MEASURING KNOWLEDGE MANAGEMENT:
A NEW INDICATOR OF INNOVATION IN ENTERPRISES

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Introduction

For at least three decades governments have measured the input of resources to national R&D programs in the firm belief that R&D has a positive, if indefinable, effect on economic growth. The first theoretical constructs of the benefits of S&T knowledge focused on the "linear" model of innovation where an investment in R&D would eventually lead to wealth creation or a social benefit. There were intervening steps where the technologies resulting from R&D were developed and commercialized, but the model suggested that resources expended on R&D would inevitably result in some good at the end of the chain, and that incremental R&D resources would result in incremental benefits. Current theories take a much wider view of the innovative process, and recognize that R&D is only one of several inputs to wealth generation and social progress within a complex socioeconomic system.

The Centre for Policy Research on Science and Technology (CPROST) at Simon Fraser University in collaboration with the Centre for Policy Studies in Education (CPSE) at the University of British Columbia has established a major multi-year, multi-phase project to study innovation in smaller economies. This research has two main goals:

1. To develop analytic tools for examining Regional Systems of Innovation for policy makers. (de la Mothe,1998 ; Edquist, 1997; Lundvall, 1992)

2. To identify and design new indicators of innovation and knowledge-creation in this context.

In the first phase of this project, firms in the Lower Mainland of British Columbia, the main urban area of the province, were surveyed using a short form questionnaire (two sides of a single page) based on the Oslo Manual, 2nd edition. (OECD, 1997) This questionnaire was qualitatively tested by focus groups. Holbrook and Hughes have reported the results of the first phase of the project. (Holbrook & Hughes, 1998) The second phase of the project was to conduct the survey in a non-metropolitan region, in this case the Okanagan region of south-central British Columbia. This paper draws on the results of the second phase of this project.

Concurrent with this project, CPROST was also conducting another project developing a quantitative tool to assist financial institutions in assessing the risk of investing in small and start-up knowledge-based enterprises (KBEs), by evaluating the innovative and absorptive capacity of these firms. This research primarily drew on management research, particularly literature on management of innovation (MOI), management of technological change (MOT), and knowledge management (KM). It occurred to the researchers that a synthesis of these two projects might yield some interesting results. Policy studies are usually more concerned with the inputs and outputs of systems of innovation Ð that is, with knowledge transfer rather than knowledge creation. On the other hand, management research, heavily dependent on case studies and interested mainly in “best practices”, rarely tests its theories empirically. We therefore decided to incorporate some of the ideas from management research, particularly the knowledge management (KM) literature, into the second phase of the regional systems of innovation project.

Innovation and Knowledge Management

The Oslo Manual is based on Josef Schumpeter’s definition (Schumpeter, 1949) of innovation, which has five elements (OECD, 1997):

1. the introduction of a new product or a qualitative change to an existing product;
2. the introduction of a process new to an industry;
3. the opening of a new market;
4. the development of new sources of supply for raw materials or other inputs;
5. changes in industrial organization.

The Oslo Manual, however, only considers the first two elements of the definition. Generally speaking, Oslo-type research treats innovation as the *introduction* of a new product or process within a given period. Innovation is also heavily dependent on science and technology (S&T) and therefore technological research and development (R&D). However, our research in the first phase of this project led us to two slightly different conclusions.

The first has to do with the term *introduce*. In our focus groups, participants pointed out that for a firm to simply introduce a new product was not necessarily innovative Ð the innovative product was the *first* to be introduced to its market. In other words, a product had to be both *new* and *uniqu*e. This distinction did not occur to the authors of the Oslo Manual. In the European context in which the Oslo Manual was developed, and within which much of the research is conducted, the *introduction* of a new product implies "first into the market". *Introduction* therefore contains both *new* and *uniqu*e. Not so in North America, where products such as soap powder or have been "introduced" almost annually for the better part of a century. In this context, *introduce* is a marketing term and nothing more.

As a result, and unlike other Canadian surveys, we required that for firm to be considered innovative, a product or process introduced in the past five years had to be both *new* and *uniqu*e. By "unique," we refer simply to a product's singularity within its market – that market may indeed be national or global, but it may only be regional or local. A product or firm that meets both of these criteria is considered innovative, and this "New & Unique" indicator is used in both the first and second phase analyses as the basic indicator of innovation.

