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The weight evaluation of intellectual capital's key factors upon financial performance of the listed IC design houses in Taiwan

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Abstract

The main purpose of this study is to evaluate the weight value of intellectual capital's key factors that affect financial performance of the listed IC Design Houses in Taiwan. The research subjects are five typical listed Taiwan IC design houses. This paper adopts Analytic Network Process (ANP) to analyze the relevance of each criterion, and to identify the important factors of each criterion and the priority ranking of their weights. Research findings show that, in the intellectual capital sub-dimension affecting the financial performance of the listed IC design houses in Taiwan, the weights from both the academic scholars' perspective and industry operators' perspective are over 0.1. This fact shows that both scholars and business operators believe that customer capital, process capital, human resource capital and innovation capital are the important indicators that affect financial performance. Although the weight values of business operators' perspectives on the above-mentioned four factors are different from those of the scholars', this difference arises because scholars take on a theoretical viewpoint, believing that innovation capital impacts financial performance the most; while business operators take on a more practical view, believing that customer capital impacts financial performance the most.

Keywords: Intellectual capital, financial performance, analytic network process, (ANP)

Research background & purposes

IC design is in the forefront of the supply chain, including IC manufacturing, packaging, testing, and support, of the IC industry. Its technology and output dominate the development of the IC

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industry in Taiwan. Therefore, improving the productivity factor of technical efficiency is relevant to the financial performance of the industry.

While the semiconductor industry is important to the economic development of a country, it is highly capital-and technology-intensive. Among the countries with leading position in semiconductor, Taiwan is the only country with a vertically integrated supply chain. The government seeks to boost the productivity of the industry by establishing science parks and creating cluster effects. In fact, Taiwan is the role model for the countries who seek to develop their semiconductor industries. The semiconductor industry in Taiwan is known for unparalleled competitiveness in efficiency and cost due to a comprehensive supply chain. This also provides an ideal backdrop for the booming development of IC design houses (Peng, 2009; Lee, 2014). This is the reason why this study chooses the Listed IC Design Houses in Taiwan as an example.

Due to the boom of knowledge-based enterprises in recent years, research on intangible assets, or intellectual capital, has become the hottest topic in the academic realm and accounting practice. The importance of intellectual capital simply cannot be ignored, particularly as we are in the era of a knowledge-based economy. Only by using a systematic and organized approach to understand the essence of knowledge assets and by thinking from a perspective of overall financial strategies can we develop the intellectual capital that is unique to each organization (Huang, 2008).

Therefore, this research selects five listed IC design houses in Taiwan as the research subjects, and focuses the study on key factors of the intellectual capital of a company, including: (1) customer capital; (2) process capital; (3) human resource capital; and (4) innovation capital. This research constructs a research framework and then performs analysis and evaluation in order to understand the weight values of intellectual capital's key factors that affect the financial performance of listed IC design houses in Taiwan. The research findings of this study can hopefully serve as a reference for operators of the listed IC design houses in Taiwan to use in their decision-making, which is the main purpose of this study.

Literature review

After reviewing domestic and overseas literature, this paper determines that the intellectual capital's key factors that affect financial performance are summarized in the following sub-dimensions, which include:

Intellectual capital

Stewart (1997) believed that intellectual capital was the culminate combination of all knowledge and capabilities that every individual brought to the competitive advantages for the company.

Masoulas (1998) believed that intellectual capital was the combination of the intangible assets of an organization that add value to its effort to achieve its goal. An organization that understands its intangible assets, such as: employee skills, experience, attitudes and information, may obtain the added value incurred through work.

Lynn (1998) divided intellectual capital into: (1) human resource capital: employees of an organization; (2) structural capital: including formal and informal systems that are the basis of efficient and effective operation of an organization; and (3) relational capital: the relationship between an organization and its external agencies, such as suppliers and customers.

Knight (1999) believed that intellectual capital can be defined as human resource capital, structural capital, external capital and financial performance.

