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The profit impact of IT investment

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Two models were used to study the relationships between profitability and the level of information technology (IT) sophistication among long-term life insurance companies in South Africa. The first model was submitted by Kwong *et al.* in a study of six petroleum producing companies in Malaysia. They proposed a computerization index (CI) which incorporated factors that affect the level of computerization in a company and compared the CI with profitability ratios such as profit/total assets, profit/turnover, turnover/total assets, gross margin/turnover, profit growth rate and sales growth rate. The second model was proposed by Harris *et al.* in a study among forty long-term life insurance companies in America. They used the ratio of non-interest operating expense to premium income (operating expense ratio) to measure profitability, and the ratio of IT expense to non-interest operating expense (IT expense ratio) to measure the level of IT capital intensity. The results of the study showed a positive correlation between the CI and the financial ratios, indicating that as the level of computerization increases, profitability also increases. The results also showed that the most profitable firms are more likely to spend a significantly higher proportion of their non-interest operating expenses on IT, and that the least profitable firms are likely to spend a significantly lower proportion of their non-interest operating expenses on IT. The study concludes by accepting the two studies as valid among the long-term life insurance industry in South Africa.

Twee modelle is gebruik om die verhouding tussen winsgewendheid en die gevorderde vlak van gesofistikeerdheid by inligtingstegnologie (IT) in langtermyn-versekeringsmaatskappye in Suid Afrika te ondersoek. Die eerste model is voorgestel deur Kwong *et al.* in 'n studie van ses petroleumvervaardigingsmaatskappye in Maleisië. Hulle het 'n rekenaarsindeks (CI) voorgestel wat faktore wat die vlak van rekenarisering in 'n maatskappy aandui, ontwikkel. Winsgewendheidsmeting is gedoen deur middel van ses strategiese verhoudings: wins/totale bates, wins/omset, omset/totale bates, bruto wins/omset, wins groeikoers en omset groeikoers. Die CI en winsgewendheidverhoudingsgetalle is vergelyk ten einde enige verwantskap vas te stel. Die tweede model is deur Harris *et al.* in 'n studie van veertig langtermyn-versekeringsmaatskappye in Amerika voorgestel. Hulle het die verhouding van (rente uitgesluit) uitgawes tot premie-inkomste (operasionele uitgawe-verhoudingsgetal) gebruik om winsgewendheid te meet, en die verhoudingsgetal van IT uitgawes tot (rente uitgesluit) uitgawes (IT uitgawe-verhoudingsgetal) om die vlak van IT kapitaalkonsentrasie te meet. Die resultaat het 'n positiewe korrelasie tussen die CI en die ses finansiële verhoudingsgetalle bewys, wat aandui dat namate die vlak van rekenarisering verhoog, die winsgewendheid verhoog. Die resultate het ook bewys dat die mees winsgewende ondernemings eerder meer van hulle nie-rente uitgawes sal bestee op IT en dat die minder winsgewende ondernemings aansienlik minder van hulle nie-rente uitgawes op IT sal bestee. Die navorsing word afgesluit deur die twee studies as geldig in die langtermyn-versekeringsindustrie van die Suid-Afrika te aanvaar.

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Introduction

In this study the relationship between profitability performance and the level of information technology (IT) investment amongst the long-term life insurance firms in South Africa is examined. In order to do this, two studies were replicated. The first of these was performed among forty life insurance companies in the United States of America (USA) by Harris *et al.* (1988) and showed that the most profitable firms are more likely to spend a significantly higher proportion of their non-interest operating expense on IT. It also showed that the least profitable firms are likely to spend a significantly smaller proportion of their non-interest operating expense on IT. The second study was performed amongst six petroleum companies in Malaysia by Kwong *et al.* (1985) and showed that profitability performance is positively correlated with the degree of computerization. The aim of this study was to see if the conclusions in the above-mentioned studies are applicable in the long-term life insurance industry in South Africa.

