Intellectual capital: an exploratory study that develops measures and models

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This paper details an empirical pilot study that explores the development of several conceptual measures and models regarding intellectual capital and its impact on business performance. The objective of this pilot study is to explore the development of items and constructs through principal components analysis and partial least squares (PLS). The final retained, subjective measures and optimal structural specification show a valid, reliable, significant and substantive causal link between dimensions of intellectual capital and business performance. These results should help both academics and practitioners more readily understand the components of intellectual capital and provide insight into developing and increasing it within an organization. Suggestions are then made to advance and improve this research programme.

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> All men by nature desire knowledge. Aristotle (384-322 BC), Greek philosopher. *Metaphysics,* Book 1, Chapter 1.
>
> Whereas at one time the decisive factor of production was the land, and later capital … today the decisive factor is increasingly man himself, that is, his knowledge. Pope John Paul II (1991). *Centesimus Annus.*

Intellectual capital has been considered by many, defined by some, understood by a select few, and formally valued by practically no one (Stewart, 1997; Sveiby, 1997). Therein lies one of the greatest challenges facing business leaders and academic researchers today and tomorrow. Recently, the job title of chief knowledge officer (CKO) has been creeping up on annual reports and job advertisements with ever-increasing frequency. These pathfinding individuals have been given the enviable task of channelling their organizations' intellectual capital as an essential source of competitive advantage. Knowledge officers are responsible for justifying the value of knowledge that is constantly being developed in their organizations (Nonaka and Takeuchi, 1995). This elusive intangible may never be evaluated in the financial terms that we are currently accustomed to. However, its strategic impact is never in question. From the capture, codification, and dissemination of information, through to the acquisition of new competencies via training and development, and on to the re-engineering of business processes, present and future success in competition will be based less on the strategic allocation of physical and financial resources and more on the strategic management of knowledge.

Intellectual capital research has primarily evolved from the desires of practitioners (Bontis, 1996; Brooking, 1996; Darling, 1996; Edvinsson and Sullivan, 1996; Saint-Onge, 1996). Consequently, recent developments have come largely in the form of popular press articles in business magazines and national newspapers. The challenge for academics is to frame the phenomenon using extant theories in order to develop a more rigorous conceptualization of this elusive intangible. This paper coalesces many perspectives from numerous fields of study in an attempt to raise the understanding and importance of this phenomenon. The objective here is to conceptualize and frame the existing literature on intellectual capital as a foundation for further study.

This topic is important because intellectual capital has been rarely studied or understood. In fact, managers and investors woefully neglect intellectual inputs and outputs, though these far outweigh the assets that appear on balance sheets (Stewart, 1991; 1994). Handy (1989) suggests that the intellectual assets of a corporation are usually three or four times tangible book value. He warns that no executive would leave his cash or factory space idle, yet if CEOs are asked how much of the knowledge in their companies is used, they typically say only about 20 per cent. The importance of this topic is also reflected in the increased importance of the professional services industry and the many new knowledge-based firms that have recently been launched.

This article is divided into five sections:

1 *review of concepts* – a review of the recent literature which includes definitions of terms as well as a conceptual model;
2 *research design* – the methodological approach utilized to administer the pilot study;
3 *results* – analysis of the measures and models;
4 *discussion* – highlights of the analysis, suggestions for future work, limitations of the research and the contribution it makes to academia and managers; and
5 *conclusion* – what managers can do next.

Review of concepts

Knowledge creation by business organizations has been virtually neglected in management studies even though Nonaka and Takeuchi (1995) are convinced that this process has been the most important source of international competitiveness for some time. Drucker (1993) heralds the arrival of a new economy, referred to as the knowledge society. He claims that in this society, knowledge is not just another resource alongside the traditional factors of production – labour, capital, and land – but the only meaningful

resource today. Because knowledge is shared among organizational members, it is connected to the firm's history and experiences (Von Krogh *et al.,* 1994) and soon becomes the ultimate replacement of other resources (Toffler, 1990). This notion underpins a more general idea that economies of the future will be education-led (Young, 1995). What does this mean for managers? It means that the capacity to manage knowledge-based intellect is the critical skill of this era (Quinn, 1992). It is up to symbolic analysts (Reich, 1991) who are equipped to identify and solve intellectual capital issues, that will sustain the knowledge advantage for their own organizations. If there is one distinguishing feature of the new economy that has developed as a result of powerful forces such as global competition, it is the ascendancy of intellectual capital. A shift is clearly perceptible from a manufacturing to a service-oriented economy: firms that are thriving in the new strategic environment see themselves as learning organizations pursuing the objective of continuous improvement in their knowledge assets (Senge, 1990). Recently, there has been exponential growth in researching this area (Crossan and Guatto, 1996). Competitive, technological, and market pressures have made continuous organizational learning a critical imperative in global strategy effectiveness (Osland and Yaprak, 1995). Organizations that have been unable to enhance their knowledge assets have failed to survive (Antal *et al.,* 1994) and are left wondering what the fuss is all about (Roos and von Krogh, 1996).

The importance of this topic is also reflected in the growth of the professional services industry and the many new knowledge-based firms that have fuelled our economy. Top MBA recruits no longer find as many positions in manufacturing companies as they did in the 1950s and 1960s. Nowadays, the career services offices of many business schools report that most new graduates secure positions with management consultants, accounting firms, investment banks, law firms, software developers and information brokers. The constant requirement found in each of these positions is the importance of intellectual capital.

To grasp the importance of why it is necessary to measure this phenomenon, we must understand the concept of Tobin's *q* from the accounting and finance literature. This ratio measures the relationship between a company's market value and its replacement value (i.e., the cost of replacing its assets). In other words, a company with a stock market value of $100 million and a book value of $25 million will have a Tobin's *q* ratio of 4.00. The ratio was developed by the Nobel Prize-winning economist James Tobin (White *et al.,* 1994). In the long run, this ratio will tend towards 1.00, but evidence shows that it can differ significantly from 1.00 for very long periods of time (Bodie *et al.*, 1993). For example, companies in the software industry, where intellectual capital is abundant, tend to have a Tobin's *q* ratio of 7.00, whereas firms in the steel industry, noted for their large capital assets, have a Tobin's *q* ratio of nearly 1.00. Intellectual capital valuation has become an industry on its own. For example, the Royal Bank of Canada has launched a subsidiary business that concentrates exclusively on investing in knowledge-based industries (Bontis, 1997).

Sveiby highlights intellectual capital valuation by citing a familiar example of a high Tobin's *q*:

> Shares in Microsoft, the world's largest computer software firm, changed hands at an average price of $70 during fiscal 1995 at a time when their so-called book value was just $7. In other words, for every $1 of recorded value the market saw $9 in additional value for which there was no corresponding record in Microsoft's balance sheet (Sveiby, 1997, p. 3).