Lee (2008) pointed out that intellectual capital was an important factor that allowed enterprises to enjoy their competitive advantages, and that intellectual capital was in essence a type of intangible asset which includes: human resources, innovation, customer relations and business processes. These intangible assets can bring more value and competitive advantage to enterprises than the conventional tangible assets (Guthrie, 2001; Chen, 2001; Kuo, 2004).

Huang (2008) divided intellectual capital into: (1) Customer capital: its measured variables are the number of major customers, market growth, and product acceptance rate; (2) Process capital: its measured variables are the increase rates in administrative expense, inventory turnover rate, and average per-person administrative expense; (3) Human resource capital: its measured variables are employee productivity, added value per employee, number of high-level staff with a high-level education ratio, and per-person operating profit; and (4) Innovation capital: its measured variables are R&D staff ratio, R&D intensity, R&D productivity, and R&D costs.

In summary, this research references Huang's (2008) classifications and definitions concerning intellectual capital's key factors, measured variables, and research variables (Table 2).

Financial performance

Currently, there are multitudes of writings published in Taiwan and overseas that discuss the measurement of financial performance indicators. A brief description of which, as relates to this research, follows:

Huang (2008) used three indicators: Return on Assets (ROA), Return on Equity (ROE), and Economic Value Added (EVA), to measure financial performance. While discussing the difference in impacts of intellectual capital and financial performance, Firer & William (2003), Liao (2004), and Lin (2004) pointed out that traditionally ROE and ROA are indicators used for measuring financial performance, and that EVA is less likely to be used as a measurement indicator for the study of the impact differences between intellectual capital ad financial performance. However, based on a quest for research objectivity, this research also includes EVA as a measurement indicator.

Li *et al.* (2011) integrated ROE, Market to Book ratio (MB), and Tobin's Q to produce a consolidated indicator --PERF to represent the financial performance of an organization.

In conclusion, concerning measured variables, this study adopts Huang's (2008) measurement indicators for financial performance, i.e. ROE, ROA and EVA. And the definition of financial performance in this study is "Measuring the results of a firm's policies and operations in monetary terms. These results are reflected in the firm's return on investment, return on assets, value added, etc" (Refer to Google website).

The relationship between intellectual capital and financial performance

Heskett *et al. (*1994) believed that customer satisfaction, customer loyalty and market share were related to financial performance.

Wang and Chang (2004) suggested that customer capital was positively correlated to financial performance.

Huang (2008) indicated that human resource capital, innovation capital and customer capital were all positively correlated to financial performance.

Hung (2008) pointed out that intellectual capital had a positive significant impact on the business performance of traditional industries, of which the most significant is process capital.

The research results Li *et al*. (2011) showed that organizational capital cannot directly interpret financial performance; however, it can generate an indirect impact on financial performance via human resource capital and customer capital.

From the above-mentioned, this study is consent the authors' opinions that Intellectual Capital has the relationship with Financial Performance, but it needs to be verified in the future study.

Methodology & design

Theoretical basis — analytic network process (ANP)

ANP is an extension of AHP (Analytic Hierarchy Process) with the addition of a feedback mechanism. The purpose is to accurately capture and predict the internal relationships among all the criteria, goals and proposals via ratio scales, so as to achieve optimal decisions (Mohamed, 2002; Chen, 2004). This study applies the ANP method in the analysis of the relationships among the green design criteria and seeks to identify the relative weights and importance rankings of individual criteria. The analytical findings of this stage may be helpful to management personnel of the listed IC design houses in Taiwan in their understanding of the weights of intellectual capital's key factors that affect financial performance, and can serve as a reference in making the strategic decisions on business management.

