2 lists eight variables because NPM and ATO can be derived from ROA. As mentioned before that DuPont Analysis will yield more insights of firm performance by breaking down ROA into NPM and ATO.

Table 2: The Interpretation and Calculation of Financial Performance Measures

Ratio	Description	Research	Calculation	Interpretation
<b>SGAS</b>	Selling & general administration expenses to	Bharadwaj; Henderson, et al; Poston & Grabski; Santhanam & Hartono	SG&A expenses expense divided by sales. SG&A expenses are not directly related to the acquisition or	<i>Cost measure</i> : the costs that are not directly related to the acquisition or production of goods; the <b>lower</b> ratio indicates more profitability.
<b>OEXPS</b>	Operating expense to sales	Bharadwaj; Mitra & Chaya; Santhanam & Hartono	Operating expenses is the sum of cost of good sold to sales (COG&S) and SG&A divided by sales.	<i>Cost measure</i> : a firm's total cost of operations; the <b>lower</b> ratio indicates more profitability.
<b>EMPRE V</b>	Revenue per employee	Hitt, et al; Poston & Grabski; Zhu & Kraemer	Total number of employees divided by net sales for the period.	<i>Productivity measure</i> : the <b>lower</b> ratio indicates more productivity per employee.
<b>OPINA</b>	Operating income to assets	Bharadwaj; Santhanam & Hartono	Operating income is earnings before taxes and depreciation divided by	<i>Profitability measure</i> : the direct value of IT; the <b>higher</b> ratio indicates more profitability.
<b>ROA</b>	Return on assets	Bharadwaj; Brynjolfsson & Hitt;; Goran; Hunton, et al; Santhanam & Hartono	Pretax income available to common shareholders from continuing operations divided by average total assets.	<i>Profitability measure</i> : the <b>higher</b> ratio indicates efficient operation of firm without regard to its financial structure.
<b>ROS</b>	Return on sales	Bharadwaj; Hunton, et al; Rai & Patnayakuni	Pretax income before extraordinary items divided by net sales for the period.	<i>Profitability measure</i> : the <b>higher</b> ratio indicates more profitability.
<b>NPM</b>	Net profit margin	Dehning& Stratopoulos; Hitt, et al; Zhu & Kraemer	Net income from continuing operations divided by net sales.	<i>Profitability measure</i> : the <b>higher</b> ratio indicates high profit generated by sales.
<b>ATO</b>	Asset turnover	Dehning& Stratopoulos; Hitt, et al	Net sales divided by average total assets.	<i>Efficiency measure</i> : the <b>higher</b> ratio indicates high level of sales generate total assets.



## THE RESEARCH METHOD AND DATA COLLECTION

### *Data Collection*

Identifying those companies who have implemented KMS proved to be an interesting and on-going challenge. For competitive reasons, most companies prefer not to make public their adoption of KMS. KMS vendors, on the other hand, wishing to promote their products and capabilities, often eagerly make public announcements whenever individual companies purchase or implement their systems. In this study, we relied on public announcements about KMS from both of these sources. We did not, however, include any public announcement from outside public auditing firms (Hayes, Hunton & Reck, 2001; Stone & Warsono, 2003).

The search for adopters began by carefully selecting “qualified KMS vendors” from the distinguished trade publication in the KM industry, the *KM World Magazine*. It lists the top 100 KMS companies in its March 2003 issue. We then conducted an initial computer search of Reuters.com, looking for any relevant announcements provided by KMS vendors. We found that Reuters only published such adopting announcement starting in the year 1999. In order to overcome this limitation and to increase our research sample size, we next searched for additional adopting firms within the Lexis-Nexis Academic Universe's News Wire Service Reports website. Lexis-Nexis includes five leading news sources-*Business Wire*, *PR Newswire*, *The New York Times*, *The San Francisco Chronicle*, and *USA Today*. We searched for announcements containing the following words: “knowledge management,” “document management,” “content management,” “business intelligence,” and “knowledge management system.” These key terms, while not exhaustive, are closely-related to widely employed KM terminology.

The initial search of the Reuters and Lexis-Nexis databases disclosed 6536 public announcements of KMS implementations during the period January 1, 1995 to October 31, 2004. Each of these announcements was then individually examined in terms of validity and possible redundancy. To maintain our focus on just KMS adoptions, we filtered out all “general business announcements”, dealing with such things as general trends in KM, announcements of partnerships between two or more KMS vendors, or the sales or performance data of a specific KM product from a vendor's perspective. After all these were eliminated, there remained 673 cases. Each announcement was associated with a specific identifiable company.

