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Measuring intellectual capital: a new model and empirical study

Measuring
intellectual
capital

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Keywords *Intellectual capital, Measurement, Modelling, Quality, Indexing, China*

Abstract *The groundwork of intellectual capital (IC) management, measuring IC, attracts much attention from academics and practitioners. The purpose of this paper is to design a measurement model and a qualitative index system of IC, so as to provide a good tool for enterprises to manage their IC. Based on a review of several IC measurement models proposed by western researchers, IC is classified into human capital, structural capital, innovation capital and customer capital, and thereupon a qualitative index system for the above four IC elements is designed through an analysis of their contents. Through an empirical study, it is found that there is a significant relationship between the scores of the four IC elements of a company and its business performance, which proves the validity and rationality of the IC measurement model and the qualitative index system. In the meantime, the empirical study further proves that there is a remarkable relationship between the four IC elements. Therefore enterprises must manage and improve their IC from an integrative perspective.*

Introduction

The pattern of global economic growth has fundamentally changed since the 1970s with the rapid development of high technology, especially in communication, computer and biology engineering. Knowledge thereupon has taken the place of monetary capital, land, and material capital as the most important capital, especially in the competitive high-tech realm.

Although widely used in literature, the concept of intellectual capital (IC) has not become popular until recently. The burgeoning field of IC is becoming an exciting area for both researchers and practitioners, but before the mid-1990s a great deal of work is purely descriptive of what was happening in various organizations without specifically relating the generalized comments to an organizational context. Since then, investigations deal mainly with the process of managing and measuring IC (Petty and Guthrie, 2000).

From a strategic perceptive, IC is used to create and enhance the organizational value, and success requires IC and the ability to manage this scarce resource controlled by a company. From another point of view, IC measurement focuses on constructing an effective measurement model (Roos



Journal of Intellectual Capital

Vol. 5 No. 1, 2004

pp. 195-212

© Emerald Group Publishing Limited

1469-1930

DOI 10.1108/14691930410513003

et al., 1997), in which financial and non-financial indices are combined together to reflect thoroughly a company's operations under the influence of knowledge economy and to offer more accurate information for knowledge management.

As the groundwork and prerequisite of IC management, IC measurement is of great significance in business administration:

- It can more thoroughly and accurately measure company's value and performance. In a knowledge-based society, knowledge constitutes a large part of a product's value as well as a company's wealth. Traditional accounting methods, which are based on tangible assets and historical, transaction-based information, are inadequate for valuing IC, which is the largest and most valuable asset for many enterprises. Indeed, traditional accounting tends to understate the value significantly (Sullivan and Sullivan, 2000). According to Lev (1997), the average proportion of market value to book value in the late 1970s was 2:1, in the mid-1990s it was 3:1, and in 1997 the market value is more than six times the book value. Therefore "the traditional model of accounting which so beautifully described the operations of companies for a half-millennium, is now failing to keep up with the revolution taking place in business" (Edvinsson and Malone, 1997). Compared with the traditional financial method, this IC measurement covers such important non-financial contents as, for example, human capital, customer satisfaction and innovation. The IC approach is therefore much more comprehensive for companies to be well-informed of their value and performance. The differences between the two approaches are significant: IC measurement is oriented towards the future while financial accounting is supposed to look backwards. IC measurement captures soft facts (qualities), while financial accounting measures hard facts (quantities). IC measurement focuses on the value creation, while financial accounting reflects the outcome of the past transactions and realized cash flows.
- It has been gradually acknowledged that traditional financial measurement is inadequate in guiding strategic policy making (Waterhouse and Svendsen, 1998). They need to be supplemented or even replaced by IC measurement, which enables managers to be well-informed of the status quo of IC management, finding out the strength and weakness of existing IC through benchmarking with which the manager can afterwards exert all the strength and remedy the weakness. In detail, IC measurement is helpful in verifying the company's ability to achieve its strategic objective, laying out its R&D, providing background information for project readjustment, and confirming the emphases of a company's education and training program. As a crucial means of strategic business and marketing management, IC measurement would be more useful as an internal management tool than as an external communicative vehicle to shareholders or investors (Bontis, 2001).

Therefore, the discovery of IC is a key strategic issue and therefore its status quo should be regularly reported to the director board.

In a word, IC measurement is significant to IC management, i.e. effective management relies on effective measurement. It is reported that a number of companies have begun to monitor, value and develop means to protect their intangible IC (Harvey and Lusch, 1999), but still the average business manager may not be prepared to take advantage of this knowledge. A Swiss think-tank – the Gottlieb Duttweiler Foundation – undertook studies on IC and found that only 20 percent of knowledge available to an organization is actually used because of lacking a proper IC measurement (Brooking, 1996).