The second conclusion from our first phase of research has to do with the relationship between innovation and S&T. Simply put, innovative firms responded similarly to our survey, *regardless of industrial secto*r. Innovation was not restricted to high technology. Firms in low technology and/or resource-based industries, which are of great interest to policy makers in BC, were also innovative. 1 These innovative low tech, or "policy sector" firms had more in common with the innovative high tech firms than did innovative and non-innovative firms in the same sectors. This conclusion led us to ask, *What characteristics do innovative firms in diverse industrial sectors share?* We decided to look for these characteristics in the firms' management practices, and in particular those practices referred to in the literature as *Knowledge Management* (KM).

Table 1: Knowledge Management Questions

Survey Questions	Reference	Question	Knowledge Management Issue
5	**KM1**	Does your company currently allocate any resources(time, money, and/or effort) to the development of new products and/or processes?	Knowledge Building
7.1	**KM2**	Is there one person in your company responsible for innovation?	Leadership
7.2	**KM3**	Is your company able to measure the quality and effectiveness of its innovation practices?	Performance Measurement
7.3	**KM4**	Does your company have any strategies in place to monitor current and potential competitors?	Competitive Intelligence
7.4	**KM5**	Does your company have any strategies in place to identify, make and manage strategic alliances?	Strategic Alliances
7.5	**KM6**	Does your company use any formal methods of forecasting and/or trend analysis?	Strategic Forecasting
8.2	**KM7**	Do [your company's]] training /education programs [if any] have provisions to incubate and spin-out new products and processes?	Human Resource Development
10	**KM8**	Would you like to receive a copy of the results of this survey, with your company positioned against the overall results for your industrial sector?	Leadership, Performance Measurement

Knowledge management (KM) is a relatively new concept in the literature of management research. It describes a set of practices that, taken together, treat knowledge as an asset to be managed in much the same way as capital. One of the focus groups in the first phase of this research defined innovation as ". . . the creative application of knowledge . . ." (Holbrook & Hughes, 1998). Thus, it might be possible to look for links between knowledge management and innovation, much as the links between financial management (in the form of R&D spending) and innovation.

A review of the KM literature raised a number of key issues. We developed questions to add to the questionnaire based on these issues. (see Table 1) Each issue was addressed by a single yes-no don't-know question. We were not, however, probing the extent, method, or successes of each of these practices – we simply sought whether the firms were aware of these practices and their supposed benefits.

1. Knowledge Production: Obviously, to manage knowledge, a firm must produce it. The KM literature insists that knowledge production be a central part of the business process. (Leonard-Barton, 1995; Nonaka,1991) An important concept here is *core competencies*, that is, understanding out a firm does well and focusing effort in that direction. (Prahalad & Hamel, 1990) Our survey question, carried forward from phase one for consistency, simply asked whether any effort was expended on knowledge production.

2. Leadership: There are many opinions on the appropriate management style for KM, ranging from a *laissez-faire*, get-out-of-the-way approach, (Quinn, 1985) to a more structured regime (Drucker, 1985). Nevertheless, a common theme in the literature is the need for a single, high-level manager responsible for innnovation.

3. Performance Measurement: Management practice demands that any considerable effort be justified, and this holds true for KM. It is important to link the efforts expended to bottom-line (or other) results. An extensive effort in this direction is presented by Chiesa, Coughlan, and Voss (Chiesa, Coughlan & Voss, 1996), who outline the efforts to build and test an "innovation audit." Our survey simply asks whether the firm is able to measure its innovative practices, without probing either the methods or the results.

4. Competitive Intelligence: It is important for a firm to understand its competitive landscape. To this end, the firm should have a fairly good idea of what its competitors are doing. Competitive intelligence is not simply corporate spying (Attaway, 1998), it is approach to the gathering, assessing, and understanding the firm's environment.

5. Strategic Alliances: This concept builds on the ideas of core competencies. In many circumstances, a firm is going to have to rely on outside sources of knowledge to support its on innovative activities. Alliances may be for short-term, specific projects, or (rarely) long term and open-ended. Allies may be firms in related or unrelated industries; universities, government labs, or other institutions; outside specialists; or non-competing firms or even competitors in the same industry. (Leonard-Barton, 1995) Our question is whether firms consider this important or not.