We next sought to obtain the financial statements from these companies as input data for our study. Our source was the Standard & Poor's COMPUSTAT database. COMPUSTAT, however, contains the financial statements only of publicly-traded companies. COMPUSTAT lists all publicly-traded companies in NYSE, NASDAQ, and Amex. Many of the listed firms are global companies with headquarters in Canada, Europe, South America, and Asia countries. This data collection limitation further reduced our sample by eliminating all announcements pertaining to non-profit organizations, government agencies, and privately held companies and KMS vendors. In a calculated decision to remain very conservative in our sample selection process, we also then decided to remove from our dataset any KMS adopting companies which had been mentioned in any separate announcements dealing with mergers, acquisition, or spin-offs. When all these eliminations had been completed, we were left with a remaining new sample of 270 KMS adopting firms.

Our intention was to measure the subsequent financial results of those adopting firms over an extended time period. IS literature has earlier indicated that it usually takes at least one year to see the impact of the implementation of IS within organizations (Brook, May & Mishra, 2001; Brynjolfsson & Hitt, 1996; Brynjolfsson & Hitt, 1998). This study followed the literature suggestions and did not include financial data observed in the year immediately following any

announced KMS adoption. Although this restriction effectively acted to further reduce our sample size, we felt it was necessary to examine firm performance fully and objectively.

In order to participate in our longitudinal study, therefore, each participating firm needed to have reported financial data covering a continuous three-year period. That information was not available in all instances, and further excluded all those firms that reportedly adopted KMS after 2001. In the end, the net result of these various exclusion processes was the identification and selection of a final sample of 103 KMS adopter firms.

In this study's we wanted to fairly examine the available evidence to see if KMS adoption improves company performance over time, *on a comparative firm wide basis*. Eliashberg and Chatterjee (1985) earlier demonstrated that the financial performance of IT adopters may or may not improve significantly, depending on a host of exogenous factors such as competitive intensity, industry heterogeneity, demand uncertainty, and adoption rate of competitor firms. Nevertheless, we might expect that the relative performance of KMS non-adopters would likely deteriorate in a competitive marketplace down the road. If so, these differences should be clearly visible to those looking at the financial data of the various firms over time. To be fair those comparisons ought to be done using pair-wise data from adopting and non-adopting firms, each drawn from the same COMPUSTAT database. Similar methodologies have been employed in previous studies to compare firm performance between two groups of firms with similar size (Barber & Lyon, 1996; Bharadwaj, 2000; Hunton, Lippincott & Reck, 2003).

Finding the proper control match was an important consideration in this study. A two-step process was used to identify a matching firm for each of the 103 KMS adopter firms. First, we selected an individual KMS adopting firm. We then examined any firms which had the same primary four-digit SIC code of that KMS adopter. Obviously, none of the other KMS adopters were eligible to be considered as a matching firm. Next, from the set of potential control firms, a "matching" control firm was chosen, but only if it had both a similar total assets and net sales level to that of the KMS adopter. If there was more than one control firm which fit these criteria in COMPUSTAT, a random number table was applied to determine the selected control firm.

Matching the firm size and the industry type helped rule out possible confounding bias in comparing two homogeneous groups. Moreover, in order to help decrease the likelihood that no actual KMS adopters were incorrectly included in the control sample, we conducted a final follow-up data survey to determine whether or not that potentially identified control firms had indeed actually adopted KMS. With respect to the KMS non-adopters, we performed a Boolean search using the control firm name and previously-used KM related keywords at both theReuters.com and the Lexis-Nexis Web sites. Adjustments were made as necessary. In the end, none of the firms considered as specific, non- KMS adopting matching firms had any news wire disclosures related to possible KMS

### ***Research Model Specification***

Hypothesis one states that the differential financial performance of KMS adopting firms is significantly better than that of the non-adopting counterparts. Barber and Lyon (1996) point out that in addition to controlling for industry type and firm size, firm's previous performance should be controlled in model testing for abnormal firm performance. We therefore devised the variable,  $\Delta PERF_{iPRE}$ , in our research model to represent such a lagged performance measure. We chose to compare the financial performance between KMS adopters and KMS non-adopters, using the basic regression model shown in formula 2.

adoption.