With her reform and opening to the outside world, China has bid farewell to the traditional planned economy. It is an objective demand of developing China's social productive forces to have a reform in its economic system targeting at establishing a socialist market-directed economic system. Different from western countries, the socialist market-directed economy in China is based on the socialist public ownership, which plays a guiding role in the market-directed economy because it can give full play to the positive effects of market and restrain its negative effects. With the socialist public ownership as the prerequisite, some non-socialist economic forms, including individual economy, private economy, and foreign-funded business, should be developed as beneficial supplements for the socialist public ownership economic system. In this way, the state-owned economy can be strengthened, a prosperous economy and a brisk market can be brought about, and thus the socialist system can be strengthened and developed. The reason is that the government can interfere and monitor, by means of economic, legal, planning, or administrative methods, the economic operations and resource allocation in certain vital fields concerning the overall situation of the national construction, in order to make the market-directed economy develop healthily and orderly. However, under the market-directed economy, state-owned enterprises have to compete equally with other enterprises in the market with the winner surviving. Nowadays, knowledge being the most important productive element, all enterprises, especially the Chinese state-owned enterprises deriving from the planned economy, should attach great importance to the significance and urgency of IC in the survival and development of enterprises. Otherwise the Chinese enterprises, taking TV and clothmaking as examples, can be competitive only in the inferior sections of the international market, and thus forever lag behind the advanced enterprises in the western world.

Compared with international standards, Chinese enterprises seem not to be aware of the significance of IC development, so they need to recognize fully the importance and urgency of IC development. Chinese enterprises will be confronted with more and more competitions as China has entered WTO in the year 2002. More and more foreign enterprises are "snatching" various Chinese qualified personnel. Some multinational corporations such as Microsoft, Intel directly establish their research and development institution in China and

employ numbers of Chinese who are elite in science and technology. Furthermore, some of them pay attention to excellent students in Chinese middle schools and even elementary schools in order to detect and foster them to be their future employees. Unfortunately, most Chinese enterprises are still using traditional financial accounting and performance measurement methods which were developed centuries ago. Although in China there is a commonly-accepted proverb "knowledge is power", until recently Chinese enterprises have begun to be aware of IC and its structure, say nothing of using any methods or tools to measure and analyze their IC for its effective management. Therefore, the designing of a measurement model for IC is becoming an urgent problem for enterprises, especially Chinese enterprises, to meet the requirements of the globalized knowledge-based economy.

It is within this context that the desire to construct an IC measurement model originates. The focus of this dissertation is on defining the structure of IC and designing corresponding qualitative indices based on a thorough understanding and integration of the former researches and measurement models. In order to develop an applicable measurement model for enterprises to manage their IC, the model's validity and rationality is verified in this study and the relationship between the four IC elements and the relationship between IC and enterprises' performance are testified through an empirical study.

A review of the available IC measurement models

IC measurement has become the main research field for both researchers and practitioners since the 1990s. Both sides have been making various efforts to measure and evaluate IC. Therefore it is necessary to review the most popular and influential IC measurement models.

According to Nick Bontis, a famous professor of Strategic Management at McMaster University, the director of the Institute for Intellectual Capital Research, there are four measurement systems among practitioners: human resource accounting, economic value added, the balanced scorecard and intellectual capital (Bontis *et al.*, 1999).

Human resource accounting (HRA)

From Hermanson's classic study in 1964, how to evaluate assets has caused numbers of debates among accountants and human resource theorists (Hermanson, 1964). The objective of HRA is to "quantify the economic value of people to the organization" (Sackmann *et al.*, 1989) to provide input to managerial and financial decisions. Researchers have proposed three types of HRA measurement models: cost models, HR value models and monetary emphasis models.

It is acknowledged that HRA has made significant contributions in the 1970s and it therefore can be regarded as an important branch of IC measurement. HRA models evaluate human capital in financial terms and they are extensively used in service organizations where human capital comprises a significant proportion of organizational value. All of these models, however,

tend to be subjective and uncertain and thus lack reliability in that their measures cannot be testified with any assurance. Besides, HRA methods require too many assumptions, some of which cannot hold and even violate common sense. Furthermore, HRA models only deal with the value of human capital without taking into consideration other important elements such as customer, internal structure, corporate culture, and innovation.

Economic value added (EVA)

Another measurement tool finding increased usage among large corporations is EVA. EVA, introduced by Stewart in the late 1980s, is a tool to assist enterprises to pursue their prime financial directive by aiding in maximizing the wealth of its shareholders (Stewart, 1994). EVA is a comprehensive performance measurement which ties capital budgeting, financial planning, goal setting, performance measuring, shareholder communicating, and incentive compensation together to account properly for all ways in which organizational value can be added or lost (Bontis *et al.*, 1999). Here:

$$\text{EVA} = \text{Net sales} - \text{operating expenses} - \text{taxes} - \text{capital charge.}$$

Even though EVA does not explicitly relate to the management of the intangible resources, it implies that the effective management of intellectual assets will increase EVA. Therefore some strategy researchers support the idea of using EVA measurement as a surrogate for the stock of IC. EVA, however, has not systematically pointed out the components in IC's structure and often leaves top executives without clear instructions on its implementation. In addition, it regards a company as a conventional industrial society rather than in term of knowledge management. It still focuses on assessing financial indices, and all it does is just identifying 164 areas of performance adjustments in traditional accounting.