Review of related literature

Weill *et al.* (1989) note that the Product Portfolio and Profit Impact of Marketing Strategy (PIMS) established the average IT expenditure in 1983 as 2.00% of revenues while the Diebold Group survey in 1984 revealed that centralized management information systems expenditures on average accounted for 1.44% of revenues. One of Weill *et al.*'s recommendations were that IT expenditure must be measured and tracked over time against a convenient base (i.e. revenues, total expenses or management-controlled costs).

Shoval *et al.* (1988) focussed on selecting among alternative computer systems, while considering not only the cost/benefit ratio, but also the relative importance of the benefit and cost factors. They assumed that benefits (unlike the costs) are difficult to measure in quantitative terms. Ahituv *et al.* (1990) record that the difficult part in cost/benefit analysis is to identify all the elements that form part of costs and benefits, and to determine how to measure or estimate these elements.

Kwong *et al.* (1985), in a case study among a sample of petroleum-producing companies in Malaysia, suggest the use of a computerization index (CI) which measures the extent and sophistication of computerization (see Appendix A). The CI incorporates a number of factors, namely: management activity level, number of years using computers, number of computers, application software used, central

processing unit (CPU) size, hardware cost, staff, number of staff, organizational location and project investment analysis.

Harris *et al.* (1988), in an empirical study among insurance companies in the USA, established a relationship between an organization's profitability and their IT capital intensity. They used the ratio of non-interest operating expense to premium income (operating expense ratio) to measure profitability, and the ratio of IT expense to non-interest operating expense (IT expense ratio) to measure the level of IT capital intensity. They concluded that the most profitable firms, or top performers, are more likely to spend a significantly higher proportion of their non-interest operating expense on IT and secondly, the least profitable firms are more likely to spend a significantly smaller proportion of their non-interest operating expense on IT. Ward (1987) conjectures that there is a trend towards decreasing IT costs and increasing IT capabilities that will make the use of IT both economically and technically feasible in the next decade.

Bender (1986) examined the relationship between the ratio of information processing expense to total operating expense and the ratio of total operating expense to premium income in life insurance companies. The correlation between the two ratios was negative, indicating that higher values of the ratio of information processing expense to total operating expense were associated with better performance. Whereas Bender did not provide a clear interpretation of the ratio of information processing expense to total operating expense, his results did establish the potential of linking firm performance to IT expense measures.

Chargeback systems are one method of quantifying the benefits an organization receives (Hufnagel *et al.*, 1989). Mautz (1983), in a study of IT controls, observes that these systems are difficult to operate. However, Allen (1987), in a literature study on methods to make IS pay its way, postulates that a competitive advantage can be gained if IT is run as a profit centre. Surveys that were done (Drury, 1980 and Choudhury, 1986) in both chargeback and non-chargeback environments show that management information system (MIS) managers are in favour of using chargeback to control the use of scarce information resources.

Hypotheses and research methodology

Hypotheses

Relationship between profitability (operating expense ratio) and IT investment (IT expense ratio)

Harris *et al.* (1988) studied the relationship between profitability and information technology expenditures among forty American insurance companies. The study of Harris *et al.* (1988) did not establish the direction of causality between profitability and IT capital intensity. However, the findings note empirical relationships.

Turner (1985) note that there is no relationship between an organizational's performance and the relative portion of resources allocated to information systems (IS). He postulates that the measure of performance will not capture all factors which contribute to high performance. Using case studies, Weill *et al.* (1989) noted the importance of converting IT investment into productive inputs with different levels of effectiveness, depending on the organization. Ward (1987) conjectures that there are trends of a decrease in costs and an increase in capabilities of IT.

Thus the first hypothesis, based on the hypothesis of Harris *et al.* (1988), can be formulated:

H_1: The most profitable firms will invest significantly more in IT capital than the least profitable firms.

