INTELLECTUAL CAPITAL TO IMPROVE THE PERFORMANCE OF PROJECT-BASED FIRMS

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Abstract - Intellectual capital is the most valuable resource of any enterprise. This empirical investigation examines the causal association between intellectual capital and the success of project-based firms in the industry. More than 100 project-based firms across Taiwan have each been assessed for the levels of human capital, structural capital, relational capital, and firm performance. These results suggest that structural capital and relational capital are achieved with greater human capital. The analysis also shows that structural capital fully mediates the impact of human capital on the success of project-based firms. In addition, relational capital may partially mediate the association between human capital and the performance of project-based 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.

Index Terms - Project, intellectual capital, human capital, financial performance, operational performance

I. INTRODUCTION

Enterprises in the knowledge-based economy have gradually emphasizedthe importance of intellectual capital [1]. The industryuses new knowledge and technologies to perform work efficiently and effectively. In the knowledge-intensive industry, one of the most valuable assets is intellectual capital. Specifically, the most valuable assets of a business are knowledge workers and their productivity. Thus, it is important to understand how to properly manage intellectual capital of a company [2].

No previous study has been conductedto evaluate the influence of intellectual capital on the success of project-based firms. This has causedproject-basedcompanies to ignore the importance of managing and exploiting intellectual capital. Thus, it isnecessary to conduct a study to investigate the association between intellectual capital and the performance of project-based firms. The primary objectives of this study were: 1) to explore the impact of intellectual capital on the success of project-based firms and 2) to assess whether the influence of human capital on project-based firm performance is mediated by structural capital or relational capital.

II. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The importance of intellectual capital in the industry has increased [3]. 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. Bontis [4] believed that know-howof a companyis not associated with money. Roos and Krogh [5] developed the evaluation standards of intellectual capitaland developed a process mode for intellectual capital. Based on Bontis [4], intellectual capital analyzed in this study includes human capital, structural capital, and relational capital.

Stewart [2] argued that human capital, structural capital, and relational capital are correlated. He stated that value is created through the integration of the three elements. Additionally, the business performance of an enterprise is probably affected by the three dimensions of intellectual capital [6]-[8]. Edvinsson and Sullivan [9] stressed that human capital is the most important 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 are also associated with the growth of human capital. Based on the above discussions, the following hypothesis wasproposed:

Hypothesis: Structural capital and relational capital mediate the association between human capital and project-based firm performance.

III. RESEARCH DESIGN

Variables assessed in this research include human capital, structural capital, relational capital, and firm performance. The items used to measure human capital were based on Guthrie [1]. Items used to assess structural capital were based on the questionnaires developed by Dzinkowski [6] and Johnson [8]. On the other hand, the scales proposed by Bontis [10] were adapted to evaluate relational capital. Finally, items used to evaluate project-based firm performance were based on Bontis [10]. A seven-point scale was used to measure the degrees of human capital, structural capital, relational capital, and project-based firm performance.

This studyconducted a survey to collect required data. The sample for this research focused on project-based firms in Taiwan. To ensure that respondents are more likely to answer honestly, the survey is anonymous.

The questionnaire was sent to 400 senior practitioners in the listed companies. Ultimately, 100 responses were analyzed in the research.

The content validity of the survey was examined through interviews with several professionals. The industry interviews encompassed five high-tech industry executives. Each of them has more than 20 years of experience. The construct validity was examined by factor analysis. No items were dropped due to low factor loadings. In other words, all of the factor loadings are over 0.5. Additionally, Reliability was evaluated for human capital at 0.902, structural capital at 0.944, relational capital at 0.945, and firm performance at 0.972. The values of Cronbach's α are above 0.7.Thus, these values are acceptable.

