

S20-1**EMPIRICAL ASSOCIATIONS BETWEEN INTELLECTUAL CAPITAL AND PERFORMANCE OF ARCHITECTURE FIRMS****Chung-Fah Huang¹ and Li-Ren Yang²**¹ Associate Professor, National Kaohsiung Univ. of Applied Sciences, Kaohsiung, Taiwan² Associate Professor, Tamkang Univ., Taipei, TaiwanCorrespond to jeffrey@cc.kuas.edu.tw

ABSTRACT: Intellectual capital is one of the most valuable assets of any enterprise. This empirical investigation examines the causal relationship between intellectual capital and the performance of architecture firms. More than 100 architecture firms across Taiwan have each been assessed for the levels of human capital, structural capital, relational capital, and business performance. The results suggest that the architecture firms exhibit higher levels of relational capital. However, the firms indicate relatively low levels of human capital. Additionally, the results from the correlation analysis suggest that all the four measures (human capital, structural capital, relational capital, and business performance) are highly correlated. The findings from the path analysis also indicate that human capital may influence the performance of architecture firms via structural capital and relational capital.

Keywords: human capital, structural capital, relational capital, architecture firm, business management

1. INTRODUCTION

With the advent of the knowledge economy, the focus of enterprises has gradually shifted from tangible assets to intellectual capital (Guthrie, 2001). The architecture firms, like firms in many other industries, use professional knowledge and emerging technologies to perform work efficiently. In the knowledge-intensive industry, one of the most valuable assets is intellectual capital, which is not shown in the balance sheet. Prior research suggested that the most important asset of an enterprise was production equipment in the twentieth century. However, the most valuable assets of a business were knowledge workers and their productivity in the twenty-first century. Previous research has also shown that business performance may be associated with intangible resources and capabilities. Since knowledge has become the most important element of modern production, it is important to understand how to properly manage the intellectual capital of a company (Stewart, 1999). Even though earlier studies have identified benefits of intellectual capital, however, no comprehensive study has been done on the levels of intellectual capital in architecture firms. In addition, there has been no industry-wide study on the impacts of intellectual capital on business performance. This lack of information regarding benefits of intellectual capital has resulted in industry reluctance to manage and exploit the intellectual capital. Thus, a study of the relationship between intellectual capital and business performance is necessary. The main objectives of this research were: 1) to investigate the extent to which intellectual capital are being used in architecture firms

and 2) to explore the impact of intellectual capital on the performance of architecture firms. This paper addresses levels of intellectual capital in architecture firms and associations with business performance. Intellectual capital metrics analyzed include human capital, structural capital, and relational capital. In addition, two subscales (financial performance and operation performance) were used to measure business performance. The data was collected on a total 107 architecture firms in the Taiwanese industry.

2. LITERATURE REVIEW

As our society has moved from the industrial age to the information age, the importance of intellectual capital in business has grown (Sonnier et al., 2007). Since the market value often exceeds book value, intellectual capital has become an important topic in the contemporary business literature. Many researchers have been discussing the importance of intangible assets for the success of organizations. The term “intellectual capital” refers to the summation of all knowledge and capabilities of every employee that brings about performance and creates wealth for the enterprises. Bontis (1996) believed that know-how, knowledge, and learning capability of an enterprise cannot be defined by money. In addition, the intellectual capital pertains to the difference between an enterprise’s market value and its existing asset. Roos and Krogh (1997) developed the evaluation standards of intellectual capital, described various intellectual capital frameworks and application processes through case studies, and finally proposed a

four-phase process mode and an indexing method for intellectual capital. Due to different research backgrounds, there are numerous definitions and classifications of intellectual capital. Based on Bontis (1996), Hubert (1996), and Guthrie and Petty (2000), intellectual capital metrics analyzed in this study include those at the human level, at the structural level, and at the relational level.