Relationship between profitability (financial ratios) and computerization index (CI)

Weill *et al.*. (1989) used case studies to investigate the measurements of IT investment and what factors influence IT investment decisions. Two key factors which are relevant to their study emerged: determining the return on investments in IT is difficult; and investment in IT alone is not sufficient. Further, according to Weill *et al.* (1989) return on investment (ROI) calculations do not apply to many IT investments as an investment in IT tends to be widespread throughout the organization, causing the effects of investments to be the result of interactions among a number of different project investments in IT. Kwong *et al.* (1985), in a case study of the profit impact of computerization, suggest that IT investment reduces the cost of revenue generation.

The second hypothesis can thus be conjectured, based on the hypothesis of Kwong *et al.* (1985):

H_2: Profitability performance is positively correlated with the degree of computerization.

Research methodology

In order to gather the data needed to complete a CI for a company, a structured questionnaire was formulated. This questionnaire collected values for the variables associated with the Kwong *et al.* (1985) model and the IT expense value needed for the Harris *et al.* (1988) ratios. The population consisted of all the long-term life insurance companies in South Africa based on a list supplied by the Financial Services Board (FSB) of South Africa. From this population, a sample was selected, based on their position in the *Financial Mail's* top twenty long-term life insurance companies for each of the three years (this list is based on the net premium income [NPI] of each company). The financial data was obtained from the FSB who maintain financial records for all long-term life insurance companies.

The completed questionnaires were analyzed to extract the data needed. The CI was calculated using questions from the questionnaire. The financial ratios were calculated using data from the FSB and the questionnaire. Graphs showing the relationships between the CI and the measures of financial performance were plotted. In addition to the analysis used by Harris *et al.* (1988) and Kwong *et al.* (1985), it was decided to perform a statistical analysis. Statgraphics was used for regression analysis and the Spearman rank correlation test.

The ratios of non-interest operating expense to premium income (operating expense ratio) and IT expense to operating expense (IT expense ratio) were calculated. Using this measure, insurance companies with similar lines of business can be compared. The IT expense ratio is a measure of

capital intensity in information technology as supported by Harris *et al.* (1988). Graphs of sample versus industry total premium income and operating expense ratio versus IT expense ratio were produced to show the various relationships. The pre-tax return on assets, pre-tax return on turnover, asset turnover, gross margin, three year profit growth rate and three year turnover growth rate were calculated in order to apply the model proposed by Kwong *et al.* (1988). Composite graphs were produced showing relationships between these ratios and the CI for each company. Finally, a graph and statistical analysis of the CI versus the operating expense ratio was produced to see if any relationship could be ascertained.

Pilot study

In order to test for aspects of the questionnaire which respondents may have had difficulty in understanding, a pilot study was completed using two companies in Cape Town. In addition, it was necessary to ensure that it was possible to collect all data required for the ratios.

Precautions taken

It was assumed that the companies figures, as reflected by the FSB of South Africa, were accurate and complete. In addition, it was assumed that the respondent completing the questionnaire did so accurately. However, a possible source of error lies in the respondent's interpretation of the terminology used in the questionnaire. Furthermore, some of the data given by the respondent in the questionnaire could not be verified in full.

The study also did not check the method of accounting and it is acknowledged that this could influence some of the results obtained. This research did not investigate the effect of inflation on IT investments. The questionnaire defined IT expenditure as all hardware costs, all software costs, communications costs, software, and other expenses such as environment, staff and supplies. These expenses were consistent across the respondent organizations.

Kwong *et al.* (1985) postulated that there was no consensus on the appropriate measurement of financial performance. That is why they used multiple measures of financial performance. Brown *et al.* (1969) conjectures that accounting ratios are a guide and must be used in conjunction with other information of a comparable nature. Cash flow-based ratios could have been employed, but limited time and funds forced the study to use the same ratios as Kwong *et al.* (1985). It is also acknowledged that the operating expense ratio is not the only measurement of profitability, but for the purpose of this study, it was deemed enough.