Balanced Scorecard (BSC)

After a multi-year, multi-company study sponsored by Harvard Business School, Kaplan and Norton (1996) suggested that managers need a multi-dimensional measurement system to guide their policy making and proposed using what they called a "balanced scorecard" approach to performance measurement. It was the first time that the company was encouraged to measure financial and non-financial factors, including the customer perspective groups, the internal business process and the learning and growth perspective, and to link all these measures in a coherent system (Bontis *et al.*, 1999).

Although Kaplan and Norton did not bring forward the concept of IC when they introduced BSC, the idea of BSC and IC measurement can achieve the same goal by different means. The BSC, however, considers employees as unimportant, overlooking the significance of knowledge management as a critical success factor of the new economic entity and as the key to its long-run

survival. The BSC is merely supplementary in balancing the traditional perspectives by adding non-financial perspectives.

Intellectual Capital – Skandia Navigator

IC much extended a practitioner-created concept and enjoyed a very rapid popularity in the 1990s. The wave of interest was sparked off by a few companies, of which the representative is Skandia – the largest insurance company in Sweden.

Skandia appointed Leif Edvinsson as director of Intellectual Capital. Edvinsson developed a dynamic and holistic IC reporting model named the Navigator. According to Skandia’s model, IC was categorized into human capital and structural capital (Edvinsson and Malone, 1997). Human capital can be described as the employees’ competence, inter-relationship ability and values. Structural capital can be described as “what remains in the company when employees go home for the night” (Roos *et al.*, 1997) such as brands, patents, processes, organizational structure and concepts. This categorization of IC, named the distinction tree, is illustrated in Figure 1.

In sum, Skandia’s value scheme contains both financial and non-financial building blocks that combine to estimate the company’s market value. It makes considerable effort to create a taxonomy to measure a company’s intangible assets and has emboldened others to look beyond the traditional financial factor to measure the real value for the company. Skandia’s model is particularly impressive in recognizing the role of customer capital in creating a company’s value. Skandia also provides a broad coverage of organizational structural and process factors that has not been attempted before (Bontis, 2001).

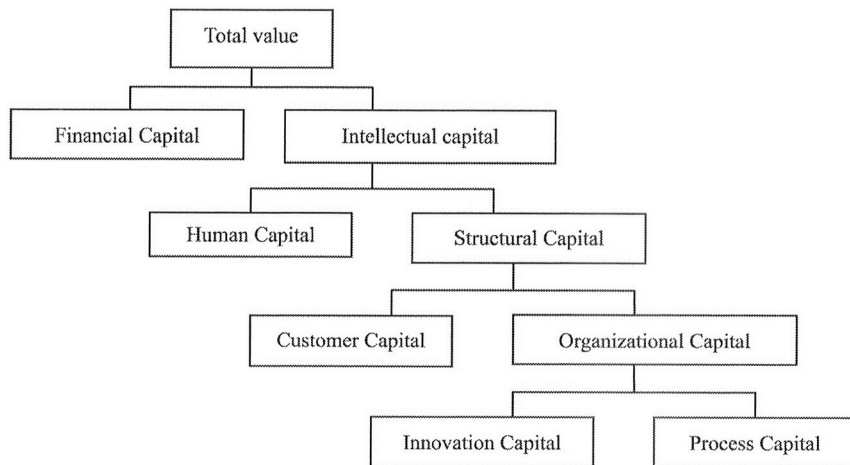


Figure 1.
The value distinction tree

Source: Roos *et al.* (1997), Lövingsson *et al.* (2000)

Skandia Navigator is an important tool. Other companies have relied extensively on Skandia's Navigator to value their R&D and patent process. However, because it relies on a balance sheet to reflect the monetary value of a company's IC, Skandia Navigator neglects many contents of IC which play important roles in creating value, such as a company's culture, organizational learning and an employee's creativity. In addition, among the more than 100 indices recommended in the Skandia model, there may be some mistaken assumptions. For example, employees showing up for work and sitting in front of their computers do not necessarily mean they are investing knowledge which can be transformed into their company's competitive advantage, so Skandia's structural capital variables, including the number of possessed computers, can be criticized (Husman and Goodman, 1999). That is to say, the Skandia Navigator needs simplification and readjustment.

A new IC measurement model

All of the above IC measurements contribute a lot to measuring IC from diverse points of view, but unfortunately, methods of measuring and evaluating IC have been slow to develop. Each of these tools had shortcomings to a certain extent and are inappropriate to Chinese companies.