The decision rules in ANP networks comprise of clusters, elements, nodes and links. If a node in a given cluster exhibits interdependence or feedback relationships with a node in another cluster, there will be a connecting link between these two clusters. ANP assumes and allows the interdependence or feedback relationships among elements within the same or across different decision criteria. If such interdependence or feedback relationships are within the same decision criteria, it is considered "inner dependence". In the absence of any inner dependence, the node in the same criterion should be compared pair-wise with the node in another criterion. The interdependence or feedback relationship between elements in different decision criteria was called "outer dependence" (Satty, 1996). The permission of interdependence or feedback relationships across criteria is in line with the actual situation of tackling complex issues in the human society. This is particularly true when the uncertainties and risks are involved in the decisions in question (Sun, 1997; Liu, 2002; Tu and Hsu, 2008).

The ANP method is suitable to solve the problems whose structures may contain one or multiple networks. The construction of the network applicable to the ANP method should take the following issues: (1) whether the classification of elements and clusters are required for problem solving; (2) the establishment of a cluster takes precedence of nodes (elements); (3) it is necessary

to select a node (element) as the parent node and examine whether other notes in the cluster are affected by the parent node. The affected nodes are "children nodes". The children nodes are compared pair-wise in order to determine the effects of parent node. This is followed by the selection of another parent node accordingly; (4) The plotting of the links between the children nodes subject to the influence of the parent node is required for the pair-wise comparisons of these nodes; (5) The establishment of the links describing the relationships among all the nodes marks the completion of the links between clusters; (6) finally, it is necessary to confirm the accuracy of the links for the influencing nodes and the influenced nodes to facilitate the pair-wise comparisons of nodes to nodes and clusters to clusters.

The calculation of the ANP network requires three matrixes, i.e. un-weighted super-matrix, weighted super-matrix and limit super-matrix. The un-weighted matrix consists of the weights based on pair-wise comparisons in the original network. The weighted matrix is constructed by multiplying the component weight with relevant cluster weight in the un-weighted matrix. If the values in the straight column add up to 1 (stochastic) in the un-weighted matrix, the weighted matrix is equivalent to the un-weighted one.

The limit matrix is established by making the weighted matrix multiplying itself until all the values in the straight column become equal. In other word, the weight of any individual node in the network can be obtained from any of the straight columns. According to the calculation method developed by Satty (1996) for the ANP method, if the super matrix is irreducible, lim SV=[w,...,w]. At this juncture, all the straight columns in the matrix will be identical and equivalent to vector w, and hence converge (Tu and Hsu, 2008). Simply put, the ANP methodology comes in the following stages: (1) the application of the Delphi method or interviews with experts to establish a hierarchical network for the assessment desired; (2) the calculation of the weights for individual elements in the hierarchical levels, such as the establishment of pair-wise comparison matrixes (by issuing questionnaires), the computation of Eigen values and vectors, consistency tests (<0.1) and calculation of super/limit matrixes; (3) the calculation of global weight for all the hierarchical levels (Hu and Wang, 2008).

Questionnaire design and sample collection

Using the research framework as the base, this study constructs the ANP method for the weight evaluation of intellectual capital's key factors that affect the financial performance of listed IC design houses in Taiwan, and establishes the relationship between each criterion. The analytical figure of the ANP method is referred to for the design of the questionnaire in aiming to evaluate the inter-relationships between intellectual capital's key factors that affect the financial performance of listed IC design houses in Taiwan. The ANP method is suitable for data collection

via interviews of a small sample of experts. This study conducts interviews with experts well-versed in the issues associated with these five IC design houses listed in Taiwan in order to understand the inter-relationships and weight value of individual criteria of intellectual capital's key factors that affect the financial performance for these companies. In addition, financial data related to the research subjects of this study is sourced from Taiwan Economic Journal's (TEJ) database for the period of 2010-2012. The selection standard of the sampled companies must meet the criteria listed in Table 3-2; i.e. the sampled company (the listed IC Company in Taiwan) must have sound financial-operation disclosures for the three consecutive years required to complete this research, in order to meet the selection criteria of this research.