6. Strategic Forecasting: Strategy is an important part of KM, as opposed to the tactical concerns that have increasingly dominated financial management. Forecasting is more than simple extrapolations based on market conditions Ð it must involve looking at long term socio-economic trends that may or may not affect the firm directly. (Sherry, 1994) It should also involve more formal forecasting techniques, like backcasting or scenario planning. (Schoemaker, 1995)

7. Human Resource Development: The main difference between knowledge assets and financial assets is their form. Knowledge ultimately resides in the heads of the firm's employees. It is therefore critical to KM practice that employees be nurtured and developed as carefully as possible.(Leonard-Barton, 1995) Our survey question, drawn from Amidon (Amidon, 1997), looks at whether a firm is prepared to take advantage of their human resource development efforts.

Methodology

British Columbia is an ideal laboratory for experiments in the measurement of innovation. The economy is simple, with one large metropolitan area, where most of the innovative firms are located, supported by a hinterland whose primary outputs are in the natural resources sector. BC is a relatively separate economic and geographic region so that external influences in the acquisition and adoption of technology are readily noticeable. Thus (in theory) economic measurements in BC should be relatively well behaved and predictable. (Holbrook & Hughes, 1997)

Within BC, the Okanagan Valley forms a distinct economic sub-region. With a population of about 140,000 centred on the city of Kelowna, the region consists of a long, narrow, fertile valley surrounded by the Central Plateau. (Figure 1) Its main economic activities are agricultural (fruit and wine), wood products and tourism.
The region is about 400 km. from Vancouver (about one hour by air). According to BC Stats (1996) the region has 307 high-tech based establishments, approximately 6% of the provincial total. 238 are service based and 69 are manufacturers.

According to survey work carried out by De Wit and Lipsett (De Wit & Lipsett, 1995), while Okanagan companies were on average as likely to be innovative as other firms in BC (which is of course heavily biased by the concentration of high-tech firms in the Greater Vancouver/Lower Mainland area), they were substantially less likely to have accessed the Scientific Research and Experimental Development (SRED) tax credit program.