There are numerous other examples that make the same case. The value of intellectual capital in these firms has been cast as quasi-value by the invisible hand of the market. However, companies do not trade their intangible assets, so the value of items such as intellectual capital stocks or organizational learning flows cannot be deduced from routine market transactions like the value of traditional tangible assets. Sometimes, the value of knowledge is attributed even without the existence of any monetary transactions at all:

> In August 1995 Netscape went public in one of the most oversubscribed initial public offerings in history. A company with negligible profits ended its first day of trading with a value of $2 billion – a value based entirely on intangible assets (Sveiby, 1997, p. 114).

Another popular example of a knowledge-intensive organization that is internationally known for its products is Nike. However, Nike is a shoemaker that makes no shoes – its work is research and development, design, marketing, and distribution, almost all knowledge-based activities – but still has $334,000 in sales for each employee (Stewart, 1997).

One of the purest examples of intellectual capital valuation is in the consulting industry. McKinsey, one of the industry's leaders, does not employ traditional marketing methods; it sells by having clients come knocking

to purchase the best analytical knowledge available (Nicou *et al.,* 1994). McKinsey generally sells its intellectual capital in teams of five, each led by a senior partner. Remarkably, clients are willing to pay for the transfer of this knowledge at an average annual rate of $500,000 per consultant (Sveiby, 1997).

Stewart (1997) defines intellectual capital as "the intellectual material – knowledge, information, intellectual property, experience – that can be put to use to create wealth." Stewart goes on to identify several organizations such as Skandia, Dow Chemical, Hughes Aircraft, and Canadian Imperial Bank of Commerce that are in the process of managing and developing this phenomenon. Stewart's major contribution was in the definition of intellectual capital and in the recognition of the difficulty to measure it. The objective of this pilot study is to explore the development of measures and models that could help both academics and practitioners more readily understand the components of intellectual capital and its impact on business performance.

Organizational learning, as described by Chris Argyris at Harvard (1992) among others, has been thought of as the flow of knowledge in a firm; it follows then that intellectual capital is the stock of knowledge in the firm (Dierickx and Cool, 1989). To marry the two concepts, it may be useful to consider intellectual capital as the stock unit of organizational learning flows. However, intellectual capital cannot necessarily be taught through education and training. The most precious knowledge in an organization often cannot be passed on (Levitt, 1991).

Prior to continuing the conceptualization of intellectual capital stocks, it may be helpful to define what it is not. Intellectual capital does not include intellectual property. Intellectual property are assets that include copyrights, patents, semiconductor topography rights, and various design rights. They also include trade and service marks. Undertaking an intellectual property audit is not a new idea. The following sections refer to the conceptualization of what intellectual capital is (see Figure 1).

Human capital

First, the organization's members possess individual tacit knowledge (i.e. inarticulable skills necessary to perform their functions) (Nelson and Winter, 1982). In order to illustrate the degree to which tacit knowledge characterizes the human capital of an organization, it is useful to conceive of the organization as a productive process that receives tangible and informational inputs from the environment, produces tangible and informational outputs that enter the environment, and is characterized internally by a series of flows among a network of nodes and ties or links (see Figure 2).

A node represents the work performed – either pure decision making, innovative creativity, improvisation (Crossan *et al.*, 1996) or some combination of the three – by a single member of the organization or by parallel, functionally equivalent members who do not interact with one another as part of the productive process (see Figure 2). Thus, individual tacit knowledge, when present, exists at the nodes themselves. A tie or link is directional in nature and represents a flow of intermediate product or information from a given node. Every node has at least one tie or link originating from it, while multiple ties originating from a single node imply that the task performed at the node includes a decision about where to direct the subsequent flow. Structural tacit knowledge, when present, implies that no member of the organization has an explicit overview of these ties or and consequently of the corresponding arrangement of nodes (see subsequent discussion on structural capital). Accordingly, a productive process characterized by a substantial degree of tacit knowledge is arranged as a hodgepodge of nodes lacking any discernible organizational logic.

Point A in Figure 2 represents the core of human capital. Multiple nodes (human capital units) attempt to align themselves in some form of recognizable pattern so that intellectual capital becomes more readily interpretable. This point represents the lowest level of difficulty for development as well as the lowest level of externality from the core of the organization.

Human capital has also been defined on an individual level as the combination of these four factors:

1 your genetic inheritance;
2 your education;
3 your experience; and
4 your attitudes about life and business (Hudson, 1993).

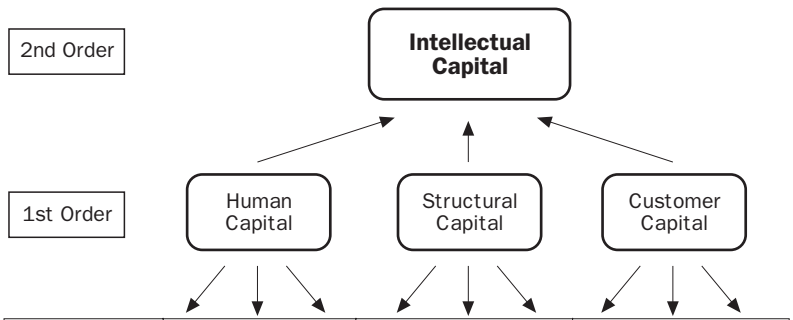
Human capital is important because it is a source of innovation and strategic renewal, whether it is from brainstorming in a research lab, daydreaming at the office, throwing out old files, re-engineering new processes, improving personal skills or developing new leads in a sales rep's little black book. The essence of human capital is the sheer intelligence of the organizational member. The scope of human capital is limited to the knowledge node (i.e. internal to the mind of the employee). It can be measured (although it is difficult) as a function of

volume (i.e. a third degree measure encompassing size, location and time). It is also the hardest of the three sub-domains of intellectual capital to codify.

The term human capital has also been used by the American Nobel Prize-winning economist Theodore W. Schultz (1981):

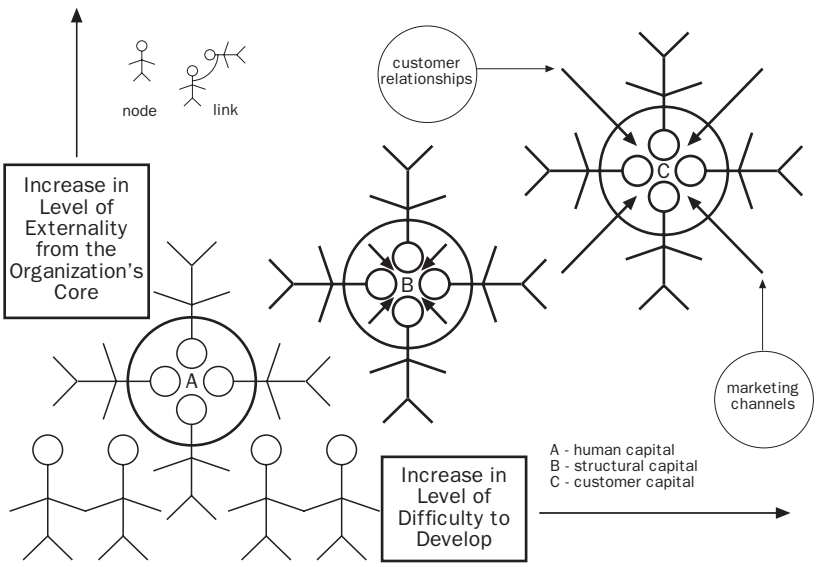
> The decisive factors of production in improving the welfare of poor people are not space, energy, and cropland; the decisive factors are the improvement in population quality and advances in knowledge. These advancements can be augmented by appropriate investment in human capital.