Response rate

Of the 20 questionnaires sent out (the population was 23), 12 were received in time to be fully analyzed. This gives a response rate of 60%. Of the 12 questionnaires that were received, two were discarded due to the fact that they were either incomplete or the data had not been filled in appropriately. The number of valid responses prescribed that the data be split into thirds (thirtiles), with three companies in each thirtile. This was necessary in order to compare the research with Harris *et al.* (1988). This meant that one response had to be discarded at random and this produced a return rate of 45% of the initial sample. The sample companies account for approximately 72% of the total premium income for the industry over the period 1989 to 1991. It can therefore be noted that the sample of nine companies represents a significant portion of the total long-term insurance industry.

Results

Hypothesis 1

The data needed for this section was gathered from financial returns provided by the FSB of South Africa. The operating expense ratio and the IT expense ratio were calculated for the companies over the period 1989–1991 (Table 1). The ratios were averaged over three years (1989 to 1991). The companies were ranked according to the operating expense ratio, as prescribed by the study of Harris *et al.* (1988), and grouped into thirtiles (Table 2 — group I represents the lowest 33% of the companies, group II the second lowest 33% and group III the highest 33%).

This gave a measure of profitability performance for the companies. The companies with the lowest operating expense ratio (group I) were the most profitable and the companies with the highest operating expense ratio (group III) were the least profitable. The graph of the operating expense ratio versus the IT expense ratio for 1989 to 1991 is plotted, based on the results in Table 2. It depicts a diagram of the relationship between IT and organizational performance.

It can be noted from this figure that companies falling in group I (most profitable companies) invested the most in IT per Rand of non-interest operating expense. The least profitable companies (group III) invested significantly less as a proportion of their non-interest operating expense. Group I companies exhibited the highest average level of IT capital intensity over the three years (0.25) while group III companies invested less (0.137).

Table 1 Operating expense ratios and IT expense ratios

	1989		1990		1991		1989–1991	
C	Opex	Itex	Opex	Itex	Opex	Itex	Opex	Itex
1	0.142	0.109	0.152	0.119	0.157	0.128	0.150	0.119
2	0.117	0.044	0.128	0.037	0.148	0.053	0.131	0.045
3	0.872	0.191	0.162	0.117	0.180	0.145	0.405	0.151
4	0.464	0.084	0.257	0.160	0.427	0.180	0.383	0.141
5	0.024	0.469	0.172	0.483	0.252	0.820	0.149	0.591
6	0.888	0.174	0.189	0.152	1.318	0.106	0.798	0.144
7	0.549	0.120	0.422	0.139	0.374	0.232	0.448	0.164
8	0.785	0.090	0.783	0.118	0.718	0.099	0.762	0.102
9	0.378	0.336	0.487	0.284	0.350	0.290	0.405	0.303

C = Company number; Opex = Operating expense ratio; Itex = Expense ratio.

Table 2 Thirtile groupings for companies (1989–1991)

Thirtiles	Opex	Itex
I	0.144	0.251
II	0.397	0.199
III	0.670	0.137

Regression analysis portrayed a negative correlation of -0.291 between the operating expense ratio and the IT expense ratio. In other words, there was nearly a 30% probability that the operating expense ratio is negatively correlated with the IT expense ratio. The R-squared figure reveals that only a 8.49% of variation in the IT expense ratio was caused by the operating expense ratio. There was a small (29.1%) relationship between profitability and IT investment in the South African long-term insurance industry.

Thus, using data and graphical analysis techniques which are consistent with those used in the study by Harris *et al.* (1988), *the first hypothesis is accepted.* There is an empirical relationship between profitability and IT investment in the South African long-term insurance industry.

Hypothesis 2

The data gathered from the questionnaires was used to determine a composite CI as defined by Kwong *et al.* (1985). The overall results are shown in Table 3. The companies were ranked in ascending order according to their CI. However, because the CI measures the relative extent of sophistication of computerization compared to the other companies, it follows that for instance C5 is not exactly two times more computerized than C2, even though C5 has a C1 of ten and C2 has a C1 of five.

It can be discerned from the next figure that the ratio of pre-tax profit to total assets showed a general increase as the sophistication of computerization increases. This suggested that, with higher sophistication of computerization, the total assets of the companies are better utilized to generate profit.