Research targets

This paper issued questionnaires to the following experts:

(1) A total of 7 questionnaires released to scholars and a total of 7 questionnaires recovered, for an effective recovery rate of 100%;

(2) A total of 8 questionnaires were released to the business operators and a total of 7 questionnaires recovered; that is an effective recovery rate of 87.5%. The high recovery rate is the result of using Convenience Sampling.

Research framework

The following Tables 1, 2 and 3 respectively summarize (1) the evaluation structure for the weights of intellectual capital's key factors that affect financial performance of IC design houses listed in Taiwan; (2) the definitions of research variables; and (3) the relationships among sub-dimensions.

Table 3 shows that the sub-dimensions are not entirely independent from each other and some of them are interrelated. In other words, the pair-wise comparisons of nodes to nodes and clusters to clusters indicate that nodes or clusters are not completely independent from each other. Therefore, this paper uses the ANP method to replace AHP (Hu and Wang, 2008).

Table 1: Evaluation structure for the weights of intellectual capital's key factors that affect financial performance of IC design houses listed in Taiwan

Target	Sub-dimension	Second sub-dimension	Criteria
Financial Performance (*FP*)	Intellectual Capital (*IC*)	Customer Capital(CC)	Market Growth(C1) Number of Major Customers(C2) Product Acceptance Rate(C3)
		Process Capital (PC)	Average Per-Person Administrative Expenses(P1) Administrative Expense Increase

		Rate(P2)
		Inventory Turn-over Rate(P3)
	Human Resource Capital (HRC)	Per-Person Operating Income(R1)
		Employee Productivity(R2)
		Employee Added Value(R3)
		High-Level Staff with High-Level Education Ratio(R4)
		R&D Staff Ratio(I1)
	Innovative Capital (IC)	R&D Costs(I2)
		R&D Intensity(I3)
		R&D Productivity(I4)

Table 2: Dimensions and definitions for the weight evaluation of intellectual capital's key factors that affect financial performance of IC design houses listed in Taiwan

Intellectual Capital's Key Factor	Measured Variables	Research Variable Definitions
Financial performance (FP)	Return on Equity (ROE) (F1)	Net operating profit / Net Sales
	Return on Assets (ROA) (F2)	Net profit after tax / Average Total Assets
	Economic Value Added (EVA) (F3)	EVA = Net operating profit after tax – Percentage of capital cost x (Total capital)
Customer capital (CC)	Market Growth (C1)	Revenue growth rate
	Number of Major Customers (C2)	Sales accounts for more than 10% of the number of customers
	Product Acceptance Rate (C3)	1 - Sales returns and rebates / Net sales
Process capital (PC)	Average Per-Person Management Fee(P1)	Administrative expenses / Total number of employees
	Management Fee Increase Rate (P2)	(Administrative expenses of the current year – Administrative expenses of the previous year)/ Administrative expenses of the previous year
	Inventory Turn-over Rate (P3)	Cost of sales / Average inventory
Human resource capital (HRC)	Per-Person Operating Income (R1)	Net operating profit / Total number of employees
	Employee Productivity (R2)	Net Sales / Total number of employees
	Employee Added Value (R3)	Net profit after tax / Total number of employees
	High-Level Staff with High-Level Education Ratio(R4)	Number of employees with college degrees/ Total number of employees
Innovation capital(IC)	R&D Staff Ratio (I1)	Number of R&D employees / Total number of employees
	R&D Costs (I2)	R&D expenses of the current year
	R&D Intensity (I3)	R & D expenses / Average total assets
	R&D Productivity (I4)	Net profit after tax / R & D expenses

Sources: Huang (2008)