IV. RESEARCH FINDINGS

A. Mediators between Human Capital and Project-based Firm Performance

Multiple regression models were proposed with human capital, structural capital, and firm performance to assess the mediating role of structural capital in the association between human capital and firm performance[11]. While firm performance is the dependent variable, human capital was associated with the Model 1 and structural capital was associated withModel 2. Human capital is the only independent variable in Model 1. Model 2 included one more independent variable (i.e. structural capital). Table 1 presents the results. For firm performance, Model 1 (i.e. human capital) accounted for 35.9% of the variance in firm performance ($p < .001$). The results show that human capital contributes significantly to firm performance. Model 2 (i.e. human capital and structural capital) accounted for 56.0% of the variance in firm performance ($p < .001$). With the addition of structural capital, human capital was not significant any more. However, the beta coefficient for structural capital is significant. Thus, structural capital plays a full mediator in the association between human capital and project-based firm performance.

Multiple regression models (Models 1 and 3) were developed with human capital, relational capital, and firm performance to evaluate whether relational capital mediates the association between human capital and firm performance. While firm performance is the dependent variable, Models 1consists of one independent variable (i.e., human capital) and Models 3 included one more independent variable (i.e. relational capital). As shown in Table 1, Model 1 accounted for 35.9% of the variance and Model 3 accounted for 55.2% of the total variance in firm performance ($p < .001$). With the addition of relational capital, standardized regression coefficients (β) for human capital decreased by 54.92% (from .599 to .270). The findings suggest that relational capital partially mediated the association between human capital and project-based firm performance.

Table 1:Hierarchical regression analysis for human capital, structural capital, and firm performance

Independent variable	Firm performance		
	Model 1	Model 2	Model 3
Human capital	.599[a,***]	.064	.270[**]
Structural capital	--	.698[***]	-
Relational capital	--	--	.549[***]
R-squared	.359	.560	.552
p value (F-test)	.000	.000	.000

[a]Beta coefficient for the particular variable; [**]significant at the .01 level; [***]significant at the .001 level

B. Mediators between Subscales of Human and Relational Capital and Financial Performance

The study also evaluated the influence of adding each sub-dimension of structural capital (i.e., information system framework and overall business process) and relational capital (i.e., association with cooperative partners and association with clients) in hierarchical linear regressions where individual subscales of human capital (i.e., staff selection and training, staff characteristics, and staff expertise) were the independent variables and financial performance was the dependent variable. Multiple regression models were proposed with subscales of human capital, sub-dimensions of structural and relational capital, and financial performance to assess the mediating roles of structural and relational capital in the association between human capital and financial performance. Similarly, while financial performance is the dependent variable, subscales of human capital were associated with Model 1 and sub-dimensions of structural and relational capital was associated with Model 2. Table 2 presents the results for staff selection and training. The first model (i.e. staff selection and training) accounted for 31.7% of the variance in financial performance ($p < .001$). The results indicate that staff selection and training contributes significantly to financial performance. Model 2 (i.e. "staff selection and training" and "information system framework") accounted for 45.9% of the variance in financial performance ($p < .001$). Both of "staff selection and training" and "information system framework" are significant variables. The results show that including information system framework produces significant reductions in the beta-coefficients for staff selection and training. The testing proves that information system framework is a partial mediator in the association between indices of "staff selection and training" and financial performance. Additionally, overall business process (Model 3) fully mediates the effect of staff selection and training on financial performance. The results also suggest that association with cooperative partners (Model 4) may partially mediate the association between staff selection and

training and financial performance. Finally, the results suggest that association with clients (Model 5) partially mediates the impact of staff selection and training on financial performance.