Figure 1
Conceptualization of intellectual capital



Essence	human intellect	organizational routines	market relationships
Scope	internal within employee node	internal organizational links	external organizational links
Parameters	volume appropriateness	efficiency accessibility	longevity volume
Codification Difficulty	high	medium	highest

Figure 2
Discriminating intellectual capital sub-domains



Structural capital

The organization itself embodies structural tacit knowledge, which exists in:

> the myriads of relationships that enable the organization to function in a coordinated way [but] are reasonably understood by [at most] the participants in the relationship and a few others…" This means that "the organization is … accomplishing its aims by following rules that are not known as such to most of the participants in the organization" (Winter, 1987, p. 171).

This construct deals with the mechanisms and structures of the organization that can help support employees in their quest for optimum intellectual performance and therefore overall business performance. An individual can have a high level of intellect, but if the organization has poor systems and procedures by which to track his or her actions, the overall intellectual capital will not reach its fullest potential.

An organization with strong structural capital will have a supportive culture that allows individuals to try things, to fail, to learn, and to try again. If the culture unduly penalizes failure, its success will be minimal. Structuring intellectual assets with information systems can turn individual know-how into group property (Nicolini, 1993). It is the concept of structural capital that allows intellectual capital to be measured and developed in an organization. In effect, without structural capital, intellectual capital would just be human capital. This construct therefore contains elements of efficiency, transaction times, procedural innovativeness and access to information for codification into knowledge. It also supports elements of cost minimization and profit maximization per employee. Structural capital is the critical link that allows intellectual capital to be measured at an organizational level.

Point B in Figure 2 illustrates the structural ties or links of human capital nodes that are required to transform human capital into structural capital. The arrows within structural capital represent the focus of intellectual capital development from the nodes into the organization's core. The essence of structural capital is the knowledge embedded within the routines of an organization. Its scope lies internal to the firm but external to the human capital nodes. It can be measured (although it is difficult) as a function of efficiency (i.e., an output function per some temporal unit). Organizational processes (such as those found in structural capital) can eventually be codified.

Customer capital

Knowledge of marketing channels and customer relationships is the main theme of customer capital. Frustrated managers often do not recognize that they can tap into a wealth of knowledge from their own clients. After all, understanding what customers want in a product or a service better than anyone else is what makes someone a business leader as opposed to a follower.

Customer capital represents the potential an organization has due to ex-firm intangibles. These intangibles include the knowledge embedded in customers, suppliers, the government or related industry associations. Point C in Figure 2 illustrates that customer capital is the most difficult of the three subdomains to develop since it is the most external to the organization's core. The arrows represent the knowledge that must flow from external to the organization (i.e. its environment) into the organization's core by way of linked nodes. The essence of customer capital is knowledge embedded in relationships external to the firm. Its scope lies external to the firm and external to the human capital nodes. It can be measured (although it is difficult) as a function of longevity (i.e. customer capital becomes more valuable as time goes on). Owing to its external nature, knowledge embedded in customer capital is the most difficult to codify.

One manifestation of customer capital that can be leveraged from customers is often referred to as "market orientation". There is no consensus on a definition of market orientation, but two recent definitions have become widely accepted. The first is from Kohli and Jaworski (1990), who define market orientation as the organization-wide generation of market intelligence pertaining to current and future needs of customers, dissemination of intelligence horizontally and vertically within the organization, and organization-wide action or responsiveness to market intelligence. Similar definitions are found in Deng and Dart (1994) and Lichtenthal and Wilson (1992). The second is from Narver and Slater (1990), who define market orientation as a one-dimension construct consisting of three behavioural components and two decision criteria – customer orientation, competitor orientation, inter-functional co-ordination, a long-term focus, and a profit objective. With close parallels to Kohli and Jaworski (1990), Narver and Slater (1990) include the generation and dissemination of market intelligence as well as managerial action.

Intellectual capital

The term intellectual capital was first published by John Kenneth Galbraith in 1969 (Feiwal, 1975). He believed that intellectual capital meant more than just "intellect as pure intellect" but rather incorporated a degree of "intellectual action". In that sense, intellectual capital is not only a static intangible asset *per se,* but an ideological process; a means to an end.

Some readers may wonder whether or not intellectual capital is just the effective dissection of information overload. To clarify this point, an examination of the difference between "information" and "knowledge" would be helpful. Simply put, information is the raw material, and knowledge is the finished product. When a manager receives a printout from a computer detailing last weeks cost per transaction figures, he or she is reading information. The implications derived from the trends or underlying issues from those data are what is referred to as knowledge. Intellectual capital is therefore the pursuit of effective use of knowledge as opposed to information.

Research design

A survey was designed that taps into the intellectual capital constructs as well as business performance within the context of the conceptual model. Many of the TDM (total design method) recommendations suggested by Dillman (1978) were adopted. A copy of the cover letter and questionnaire can be requested from the author. The questionnaire was administered to one section of MBA students at the Ivey School of Business in the University of Western Ontario. The questionnaire was designed in an easy to read booklet format with a total of eight pages. The cover letter was on the first page and it introduced the concept of intellectual capital. There was no incentive to fill out the survey for the students and it was completely optional. Sixty-four students took approximately ten minutes to complete the questionnaire.

Since this study concentrates on the firm level of analysis, each respondent was required to answer the questionnaire as a representative of the organization they worked for prior to entering the MBA programme. In effect, each respondent acted as a proxy for their organization. Some students returned the questionnaires unanswered because they worked for governmental offices and felt that they could offer absolutely no feedback on the topic. Others were uncomfortable in filling out the survey because they felt that they did not know enough about the firm and were not in a position high enough to fill out the questionnaire adequately.

In designing the questionnaire, a 7-point Likert scale (strongly disagree to strongly agree) for each item with medium-length (16 to 24 words) questions was used, as suggested by Andrews (1984). A total of 63 items, designed to tap into four constructs (three constructs relating to intellectual capital plus performance), were included in the questionnaire. The items included in the survey were developed from concepts that were accentuated during the literature review phase of the study. Since this is an exploratory pilot study, no previous instruments were replicated. See Appendix 1 for a summary of the items that were developed and used for each construct.