Table 3: Relationships between the criteria of each sub-dimension

Dimension / Criteria		FP						IC									
Dimension/Criteria		F1	F2	F3	C1	C2	C3	P1	P2	P3	R1	R2	R3	R4	I1	I2	I3	I4
FP	F1	v	v	v	v	v	v	x	x	v	v	v	v	x	x	v	x	v
	F2	v	v	v	v	v	v	v	v	v	v	v	v	x	x	v	v	v
	F3	v	x	v	v	x	v	x	x	v	v	v	v	x	x	x	x	v
IC	C1	v	v	v	v	v	v	x	x	v	v	v	v	x	x	x	x	v
	C2	v	v	v	v	v	v	v	v	v	v	v	v	x	x	x	x	v
	C3	v	v	v	x	x	v	v	v	v	v	v	v	x	v	v	v	v
	P1	x	x	x	x	x	x	v	v	x	x	x	v	v	v	v	v	v
	P2	v	v	v	x	x	v	v	v	v	v	x	x	x	v	v	v	v
	P3	v	v	v	v	v	v	x	x	v	v	v	v	x	x	x	x	v
	R1	v	v	v	v	x	v	x	x	v	v	v	v	x	x	x	x	v
	R2	v	v	v	v	x	x	x	x	x	v	v	v	v	v	v	v	v
	R3	v	v	v	v	x	x	x	x	x	v	v	v	v	v	v	v	v
	R4	x	x	x	x	x	x	v	v	x	v	v	v	v	v	v	v	v
	I1	v	v	v	x	x	x	v	v	x	v	v	v	v	v	v	v	v
	I2	v	v	v	x	x	x	v	v	x	v	v	v	v	v	v	v	v
	I3	v	v	v	x	x	x	v	v	x	v	v	v	v	v	v	v	v
	I4	v	v	v	v	x	v	v	v	x	v	v	v	v	v	v	v	v

Note: 1 Please refer to "straight" columns for inputs;

2. Please refer to "horizontal" rows when plotting in a Word document.

3. FP: Financial Performance; IC: Intellectual Capital; Please refer to

Table 3-2 for other symbols (F1; F2; F3; C1; C2; C3; P1; P2; P3; R1; R2; R3; R4; I1; I2; I3; I4)

ANP analytical procedures

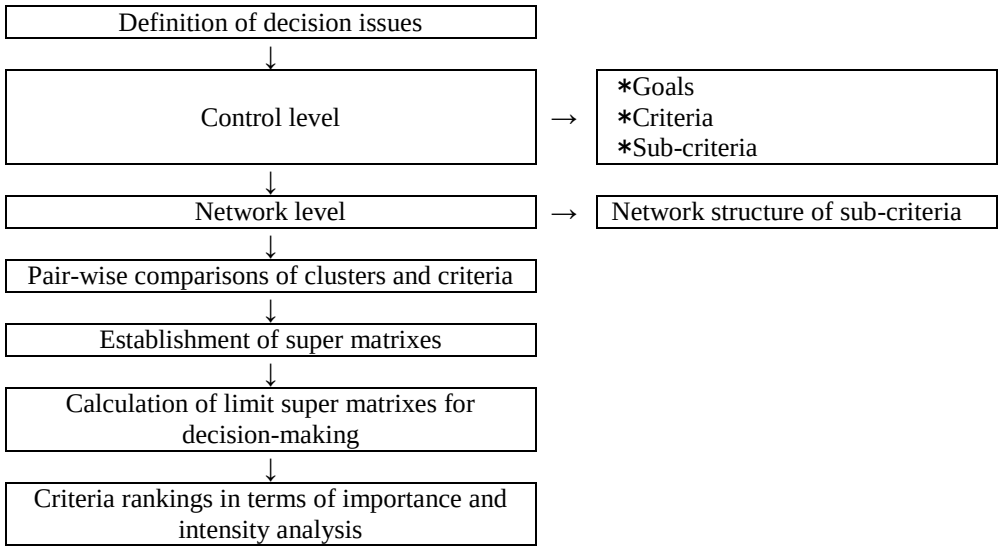

Figure 1: Illustrates the AHP procedures for the analysis

(1) Construction of decision-making systems

The first step in the ANP methodology is to divide the system into two parts. The first part is the control level, consisting of goals, criteria and sub-criteria. All the decision criteria are considered

independent and only subject to the dominance of goal elements. There may not be decision criteria among the control factors but there will be at least a goal. The weight of each criterion in the control level can be obtained with the traditional AHP approach. The second part is the network level, composed of clusters or components subject to the dominance of the control level. Inside the network level are the structures that influence each other.