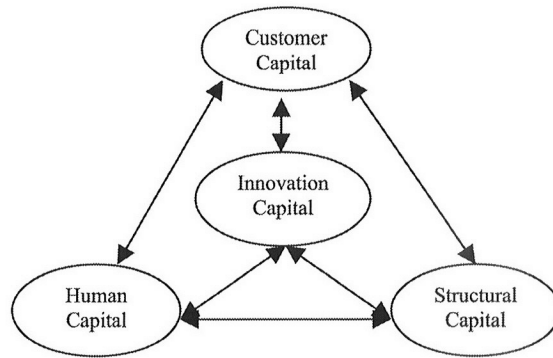
This dissertation intends to develop a new IC measurement model based on the above studies, especially the Skandia Navigator. It should be pointed out in advance that the main purpose of this new IC measurement is not to calculate the financial value. The former studies have placed a too high emphasis on the highly aggregated financial measure, which makes little sense. Furthermore, owing to the intangibility of IC, it cannot be measured with economic variables. The formula may never exist (Bontis, 1998a, b). The significance of this IC measurement model lies in its capability of providing timely necessary information for the manager of a company, which thus enables him/her to modify their strategies of IC management according to the specific situation, to obtain and make full use of knowledge, and to achieve long-term competitive excellence. Consequently, this model will focus on evaluating the indices and the trend of IC instead of calculating its economic value painstakingly.

The structure of IC

IC does not exist isolated, so the first step of setting up this new measurement model is to define the structure of IC. In this model, IC is categorized into four elements, human capital, structural capital, innovation capital and customer capital (Figure 2). It is a fragile structure, which has to be continuously supported by an integral array of the four interrelated and independent elements in order to realize a company's value.

Human capital. Human capital is the foundation of IC, a primary element to perform IC's functions. It refers to such factors as employees' knowledge, skill, capability, and attitudes in relation to fostering performances which customers are willing to pay for and the company's profit comes from. In addition, such knowledge and skill are contained in the employee's head, i.e. the head is the

Figure 2.
Intellectual capital
measurement model



carrier of knowledge and skill. If an intellectual employee does not serve the company, the knowledge and skill in his/her head cannot be activated, let alone converted into market value.

Structural capital, innovation capital, and customer capital are affiliated to human capital. On one hand, human capital can convert knowledge into market value by converting the other three capitals. On the other hand, human capital can determine the operational forms of the other three capitals while the latter can convert immaterial knowledge and information into material output and benefit, so as to accomplish the whole conversion.

Structural capital. Structural capital deals with the mechanism and structure of an enterprise that can help support employees in their quest for optimum intellectual performance, and the overall business performance can thereupon be achieved. Structural capital is subject to human capital, since human capital is a determinative factor of the organizational form. On the other hand, once influenced by human capital, structural capital exists objectively independent of human capital. For example, organizational structure and company culture can exert foundational effects independently. Furthermore, structural capital and human capital enable enterprises to form, develop, and use innovation capital and customer capital in a coordinated way.

Innovation capital. Skandia Navigator, in which innovation capital is regarded as a part of structural capital, undervalues innovation in the new economic era. In the new economic era, innovation is becoming a key factor for a company to keep its long-term competitive excellence. Economic growth in developed countries has been driven by innovation rather than by investment. Therefore, innovation is not subject to structural capital; as a matter of fact, it is the pivotal link of IC. On one hand, innovation capital cannot come into being spontaneously because its origination and development are based on the conjoint effects of human capital and structural capital. Innovation can be made only with the combination of excellent employee, reasonable regulations, culture and technique. On the other hand, innovation capital can give an impetus to the growth of customer capital. The lifecycle of products is

becoming shorter and shorter, so an enterprise can remain invincible in the heated competition only because it can ceaselessly develop new products to meet customers' demands.

Customer capital (market capital). Customer capital, which acts as a bridge and a catalyst on the operations of IC, is the main requirement and determinant in converting IC into market value and thereupon organization business performance. Without customer capital, market value or organizational performance cannot be achieved. Customer capital is most directly related to a company's business performance. The cultivation of customer capital relies on the support from human capital, structural capital and innovation capital.

Analysis of IC elements and design of measuring indices

Human capital and its evaluation indices. Human capital represents the individual tacit knowledge embedded in the mind of the employees. Human capital is important as the foundational source of innovation, strategic renewal of a company and the company can thus realize and create value in the knowledge-based economy. Human capital can be defined as a combination of employee's competence, attitude and creativity (Table I).

Employees' competence is the hard part of IC. It includes employee's knowledge, skills, talents, and knack, of which knowledge and skill are uppermost. Knowledge, which consists of technical knowledge and academic knowledge, is obtained mainly through school education and is thus theoretical. Skills, the employee's capability of accomplishing practical assignments, are obtained primarily through practice, especially the tacit skills that cannot be literally expressed, even though it can also be developed through school education.

Employees' attitude is the soft part of IC, including their motivation for work and satisfaction from work. It is regarded as the prerequisite for employees to give full play to their competence. A number of well-known companies like McKinsey, Procter and Gamble attach the same importance to it as to their competence. When these companies recruit a new employee,

Employees' competence	Strategic leadership of the management Qualities of the employees Learning ability of the employees Efficiency of employee training The employees' ability to participate in policy making and management Training of key technical and managerial employees
Employees' attitude	Identification with corporate values Satisfaction degree Employees' turnover rate Employees' average serviceable life
Employees' creativity	Employee's creative ability Income on employees' original ideas

Table I.
The indices of human
capital

they might consider more about the conformity of an applicant's attitude to the company's requirement, and later train the new employee for special skills instead of employing the applicant according to his/her specialty.