Human capital is the most important part of intellectual capital (Stewart, 1999; Dzinkowski, 2000; Hubert, 1996; Edvinsson and Sullivan, 1996; Edvinsson, 1997; Edvinsson, 2000). It refers to knowledge, skill, expertise of employees and managers, proactive response, and entrepreneurship, but also to company values, culture, and philosophy (Dzinkowski, 2000; Agndal and Nilsson, 2006). Roos and Krogh (1997) argued that human capital is the soul of a company. In order to take full advantage of human capital, the top management should be well aware of the considerations of staff, provide them with proper training, and work with collective wisdom (Watson, 1996). Grantham and Nichols (1997) also underlined the importance of human capital. They contended that intellectual capital is a value-based activity, both in creation and use. In addition, the content of education needs to be based in four areas: 1) analytical thinking, 2) experimentation, 3) systemic integration, and 4) collaboration. Despite the fact that employees are the most important assets of an enterprise, Edvinsson and Malone (1997) noted that the company cannot own human capital. The enterprise owners should be aware of the principle of resource-sharing. By properly utilizing the knowledge, skill, and capability of employees, a firm can create and sustain a competitive advantage. In summary, the prior research suggested that enterprises must not only teach the employees how to foster their professional skill through analytical thinking, but also tell them the reason why this is important. Additionally, an effective way to increase intellectual capital is to appropriately invest in employees (Stewart, 1999).

Structural capital is defined as the sum of the strategy, structure, systems, and processes that enable an organization to produce and deliver a product to customers (Grantham and Nichols, 1997). It includes the physical systems used to transmit and store intellectual material. Additionally, it provides the environment to create and share knowledge effectively, shorten learning time, and improve the productivity of human capital. The structural capital of a firm consists of four elements: system, structure, strategy, and culture (Hubert, 1996). With the help of tools such as technology, manufacturing descriptions, operations manuals, and Internet, structural capital can improve the productivity of human capital and help transform human capital into wealth for a firm (Stewart, 1999; Hubert, 1996).

The relational capital refers to the relationships between enterprises, customers, suppliers and partners (Johnson, 1999), which is a key to long-lasting economic profit and an essential element for operating a successful business. Major considerations include customer satisfaction, purchase frequency, characteristics of customers, price and quantity of transaction, product quality, and service. In the information-explosion era, it is

easy for customers to find suppliers, which changes the balance between buyers and sellers. In such an environment the key to creating profit is to win customer's trust and loyalty and build long-term relationships with them.

The literature review provides background for developing an understanding of the issues related to the use of intellectual capital and the benefits to be derived from intellectual capital. Researchers in a number of disciplines outside of architecture have suggested that intellectual capital is becoming increasingly critical to business success. However, the literature on architecture has largely ignored the impact of intellectual capital on business performance. No industry-wide study has been done on the levels of intellectual capital in architecture firms. In addition, there has been no comprehensive industry-wide study on the impacts of intellectual capital at various levels on the performance of architecture firms. Since little research has explored intellectual capital in the architecture, engineering, and construction (A/E/C) industry, this research adds to the literature in two valuable ways. First, it provides important results on the uses of intellectual capital at various levels. Second, it provides evidence of performance implications of intellectual capital in the A/E/C industry.

3. RESEARCH DESIGN

3.1 Theoretical Model

The primary purpose of this study was to explore the impact of intellectual capital on the performance of architecture firms. Intellectual capital metrics analyzed include human capital, structural capital, and relational capital. In addition, financial performance and operation performance were used to measure overall business performance. This research also determines the correlations among the three dimensions of intellectual capital (i.e., human capital, structural capital and relational capital). Stewart (1999) argued that human capital, structural capital, and relational capital are correlated. He stated that intellectual capital management is based on the assumption that value is created through the integration of the three elements. Additionally, the business performance of an enterprise is probably influenced by the interactions among the three dimensions of intellectual capital (Dzinkowski, 2000). Edvinsson and Sullivan (1996) stressed that human capital is a highly influential factor in intellectual capital. Based on the literature review, human capital is believed to be the most crucial factor for intellectual capital. Furthermore, human capital drives structural capital and relational capital. On the other hand, structural capital and relational capital also contribute to the development of human capital. Based on the aforementioned theories and the framework established by Bontis (1998), the theoretical model for the research is presented in Figure 1.

3.2 Questionnaire Design and Sampling Method

Variables assessed in this research include human capital, structural capital, relational capital, and business performance. There are 4 main dimensions and each

dimension is further divided into several sub-dimensions (see Table 1). The items used to measure the constructs were based on the scales developed by Bontis (1996), Bontis (1998), Dzinkowski (2000), Guthrie and Petty (2000), Edvinsson and Sullivan (1996), Edvinsson (1997), Edvinsson (2000), Buren (1999), and Sullivan (2000). Additionally, the data collection tool was developed based on understanding gained from interviews conducted with 5 executives in the industry. Each of the professionals has over 10 years of experience in the field of architecture, engineering and construction. Copies of a draft survey were sent to these industry professions to pre-test the survey. Their insights were incorporated into the final version of the survey. A 7-point Likert-type scale was used (from 1= strongly disagree to 7= strongly agree) to measure the degrees of human capital, structural capital, relational capital, and business performance.