The results were coded in SPSS for Windows. The following items were reverse coded: human capital (H5R, H13R, H14R, H15R, H19R), customer capital (C13R, C15R), and structural capital (S13R, S16R). Of the total 4,032 data cells (63 items * 64 observations), less than 2.5 per cent had missing values which were assigned to the means of each variable.

The following statistical tests were executed:

- Kolmogorov-Smirnov test for normality;
- Cronbach's alpha test for reliability;
- principal components analysis with VARIMAX rotation , and
- Partial least squares (PLS).

Results

The 64 observations represented a variety of organizations in numerous industries. Table I highlights the profile of the data with some descriptive statistics.

Respondents were promised organizational anonymity. These industries and the number of times they were each represented show a wide cross-section of businesses accounted for by the data: financial services (7), chemical (4), insurance (4), computers and software (3), and courier services (2).

Kolmogorov-Smirnov Test

The results show that most items spanned the whole range of possible responses except for: C6, C13R (customer capital), H1, H14R (human capital), S5, S6, S7, S12, S16R (structural capital), and P1, P5, P8 (performance).

Table I
Profile of data

Item	Mean $	Std. dev. $	Minimum $	Maximum $
Sales ($million)	588.15	931.46	1.00	4,000.00
Employees (#)	8,731	28,489	8	180,000

The Kolmogorov-Smirnov test for normality was used to see whether the responses had a normal curve about the mean. Just over half of the items (33 out of 63) were considered to have normal distributions. However, the assumption of normality is not a major issue for structural modelling. In fact, PLS is robust enough to not require normal data (Barclay *et al.*, 1995).

Feedback from respondents highlighted certain items that were difficult to interpret and thus rejected. For example, C4 (our market share is the highest in the industry) was difficult to answer on a "strongly disagree" or "strongly agree" scale from 1 to 7. If you had the third highest market share in your industry, where would you mark your response? It would be difficult to decide in this case because respondents interpret the question differently.

Cronbach's Alpha

To test the reliability of the measures, Cronbach's alpha was used as suggested by Nunnally (1978). This calculation should be the first measure one calculates to assess the quality of the instrument (Churchill, 1979). A satisfactory level of reliability depends on how a measure is being used. In the early stages of research on predictor tests or hypothesized measures of a construct (as is the case with this exploratory pilot study) instruments that have reliabilities of 0.7 or greater will suffice (Nunnally, 1978). The reliabilities for each of the four constructs is fine since the alpha values for each are greater than 0.85.

Principal components analysis

Factor analysis is a multivariate statistical method whose primary purpose is data reduction and summarization (Hair *et al.*, 1987). By using factor analysis, a factor loading for each item and its corresponding construct was determined. In order to verify that the items tapped into their stipulated constructs, a principal components analysis with a VARIMAX rotation was executed. The items were forced into three factors and the output was sorted and ranked based on a 0.5 loading cutoff. Typically, loadings of 0.5 or greater are considered very significant (Hair *et al.*, 1987).

The VARIMAX rotation was used because it centres on simplifying the columns of the factor matrix. With the VARIMAX rotational approach, there tends to be some high loadings (i.e. closer to 1) and some loadings near 0 in each column of the matrix. The logic is that interpretation is easiest when the variable-factor correlations are either closer to 1, thus indicating a clear association between

the variable and the factor, or 0 indicating a clear lack of association (Hair *et al.*, 1987).

Only the items that loaded on their corresponding factors at levels of 0.5 or greater were retained for the rest of the analysis. These items are highlighted in the last column. Items were not retained because they

- did not load on any factor with a value of 0.5 or greater;
- loaded on the wrong factor; or
- had cross-loadings on two factors.

Items S12, S7, S8, and S13R were not retained because they did not load on their appropriate factor and also cross-loaded on Factor 3 at a loading of less than 0.5. The three factors had Eigenvalues and percentage of variance explained of 13.735 (25.9 per cent), 7.634 (14.4 per cent) and 3.289 (6.2 per cent) respectively with a total cumulative variance explained of 46.5 per cent.

Partial least squares

Partial least squares (PLS) allows the researcher to test a model within its nomological network. Constructs derive their meaning from their underlying measures as well as their antecedent and consequent constructs giving a researcher the benefit of examining the constructs in an overall theoretical context.

The objective in PLS is to maximize the explanation variance. Thus, R^2 and the significance of relationships among constructs are measures indicative of how well a model is performing. The conceptual core of PLS is an iterative combination of principal components analysis relating measures to constructs, and path analysis permitting the construction of a system of constructs. The hypothesizing of relationships between measures and constructs, and constructs and other constructs is guided by theory. The estimation of the parameters representing the measurement and path relationships is accomplished using ordinary least squares (OLS) techniques.

The first step in PLS is for the researcher to explicitly specify both the structural model and the construct-to-measures relationships in the measurement model. The exogenous constructs are consistent with the idea of independent variables (antecedents). Similarly, the endogenous constructs are consistent with the idea of dependent variables (consequents).

The constructs can be specified as "formative" indicators or "reflective" indicators. Formative indicators imply a construct that is expressed as a function of the items (the items form or cause the construct). Reflective indicators imply a construct where the observable items are expressed as a function of the construct (the items reflect or are manifestations of the construct). One looks to theory to decide on which type of epistemic or construct-to-measure relationship to specify. In this case, all constructs were "reflective" indicators. Once specified, the measurement and structural parameters are estimated using an iterative process of OLS, simple and multiple regressions. The process continues until the differences in the component scores converge within certain criteria.

One of the key benefits of using PLS as a structural modelling technique is that it may work with smaller samples. In general, the most complex regression will involve:

1. the indicators on the most complex formative construct; or
2. the largest number of antecedent constructs leading to an endogenous construct.

Sample size requirements become at least 10 times the number of predictors from 1 or 2, whichever is greater (Barclay *et al.*, 1995). In this study, the sample size of 64 is high enough for PLS. There were no formative indicators so it is the second requirement that must be met. The largest number of antecedent constructs leading to an endogenous construct is three ($3 * 10 = 30 < 64$).

The retained items from the previous tests were used in PLS to test their loadings within a nomological network. Nine structural combinations were examined using different relative positions for the intellectual capital constructs. The nine models represent different combinations of the intellectual capital constructs leading into performance. The R^2 figures represent the predictive power within those constructs as explained by the measures that represent the preceding constructs. The path loadings represent the causal links from one construct to the other.

The previous analysis was used to determine which of the retained items (from the original principal components analysis) were now going to be kept for further investigation. These remaining items were then placed in a structural configuration which yielded the highest original R^2 for performance at 56.0 per cent (which is very high relatively speaking for such a construct). The selected model was then tested using PLS once more and the statistical highlights are illustrated in Appendix 2.