Table 3 Relationship between CI and financial performance statistics

Company	CI	NP/TA	NP/TR	TR/TA	GP	3yr NPI growth	3yr turnover growth
C1	2	0.14	0.30	0.48	0.94	0.19	0.45
C2	5	0.07	0.24	0.30	0.82	0.29	0.92
C3	6	0.13	0.18	0.69	0.29	0.10	0.25
C4	7	0.01	0.01	0.72	0.21	0.25	0.19
C5	10	0.06	0.44	0.13	0.78	(0.12)	1.02
C6	11	0.41	0.48	0.84	0.77	0.30	0.50
C7	13	0.20	0.59	0.34	0.68	0.29	0.23
C8	47	0.72	0.81	0.89	0.85	0.42	0.36
C9	73	0.20	0.64	0.31	0.72	0.41	0.38

CI = Computerization Index; NP = Profit before Tax; GP = Gross Profit Margin; TA = Total Assets; TR = Total Revenue; C1 to C9 = companies; NPI = Net Premium Income.

The ratio of pre-tax profit to turnover showed a decline and then an increase with the level of computerization. With regard to the total revenue to total assets ratio, the upward trend reflects a general increase with the level of computerization.

There seemed to be two clusters of companies, those with a CI of seven or below and those with a CI above ten. The lower cluster exhibited an overall general decrease whereas the higher cluster exhibited an overall increase. This could be due to the fact that as a company moved towards a higher level of computerization, its profitability seems to decrease until it reached some point where the sophistication of computerization had a positive effect on profitability.

CI versus return on assets, return on turnover and asset/ turnover ratio

This trend continued when the CI were compared with the other ratios. The following figure illustrates that the ratio of gross profit to turnover showed an initial decrease and then increased slightly. This suggests that the cost of revenue generation declines in a more sophisticated IT environment

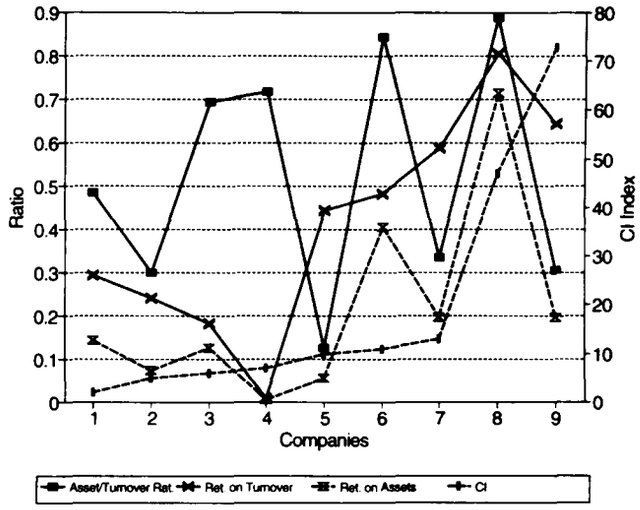

Figure 1 CI versus return on assets, return on turnover and asset/ turnover ratio

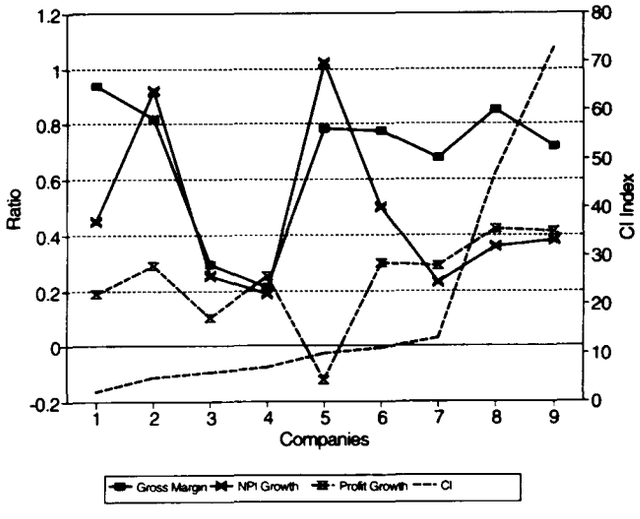

Figure 2 CI versus gross margin, NPI growth and turnover growth

as a result of a more efficient operations function. Similarly, the profit growth rate in the higher cluster companies shows a general increasing trend. The trend in the turnover growth rate is not as clear, but appears to decrease well into the higher cluster companies and only then reflected a general increase.