Table 2:Hierarchical regression analysis for staff selection and training and financial performance

Independent variable	Financial performance				
	Model 1	Model 2	Model 3	Model 4	Model 5
Staff selection and training	.56[a,**]	.218[*]	.185	.374[***]	.320[***]
Information system framework	--	.511[***]	--	--	--
Overall business process	--	--	.566[*,**]	--	--
Association with cooperative partners	--	--	--	.430[***]	--
Association with clients	--	--	--	--	.507[***]
R-squared	.317	.459	.494	.466	.515
P value (F-test)	.000	.000	.000	.000	.000
R-squared increased	--	.142	.177	.149	.198
% of β decreased	--	61.82 %	--	33.57 %	43.16 %

[a]Beta coefficient for the particular variable; [*]significant at the .05 level; [***]significant at the .001 level

Similarly, Table 3 presents the results for staff characteristics. The testing supports a role for information system framework (Model 2) as a full mediator in the association between indices of staff characteristics and financial performance. Additionally, overall business process (Model 3) fully mediates the impact of staff characteristics on financial performance. The findings also indicate that association with cooperative partners (Model 4) may fully mediate the association between staff characteristics and financial performance. Finally, the results suggest that association with clients (Model 5) fully mediates the effect of staff characteristics on financial performance.

Table 3:Hierarchical regression analysis for staff characteristics and financial performance

Independent variable	Financial performance				
	Model 1	Model 2	Model 3	Model 4	Model 5
Staff characteristics	.289[a,**]	.033	.038	.057	.131
Information system framework	--	.645[*,**]	--	--	--
Overall business process	--	--	.707[*,**]	--	--
Association with cooperative partners	--	--	--	.571[*,**]	--
Association with clients	--	--	--	--	.627[*,**]
R-squared	.084	.434	.476	.356	.452
P value (F-test)	.004	.000	.000	.000	.000
R-squared increased	--	.350	.392	.272	.368

[a]Beta coefficient for the particular variable; [**]significant at the .01 level; [***]significant at the .001 level

Table 4 presents the results for staff expertise. As presented in Table 4, the testing proves that information system framework (Model 2) is a full mediator in the association between indices of staff expertise and financial performance. Additionally, overallbusiness process (Model 3) fully mediates the impact of staff expertise on financial performance. The findings also indicate that association with cooperative partners (Model 4) may fully mediate the association between staff expertise and financial performance. Finally, the results suggest that association with clients (Model 5) fully mediates the effect of staff expertise on financial performance.

Table 4: Hierarchical regression analysis for staff expertise and financial performance

Independent variable	Financial performance				
	Model 1	Model 2	Model 3	Model 4	Model 5
Staff expertise	.261[a,**]	.009	.075	.033	.084
Information system framework	--	.655[*,**]	--	--	--
Overall business process	--	--	.724[*,**]	--	--
Association with cooperative partners	--	--	--	.610[*,**]	--
Association with clients	--	--	--	--	.637[*,**]
R-squared	.068	.433	.479	.354	.442
P value (F-test)	.009	.000	.000	.000	.000
R-squared increased	--	.365	.411	.286	.374

[a]Beta coefficient for the particular variable; [**]significant at the .01 level; [***]significant at the .001 level

C. Mediators between Subscales of Human and Relational Capital and Operational Performance

Multiple regression models were proposed with subscales of human capital, sub-dimensions of structural and relational capital, and operational performance to assess the mediating roles of structural and relational capital in the association between human capital and operational performance. Similarly, while operational performance is the dependent variable, subscales of human capital were associated with Model 1 and sub-dimensions of structural and relational capital were associated with Model 2. Tables 5 to 7 present the analysis results. The testing supports a role for information system framework

(Model 2) as a full mediator in the association between each sub-dimension of human capital (i.e., staff selection and training, staff characteristics, and staff expertise) and operational performance. Additionally, overall business process (Model 3) fully mediates the effect of each sub-dimension of human capital on operational performance. The findings also indicate that association with cooperative partners (Model 4) may fully mediate the association between staff characteristics and operational performance and between staff expertise and operational performance. However, association with cooperative partners may only partially mediate the associationbetween staff selection and training and operational performance. Finally, the results suggest that association with clients (Model 5) partially mediates the association between staff selection and training and operational performance and between staff characteristics and operational performance. However, association with clients fully mediates the effect of staff expertise on operational performance.