Tests for individual item reliability, internal consistency and discriminant validity were completed for the selected model. The R^2 or predictive power in the endogenous constructs were as follows: customer capital = 24.53 per cent, structural capital = 24.89 per

cent and performance = 56.02 per cent. Individual item reliability is assessed by examining the loadings, or simple correlations, of the measures with their respective construct. A rule of thumb is to accept items with loadings of 0.7 or more, which implies more shared variance between the construct and its measures than error variance (Carmines and Zeller, 1979). All lambdas (or loadings) were over the 0.7 threshold.

Internal consistency was verified since all of the items loaded at 0.7 or greater on their corresponding constructs. Internal consistency was tested using the Fornell and Larcker (1981) measure. Discriminant validity was tested using the correlation matrix of constructs. The diagonal of this matrix is the square root of the average variance extracted. For adequate discriminant validity, the diagonal elements should be significantly greater than the off-diagonal elements in the corresponding rows and columns as was the case for the selected model (see Appendix 2).

To assess the statistical significance of the path coefficients, which are standardized betas, a jackknife analysis was performed using a program developed by Fornell and Barclay (1983). The use of jackknifing, as opposed to traditional *t*-tests, allows the testing of the significance of parameter estimates from data which are not assumed to be multivariate normal. In this case, 32 subsamples were created by removing two cases from the total data set. PLS estimates the parameters of each subsample and "pseudovalues" are calculated by applying the jackknife formula. Four of the five paths proved to be significant at the p-value < 0.001 level. The one path from customer capital to structural capital was not significant. Interestingly, this was also the only path to have a negative coefficient and was the least substantive of them all.

Path analysis can be used to calculate the total direct, indirect and spurious effects for each endogenous construct. Table II summarizes the results for each path highlighted in Appendix 2:

$$1\frac{(\sum \lambda_{yi})^2}{(\sum \lambda_{yi})^2 + \sum Var(\varepsilon_i)}$$

$$2\frac{\sum \lambda^2{}_{yi}}{\sum \lambda^2{}_{yi} + \sum Var(\varepsilon_i)}$$

Discussion

PLS analyses the measurement model and structural model concurrently. Model fit is dependent upon the integrity of the data as well as the strength of the theory. In the case of my model, the integrity of the data was fine and all but one of the paths proved to be significant. The strong contribution of PLS in exploratory work is that principal components analysis and path analysis are incorporated into an a priori theoretical and measurement model, and thus the parameters are estimated in this specific context.

There are numerous improvements that can be made from this pilot study for future research. First of all, the use of a convenience sample (MBAs) is a strong criticism against these data because of the appropriateness and representativeness of the respondents. Some of the MBAs mentioned that they had forgotten or were not currently close enough to the organization to respond accurately to some of the questions. Others thought that they were not in high enough positions to respond thoughtfully.

To improve on this study it would be beneficial in the future to elicit responses directly from a wide variety of organizations that include both manufacturing and service industries. By examining these two different types of organizations, one would hope to find a relatively larger concentration of intellectual capital in the professional services industry (i.e. organizations such as software developers, research laboratories and law firms).

The objective of the study thus far has been to determine which items effectively capture the constructs of human capital, structural capital, customer capital, and performance. This was done by examining their loadings using a variety of structural model specifications. It was also noted that certain paths (i.e. the ones leading into customer capital) were neither substantive nor significant). To solve this dilemma, it may be useful in future studies to utilize model specifications that do not require paths into structural capital. Two examples of this possibility using the current pilot study data are depicted in Appendix 3.

The Diamond specification is the optimal model encountered in the pilot study. All of the paths are substantive and significant and the R^2 of performance is high. This model also makes intuitive sense. A brilliant business school graduate that is recruited into an organization as a product manager symbolizes the human capital that starts off this model. With the advent of a supportive culture (structural capital) and market research (customer capital), the new employee can launch a very successful product (performance).

Although the Simplistic specification conjectures that the three components of intellectual capital lead into performance directly, it does not account for the interrelationships among the three. It is for this reason that it is

Table II
Results for path analysis

Path from → to	Correlation r	Direct Path (1)	Indirect Path (2)	Total Effect (1) + (2)	Spurious (3)	Total Sum (1)+(2)+(3)
Human → Customer	0.499	0.499	0	0.499	0	0.499
Human → Structural	0.492	0.524	(0.499)(–0.065)	0.492	0	0.492
Customer → Structural	0.197	–0.065	0	–0.067	(0.499)(0.524)	0.197
Customer → Performance	0.639	0.560	(–0.065)(0.398)	0.534	(0.499)(0.524)(0.398)	0.639
Structural → Performance	0.508	0.398	0	0.398	(–0.065)(0.560) + (0.524)(0.499)(0.560)	0.508

not supported even though the R^2 value was still high for the performance construct. Given the literature review of intellectual capital, the three constructs that make up this phenomenon are known to affect each other. In other words, an intellectual employee (human capital) is practically useless without the supportive structure of an organization (structural capital) that can utilize and nurture his or her skills. This may account for the unsubstantive and insignificant path from human capital to performance.

There is an important implication hidden behind Appendix 3 for managers. What the two different model specifications are saying is that there must exist a constant interplay among human, structural and customer capital in order for an organization to leverage off its knowledge base. Isolated stocks of knowledge that reside in the employees' minds that are never codified into organizational knowledge will never positively affect business performance. In other words, it is not enough for an organization to hire and promote the brightest individuals it can find. An organization must also support and nurture bright individuals into sharing their human capital through organizational learning. Unlike normal inventory that can be found in traditional manufacturing settings, individual knowledge stocks that reside in human capital become obsolete. This obsolescence is not necessarily due to outdated knowledge. There is a behavioural explanation instead. Human beings become unmotivated when they feel they are not being utilized or challenged. That is why a stock of human capital will deteriorate if not constantly supported and nurtured.

The results of this research programme should be very beneficial to both academics and practitioners. Academics in the policy and accounting areas have traditionally been very interested in how intangible assets reflect on the performance of firms. The pilot study thus far has shown that intellectual capital has a significant and substantive impact on performance. Future research may show that this causal link may be more substantive in certain specific industries. Also, future research may show that organizations with predominant home country profiles may be more in tune with intellectual capital and its effect on performance. Cross-referencing the intellectual capital data with a variety of international respondents and Hofstede's (1978) cultural dimensions may highlight some interesting relationships in this case.

For accounting researchers, intellectual capital may prove to be an important item of disclosure in the future (especially for professional services firms whose knowledge assets are not currently reflected in today's accounting procedures). Churchill's (1979) final suggestion in creating better measures is to "develop norms". Once accepted items for measuring intellectual capital are selected, organizations might be assessed by their relative positioning on each characteristic. Since respondents in this study participated anonymously, the relative positioning of actual firms was not reported.