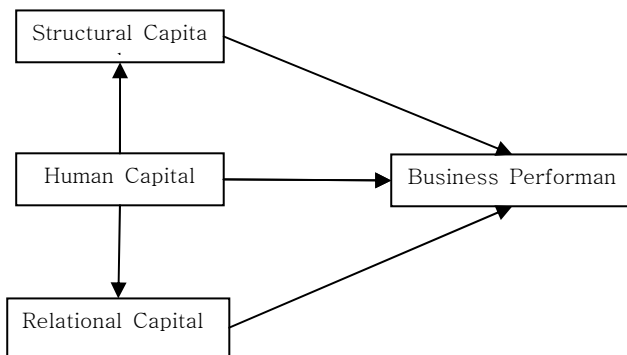


Figure 1. Theoretical model

Table 1. Distribution of survey items

Dimension	Sub-dimension	Number of items
Human capital	Staff capability	5
Human capital	Knowledge exchange among staff	6
Human capital	Staff education and training	2
Human capital	Staff stability	2
Structural capital	Overall business process	4
Structural capital	Organizational design	3
Structural capital	Information system Framework	3
Relational capital	Cooperation with clients	4
Relational capital	Relationship with cooperative partners	3
Relational capital	Cultivating friendship with clients	3
Business performance	Financial performance	4
Business performance	Operations performance	3

This research employed a mail survey methodology for data collection. The sample for this study focuses on architecture firms in the Taiwanese A/E/C industry. The sample was selected from the National Association of Architect, Taiwan. To ensure that respondents are more likely to answer honestly, the survey is anonymous. The survey questionnaire was sent to 714 senior practitioners. Of the questionnaires sent, 114 were returned. The overall response rate was 15.97 percent. Among the returned surveys, 7 were discarded since they contained too many missing values. Ultimately, 107 survey responses were used in the analysis. With respect to years in business, 43.0 percent of the companies are less than 10, 38.3 percent are between 10 and 20, and the remaining 18.7 percent are more than 20. These firms averaged 14.3 years in business.

3.3 Analytical Methods

The analysis was divided into three steps. Step 1 consisted of developing descriptive statistics. Included in the descriptive statistics are the means and standard deviations of the computed indices. The purpose of generating the descriptive statistics was to determine the levels of intellectual capital in use. Step 2 entailed investigating the correlations among the three dimensions of intellectual capital and business performance. Additionally, Cronbach’s coefficient (α) was calculated to test the reliability and internal consistency of the responses. Step 3 involved identifying the cause-effect relationship between the three dimensions of intellectual capital and business performance. Path analysis was employed to verify the theoretical model. Furthermore, the correlation analysis was also used to check linear relationship between the variables, which constituted the basic assumptions of path analysis (Brown et al., 2007).

4. RESEARCH FINDINGS

4.1 Levels of Intellectual Capital and Business Performance

Intellectual capital metrics analyzed include those at the human level (human capital), the structural level (structural capital), and the relational level (relational capital). These indices were developed for measuring the use of intellectual capital in the architecture firms. Table 2 shows Capital Index and Performance Index descriptive statistics. The results suggest that the architecture firms exhibit the highest levels of relational capital.

However, these firms indicate the lowest levels of human capital. Among the sub-dimensions of relational capital, the highest level is associated with “cooperation with clients” and the lowest level pertains to “cultivating friendship with clients.” Of the sub-dimensions of human capital, the highest level is associated with “staff capacity” and the lowest level pertains to “staff education and training.” Additionally, among the sub-dimensions of structural capital, the highest level is associated with “information system framework” and the lowest level pertains to “overall business process.”

Table 2. Capital index and performance index descriptive statistics

Dimension/ sub-dimension	Mean	Standard deviation
Human capital/	5.31	1.14
Staff capability	5.65	1.01
Knowledge exchange among staff	5.29	1.17
Staff education and training	4.54	1.23
Staff stability	5.27	1.33
Structural capital/	5.37	1.02
Overall business process	5.28	1.06
Organizational design	5.35	0.92
Information system framework	5.51	1.08
Relational capital/	5.62	1
Cooperation with clients	5.86	0.93
Relationship with cooperative partners	5.58	0.89
Cultivating friendship with clients	5.25	1.23
Business performance/	4.7	1.14
Financial performance	4.82	1.17
Operations performance	4.53	1.1

” The specific business performance measures are also detailed in Table 2. Respondents indicate higher levels of success in the area of operations performance. They report lower levels of success in financial performance.