Employees' creativity enables them to use their knowledge elastically and to make innovations continuously. It is therefore one of the key factors in developing the IC of an enterprise.

Structural capital and its indices. Structural capital deals with the system and structure of an enterprise. It is the business routines. An enterprise with strong structural capital will create favorable conditions to utilize human capital and allow human capital to realize its fullest potential, and then to boost its innovation capital and customer capital. In detail, structural capital can be classified into company culture, organizational structure, organizational learning, operational process, and information system (Table II).

A company's culture is the values, faith and behavior criterions approved and shared by all the staff. Values are what a company regards as the most important to its business, employees and customers. Faith refers to an employee's attitude towards him/herself, his/her company and customers. Meanwhile behavioral criterions are the unwritten rules emphasizing such matters as employees' appearance and cooperation with one another. Company culture under the guidance of a favorable managing philosophy is a valuable asset. Only under the strong culture can a company give full play to its employees' competence and motivate them to serve the company and customer heart and soul.

Organizational structure is the power and responsibility structure formed in the managing process. This power and responsibility structure can find expression in the policy-making structure, the leading structure, the controlling structure and the information structure. Organizational structure is both static and dynamic since organizational structure includes not only the formal organizational relationship consisting of the power relationship and the control system, but also the informal organizational relationship. On the other hand,

Corporate culture	Construction of company's culture Employee's identification with company's perspective
Organizational structure	Clarification of relationship among authority, responsibility and benefit Validity of enterprise controlling system
Organizational learning	Construction and utilization of inner information net Construction and utilization of company repository
Operation process	Business process period Product quality level Corporate operating efficiency
Information system	Mutual support and cooperation between employees Availability of enterprise information Share of knowledge

Table II.
The indices of structural capital

organizational structure is influenced by its internal and external environments; as a result, there will be an organizational change to promote the organizational development.

Some managers usually believe that the more they learn about the change, the better they will manage it and the better the company will perform. Organizational competence is the result of the perennial learning and accumulating, and it is becoming one of the most important core competence of a company. It is affirmed that in the twenty-first century the only way for a successful company to maintain its competitive excellence is to be quicker in learning than its competitors.

The operational process, which ensures a company to complete its various operational tasks, is the most effective working methods and processes after a long-term accumulation and deposition. The total quality management (TQM) and the company reconstruction, which are popular in the later twentieth century, focus on the reform in operational processes in order to increase operational efficiency and reduce production cost.

The information system includes the storage, disposal and transmission of the inner information of a company. A favorable information system enables a company to quicken the flow of the inner information, heighten the operational efficiency, and hasten learning within the company.

Innovation capital and its indices. Innovation refers to the introduction of a new combination of the essential factors of production into the production system. It involves the new product, the new technology, the new market, the new material and the new combination. Innovation capital is the competence of organizing and implementing R&D, unremittingly bringing forth the new technology and the new product to meet the demands of customers. With the increasing importance of knowledge, innovation capital has become the core of IC providing a powerful drive for a company's continuous development. Innovation capital can be classified into three parts: innovational achievements, innovational mechanism and innovational culture (Table III).

Innovational achievements are the new products, patents and technologies obtained through the technical innovation. They reflect the historical information of the innovation capital of a company.

For the sake of the effective innovation, a company should be provided with a sound innovational mechanism involving the investment mechanism, the operation mechanism, the cooperation mechanism, and the motivation mechanism. It has been indicated that the effective innovation needs the sufficient investment in both human and material resources, the resolute strategic policy-making of the top levels of the company, the good cooperation between R&D, marketing and manufacture departments, and the good cooperative relationship with outside to win the technical support.

Innovation culture is the foundation of a sound innovational mechanism. All the companies renowned for innovation such as 3M, INTEL have their strong innovational culture. Such a culture can drive a company to make adjustments in its strategy, organization and personnel according to the specific

Table III.
The indices of
innovation capital

Innovation achievements	Average quantity of patents of employees Percentage of new developed product sales in total sales (the last three years)
Innovation mechanism	Numbers of new developed technologies (the last three years) Percentage of R&D investment in total sales Quality and quantity of R&D employees Interface cooperation between R&D, manufacture and market departments in innovation Cooperation with external innovation force Management ability of innovation projects Incentives for innovative employees
Innovation culture	Corporate culture's support and encouragement to employees' innovation High management support to innovation

unfavorable conditions in the innovation process in order to ensure the company to hold its ground at the forefront in innovational management.