By making periodic assessments of key intellectual capital components, their potential sale value to an outsider, and any measurable trends in these values can offer a new perspective. Another interesting calculation for accounting and finance academics is to examine what the companies actually did with their intellectual capital. For example, one might calculate a firm's "exploitation ratio" comparing the value of its intellectual capital with its actual relative performance. This would suggest how effective the organization has been in making the causal link from intellectual capital to performance.

Once managers realize the importance of measuring and developing their intellectual capital, they will invariably want to increase it since it positively affects firm performance. In recognizing the key to intellectual capital development, Professor Neil Postman (1985) of New York University believes that the most important thing one learns is always

something about how one learns. This notion is similar to the idea of deutero learning as put forward by Argyris, one of the most prolific writers on organizational learning. Argyris and Schon (1978) identified three types of learning, single loop, double loop and deutero learning. Through case study analysis they examined which of the three types of learning was most prevalent in business. They concluded that most businesses follow single loop learning which merely detects and corrects problems as soon as possible so that the organization can continue with their regular activities. Double loop learning on the other hand not only involves the detection and correction phase of problem resolution, but also attempts to modify underlying norms, policies and objectives. Deutero learning, the most advanced of the three, involves understanding the whole process or learning how to learn. Although this concept is intuitively appealing, managers have yet to find a practical means to adopt the deutero learning process and will therefore continue to struggle to develop intellectual capital.

Conclusion

The management of intellect lies at the heart of value in the current "knowledge era" of business. Unfortunately, methods of measuring and evaluating intellectual capital have been slow to develop. There is an extremely limited literature on the study and management of intellectual capital. This is partly due to the privacy that accompanies most organizations and their discussion on intellectual capital. Continued research of this phenomenon should show that organizations with a high level of intellectual capital will be those in which the value-added service of the firm comes from deep professional knowledge, organizational learning, and protection and security of information. Managers, analysts and researchers should also be wary of looking for a formula of intellectual capital. By definition, the tacitness of intellectual capital may not allow analysts to ever measure it using economic variables. A warning must be sent out to those accountants and financial analysts who are asking the question, "How much is my intellectual capital worth?" A formula may never exist. That is not to say that metric development is a waste of time. Longitudinal examination of metrics as well as benchmarking against industry norms can help managers in examining their own intellectual capital. In this case, examining the processes underlying intellectual capital development may be of more importance than ever finding out what it is all worth.

Managers who are interested in strategically managing their intellectual capital for their own organizations should follow these steps (Bontis, 1996):

1. Conduct an initial intellectual capital audit. Such an examination may consist of a survey design and administration using Likert-type scales in order to get a snapshot of the benchmark level of intellectual capital in existence. Some firms like Skandia (1994, 1995a, 1995b, 1996a, 1996b) use their own metrics of intellectual capital. However, each firm is different and must thrive in the context of its own industry. Each organization should design their metrics for their own strategic purposes.
2. Make knowledge management a requirement for evaluation purposes for each employee – assign personal targets to intellectual capital development. For example, companies can have each employee aim to learn something that the organization currently does not know.
3. Formally define the role of knowledge in your business and in your industry – find and secure the greatest resources of intellectual capital inside and outside your firm from places like industry associations, academia, customers, suppliers, and the government.
4. Recruit and hire a leader responsible for the intellectual capital development of your organization. This person must have an integrated background in human resources, strategy and information technology.
5. Classify your intellectual portfolio by producing a knowledge map of your organization – determine in which people and systems knowledge resides. For example, create a central database in which all competitive intelligence information can be accumulated and accessed.
6. Utilize information systems and sharing tools that aid in knowledge exchange and codifying such as groupware technology, videoconferencing, Intranets, corporate universities and storytelling amongst employees.
7. Send employees to conferences and trade shows and have them spy. Do not pay for their travel expenses unless they share what they learned with the rest of the organization when they return.
8. Consistently conduct intellectual capital audits to re-evaluate the organization's knowledge accumulation – use monetary values if at all possible, but do not be afraid to develop customized indices and metrics.

9 Identify gaps to be filled or holes to be plugged based on weaknesses relative to competitors, customers, suppliers and best practices.
10 Assemble the organization's new knowledge portfolio in an intellectual capital addendum to the annual report.

As with the human body's muscles, intellectual capital suffers from, if you don't use it, you lose it (Cohen *et al.,* 1993). There is an increasing emphasis on survival of the fittest in international competitiveness. In order to stay alive, organizations must win the international organizational learning race (Hampden-Turner, 1992). Future research in this area may want to tap into comparisons of knowledge management characteristics by personality type with the use of the Myers-Briggs type indicator (Wiele, 1993). Also, researchers could correlate knowledge management with diversity or different leadership traits (Boehnke *et al.,* 1997) and determine if in fact there is a relationship between the interorganizational learning of diverse groups or international teams and overall business performance.

The purpose of this study was to explore the ideas and concepts that have been published thus far on intellectual capital as well as push these forward through empirical analysis. The measures and models developed have been proven to be valid and reliable in addition to significant and substantive. This phenomenon should interest both academics and business practitioners alike because the development and management of intellectual capital will require more dedication and effort in the future relative to the traditional tasks of monitoring and deploying the physical and capital assets of an organization. Ideally, the shift of thinking in the future will be from shorter-term product focus strategies to longer-term human, structural and customer capital focus strategies.

Finally, all business leaders should be appreciative of the power knowledge management can have on business performance. The study of intellectual capital produces a tremendous amount of energy, energy that can take companies far beyond their current vision (Ward, 1996). It requires people to rethink their attitudes on intangible assets and to start recognizing that measuring and strategically managing knowledge may make the difference between mediocrity and excellence.

References

Andrews, F.M. (1984), "Construct validity and error components of survey measures: a structural modeling approach", *Public Opinion Quarterly,* Vol. 48, pp. 409-42.

Antal, A.B., Dierkes, M. and Hahner, K. (1994), "Business in society: perceptions and principles in organizational learning", *Journal of General Management,* Vol. 20 No. 2, pp. 55-77.

Argyris, C. (1992), *On Organizational Learning,* Blackwell, Cambridge, MA.

Argyris, C. and Schön, D. (1978), *Organizational Learning: A Theory of Action Perspective,* Addison-Wesley, Reading, MA.

Barclay D., Higgins, C. and Thompson, R. (1995), "The partial least squares (PLS) approach to causal modeling", *Technology Studies,* Vol. 2 No. 2.

Bodie, Z., Kane, A. and Marcus, A.J. (1993), *Investments,* Irwin, New York, NY.

Boehnke, K., DiStefano, A., DiStefano, J. and Bontis, N. (1997), "Leadership for exceptional performance", *Business Quarterly,* Summer.