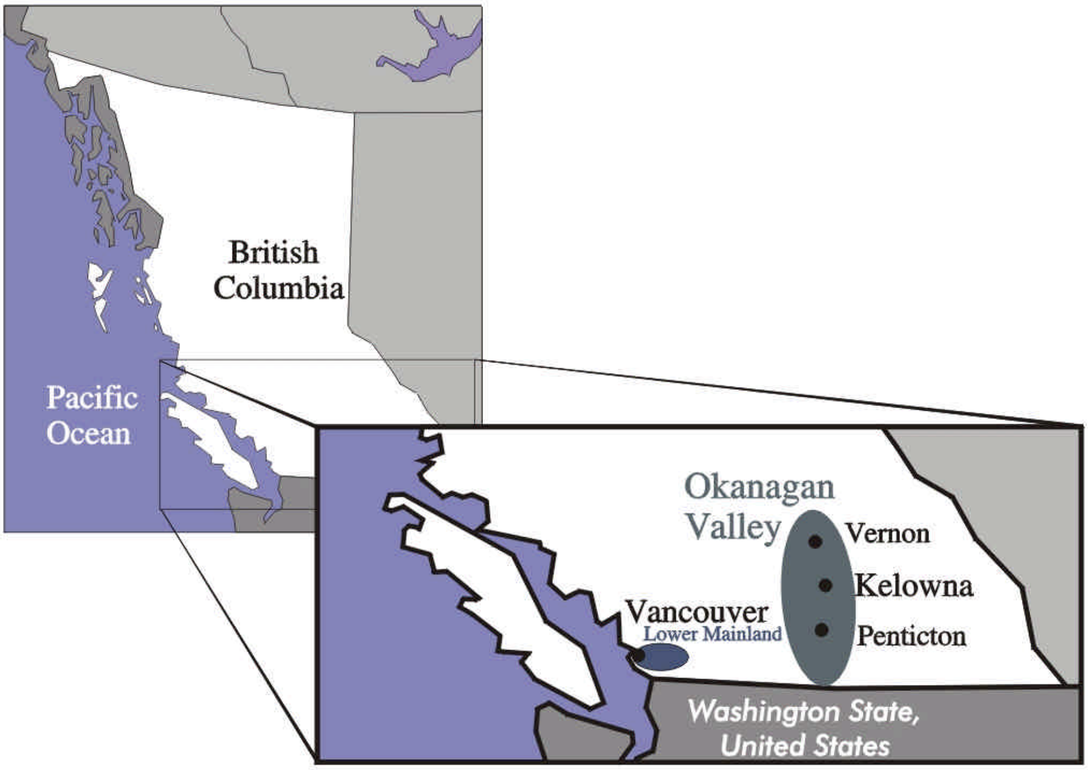

Figure 1: Southern British Columbia

Only 21% of Okanagan firms had used the program compared to 35% of firms in the two metropolitan areas of BC (Vancouver and Victoria)

For these reasons, and with the encouragement and support of the Central Okanagan Regional Development Commission, we decided to carry out the first non-metropolitan study in the Okanagan region.

The questionnaire from the first phase was modified by the addition of the KM questions discussed above. This questionnaire, although not intended to cover all aspects of technological innovation identified in the OECD "Oslo Manual" (OECD, 1997), had to conform to the main points in the OECD standard. To ensure a reasonable response rate, the questionnaire had to be short (no more than one page, printed on both sides) so that it would be user friendly, take little managerial time to complete, be comprehensible to a small technology-based entrepreneur based in BC, and be faxable to expedite its return.

It was decided that two samples be drawn, one from the high-tech sector and one from other areas of policy interest in the BC economy. Only firms with more than 6 employees were surveyed, which accounts for the wide variance in population numbers between our survey frame and those figures reported by BC Stats. (BC Stats, 1997) The sample is a census of the high tech firms in the region, and a random sample of firms in agrifoods, forest products, and construction, drawn from the British Columbia Manufacturers Directory database provided by BC stats.

Table 2: ***Survey Responses by Industrial Sector***

Sector	Responses		New & Unique = Yes		
	N	%	N	Sector %	Total %
High Technology (1)	31	27.9%	22	71.0%	19.8%
Agrifoods	38	34.2%	21	55.3%	18.9%
Construction	15	13.5%	7	46.7%	6.3%
Forest Products	27	24.3%	12	44.4%	10.8%
Total	**111**	**100.0%**	**62**	**55.9%**	

Note (1): "High Technology" is defined by BC Stats

Results

General Results

A total of 204 surveys were sent to firms in four industrial sectors in the Okanagan region of British Columbia. Of these, 111 were completed and returned, giving an overall response rate of 54.4%. Table 2 shows the sectoral breakdown of the responses.

Firms ranged in size from 10 to 500 employees, with the majority, 81.9%, having fewer than 50 employees. The firms also tended to be regional in focus, with 61% of those responding reporting less than 40% of their sales to be outside the province.

A majority of the firms believed that they were innovative. 86% (n = 95) of firms reported having introduced a new product in the past five years, with 65% (n = 62) of these firms reporting that their product was unique. By the New & Unique filter, therefore, 55.6% of the firms responding to the survey were innovative.

Knowledge Management Results

One of the primary goals of this research was to identify any correspondence that may exist between knowledge management practices and “innovation” as identified by Oslo-type research. To this end, a number of analyses were performed.

The first step was to recode the data. For this research, we were specifically looking for firms who were engaged in knowledge management practices. That is, we were looking for positive responses to the survey questions. We thus assumed that firms that answered yes to any of these questions were engaged in these practices, while any other response indicated that they were not. For the purposes of analysis, therefore, responses were grouped into “yes” and “not-yes,” which included negatives, don’t-knows, and non-responses. We felt that this assumption was valid, since if a senior executive at a firm did not understand a question, it is unlikely that the firm is engaged in that practice. The uncoded distributions of responses to the KM questions are shown Table 3.