Customer capital and its indices. Customer capital, an essential part of IC, is the value embedded in the marketing channels and relationships that an enterprise develops by conducting business. Compared with human capital and structure capital, it more directly affects the realization of company's value and is increasingly becoming the critical factor. Claes Fornell, a professor of Michigan University, found that the satisfaction of customers could maintain the business relationship, decrease the elasticity of product price and improve company's prestige (Fornell, 1992). In this study, customer capital is classified into basic marketing capability, market intensity and customer's loyalty (Table IV).

The basic marketing capability is the groundwork for a company to manage its human capital. To increase market intensity and customer's loyalty, a company should first enhance its basic marketing capability, such as the serving capability, and the capability of collecting and utilizing customers' data.

Market intensity, the ultimate expression of customer capital, refers to the current state of market building and its potential.

Basic marketing capability	Construction and utilization of the customer database Customer service capability
Market intensity	Identifying ability of customer's needs Market share Market potential Unit sales to customer Brand and trademark reputation Construction of sales channel
Customer loyalty indices	Customer satisfaction Customer complaint Customer outflow Investment on customer relationship

Table IV.
The indices of customer
capital

Customer's loyalty is playing a more and more important role in today's heated competition. A company without loyal customers will have to resort to various sales promotions to allure new customers who are sometimes unprofitable to the company. Accordingly, the company should make great efforts to improve the quality of product and service pertaining to the current and future needs of customers, and to enhance customer's satisfaction and thereupon customer's loyalty.

An empirical study

To test and verify its rationality and validity, an empirical study has been done on the above IC measurement model and its index system, and a detailed analysis has been made on the relationship between the four elements of IC.

Method

It should be pointed out that the major purpose of IC measuring is not to measure the financial value of the IC because its financial value is not of too much importance. Furthermore, its tacitness makes the IC calculating formula almost unachievable. The importance of an IC measurement model lies in its ability to offer the enterprise management timely information feedback, which enable them to modify their IC strategy accordingly for their long-term competitive advantages through retrieving and utilizing knowledge (Arthur, 1990). The purpose of this study is to assess the status quo effectively and tendency of the elements of IC rather than to measure painstakingly the economic value of IC.

A questionnaire with a seven-point scale has been employed in this study. Each index has a seven-point scale, ranging from 7 to 1, and accordingly presenting completely satisfied, satisfied, fairly satisfied, so-so, fairly dissatisfied, dissatisfied, and completely dissatisfied.

Because an enterprise has to face different situations and accordingly to adopt different strategies, the importance of each element of IC to the enterprise is different (Petty and Guthrie, 2000). This research made the subjects assess the importance of each factor to their enterprise by using weight Q_{ij} ranging from 3 to 1, and the value of each factor is expressed by the weighted means:

$$IC_i = \sum_{j=1}^m C_{ij} \times Q_{ij} \sum_{j=1}^m Q_{ij}.$$

Here:

- IC₁ : human capital marks;
- IC₂ : structural capital marks;
- IC₃ : innovation capital marks;
- IC₄ : customer capital marks;

C_{ij} : factor value; and
 m : the number of the factors of IC.

This research was conducted mainly in the high-tech enterprises. Owing to the difficulties in collecting samples, only those enterprises willing to accept our survey were randomly chosen as the samples. The subjects of this survey are mainly the entrepreneur, the general manager, or the top executives of the corporations. There were 60 subjects filling in the questionnaires on behalf of their corporations, with 31 valid questionnaires, because some of the subjects were not able to obtain sufficient information about their corporations owing to their comparatively inferior positions in their corporations. Certain tendency can be proved with a thorough analysis on the data obtained from these relatively small-scope samples.

Reliability test

In this study the Cronbach test was used to examine the reliability of the data. Nunnally (1978) has stated that if α is bigger than 0.7, the result is reliable. From the results (see Table V), a conclusion can be drawn that the obtained data are reliable.

Validity test: a correlation analysis between IC and enterprise performance

At the new economic era, IC, as the most important factor to the capital of an enterprise, has a dominant influence on its performance (Brennan and Connell, 2000; Bornemann *et al.*, 1999).

In detail, innovation capital is the core of the IC. An enterprise can reduce the production cost effectively with technology innovation, and obtain extra overflow revenue with product innovation by providing diversified products. Human capital is the foundation of IC. The knowledge, skill, attitude and creativity of the outstanding personnel are the vital capital since the outstanding personnel can result in outstanding products and improve the total production efficiency. A proper structural capital can sufficiently exert efficiency on human capital, and customer capital can directly influence the realization of enterprise value. As a result, all IC elements play a direct or indirect role in not only reducing the enterprise operating cost, but also providing the diverse products and services to meet customers' demands. Thus, there must be a significant positive correlation between an enterprise's IC elements and its performance. Roos *et al.* (1997) pointed out that if the

Table V.
The results of α value of each IC element from the investigation

	Human capital	Structural capital	Innovation capital	Customer capital
α value	0.86	0.91	0.91	0.89

correlation is insignificant, there must be something wrong with the measurement model and indices.