Bontis, N. (1996), "There's a price on your head: managing intellectual capital strategically", *Business Quarterly,* Summer.

Bontis, N. (1997), "Royal Bank invests in knowledge-based industries", *Knowledge Inc.,* Vol. 2 No. 8.

Brooking, A. (1996), *Intellectual Capital: Core Asset for the Third Millennium Enterprise,* International Thomson Business Press, London.

Carmines, E. and Zeller, R. (1979), *Reliability and Validity Assessment. Sage Paper Series on Quantitative Applications No. 07-017.* Sage, Beverly Hills, CA.

Churchill, G.A. Jr (1979), "A paradigm for developing better measures of marketing constructs", *Journal of Marketing Research,* Vol. 16, pp. 64-73.

Cohen, G., Kiss, G. and Le Voi, M. (1993), *Memory – Current Issues,* Open University, Buckingham.

Crossan, M. and Guatto, T. (1996), "Organizational learning research profile", *Journal of Organizational Change Management,* Vol. 9 No. 1.

Crossan, M., White, R.E., Lane, H.W. and Klus, L. (1996), "The improvising organization: where planning meets opportunity", *Organization Dynamics,* Vol. 24 No. 4, pp. 20-34.

Darling, M. (1996), "Building the knowledge organization", *Business Quarterly,* Winter.

Deng, S. and Dart, J. (1994), "Measuring market orientation: a multi-factor, multi-item approach", *Journal of Marketing Management,* Vol. 10, pp. 725-42.

Dierickx, I. and Cool, K. (1989), "Asset stock accumulation and sustainability of competitive advantage", *Management Science.*

Dillman, D.A. (1978), *Mail and Telephone Surveys: The Total Design Method,* Wiley & Sons, New York, NY.

Drucker, P.F. (1993), *Post-Capitalist Society,* Butterworth Heinemann, Oxford.

Edvinsson, L. and Sullivan, P. (1996), "Developing a model for managing intellectual capital", *European Management Journal,* Vol. 14 No. 4.

Feiwal, G.R. (1975), *The Intellectual Capital of Michal Kalecki: A Study in Economic Theory and Policy,* The University of Tennessee Press, Knoxville, TN.

Fornell, C. and Barclay, D. (1983), *Jackknifing: A Supplement to Lohmoller's LVPLS Program,* University of Michigan, Ann Arbor, MI.

Fornell, C. and Larcker, D. (1981), "Evaluating structural equation models with unobservable variable and measurement error", *Journal of Marketing Research,* Vol. 18, pp. 39-50.

Hair, J., Rolph, A. and Tatham, R. (1987), *Multivariate Data Analysis,* 2nd ed., Macmillan, New York, NY.

Hampden-Turner, C. (1992), *Creating Corporate Culture: From Discord to Harmony,* Addison-Wesley, Reading, MA.

Handy, C.B. (1989), *The Age of Unreason,* Arrow Books Ltd, London.

Hofstede, G. (1978), "Value systems in 40 countries", *Proceedings of the 4th International Congress of the Association for Cross-Cultural Psychology.*

Hudson, W. (1993), *Intellectual Capital: How to Build it, Enhance it, Use it,* John Wiley & Sons, New York, NY.

Kohli, A.K. and Jaworski, B.J. (1990), "Market orientation: the construct, research propositions, and managerial implications", *Journal of Marketing,* Vol. 54, pp. 1-18.

Levitt, T. (1991), *Marketing Imagination,* The Free Press, New York, NY.

Lichtenthal, J.D. and Wilson, D.T. (1992), "Becoming market oriented", *Journal of Business Research,* Vol. 24, pp. 191-207.

Narver, J.C. and Slater, S.F. (1990), "The effect of a market orientation on business profitability", *Journal of Marketing,* October, pp. 20-35.

Nelson, R.R. and Winter, S.G. (1982), *An Evolutionary Theory of Economic Change,* Belknap Press, Cambridge, MA.

Nicolini, D. (1993), "Apprendimento organizzativo e pubblica amministrazione locale", *Autonomie Locali e Servizi Sociali,* Vol. 16 No. 2.

Nicou, M., Ribbing, C. and Ading, E. (1994), *Sell Your Knowledge,* Kogan Page, London.

Nonaka, I. and Takeuchi, H. (1995), *The Knowledge-Creating Company,* Oxford University Press, New York, NY.

Nunnally, J.C. (1978), *Psychometric Theory,* 2nd ed., McGraw-Hill, New York, NY.

Osland, G.E. and Yaprak, A. (1995), "Learning through strategic alliances: processes and factors that enhance marketing effectiveness", *European Journal of Marketing,* Vol. 29, pp. 52-66.

Postman, N. (1985), *Amusing Ourselves to Death: Public Discourse in the Age of Show Business,* Viking, New York, NY.

Prusak, L. (1996), "The knowledge advantage", *Strategy & Leadership,* March/April.

Quinn, J.B. (1992), *Intelligent Enterprise,* Free Press, New York, NY.

Reich, R.B. (1991), *The Work of Nations,* Alfred A. Knopf, New York, NY.

Roos, J. and von Krogh, G. (1996), "The epistemological challenge: managing knowledge and intellectual capital", *European Management Journal,* Vol. 14 No. 4.

Saint-Onge, H. (1996), "Tacit knowledge: the key to the strategic alignment of intellectual capital", *Strategy & Leadership,* April.

Schultz, T.W. (1981), *Investing in People: the Economics of Population Quality*, University of California, Berkeley and Los Angeles, CA.

Senge, P.M. (1990), *The Fifth Discipline: The Art and Practice of the Learning Organisation,* Doubleday Currency, New York, NY.

Skandia (1994), "Visualizing intellectual capital in Skandia", A supplement to Skandia's 1994 Annual Report, Sweden.

Skandia (1995a), "Renewal and development: intellectual capital", A supplement to Skandia's 1995 Interim Annual Report, Sweden.

Skandia (1995b), "Value-creating processes: intellectual capital", A supplement to Skandia's 1995 Annual Report, Sweden.

Skandia (1996a). "Power of innovation: intellectual capital", A supplement to Skandia's 1996 Interim Annual Report, Sweden.

Skandia (1996b), "Customer value", a supplement to Skandia's 1996 Annual Report, Sweden.

Stewart, T.A. (1991), "Brainpower: how intellectual capital is becoming America's most valuable asset", *Fortune,* 3 June, pp. 44-60.

Stewart, T.A. (1994), "Your company's most valuable asset: intellectual capital", *Fortune,* 3 October, pp. 68-74.

Stewart, T.A. (1997), *Intellectual Capital: The New Wealth of Organizations,* Doubleday/Currency, New York, NY.

Sveiby, K.E. (1997), *The New Organizational Wealth: Managing and Measuring Knowledge-Based Assets,* Berrett-Koehler, New York, NY.