Table 3: ***Survey Response Distributions***

Survey Qs	Ref #		Yes	No	Don't Know	No Response
5	KM1	#	73	31	2	5
		%	65.8%	27.9%	1.8%	4.5%
7.1	KM2	#	48	61	0	2
		%	43.2%	55.0%	0.0%	1.8%
7.2	KM3	#	61	36	10	4
		%	55.0%	32.4%	9.0%	3.6%
7.3	KM4	#	48	57	4	2
		%	43.2%	51.4%	3.6%	1.8%
7.4	KM5	#	52	52	5	2
		%	46.8%	46.8%	4.5%	1.8%
7.5	KM6	#	41	67	1	2
		%	36.9%	60.4%	0.9%	1.8%
8.2	KM7	#	29	62	7	13
		%	26.1%	55.9%	6.3%	11.7%
10	KM8	#	82	27	0	2
		%	73.9%	24.3%	0.0%	1.8%

The recoded KM results were then analyzed against the New & Unique indicator of innovation, and a second assumption was made: that New & Unique was dependent on the KM practices.

Three different models were constructed for analysis. The first, referred to as KMQ-1, includes variables KM1 through KM7 (please refer to Table 1). This was the original model to be tested. However, we were not entirely confident in the results for the Human Resources Development question KM7 Ð the question was the shakiest from a theoretical viewpoint, and may have been hard to understand. Did this question give us meaningful results?

We decided therefore to test two other models: the one, referred to as KMQ-b, which omitted the HRD question KM7 and added question KM8 (whether the respondent wanted a copy of the survey results); the other, KMQ-c, which included both KM7 and KM8 in the model.

Correlations

Since all the variables in this analysis are categorical and dichotomous, the most appropriate analysis of correlation is crosstabulation. Each of the KM variables was compared to the New & Unique variable, and chi-square and lambda. The Spearman correlation coefficient was also calculated for each crosstabulation, but was not used since the data was deemed to be simply nominal. Table 4 shows the values and significances of chi-square and lambda for each crosstabulation.

Table 4: *Crosstabulation of individual Knowledge Management variables by "New & Unique"*

New & Unique by:	*Ref #*	Pearson Chi-Squared Value	*Significance*	Lambda Value	Significance
Allocate R&D Resources	KM1	24.254	0.000	0.408	0.001
Assign Management Responsibility	KM2	4.009	0.045	0.061	0.705
Measure Innovation Performance	KM3	17.626	0.000	0.327	0.021
Competitive Intelligence Strategy	KM4	2.613	0.106	0.020	0.900
Alliance Strategy	KM5	3.603	0.058	0.061	0.696
Use Formal Forecasting Techniques	KM6	2.636	0.104	0.000	1.000
Leverage Training Programs	KM7	8.758	0.003	0.082	0.658
Want Results of Survey	KM8	3.337	0.068	0.102	0.351

Three of the KM variables exhibit strong correspondence with New & Unique – the probability that these results are attributable to random factors is less than 0.05% -- while a fourth has a significance of less than 5%. These variables are: allocate R&D resources (KM1); assign management responsibility for innovation (KM2); measure innovation performance (KM3); and leverage training programs (KM7).

Analysis of the lambda term yields an indication of the strength and direction of the relationship. Only in the instances of KM1 (allocate R&D resources) and KM3 (measure innovation performance) is there clearly a positive relationship indicated between the two variables. In all other instances, the relationship is either sym- metrical or weakly positive.

It is interesting to note which questions do **not** exhibit significant correspondence – these are the practices that we will refer to, for want of a better term, as "advanced" management techniques: competitive intelligence, alliance strategies, and formal forecasting. It is impossible, however, to draw conclusions from these results Ð are these practices less important in general, or is this result specific to this population or sample? These variables will be examined again later.

Analysis of Variance

For this analysis, the responses to the individual KM questions were summed. This is, in effect, a classification process, where each case is categorized by the number of positive responses given. Three new variables were created: the first, KM-a, was the sum of questions KM1 to KM7; the second, KM-b, was the sum of questions KM1 to KM6 and KM8; and the third, KM-c, was the sum of all eight questions. These three new variables were then analyzed against New & Unique using one-way ANOVA. The results of this analysis are shown in Table 5. In all three analyses, the value of F is significant to less than 0.1%.
A fourth ANOVA was performed, using a variable built from the four non-significant variables from above. For this variable, the value of F is significant to within 0.5%. This allows us to conclude that, although the individual relationships may be weak, when taken together there is a relationship between these knowledge management practices and innovation.

