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A Quantitative Approach to Human Capital Management

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Abstract

The objective is to provide a quantitative technique to help managers to make decisions by objectively evaluating their Human Capital Management (HCM) and projecting profit increase generated by HCM. This study approach is divided into two steps. In the first step, this study selects and formulates the factors which represent HCM practices by means of principal component and factor analysis. In the second step, personnel adjusted added (PAV) value is defined as the corporate output. Multiple regression model is constructed to identify the HCM factors which influence PAV. This process establishes the model for objectively judging their success of HCM.

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1. Introduction

In recent years, competition among companies has been intensified by globalization, innovation, and consolidating IT technologies. Management structure changes have been carried out in companies. Profit structure supported by tangible assets has been changed to be supported by intangible assets (Lev, 2001). Regarding the percentage of GDP in the United States, tangible investment was about 1.5 times more than intangible investment in around 1980. However around 2000, intangible investment has exceeded tangible investment (Corrado, 2006). In Japan, tangible investment was about three times more than intangible investment in around 1980, but around 2000, tangible investment decreasing to about 1.5 times more than intangible investment (Fukao, 2008). Thus intangible investment

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as percentage of GDP has been increasing in Japan, intangible investment will be greater than tangible investment in the future. Intangible assets have grown to become an important part of business resource.

1.1. Intangibles

In financial accounting, intangible assets are defined as claims to future benefits that do not have a physical or financial form (Lev, 2001). As noted above, intangibles are the source of corporate value. To evaluate intangibles, various ideas are born from various points of view, not only accounting. Intangibles in the RBV (Resource Based View), Intangible assets and IC (Intellectual Capital) are the three main ideas that are represented regarding this issue.

The concept of intangible assets is born in accounting theory, where it is intended to be accounted as the assets on the balance sheet classifies intangibles into three categories: innovation-related, human resource, and organizational intangibles (Lev, 2001).

RBV (Resource Based View) is a concept of management strategy where the internal resources are a source of competitive advantage. Hofer and Schendel (1978) classifies the internal resources into five main part. Human resources, organizational resources, and technological resources are in the intangibles category.

The MERITUM project report (2002) is a representative study of IC (Intellectual Capital) where intangibles is a component of the kind of company's value, classified into human capital, structural capital, and relational capital.

This study recognize that internal resources are constructed from financial resources, physical resources or tangibles, and intangibles, which are human capital, organizational capital and relational capital.

The value of human capital originates from competence and attitude (Roos, 1997) (Fujita, 2007).

- Competence; the content part of human capital; the knowledge, skills, talents and know-how of employees.
- Attitude; the employees' willingness to use their abilities to the advantage of the company: motivation.

The organizational capital consists of process and intellectual property.

- Process; those are accumulating in the organization and not protected by law: organizational structure, process, regulations and knowledge database.
- Intellectual property; those are intangibles in the organization, and protected by law; patents, licenses, copyrights, and self-developed software and applications.

The relational capital is consists of networks, brands and customers.

- Network: material procurement, funding procurement and finding new partners.
- Customer: sales base, partnerships, formation provision capability and closeness of relationship.
- Brand: awareness potential, contribution to finding new customers and contribution to finding new partners.

1.2. Human capital management

The common concept of these is denoted as human capital or human resources. In general, human capital is more important than other capitals. Thus, human capital management is an important research subject. The research subjects of so-called human resource management are the schemes at every stage of employees between their employments and their exits.

Recently, human resource management coupled with financial performance becomes the "Human resource management and organization performance model", which is an important issue. Bratton and Gold (2003) cites the main approaches of this model.

- Statistical evaluation; measuring change due to personnel measures by the correlation relationships and achievement variables
- Financial evaluation; measuring ROI (return on investment) of the measures.

Analyses are mainly based on the individual companies' case studies, in which employees are samples, in these researches.

This study proposes a quantitative approach to human capital management, based on the "Human resource management and organization performance model" in a broad sense. It also evaluates each company's human capital management financially by using several statistical methods. However it differs from previous research. In that it uses sample companies and it intends to present inter-company comparisons. This analysis is based on a survey; assess the human capital management of an entire company.

Human capital, human assets, and human resources are not strictly distinguished in this study.

2. Objective

As mentioned above, it is necessary for successful human capital management to quantitatively evaluate human capital. However, objective of this study is not to evaluate the human capital. The objective is to construct the tool to evaluate human capital management. It must be useful in decision-making by company managers to manage their human capital.