To testify to the validity of the above measurement model, the correlation between the measuring results and enterprise performance was further analyzed in this study. Two typical indices were used to reflect an enterprise's present and potential performance respectively. One is the rate of returns of net assets, the other is the prospect of an enterprise. The ultimate performance index is defined as the arithmetical mean of the score of the rate of returns of net assets and the score of enterprise growth. The average performance of the investigated enterprises is a middle level of 4.56, and α value is 0.79.

The results from the correlation analysis between intellectual capital and enterprise performance are shown in Table VI.

Based on the above statistical results, it is concluded that a remarkable positive correlation exists between the score of the IC and that of enterprise performance. This correlation has verified the rationality and validity of this new IC measurement model.

Path analysis of IC elements

As the research has verified the rationality and validity of the IC measurement model, a path analysis should be made to show the actual mutual relationship between the IC elements.

First, Person correlation was analyzed through the SPSS software, and the result is shown as in Table VII.

Second, a path analysis was made through the SAS software, and the model is illustrated in Figure 3.

It is shown that human capital can remarkably influence both structural capital and customer capital at 0.01 level $p < 0.01$, and so does structural capital to both innovation capital and customer capital.

	Human capital	Structural capital	Innovation capital	Customer capital	Intellectual capital
Enterprise performance	0.678*	0.733*	0.824*	0.798*	0.928*

Note: * Correlation is significant at the 0.01 level in the two-tailed test

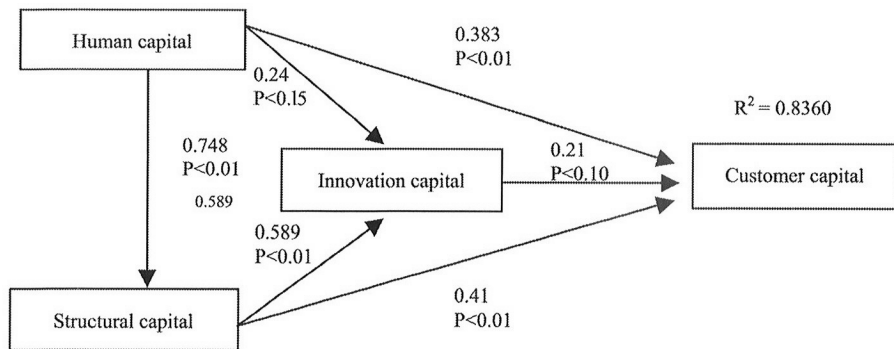
Table VI.
Correlation coefficient
between IC and
enterprise performance

	Human capital	Structural capital	Innovation capital	Customer capital
Human capital	1.00	0.748*	0.681*	0.833*
Structural capital	0.748*	1.000	0.769*	0.858*
Innovation capital	0.681*	0.769*	1.000	0.786*
Customer capital	0.833*	0.858*	0.786*	1.000

Note: * Correlation is significant at the 0.01 level in the two-tailed test

Table VII.
Correlation coefficients
of IC elements

Figure 3.
The results of the path
analysis



Relatively, the influence of human capital on innovation capital and that of innovation capital on customer capital, only at 0.15 and 0.10 levels ($p < 0.15$ and $p < 0.10$), were less prominent. It indicates that, in terms of enhancing human capital, there is still room for improvement in the innovation ability of the employees in the companies investigated in this study. In addition, because customers need time to accept innovation, the influence of innovation capital on customer capital may slightly be delayed, which reduces the prominence of the correlation between the two capitals. Despite this, the relationship between the IC elements accords with the expected conclusions.

Results and discussion

Under the competitive circumstances with knowledge as the vital capital, an enterprise must strive for a dominant position for survival and development in the learning competition among enterprises. IC management has already become the core of the enterprise management in the knowledge economy era. It is a pity that the progress of IC measurement method study is relatively slow, and that so far only limited documents can be found in China. Therefore this study aims at designing a new IC measurement model with its own indices.

As discussed above, it is almost impossible to form a detailed formula to calculate the economic value of IC, which, however, does not mean that it is insignificant to design a measurement model. On the contrary, it is useful to design a set of qualitative measuring indices, which enable an enterprise to recognize the status quo of IC through both the horizontal and vertical comparisons, and then adopt correspondent measures to avoid its weakness and develop its strength.

With a theoretical analysis, in this study IC is classified into human capital, structural capital, innovation capital and customer capital, and the qualitative measuring indices are designed according to their respective content. Thereupon the rationality and validity of the IC measurement model and its index system is verified through an empirical study. In addition, a path analysis was made and it indicates that there is a strong correlation between the four IC elements, which is significant in directing the enterprise

management to manage the IC. This correlation indicates that an interactive relationship exists between the four IC elements and that the enterprise must understand and improve its IC level with an overall point of view so as to occupy a dominant position in today's knowledge-based economy.