Table 5: ***Analysis of Variance***

New & Unique by:		Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
KM-a: KM1 to KM7	Between Groups	85.546	1	85.546	24.655	0.000
	Within Group	378.202	109	3.470		
	Total	463.748	110			
KM-b: KM1 to KM6, KM8	Between Groups	76.588	1	76.588	22.641	0.000
	Within Group	368.71	109	3.383		
	Total	445.297	110			
KM-c: KM1 to KM8	Between Groups	101.034	1	101.034	24.912	0.000
	Within Group	4420.65	109	4.056		
	Total	543.099	110			

Correlation Revisited

The three composite variables used for the analysis of variance were then recoded, based on their mean value, into three dichotomous variables. These trial indicators were coded "low" and "high," and were crosstabulated against the New & Unique variable. The chi-square and lambda results are shown in Table 6. The number of elements in this table refers to how many KM questions are included in the indicator variable, while the mean is shown to indicate the cut-point between "low" and "high" for each variable. In all three instances, both chi-square and lambda indicate a strong positive relationship between the indicator variables and New & Unique – that is, there is a relationship between increased application of KM practices and innovation.

Table 6: ***Crosstabulation of trial KM Indicators by "New & Unique"***

New & Unique by:	# of Elements	Mean	Pearson Chi-square		Lambda	
			Value	*Significance*	Value	Significance
KMQ-a KM1 to KM7	7	3.17	14.155	0.000	0.265	0.081
KMQ-b KM1 to KM6, KM8	7	3.65	17.626	0.000	0.327	0.021
KMQ-c KM1 to KM8	8	3.91	15.730	0.000	0.306	0.025

Regression

Having demonstrated a correspondence between the KM variables and innovation as indicated by the New & Unique variable, we decided to test this hypothesis using another analytic technique. For testing relationships between one dependent categorical variable and a number of categorical factors, an appropriate technique is *logistic regression*. This technique attempts to build an equation that can predict the results of the dependent variable from the independent factors. This equation takes the form:

$$Z = \hat{a}_0 + \acute{O}_n \, \hat{a}_n x_n$$

Where **Z** = the probability of a given state of the dependent variable

$\hat{a}_0$ = a constant coefficient

$\hat{a}_n$ = the *n*th independent factor

x_n = a coefficient associated with the *n*th factor

Logistic regression is an iterative technique that estimates the values of in the above equation.

Initially, three logistic regressions were performed, each corresponding to the three composite variables KM-a, KM-b, and KM-c. Each covariate was entered into the model separately, with no interaction assumed between covariates. The results of these regressions are shown in Table 7.

These regressions confirm the observation from the crosstabulations of the lower relative importance of the three "advanced" variables, namely KM4 (competitive intelligence), KM5 (alliance strategies), and KM6 (formal forecasting techniques). In all three regressions, the estimates of for these variables are small, and, more significantly, have the opposite sign to the other coefficients. The larger the value of the coefficient, the greater its influence on the outcome. Since we are attempting to construct a composite indicator that is the sum of the results of a set of questions, we are looking for the signs of all the coefficients, except the constant, to be the same.

To attempt to correct this problem, three further regressions were performed, with the "advanced" variables brought into the models as an *interaction*. The product of the three variables is used in the model, meaning that only if all three responses are "yes" is the interaction treated as a "yes" in the model. The results of these regressions are shown in Table 8. As can be seen, the coefficient of the interaction of the "advanced" variables is now negative, although the value is still small.

Nevertheless, the correspondence between the predictions from the regressions and the trial KM indicators, and indeed between the predicted values and innovation as measured by the New & Unique indicator, is very close, as shown in Table 9.