This study does not intend to calculate the value of each company's human capital. The objective is to explain how to evaluate human capital management. The unique point of this study is that new graduates are not yet considered as company-specific human capital. From the company's viewpoint of usefulness, most of new graduates, as human capital, are not different among the same industry companies. Human capital management will increase their competence and encourages their attitude to create the value of their company.

3. Approach

This study has two steps. The first step; this step is creating indices that represent the human capital by using a statistical approach. The human capital index candidates are selected. The principal component factor analyses are conducted to them to create the indices. The second step; this step makes models to express useful human management using multiple regression analyses. The dependent variable is a kind of added value newly defined in this study, and the independent variables are indices representing human capital management, including those are selected at the first step.

3.1. Indices representing human capital: the first step

In view of guideline for the disclosure of intellectual property management by Ministry of Economy, Trade and Industry (METI), human capital indices are chosen from CSR reports, Annual reports and Securities reports as candidates in table1 (METI, 2005)(Toyo-keizai, 2005,2006)(Toyo-keizai, 2007,2008). Especially, the payment structure indices of each company, which are mentioned as essential in the previous research, are estimated as follows;

1. To draw each industry's wage curve based on the Ministry of Health, Labor and Welfare data (approximation formula)

2. To calculate the three ratios of each company to its industries of first year salary, pay at 30, and average payment, and to draw two wage curves for each company as follows;

a. The curve with a fixed ratio over the average age of employees.

b. The curve with a fixed change ratios from the first year to age 30, and from age 30 to the average age.

. To estimate salary and benefits at ten years intervals using the curves of 2-a. and 2-b.

4. To calculate the weighted average of pay at every ten year intervals, and adopt as estimator index as closer as possible to the company's average payment.

To integrate the structure factors of real human capital, Factor Analysis is applied to all the above indices. Every coefficient of factors is divided by their standard deviations to simplify factor scores. Factor Analysis is conducted where the cumulative contribution ratio of principal components is more than 70%.

Table 1. Human capital variables

Classification and Indices

Competence

Structure of employees: Average age, Average length of service, Temporary worker percentage, Percentage of employees under 30 in 30s,40s,50s,60s, Female employee percentage

Internal systems: Qualification and technical certification acquisition incentive scheme, Studying in Japan program, abroad program, Career-up support program

Employment: New graduate percentage, Mid-career percentage

Attitude

Structure of managers: Female manager ratio, Female executive ratio

Structure of directors: Directors serving concurrently as officers percentage, The number of outside directors

Internal systems: Half day paid holiday, Entrepreneur system, In-house staff recruitment system, Free agency, Special achievement award plan, Stock option

Overtime and paid holiday: Monthly average of overtime, Overtime pay, Average days of paid holiday acquired, Acquisition rate of paid holiday

Influence: Director's shareholding ratio

Difference: Wage differential at 30

Turnover: Employee turnover rate in his/hers first three years, Employee turnover rate

Competence and attitude

Payment: Director's compensation, Pay at 22, 25, 30, 35,40,45,50,55,60,65,70

Payment and welfare: Personnel expenses* per employee

Others

The number of people: The number of employees, The number of directors (scale adjusted)

* $(\text{Labor cost} + \text{Payroll cost} + \text{Director's compensation} + \text{Director's termination benefits} + \text{Termination benefits}) / \text{Number of employee}$

3.2. Human capital contributing to added value: the second step

The research of “human resource management and organization performance model” focuses on organization performance indices. Especially, profitability ratio indices such as ROI and labor productivity are used as representative organization performance indices. However, profitability ratio indices such as ROI reflect a lot of complex factors. Therefore, it is difficult to connect actual actions to results. Also, labor productivity is not proportional to the size at actual companies. Thus, this study uses the personnel adjusted added value (PAV) defined as follows.

In this study the added value is calculated by the deduction method as formula (1).

Personnel Adjusted Added Value (PAV)

= the price that the product/service is sold at - cost of producing the product

= Sales - external purchases

(1)

Investments in intangibles are not a cost. Thus, external purchases do not include intangibles investments.

The value of new graduates is not the result of human capital management of each company. It has classified the Personnel expenses into two.

- Basic personnel expenses: the minimum payments required if all employees were new graduates, whose value are not yet considered as company-specific human capital.
- Additional personnel expenses: the amount of real personnel expenses over the basic personnel expensed defined above.