(2) Pair-wise comparisons of individual clusters and criteria

After the construction of the decision-making system and the feedback relationships in Step (1), pair-wise comparisons are made on the clusters, criteria and clusters/criteria with feedback relationships in the same manner as the AHP method.

(3) Establishment of super matrixes

After the pair-wise comparisons on the clusters and criteria described in Step (2), the feature vector of individual criteria in the control level can be calculated with the AHP method. All the feature vectors are expressed in the form of super matrixes.

If the normalized vectors in the super matrix add up to 1, it is called "stochastic matrix" or "weighted super matrix"; if not, it becomes an un-weighted super matrix. The advantage of a stochastic matrix is that the maximum eigen-value is 1, making the calculations easier.

(4) Calculation of limit super matrixes for decision-making

Step (3) classifies the super matrixes into different types on the basis of eigenvalues. The next step is to multiply the weighted super matrixes to derive limit super matrixes. Different system structures result in the calculations for different super matrixes (decomposable, non-decomposable, basis and non-basis).

(5) Criteria rankings in terms of importance and intensity analysis

The final step is to rank the criteria based on weights and conduct an analysis on intensity of the managerial job performance dimensions of IC design houses listed in Taiwan.

Research findings & conclusions

According to the above descriptions, the value of each row and column of the limiting super-matrix (Table 4) of the decision problems computed in this paper is nearly the same, which indicates that the results are stable.

In addition, using the research framework as the base, this study constructs the ANP method for the weight evaluation of intellectual capital's key factors that affect the financial performance of

listed IC design houses in Taiwan, and establishes the relationship between each criterion. The analytical figure of the ANP method is referred to for the design of the questionnaire aiming to evaluate the inter-relationships between intellectual capital's key factors that affect the financial performance of listed IC design houses in Taiwan. This paper conducts expert interviews with the management staff of the five sampled companies so as to understand the emphasis placed by these experts regarding the relative importance of individual criteria of the intellectual capital's key factor that affect financial performance of IC design houses listed in Taiwan. The answers to the questionnaires are translated into values and the geographic means of respective criteria are computed. Finally, the software package for ANP analysis, Super Decisions, is run to rank the criteria concerned in the priority of importance, and then these rankings can be effective in the assessment of the dimensions of intellectual capital's key factors that affect the financial performance of IC design houses listed in Taiwan.

Tables 5 and 6 summarize the CI values, weights and rankings of the dimensions and criteria of intellectual capital's key factors that affect the financial performance of IC design houses listed in Taiwan according to the feedback from scholars and business operators.

Tables 5 and 6 show that the CI values of overall dimensions and sub-dimensions, based on the reviews from scholars and business operators, are all less than 0.1, which is consistent with the criteria proposed by Satty (2008, Hu Yi-Chung and Wang Jen-Hung). As for "financial performance" and "intellectual capital", the weight values from both the scholars and business operators are over 0.1, which passes the statistical testing for consistency criteria.

The results show that the sub-dimension ranking of "financial performance", from the academic scholars' perspective, in terms of importance, is ROA, ROE, and EVA; while the importance ranking from the business operators' perspective is ROE, ROA, and EVA. In addition, the sub-dimension ranking of "intellectual capital", from the academic scholars' perspective, in terms of importance, is innovation capital, customer capital, human resource capital, and process capital; while the ranking from the business operators' perspective is customer capital, innovation capital, human resource capital, and process capital. The differences arise because scholars take on a theoretical viewpoint, while business operators take on a more practical view.