Toffler, A. (1990), *Powershift: Knowledge, Wealth and Violence at the Edge of the 21st Century,* Bantam Books, New York, NY.

Von Krogh, G., Roos, J. and Slocum, K. (1994), "An essay on corporate epistemology", *Strategic Management Journal,* Vol. 15.

Ward, A. (1996), "Lessons learned on the knowledge highways and byways", *Strategy & Leadership,* March/April.

White, G.I., Sondhi, A.C. and Fried, D. (1994), *The Analysis and Use of Financial Statements,* John Wiley & Sons, New York, NY.

Wiele, B. (1993), "Competing from the neck up", *Performance & Instruction,* March.

Winter, S.G. (1987), "Knowledge and competence as strategic assets", in Teece, D.J. (Ed.), *The Competitive Challenge: Strategies of Industrial Innovation and Renewal,* Ballinger, Cambridge, MA, pp. 159-84.

Young, M. (1995), "Post-compulsory education and training for learning society", *Australian and New Zealand Journal of Vocational Educational Research.*

Appendix 1. Summary of survey items (excerpts from questionnaire)

Human capital

H1	competence ideal level	H11	employees perform their best
H2	succession training program	H12	recruitment program comprehensive
H3	planners on schedule	H13R	big trouble if individuals left
H4	employees cooperate in teams	H14R	rarely think actions through
H5R	no internal relationships	H15R	do without thinking
H6	come up with new ideas	H16	individuals learn from others
H7	upgrade employees' skills	H17	employees voice opinions
H8	employees are bright	H18	get the most out of employees
H9	employees are best in industry	H19R	bring down to others' level
H10	employees are satisfied	H20	employees give it their all

Customer capital

C1	customers generally satisfied	C10	meet with customers
C2	reduce time to resolve problem	C11	customer info disseminated
C3	market share improving	C12	understand target markets
C4	market share is highest	C13R	do not care what customer wants
C5	longevity of relationships	C14	capitalize on customers' wants
C6	value added service	C15R	launch what customers don't want
C7	customers are loyal	C16	confident of future with customer
C8	customers increasingly select us	C17	feedback with customer
C9	firm is market-oriented		

Structural capital

S1	lowest cost per transaction	S9	develops most ideas in industry
S2	improving cost per revenue $	S10	firm is efficient
S3	increase revenue per employee	S11	systems allow easy info access
S4	revenue per employee is best	S12	procedures support innovation
S5	transaction time decreasing	S13R	firm is bureaucratic nightmare
S6	transaction time is best	S14	not too far removed from each other
S7	implement new ideas	S15	atmosphere is supportive
S8	supports development of ideas	S16R	do not share knowledge

Performance

P1	industry leadership	P6	after-tax return on assets
P2	future outlook	P7	after-tax return on sales
P3	profit	P8	overall response to competition
P4	profit growth	P9	success rate in new product launch
P5	sales growth	P10	overall business performance

Note: R – reverse coded items

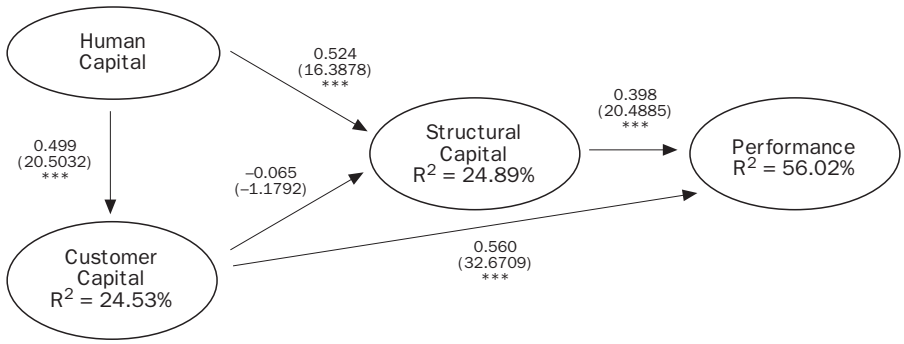
Appendix 2. Statistical highlights on selected model specification

Table AI

	Number of items	Internal consistency (Fornell and Larcker)	Discriminant validity correlation of constructs				R squared (%)
Human	7	0.9194	0.936				
Customer	7	0.9228	0.499	0.940			24.43
Structural	7	0.9258	0.492	0.197	0.943		24.89
Performance	9	0.9535	0.509	0.639	0.508	0.967	56.02

Human capital	H8	H15R	H9	H20	H18	H6	H11		
	0.8055	0.7855	0.8392	0.8556	0.7006	0.7059	0.8091		
Customer capital	C14	C1	C16	C9	C6	C5	C8		
	0.8189	0.7924	0.8365	0.7297	0.8205	0.7879	0.7706		
Structural capital	S10	S2	S6	S5	S1	S3	S4		
	0.8215	0.8431	0.8030	0.7368	0.7873	0.8058	0.8021		
Performance	P2	P3	P4	P5	P6	P7	P8	P9	P10
	0.7823	0.8209	0.8978	0.7977	0.8514	0.8348	0.8054	0.7406	0.9591

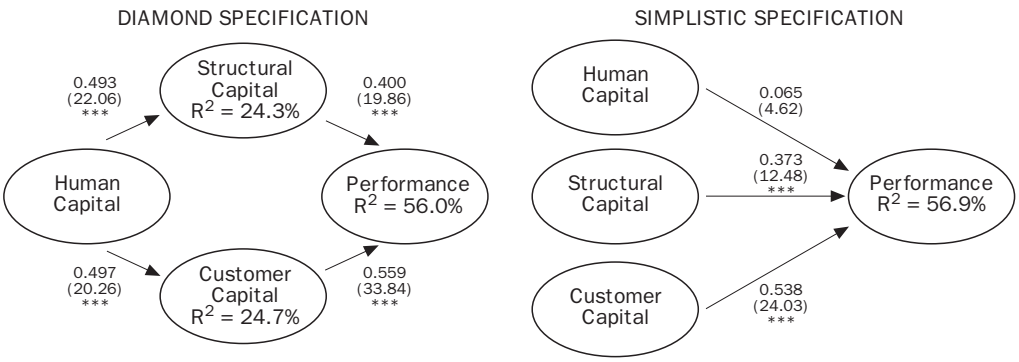
Figure A1



Note: top number is path, *t*-values in brackets, *** significant at *p*-value < 0.001

Appendix 3. Further statistical highlights on selected model specifications

Figure A2



Note: top number is path, *t*-values in brackets, *** significant at *p*-value < 0.001

Application questions

1 Will "intellectual capital" start appearing on balance sheets as an asset with monetary value? How would you start to calcuate the intellectual capital asset base of your organization?

2 Does high intellectual capital suggest business success?