This IC measuring index system enables enterprises to have a more definite and direct understanding of the composition of IC, and to evaluate its developing tendency periodically. None of the surveyed enterprises claimed that they have begun to have a systematic management of their IC because, with a vague idea of IC, they are not clear what is included in IC or by what method to evaluate their own IC so as to have an effective management of it. Meanwhile, there is still room for improvement in the overall levels of IC in Chinese enterprises. For those enterprises with a desire to manage their IC better, this IC measurement model can first help them recognize the status quo of their IC by offering a periodic evaluation of their IC so as to discover their distance from their competitors, the demands of customers, and the enterprises with the best IC management. Second, this model enables them to understand the functions of various IC defined within the setting of their enterprises and their line of business, to find out and strive for the main IC within and outside their enterprises. Only with a thorough understanding of the IC of their enterprise, an effective IC management can become possible. Finally, with this measurement system an enterprise can apply the knowledge management to each department and to the assessment of their employees' achievements by setting the aims in enhancing the IC for each department and each employee. Proper adjustments in this measurement system, of course, should be made according to the specific situations of the enterprises.

References

- Arthur, W.B. (1990), "Positive feedbacks in the economy", *Scientific American*, February, pp. 80-5.
- Bontis, N. (1998a), "Managing organizational knowledge by diagnosing intellectual capital: framing and advancing the state of the field", *International Journal of Technology Management*, Vol. 18, May-August, pp. 433-62.
- Bontis, N. (1998b), "Intellectual capital: an exploratory study that develops measure and models", *Management Decision*, Vol. 36 No. 2, pp. 63-76.
- Bontis, N. (2001), "Assessing knowledge assets: a review of the models used to measure intellectual capital", *International Journal of Management Reviews*, Vol. 3 No. 1, pp. 41-60.
- Bontis, N., Dragonetti, N.C., Jacobsen, K. and Roos, G. (1999), "The knowledge toolbox: a review of the tools available to measure and manage intangible resources", *European Management Journal*, Vol. 17 No. 4, pp. 15-27.
- Bornemann, M., Knapp, A., Schneider, U. and Sixl, K.I. (1999), "Holistic measurement of intellectual capital", paper presented at the International Symposium: Measuring and Reporting Intellectual Capital: Experience, Issues, Prospects, OECD, Amsterdam, June.
- Brennan, N. and Connell, B. (2000), "Intellectual capital: current issues and policy implications", paper presented at the 23rd Annual Congress of the European Accounting Association, Munich, 29-31 March.

- Brooking, A. (1996), *Intellectual Capital – Core Asset for the Third Millennium Enterprises*, International Thomson Business Press, London.
- Edvinsson, L. and Malone, M.S. (1997), *Intellectual Capital: Realizing Your Company's True Value by Finding Its Hidden Brainpower*, HarperBusiness Press, New York, NY.
- Fornell, C. (1992), "A national customer satisfaction barometer: the Swedish experience", *Journal of Marketing*, Vol. LVI, January, pp. 6-21.
- Harvey, M.C. and Lusch, R.F. (1999), "Balancing the intellectual capital books: intangible liabilities", *European Management Journal*, Vol. 17 No. 1, pp. 85-92.
- Hermanson, R. (1964), *Accounting for Human Assets: Bureau of Business and Economic Research*, Occasional Paper No. 14, Bureau of Business and Economic Research, Michigan State University, East Lansing, MI.
- Husman, R. and Goodman, J. (1999), *Leading with Knowledge: The Nature of Competition in the 21st Century*, Sage, London.
- Kaplan, R. and Norton, D.P. (1996), *The Balanced Scorecard: Translating Strategy into Action*, Harvard Business School Press, Boston, MA.
- Lev, B. (1997), "The old rules no longer apply", *Forbes*, 7 April.
- Lövingsson, F., Dell'Orto, S. and Baladi, P. (2000), "Navigating with new managerial tools", *Journal of Intellectual Capital*, Vol. 1 No. 2, pp. 147-54.
- Nunnally, J.C. (1978), *Psychometric Theory*, 2nd ed., McGraw-Hill, New York, NY.
- Petty, R. and Guthrie, J. (2000), "Intellectual capital literature review", *Journal of Intellectual Capital*, Vol. 1 No. 2, pp. 155-76.
- Roos, J., Roos, G., Dragonetti, N. and Edvinsson, L. (1997), *Intellectual Capital*, Macmillan Business, New York, NY.
- Sackmann, S., Flamholz, E. and Bullen, M. (1989), "Human resource accounting: a state-of-the-art review", *Journal of Accounting Literature*, No. 8, pp. 235-64.
- Sullivan, P.H. Jr and Sullivan, P.H. sen (2000), "Valuing intangibles companies: an intellectual capital approach", *Journal of Intellectual Capital*, Vol. 1 No. 4, pp. 328-40.
- Waterhouse, J. and Svendsen, A. (1998), *Strategic Performance Monitoring and Management*, CICA, Toronto.

Further reading

- Bontis, N., Keow, W.C.C. and Richardson, S. (2000), "Intellectual capital and business performance in Malaysian industries", *Journal of Intellectual Capital*, Vol. 1 No. 1, pp. 85-100.