4.2 Correlation Analysis

The data analysis also entailed investigating the correlations among the three dimensions of intellectual capital and business performance. Correlation measures the strength and the direction of the relationship between the variables. Additionally, Cronbach’s coefficient (α)

was calculated to test the reliability and internal consistency of the responses. The results of the correlation analysis for the main dimensions are presented in Table 3. There are positive correlations between the three dimensions of intellectual capital and business performance. The empirical results indicate that human capital exhibits the highest correlation coefficient with business performance. On the other hand, there are also positive correlations among the three dimensions of intellectual capital; moreover, all coefficients exceed 0.5. The correlation between human capital and structural capital is relatively high. The results from the analysis suggest that all the four measures (human capital, structural capital, relational capital, and business performance) are highly correlated. Furthermore, using Cronbach’s coefficient alpha, reliability was assessed for human capital at 0.894, structural capital at 0.881, relational capital at 0.879, and business performance at 0.906, which indicate a high degree of internal consistency in the responses. The results of the correlation analysis for the sub-dimensions are presented in Table 4. There are positive correlations among most of the sub-dimensions. Among the sub-dimensions, there appears to be stronger positive correlations between the following pairs of variables: 1) “knowledge exchange among staff” and “information system framework”, 2) “knowledge exchange among staff” and “overall business process”, 3) “overall business process” and “information system framework”, and 4) “financial performance” and “operations performance.”

4.3 Path Analysis

Path analysis was conducted to identify a causal pattern of the variables in the theoretical model. The analysis is an extension of the regression model. In this study, it consists of two parts. In the first part, the causal effects of intellectual capital on business performance were estimated. In the second part, the interactions among human capital, structural capital and relational capital were determined.

First part:

$$BP = \beta_1 SC + \beta_2 HC + \beta_3 RC + \varepsilon \quad (1)$$

Second part:

$$SC = \beta_1 HC + \varepsilon \quad (2)$$

$$RC = \beta_1 HC + \varepsilon \quad (3)$$

where:

BP = business performance;

SC = structural capital;

HC = human capital;

RC = relational capital; and

ε is the error term.

Table 3 Correlation between the main dimensions

Variable	Human capital	Structural capital	Relational capital	Business performance
Human capital	1.000	--	--	--
Structural capital	0.747**	1.000	--	--
Relational capital	0.555**	0.706**	1.000	--
Business performance	0.533**	0.492**	0.491**	1.000

*significant at the 0.05 level; **significant at the 0.01 level

Table 4 Correlation between the sub-dimensions

Variable	A	B	C	D	E	F	G	H	I	J	K	L
A. Staff capability	1	--	--	--	--	--	--	--	--	--	--	--
B. Knowledge exchange among staff	0.55**	1	--	--	--	--	--	--	--	--	--	--
C. Staff education and training	0.22*	0.59**	1	--	--	--	--	--	--	--	--	--
D. Staff stability	0.32**	0.62**	0.57**	1	--	--	--	--	--	--	--	--
E. Overall business process	0.36**	0.69**	0.57**	0.51**	1	--	--	--	--	--	--	--
F. Organizational design	0.41**	0.46**	0.42**	0.38**	0.62**	1	--	--	--	--	--	--
G. Information system framework	0.40**	0.75**	0.54**	0.55**	0.67**	0.53**	1	--	--	--	--	--
H. Cooperation with clients	0.35**	0.43**	0.34**	0.36**	0.55**	0.58*	0.45**	1	--	--	--	--
I. Relationship with cooperative partners	0.33**	0.55**	0.41**	0.39**	0.54**	0.51**	0.60**	0.59**	1	--	--	--
J. Cultivating friendship with clients	0.19	0.33**	0.35**	0.27**	0.44**	0.48**	0.33**	0.45**	0.55**	1	--	--
K. Financial performance	0.45**	0.36**	0.40**	0.32**	0.34**	0.30**	0.45**	0.33**	0.27**	0.33**	1	--
L. Operations performance	0.32**	0.30**	0.48**	0.48**	0.37**	0.35*	0.35**	0.41**	0.31**	0.47**	0.66**	1