A series of six (6) separate regression studies were conducted using data from all 214 firms



(adopting and non-adopting) in our study. In each case, one specific financial ratio was studied both before and after KMS adoption. In each regression model a “dummy variable” was included to differentiate KMS adopters versus non-adopters. More formally,

$$\Delta PERF_{iPOST} = f(\Delta PERF_{iPRE}, KMS \text{ Adoption}) + \varepsilon \quad (2)$$

$\Delta PERF_{iPOST}$  = the difference in financial performance in the  $i$ th pair between the KMS adopter and non-adopter in year  $t$ . Year  $t_0$  is the baseline year.

Each one of the following financial performance indicators was separately analyzed:  $\Delta ROA$ ,  $\Delta ROS$ ,  $\Delta OPINA$ ,  $\Delta SGAS$ ,  $\Delta OEXPS$  and  $\Delta EMPREV$ . Three time periods were considered:  $t_{+1}$  (one year after KMS adoption),  $t_{+2}$  (two years after KMS adoption), and  $t_{+3}$  (three years after KMS adoption).

$\Delta PERF_{iPRE}$  = the difference in financial performance in the  $i$ th pair of KMS adopting and matched firm for the time period  $t_{-1}$  preceding to the KMS adoption for all ratios and;

$KMS \text{ Adoption}$  = a dummy variable, which takes the value of  $KMS \text{ Adoption} = 0$  if the firm is a non-adopter, and 1 if the firm is a KMS adopter; and  $\varepsilon$  is the error term.

In each regression, we were partially interested in the statistical significance of the coefficient in front of the dummy variable. Its role was to indicate whether or not adopting KMS generated an incremental effect on the firm’s financial performance.

## RESULTS

### Descriptive Statistics

Prior to running the various regressions, a final check on the composition of the resultant two groups was conducted. Using a t-test of group means, we looked for any initial size differences between the KMS adopters and KMS non-adopters. The two sample groups appear to be well matched based on firm size since the results of means from the t-test does not show any significant differences between the two groups. Table 3 depicts the descriptive statistics for each of these performance ratios for both groups.

**Table 3: Descriptive Statistics and Mean Tests Results.**

Item	Sample	N	Mean	Std. deviation	t statistic	P value
Time= $t_{-1}$						
Total Asset	KMS adopters	103	33.79	77.04	0.162	0.872
	Non-adopters	103	33.01	82.40		

Net Sales	KMS adopters	103	16.06	29.19	0.850	0.397
	Non-adopters	103	14.78	31.28		
Time= $t_0$						
Total Asset	KMS adopters	103	39.15	86.79	0.054	0.957
	Non-adopters	103	39.42	101.64		
Net Sales	KMS adopters	103	19.32	33.61	1.026	0.307
	Non-adopters	103	16.55	34.13		

There are no significant differences between KMS adopters and non-adopters in terms of total asset and sales, which usually determine the size of the firm with the significant level at .05 and dollar amounts in billion \$.

### *Hypothesis 1*

Table 4 shows the results of the regression analysis between KMS adopters and non-adopters. As mentioned, both profit and cost ratios were analyzed. It is important to note that if KMS matters, a positive coefficient of the dummy variable should be associated with profit ratios, while a negative coefficient ahead of the dummy variable should be associated with cost ratios. Table 4 has three sections to show the longitudinal results in three time periods:  $t_{+3}$ ,  $t_{+2}$ , and  $t_{+1}$ .

Within the cost ratios studied, the results indicate that selling and general administration expenses divided by sales (SGAS) are significantly different between KMS adopters and non-adopters in three consecutive years. The results of the number of employees divided by sales (EMPREV) and the operating expense divided by sales (OEXPS) are significantly different between KMS adopters and non-adopters in the first year, but not significant in the second and third years.

Within the profit ratios studied, the ROA of adopters differs significantly from non-adopters in all three consecutive years. The result of ROS analysis also evidences significant different results between KMS adopters and non-adopters in the first and second years, but is insignificant in the third year. Operating income divided by asset (OPINA) is once again significantly different between KMS adopters and non-adopters in the third year, but is insignificant in the first and second years. Overall, the test results of both ROA and SGAS do support Hypothesis 1. The other financial ratios show mixed results and can not be said to support Hypothesis 1 in this longitudinal study.

### *Hypothesis 2*

The ROA results shown above in Table 4 indicate better outcomes for KMS adopters than non-adopters during each of the three studied years. Further insight into this positive result was obtained upon conducting a DuPont Analysis of the data. Two additional financial variables were individually regressed in an attempt to assess the impact of KMS adoption on 1) relative firm efficiency via asset turnover (ATO) ratio, and 2) relative firm "profitability" via net profit margin (NPM).