Table 5:Hierarchical regression analysis for staff selection and training and operational performance

Independent variable	Operational performance				
	Model 1	Model 2	Model 3	Model 4	Model 5
Staff selection and training	.541[a,*,**]	.081	.129	.262[*]	.232[*]
Information system framework	--	.643[*,**]	--	--	--
Overall business process	--	--	.576[*,**]	--	--
Association with cooperative partners	--	--	--	.573[*,**]	--
Association with clients	--	--	--	--	.590[*,**]
R-squared	.264	.490	.448	.530	.533
P value (F-test)	.000	.000	.000	.000	.000
R-squared increased	--	.226	.184	.266	.269
% of β decreased	--	--	--	51.57 %	57.12 %

[a]Beta coefficient for the particular variable; [**]significant at the .05 level; [***]significant at the .001 level

Table 6:Hierarchical regression analysis for staff characteristics and operational performance

Independent variable	Operational performance				
	Model 1	Model 2	Model 3	Model 4	Model 5
Staff characteristics	.376[a,*,**]	.118	.088	.114	.213[*]
Information system framework	--	.650[*,**]	--	--	--
Overall business process	--	--	.621[*,**]	--	--
Association with cooperative partners	--	--	--	.642[*,**]	--
Association with clients	--	--	--	--	.647[*,**]
R-Squared	.141	.498	.445	.485	.524
P value (F-test)	.000	.000	.000	.000	.000
R-squared increased	--	.357	.304	.344	.383
% of β decreased	--	--	--	--	43.35 %

[a]Beta coefficient for the particular variable; [**]significant at the .05 level; [***]significant at the .001 level

Table 7:Hierarchical regression analysis for staff expertise and operational performance

Independent variable	Operational performance				
	Model 1	Model 2	Model 3	Model 4	Model 5
Staff expertise	.327[a,**]	.068	.025	.007	.143
Information system framework	--	.671[*,**]	--	--	--
Overall business process	--	--	.651[*,**]	--	--
Association with cooperative partners	--	--	--	.692[*,**]	--
Association with clients	--	--	--	--	.661[*,**]
R-squared	.107	.490	.439	.474	.510
P value (F-test)	.001	.000	.000	.000	.000
R-squared increased	--	.383	.332	.367	.403

[a]Beta coefficient for the particular variable; [**]significant at the .05 level; [***]significant at the .001 level

CONCLUSION

The results suggest that human capital, structural capital, and relational capital contribute significantly to project-based firm performance. More specifically, the results indicate that increases in levels of human capital, structural capital, or relational capital may enhance project-based firm performance. Additionally, human capital was found to be positively related to structural capital and relational capital, suggesting that structural capital and relational capital can be achieved with greater human capital. The mediating roles of structural capital and relational capital in the associations between human capital and firm performance were also evaluated. The results suggest that structural capital fully mediated the effects of human capital on project-based firm performance. The findings also indicate that relational capital may partially mediate the association between human capital and project-based firm performance. The study also evaluated the impact of including each sub-dimension of structural capital (i.e., information

system framework and overall business process) and relational capital (i.e., association with cooperative partners and association with clients) in hierarchical linear regressions where individual subscales of human capital (i.e., staff selection and training, staff characteristics, and staff expertise) were the independent variables and financial or operational performance was the dependent variable. Multiple regression models were proposed with subscales of human capital, sub-dimensions of structural and relational capital, and sub-dimensions of firm performance in order to assess the mediating roles of structural and relational capital in the association between human capital and project-based firm performance.The results suggest that human capital may influence the performance of high-tech project-based firms via structural and relational capital.As prior research highlighted the role of human capital in the development of intellectual capital, the findings indicate that increases in human capital tend to improve the degrees of structural capital and relational capital for high-tech project-based 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 selection and training, staff characteristics, and staff expertise.

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