CI versus gross margin, NPI growth and turnover growth

The last figure shows that the CI's of the companies compared to the profitability ratio used by Harris *et al.* (1988) (operating expense ratio). As the level of computerization increased, the operating expense ratio decreased, showing that the higher the level of computerization, the better the profitability performance of the companies.

CI versus operating expense ratio

The CI correlated positively with the net profit/total revenue ratio (+0.817). This could be because of the inter-relationship between benefits received and positive management. This supports the previous findings. The CI was positively correlated with the net profit/total asset ratio (+0.602); again supporting the conclusions drawn from previous figures. This is consistent with the findings of Kwong *et al.* (1985).

A correlation of 0.167 between the CI and the total revenue/total assets ratio was discovered, which is inconsistent with that of Kwong *et al.* (1985). Therefore, it was generally found that the CI correlated positively with the profitability performance ratios. This leads to *the acceptance of this hypothesis.*

Conclusion

From the results in the previous section, it can be concluded that both the studies by Harris *et al.* (1988) and Kwong *et al.* (1985) are applicable in the long-term life insurance industry in South Africa. The direction of causality between profitability (operating expense ratio) and IT capital intensity (IT expense ratio) was not established, but empirical relationships were discovered. The analyzed results for hypothesis 1 show that:

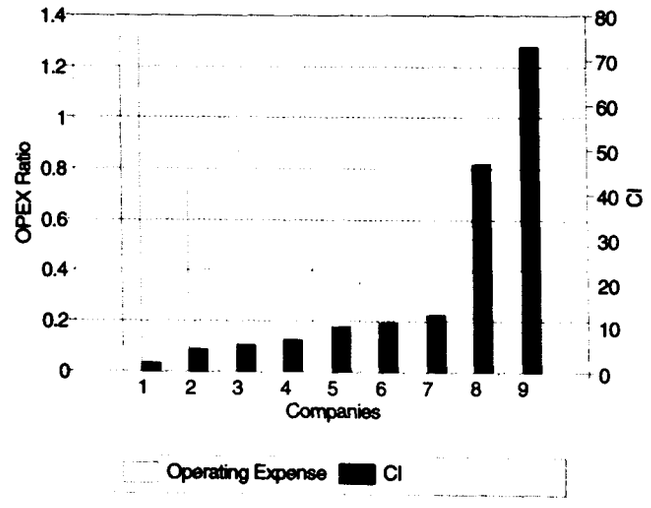

Figure 3 CI versus operating expense ratio

— the most profitable companies, or top performers, are likely to spend a significantly higher proportion of their non-interest operating expense on IT; and

— the least profitable companies are more likely to spend a significantly smaller proportion of their non-interest operating expense on IT.

Levels of IT capital intensity are related to profitability performance. The findings suggested that low profitability companies (high operating expense ratio) are at greater risks with low levels of IT capital intensity than high profitability companies with high levels of capital intensity. In addition, when the technology fits the organizational situation, significant savings in operating costs are possible.

Kwong *et al.* (1985) constructed a composite measure of the various factors influencing the extent and sophistication of computerization. It can be seen from the results for hypothesis 2 that the degree of computerization, when related to multiple measures of profitability performance, generally exhibited a positive correlation. However, the companies appeared to be divided into two clusters, the low cluster having a very low computerization index and the high cluster having a higher set of computerization indices. The results for the high cluster show a general increase, suggesting that increased profitability performance increases as the level of sophistication of computerization increases. The results for the low cluster show a general decrease, suggesting that profitability performance initially decreases as the level of computerization rises. Once a certain threshold has been reached, then the increase in computerization shows a positive effect on profitability performance.