These latest results are also shown in Table 4, and both indicate once again better outcomes for KMS adopters than non-adopters during each of the consecutive years. (Recall from Table 3, that

initially neither ATO nor NPM had been shown to be significantly different either before KMS adoption or during the year when KMS adoption is announced.) Yet, after three years of adopting KMS ( $t_{+1}$ ,  $t_{+2}$ ,  $t_{+3}$ ), except for the net profit margin in the second year, both asset turnover and net profit margin are shown to be different in the two groups.

H1: *Firms that adopt KMS will show greater performance as measured by financial performance ratios than non-adopters with the same firm size and industry.*

**Table 4: Results of Hypothesis Tests.**

<b>Three-Year Differential Performance Post-Adoption</b>	<b>Differential Performance Pre-Adoption</b>	<b>KMS Adoption</b>	<b>Adjusted R<sup>2</sup></b>
$\Delta$ ROA $t_{+3}$	0.246 (4.777) **	<b>12.730 (2.754) **</b>	R <sup>2</sup> =0.277
$\Delta$ ROA $t_{+2}$	0.465 (2.738) **	<b>22.081 (1.720) *</b>	R <sup>2</sup> =0.222
$\Delta$ ROA $t_{+1}$	0.258 (2.351) **	<b>17.716 (2.135) **</b>	R <sup>2</sup> =0.219
$\Delta$ OPINA $t_{+3}$	0.270 (7.005) **	<b>0.063 (2.196) **</b>	R <sup>2</sup> =0.302
$\Delta$ OPINA $t_{+2}$	0.287 (6.406) **	0.029 (0.963)	R <sup>2</sup> =0.425
$\Delta$ OPINA $t_{+1}$	0.359 (7.361) **	0.035 (1.073)	R <sup>2</sup> =0.227
$\Delta$ ROS $t_{+3}$	0.270 (4.905) **	0.134 (0.794)	R <sup>2</sup> =0.272
$\Delta$ ROS $t_{+2}$	0.225 (3.191) **	<b>0.178 (1.900) *</b>	R <sup>2</sup> =0.230
$\Delta$ ROS $t_{+1}$	0.624 (7.319) **	<b>0.624 (2.116) **</b>	R <sup>2</sup> =0.232
$\Delta$ SGAS $t_{+3}$	0.267 (6.262) **	<b>0.093 (-1.900) *</b>	R <sup>2</sup> =0.249
$\Delta$ SGAS $t_{+2}$	0.670 (5.830) **	<b>-0.245 (-1.715) *</b>	R <sup>2</sup> =0.237
$\Delta$ SGAS $t_{+1}$	0.771 (7.099) **	<b>-0.257 (-1.907) *</b>	R <sup>2</sup> =0.244
$\Delta$ OEEXPS $t_{+3}$	0.083 (2.438) **	-0.092 (-1.218)	R <sup>2</sup> =0.240
$\Delta$ OEEXPS $t_{+2}$	0.120 (5.866) **	-0.037 (-0.798)	R <sup>2</sup> =0.423
$\Delta$ OEEXPS $t_{+1}$	0.365 (5.265) **	<b>-0.266(-1.700) *</b>	R <sup>2</sup> =0.400
$\Delta$ EMPREV $t_{+3}$	0.186 (5.849) **	0.001 (-0.846)	R <sup>2</sup> =0.246
$\Delta$ EMPREV $t_{+2}$	0.150 (5.514) **	0.003 (-0.152)	R <sup>2</sup> =0.378
$\Delta$ EMPREV $t_{+1}$	0.286 (11.871) **	<b>0.001 (-2.171) **</b>	R <sup>2</sup> =0.436

\*\* Significant at 0.05 level and \* Significant at 0.10 level.

'**Bold**' figures indicate instances where the KMS adopters performed better than non-adopters.

Asset turnover reflects the firm's efficiency of asset utilization to achieve firm performance. As a

result, we believe Hypothesis 2 is strongly supported with these ATO results. This result is in line with other IS research findings. Increased efficiency is the most often cited advantage of IS implementation. Though increased profitability is equally important, NPM results, although positive, here fail to yield a strong support to the Hypothesis 2.