Table 7: *Logistic Regression Covariant Coefficients (No Interaction)*

Question	Ref #	Covariant Coefficients		
		ZKM-a	ZKM-b	ZKM-c
Allocate R&D Resources	KM1	1.6896	1.7576	-1.6681
Assign Management Responsibility	KM2	-0.3313	0.4721	-0.3212
Measure Innovation Performance	KM3	-1.1014	-1.1055	-1.0972
Competitive Intelligence Strategy	KM4	0.1107	0.1448	0.1200
Alliance Strategy	KM5	0.3061	0.0823	0.3097
Use Formal Forecasting Techniques	KM6	0.1633	0.0627	0.1522
Leverage Training Programs	KM7	-0.9672		0.9717
Want Results of Survey	KM8		0.0453	
		0.1962	0.0675	0.1804
Model prediction correct		**75.68%**	**72.97%**	**74.77%**

Table 8: ***Logistic Regression Covariant Coefficients (With Interaction)***

Question	Ref #	Covariant Coefficients		
		ZKM-a	ZKM-b	ZKM-c
Allocate R&D Resources	KM1	-1.4260	-1.5163	-1.4240
Assign Management Responsibility	KM2	-0.2992	-0.4441	-0.2977
Measure Innovation Performance	KM3	-1.0292	-1.0374	-1.0287
Competitive Intelligence Strategy	KM4	-0.2924	-0.4381	-0.2900
Alliance Strategy	KM5			
Use Formal Forecasting Techniques	KM6			
Leverage Training Programs	KM7	-0.7556		-0.7578
Want Results of Survey	KM8		0.0471	
Constant		0.2999	0.1456	0.2968
Model prediction correct		**75.68%**	**74.77%**	**75.68%**

Table 9: ***Cross Tabulation of Measured Results by Results Predicted by Regression***

Crosstab	Chi-square		Lambda	
	Value	Significance	Value	Significance
New & Unique x ZKM-a	28.945	0.000	0.449	0.001
KMQ-a x ZKM-a	53.931	0.000	0.685	0.000
New & Unique x ZKM-b	26.200	0.000	0.429	0.001
KMQ-b x ZKM-b	66.667	0.000	0.740	0.000
New & Unique x ZKM-c	28.945	0.000	0.449	0.001
KMQ-c x ZKM-c	71.609	0.000	0.766	0.000

Selecting The Final Indicator

Three trial indicators have been created and analyzed. We have shown that there are relationships between various knowledge management practices and innovation, both individually (using crosstabulation) and in combination (using ANOVA). We have also confirmed our model for the indicators. A simple sum of the responses to the KM questions for each case, then recoding to “low” or “high” by comparing to the mean of the summations, yields results very close to the more complicated procedure of logistic regression.

All that remains is to select one of the three trial indicators as most appropriate. From Table 6, we can see that KMQ-b, when compared to New & Unique, has the highest values, and therefore the greatest significance, for chi-square and lambda. However, the ANOVA and regression analyses show some weaknesses of this model. The ANOVA for KMQ-b (Table 5) generates a slightly lower value of *F* than the other two models. The regression models for KMQ-b, both with and without interaction, are slightly less accurate than the other two models.
The problem with this model is question KM8: does the respondent want a copy of the results of this research?
Most of the companies that were innovative (by New & Unique) wanted the results. However, so too did a majority of the non-innovative firms. This question yields ambiguous results. Additionally, the model does not address the area of Human Resource Development, which is considered to be a very important element of Knowledge Management by much of the literature.
Trial indicator KMQ-a also has a problem; with the HRD question KM7, as discussed above. However, these theoretical and methodological issues can probably be addressed by further testing. Nevertheless, model KMQ-c was

chosen as the most appropriate, for three reasons. First, the results of comparing this model to New & Unique are at least as good as the others for all three analyses. Second, the inclusion of eight questions dilutes the individual effects, and therefore any ambiguities from questions KM7 and KM8. Third, the data gives a mean of less than 4.0 – this gives a slightly asymmetrical cut point in recoding the summation that produces this indicator. Scores of 0 to 3 (4 groups) are coded as “low,” while scores of 4 to 8 (5 groups) are coded as “high”, giving slightly less weight to the less frequent responses. This can be seen in Table 10.