Table 4: The limiting super-matrix

	F1	F2	F3	C1	C2	C3	P1	P2	P3	R1	R2	R3	R4	I1	I2	I3	I4
F1	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061
F2	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
F3	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
C1	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
C2	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061
C3	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
P1	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
P2	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063
P3	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
R1	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
R2	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061
R3	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082
R4	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
I1	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
I2	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082
I3	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
I4	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021

Table 5: CI values, weights and rankings of financial performance dimensions according to feedback from scholars and business operators

Overall Dimension	CI value		Sub-dimension	CI value		Weight		Ranking	
	Scholars	Business operators		Scholars	Business operators	Scholars	Business operators	Scholars	Business operators
Financial Performance (FP)	0.01	0.01	Return on Equity(ROE) (F1)	0.00	0.00	0.336	0.432	2	1
			Return on Assets(ROA) (F2)	0.00	0.01	0.461	0.343	1	2
			Economic Value Added(EVA (F3)	0.00	0.01	0.203	0.225	3	3

Table 6: The Weight and Priority Ranking of the Dimensions of Intellectual Capital's Key Factors between Scholars and Business Operators

Overall Dimension	CI value		Sub-dimension	CI value		Weight		Ranking	
	Scholars	Business operators		Scholars	Business operators	Scholars	Business operators	Scholars	Business operators
Intellectual Capital (IC)	0.01	0.01	Customer Capital(CC)	0.00	0.00	0.253	0.361	2	1
			Process Capital(PC)	0.00	0.01	0.152	0.153	4	4
			Human Resource Capital(HC)	0.00	0.01	0.223	0.234	3	3
			Innovation Capital(IC)	0.00	0.01	0.372	0.252	1	2

Conclusions and follow-up studies

Conclusions

In summary, the specific conclusions for the analysis of evaluating weight values of intellectual capital's key factors that affect the financial performance of listed IC design houses in Taiwan are described as follows:

Sub-dimensions

After performing ANP analysis, we learn that the CI values of overall dimensions and sub-dimensions from both the scholars and business operators are less than 0.1, which is consistent with the criteria proposed by Satty (1996). This fact proves that the CI values of overall dimensions and sub-dimensions obtained by using ANP method meet the criteria of consistency

testing. In addition, the values of columns and rows calculated from the limit matrix are all the same, hence stable, which also means that the weight calculation of factors of all levels is reasonable.

Criteria

As for the sub-dimensions of *financial performance*, the scholars' perspective on the criteria ranking in terms of its importance is ROA, ROE, and EVA, while the business operators' perspective on the criteria ranking in terms of its importance is ROE, ROA, and EVA.

This study learns from the above ranking comparison that, in the weight dimension of intellectual capital's key factors that affect financial performance of listed IC design houses in Taiwan, the weight values from both scholars and business operators are over 0.1. This shows that both scholars and business operators believe that ROE, ROA, and EVA are three important indicators that affect financial performance. Although business operators hold a different perspective on the weight of the above-mentioned factors, this difference arises because scholars take on a theoretical viewpoint, while business operators take on a more practical view.

Research contributions

This paper applies the ANP method to evaluate the weight of intellectual capital's key factors that affect the financial performance of IC design houses listed in Taiwan. This is an innovative application of theories in the field of management and accounting. In practice, the results of this study can serve as a reference to business operators of listed IC design houses for decision-making.

Research limitations

(1) This paper adopts ANP method; thus, the Convenience Sampling method is used for questionnaire interview with a very high valid-return ratio. Because the interviewees are scholars and experts, coupled with a small-scale sampling, the research results may lean to being subjective.

(2) This paper carries out research specifically on IC design houses. The results may be different if researching on different industries.

Suggestions for follow-up studies

(1) Future researchers may compare weight evaluation of intellectual capital's key factors that affect financial performance from different industries.

(2) This paper only discusses the relationships between dimensions and criteria. Future studies may add proposal evaluations, or other research techniques such as grey correlation analysis.
(3) Research conducted by past scholars indicate that the ANP method requires the use of "Super Decisions" software to process data collected from small-scale expert interviews; hence, future research should continue to use the ANP method to manage proposals of assessment research.

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