*H2: Firms that adopt KMS will improve profitability and efficiency in firm performance than non-adopters with the same firm size and industry.*

**Table 5: The Results of DuPont Analysis.**

KMS Adopters vs. Non-adopters					
	t <sub>-1</sub>	t <sub>0</sub>	t <sub>+1</sub>	t <sub>+2</sub>	t <sub>+3</sub>
ROA					
t	0.026	1.542	2.135	1.720	2.754
P value	(0.980)	(0.126)	<b>(0.034) **</b>	<b>(0.087) *</b>	<b>(0.008) **</b>
NPM					
t	1.264	1.513	2.874	1.398	3.012
P value	(0.209)	(0.133)	<b>(0.005) **</b>	(0.165)	<b>(0.004) **</b>
ATO					
t	1.066	1.344	2.643	1.809	1.690
P value	(0.289)	(0.182)	<b>(0.010) **</b>	<b>(0.073) *</b>	<b>(0.096) *</b>

\*\* Significant at 0.05 level and \* Significant at 0.10 level.

'**Bold**' figures indicate instances where the KMS adopters performed better than non-adopters.

## CONCLUSION

### *Research Findings and Implications*

Using a matched pair design to compare KMS adopters and non-adopters, this study examines the longitudinal impact of adopting KMS on firm performance. According to the statistical results, significant findings are found in most of the cost ratios. The results indicate a significant difference of administrative expenses (SGAS) in all three consecutive years after firm implementing KMS. The operating expenses to sales (OEXPS) and the number of employee to sales (EMPREV) are significantly different in the first year between KMS adopters and non-adopters. The main purposes of KMS are to reduce administrative expenses and to improve employee productivity by maximizing firm's KM capability. This study supports the claim that firms adopting KMS do reduce the administrative expenses and also strengthen employee productivity at some degree. The other cost ratio, OEXPS, shows significant performance in the first year after KMS adoption but fail to show any significant result of reducing operating expense to sales in the second and third year.

As to the profit ratios, the results show that there is a significant difference of the return on assets

(ROA) between KMS adopters and non-adopters in all three years. The results of return on sales (ROS) are significantly different between KMS adopter and non-adopters in the first and second years. The operating income to assets (OPINA) is significantly different between KMS adopter and non-adopters in the third year. The results of the DuPont Analysis provide an in-depth look at the firm performance in terms of efficiency and profitability after the implementation of KMS. Corporate efficiency can be achieved by implementing KMS. This result is consistent with findings in previous IS research such as efficiency increased after the implementation of an ERP system. Profitability is the bottom line of business. From DuPont Analysis, NPM did not show promising results of increased profitability after the implementation of KMS. The findings thus provide new insights into the productivity paradox associated with KMS adopters. This study finds that KMS adopting firms will gain efficiency such as agility, a competitive advantage over non-adopters. However, firms that implemented KMS have not achieved the leverage effect on the overall profitability.

### **Research Limitations and Future Research**

As one of the first papers to investigate the effects of the implementation of KMS on firm performance across industry sectors, this study makes contribution to the IS literature by applying DuPont Analysis to further examine the firm performance of profitability and efficiency. There are some limitations in this study. First, this study uses the Reuters.com to search for KMS adopters. Reuters.com only lists news announcements after 1999. Other major portals that carry business news such as CNNfn.com, Yahoo.com and MSN.com all have the same cutoff date of 1999. Under this constraint, this study searches the Lexis-Nexis databases for KMS adopters as a remedy. Some KMS adopters may be still left out if they chose not to be reported.

Second, the COMPUSTAT publishes the financial data of publicly-traded companies. This study does not examine the effects of KMS adoption on private companies, non-profit organizations, and government agencies due to lack of data. Third, to examine the long-term impacts of KMS adoption, this study selects firms that adopt KMS before 2001, which have at least three-year financial data for this research. This three-year timeframe may fall short to capture some longer term effects of the implementation of KMS on firm performance. Finally, another limitation of this study lies in the additional value associated with capturing and controlling for variables that reflect the level of success of KMS adoption. Other financial metrics such as Tobin q could be applied to measure the firm performance during the KMS transformational period (Chen & Lee, 1995).

This research has introduced a theory-based foundation on discovering the causal relationship between KMS adoption and firm performance. We believe this study has broken the ground and paves a path for future KM research in firm performance. Further in-depth research is needed to study other important issues that may influence the relationship of KMS adoption and financial performance while controlling other exogenous factors. Future research could be conducted to see the longitudinal effects by adding data of subsequent years. Moreover, prospective researchers might test these hypotheses through survey or case study. Finally, it would be useful to examine other firm-specific factors, such as intangible assets or intellectual capital that could also affect firm performance.

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