*significant at the 0.05 level; **significant at the 0.01 level

Path coefficients for the model of are reported on the path diagram shown in Figure 2. The results indicate that business performance increases by 0.357 standard units for each 1 standard unit increase in structural capital, which suggests that higher levels of structural capital may contribute to the success of architecture firms. These analyses also reveal that increased levels of relational capital are associated with improvement in the performance of architecture firms. As previous research highlighted the role of human capital in the development of intellectual capital (Roos and Krogh, 1997; Stewart, 1999; Grantham and Nichols, 1997), the remaining causal paths suggest that increases in human capital tend to improve the degrees of structural capital and relational capital for architecture firms. In addition to the

mentioned cause-effect relationship, the findings also indicate that human capital may influence the performance of architecture firms via structural capital and relational capital.

5. CONCLUSIONS

The primary purpose of this study was to examine the causal relationship between intellectual capital and business performance. The second objective in this research was to investigate the extent to which intellectual capital are being used in architecture firms. These were accomplished by an industry-wide survey and analysis of 107 architecture firms. Descriptive statistics were developed to determine levels of human capital,

structural capital, relational capital, and business performance. This research also determines the correlations among the three dimensions of intellectual capital (i.e., human capital, structural capital and relational capital) and business performance. Additionally, path analysis was conducted to identify a causal pattern of the variables in the theoretical model.

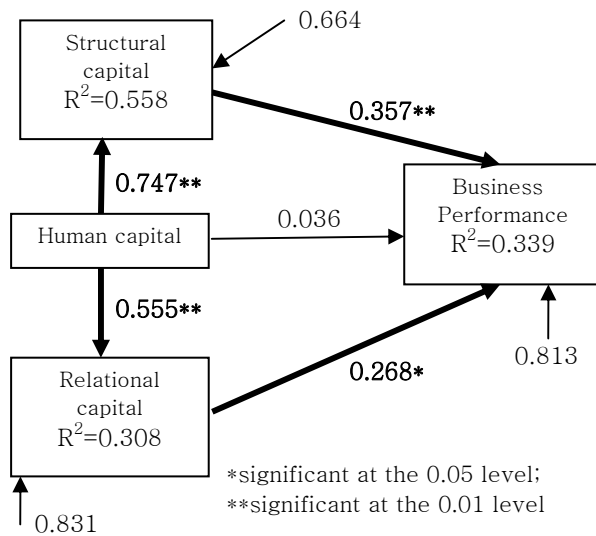


Figure 2. Path diagram

Results from the analyses suggest that the architecture firms exhibit the highest levels of relational capital. However, these firms indicate the lowest levels of human capital. This suggests that attention should be paid to human resource management in architecture firms. The data analysis also entailed investigating the correlations among the three dimensions of intellectual capital and business performance. For architecture firms, there are positive correlations between the three dimensions of intellectual capital and business performance. The empirical results indicate that human capital exhibits the highest correlation coefficient with business performance. In summary, the results from the analysis suggest that all the four measures (human capital, structural capital, relational capital, and business performance) are highly correlated. Additionally, there are positive correlations among most of the sub-dimensions.

Correlation only measures the strength and the direction of the relationship between the variables. Thus, path analysis was conducted to identify a causal pattern of the variables in the theoretical model. In this study, it consists of two parts. In the first part, the causal effects of intellectual capital on business performance were estimated. In the second part, the interactions among human capital, structural capital, and relational capital were determined. The findings from the path analysis indicate that 6 paths in the model of general contracting

firms are significant: 1) structural capital → business performance, 2) relational capital → business performance, 3) human capital → structural capital, 4) human capital → relational capital, 5) human capital → structural capital → business performance, and 6) human capital → relational capital → business performance. The results also suggest that human capital may influence the performance of architecture firms via structural capital and relational capital.

In summary, as prior research highlighted the role of human capital in the development of intellectual capital, the causal paths suggest that increases in human capital tend to improve the degrees of structural capital and relational capital for architecture firms. The results of the analyses are consistent with previous theories, which suggest that an effective way to increase intellectual capital is to appropriately invest in employees. Thus, consideration should be given to human resource management such as staff education and training, staff capability, and knowledge exchange among staff. This research provides empirical evidence that supports the expectation of gaining significant benefits with higher levels of intellectual capital. The results of this study indicate that intellectual capital is critical to the performance of architecture firms. Findings from this study provide direction for the decision making of investment in intellectual capital.

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