Table 10: ***Distribution of Positive Responses to KM Question, by Indicator KMQ-c***

Question	Ref #	KMQ-c Indicator	
		Low	High
Total in Indicator Category		47	64
Allocate R&D Resources	KM1	14	59
Assign Management Responsibility	KM2	11	37
Measure Innovation Performance	KM3	10	51
Competitive Intelligence Strategy	KM4	5	43
Alliance Strategy	KM5	6	46
Use Formal Forecasting Techniques	KM6	6	35
Leverage Training Programs	KM7	1	28
Want Results of Survey	KM8	27	55

Conclusions

The aggregate indicator of innovation in enterprises reported in this paper, based on ideas drawn from the knowledge-management literature, allows new understanding of innovation at the firm level. This indicator gives similar and equivalent results to other indicators of innovation, and in some instances yields better insights into how management attitudes and practices affect innovation at the firm level.

In addition to this general observation, some specific conclusions can be made from this research. For our sample, there is a definite relationship between knowledge management practices and innovation. A particularly good way of illustrating this is shown in Figure 2, which is a graph of the cell percentages of a crosstabulation of KMQ-c and New & Unique. The two tall bars, diagonally placed, indicate the strength of the positive relationship between the two variables.

An interesting observation can also be made in the other direction. Innovation depends on good old-fashioned management practices – efforts in R&D, individual management responsibility for innovation, performance measurement, and attention to the needs of the employees. For this sample, competitive intelligence, alliance strategies, and forecasting do not have a large influence on whether a firm is innovative or not, although these practices are not widespread. More research in this area would be very useful.

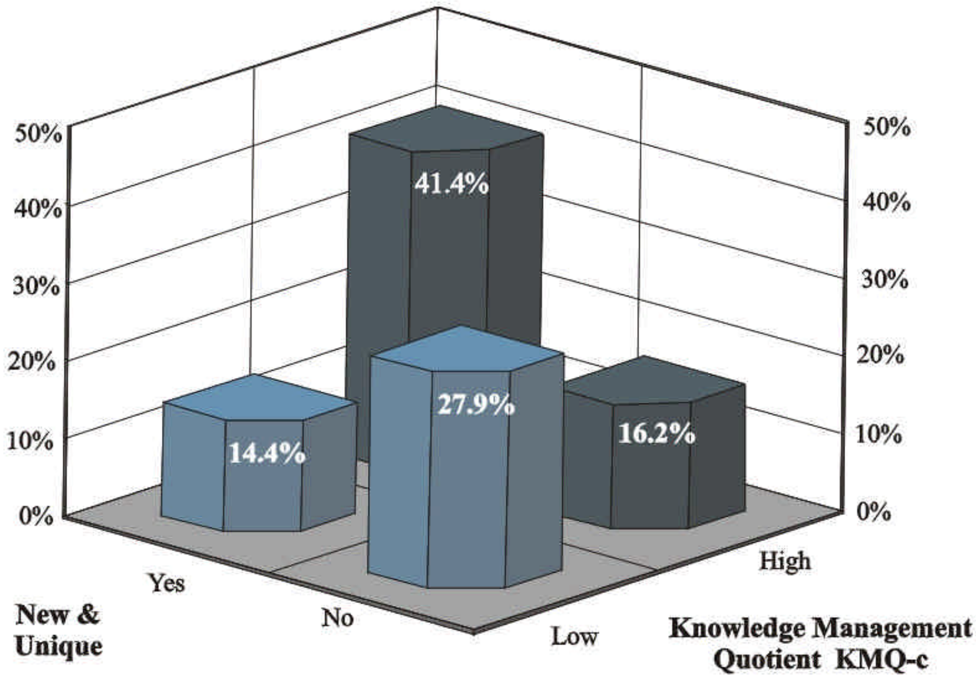

Figure 2: New&Unique by Knowledge Management Quotient

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Notes

1. Albeit, to a lesser degree. In this study, 71% of high technology firms were innovative, while only 50% of firms in the technology sectors were innovative. In the Lower Mainland, the proportions were much closer, with 48% of high technology firms and 46% of policy sector firms being innovative.
2. While becoming more stringent in our definition of innovation, we lowered the bar slightly in another way. Most Oslo-based surveys look only at products or processes introduced in the past three years.
3. An innovation “litmus test” presented by Debra Amidon (Amidon, 1997) was our starting point.
4. Other parts of the survey do probe some of the costs and benefits of innovation.
5. There were no respondents that did not answer at least one of the eight KM questions, and only one respondent did not answer seven of them.

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