When the CI for each company was compared to the profitability measure proposed by Harris *et al.* (1988) (the operating expense ratio), a clear positive relation was found without any apparent clustering of companies. This suggests that the level of computerization is positively related to profitability performance, even in the short term.

It may be difficult to evaluate the relationship between investments in IT and the performance of an organization because there is several complex factors that must be considered. Some of these factors are the structure of the industry, the business strategy of the organization and the 'tradition' and behaviour of the organization. This is because these factors change over time. IT decisions could interact directly on the organization, especially where IT budgets are determined by the accomplishments of the organization. IT management can be a critical activity in any IT intensive industry and must be handled with maximum care.

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Appendix A Kwong *et al.* model

A1. Computerization Index (CI)

The Computerization Index (CI) that measures the extent and sophistication of computerization is constructed according to the following formula:

$$CI = V1(W1) + V2(W2) + ... + Vn(Wn)$$

where:

CI = Computerization Index
V1 to Vn = Variable affecting the degree of computerization
Wi = Weight applied to Variable Vi.

Ten variables (V1 to V10) were chosen to collectively represent the computerization process and their importance was indicated by the weight applied to each variable as follows:

Variable	Weight
Management activity level	0.40
Years using computers	0.10
Number of computers	0.10
Application software	0.06
Size of CPU	0.06
Hardware cost	0.06
Staff	0.06
Number of shifts	0.06
Organizational location	0.05
Project investment analysis	0.05

A2. Management activity level

Computer applications in each of the four management activities were weighted by Kwong *et al.* as follows: strategic planning (40%), management control (30%), operational control (20%) and transaction processing (10%). The calculation for the management activity level can be represented as follows:

Total score for management activity level =
(Number of strategic planning applications x 0.4)
+ (Number of management control applications x 0.3)
+ (Number of operational control applications x 0.2)
+ (Number of transaction processing applications x 0.1)

A3. Other variables

For the variables: years using computers, number of installations, number of application software, number of staff and number of shifts, the score is simply the numerical value multiplied by the predetermined weight (A1).

For the other variables: size of CPU, hardware cost, organizational location and method of project investment analysis, a ranking procedure is used. The largest CPU size is given an interval ranking of 6 while the smallest CPU size is given a ranking of 1. Hardware cost has a value from 5 for the highest to 1 for the lowest, reflecting its lesser importance compared to CPU size. For computing facilities located in the autonomous computer/IT department the value is 5 and for any other department, the value is 2. Companies using the discounted cash flow (DCF) method in evaluating hardware purchase were assigned a value of 5, and for non-DCF users a value of 2.

A4. Measures of financial performance

As discussed in the literature review, return on investment as used in the BCG and PIMS approaches) has been found to be deficient as the best measure of corporate financial performance. Kwong *et al.* suggest measures of financial performance be used. They are:

1. Pre-tax return on assets *(Pre-tax profit/total asset)*
2. Pre-tax return on turnover *(Pre-tax profit/total turnover)*
3. Asset turnover ratio *(Total turnover/total assets)*
4. Gross margin *(Gross profit/total turnover)*
5. Three-year net premium income growth rate
6. Three-year turnover growth rate

A5. Classification of computer applications

This is done according to the Robert Anthony framework. This is acceptable to IT research as supported by Burns in her study of the impact of IT on organizational structures (1989).

Transaction processing	Operational control	Management control
Accounts receivable	Inventory control:	Budgeting
Accounts payable	Raw material	Wage and salary analysis
General ledger	Work in progress	Sales analysis
Delivery report	Finished goods	Sales forecasting
Payroll	Sales report	Financial analyis
Processing job request	Sales planning	Responsibility accounting
Customer billing and invoicing	Personnel status report	Investment analysis
Share registration	Computer utilization report	Production/job costing
	Production scheduling	Product variance analysis
	Computer scheduling	Computer budget
Strategic management	Petroleum production systems	
Corporate modelling	Plant/factory automation	
	Technical systems	
	Material requirements planning	
	Purchase requirements planning	
	Linear programming	
	Simulation	