In this study, external purchases include Basic personnel expenses. On the other hand, Additional personnel expenses are considered as human capital investments. Therefore, external purchases do not include Additional personnel expenses. This separated treatment of personnel expenses is different from other previous research. In this study, the personnel adjusted added value is calculated by deduction method as formula (2).

Personnel adjusted added value (PAV) = Sales - initial costs

(2)

Multiple regression analysis is adopted regressing PAV on human capital variables (table 1) scores and control variables (table 2)

Table 2. HCM factors

Item	Indices	Definition and source
Structural capital	R&D budget	Financial statement
	Years since establishment	Securities report
Relational capital	Advertising cost	Financial statement
	Shareholding ratio:	
	Major shareholders	
	Financial institutions	Shares per Shares issued
	Main banks	
Tangible assets	Initial costs	Selling and administrative expenses+ Production total cost + Purchases goods - R&D expenses- Advertising expenses - (Personnel expenses - Starting salary multiplied by number of employees)
Environment	Manufacturing / non-manufacturing industries	Japan standard industrial classification

Human capital management does not affect financial performances immediately. This is what we call time lag (Wakasugi, 1979). This study uses the financial results of the five-year-average and three-year-average after the survey of human capital managements, in order to reduce economic noise and time lag. The fifth percentiles of Average length of service are 4.9 and 4.765 in '07 and '08. It suggests that more than 95% of employees continue to work at same company for more than five years. Therefore, this study uses 5 year average of PAV. On the other hand, three years is used well as a separator of medium-term, as Employee turnover rate (first three years). Then this study also uses 3 year average of PAV. Adopted models are six regressions. Four models are regressing log PAV on human capital management scores and control variables at each fiscal year. (A1:'07-'11, B1:'07-'09, A2:'08-'12 B2:'08-'10) The remaining two models are regressing log PAV on '08FY score of variables selected in '07FY results of the first step. (A3:'07-'08-'12, B3:'07-'08-'10)

4. Results and discussions

Table 3. HCM factors and coefficient

Factors	Indices	2007	2008	Factors	Indices	2007	2008	
Pay at and over 35	Pay at 35	0.658	0.706	Size	The number of outside directors	0.478		
	Pay at 40	0.913	0.840			The number of employees	0.578	
	Pay at 45	0.968	0.883	Pay for young employees	Pay at 25	0.931	0.952	
	Pay at 50	0.985	0.913			Pay at 30	0.955	0.931
	Pay at 55	0.995	0.917			Pay at 35	0.562	
	Pay at 60	0.987	0.898	Female employee	Female employee percentage	0.596	0.688	
	Pay at 65	0.943	0.755			Female manager ratio	0.948	0.886
					Female executive ratio	0.717	0.623	
Structure of employees	Average age	0.959	0.910	Overtime	Monthly average of overtime	0.925	0.968	
	Average length of service	0.809	0.670			Overtime pay	0.890	0.810
	Percentage of employees under 30	-0.934	-0.941	Employee liquidity	Average length of service		-0.371	
	Percentage of employees in 40s	0.649	0.638			Percentage of employees in 60s	0.320	
	Percentage of employees in 50s	0.778	0.682			Mid-career percentage	0.511	0.725
	New graduate percentage	-0.769	-0.666	Manager generation	Director's shareholding ratio		0.487	
	Mid-career percentage	-0.408				Employee turnover rate	0.329	0.704
	Director's shareholding ratio	-0.444				Employee turnover rate (first three years)	0.351	0.465
	Employee turnover rate	-0.445			Percentage of employees in 40s	0.712	0.658	
	Employee turnover rate (first three years)	-0.488			Percentage of employees in 50s	-0.310		
Internal system	Studying in Japan program	1.000	1.000		Percentage of employees in 60s	-0.240	-0.415	
	Studying abroad program	1.000	1.000	Paid holiday	Average days of paid holiday		0.899	
	In-house staff recruitment system	1.000	1.000			Acquisition rate of paid holiday		0.967
Target company	Free agency	1.000			The cumulative contribution ratio	72.0	72.9	
	Number of manufacturing company	142	99					
	Number of nonmanufacturing company	105	115					

4.1. Indices representing human capital: the first step

Factor analysis results are in table 3. Table 3 shows that the structure of human capital is common in '07FY and '08FY. Coefficients are also similar in some factors. The structure of human capital is stable in these years.

4.2. Human capital contributing to added value: the second step.

Table 4 shows the results of the regression of PAV (Personnel-adjusted Added Value) on human capital management scores and control variables at '07FY (A1, B1), '08FY (A2, B2) and '08FY score of variables selected in '07FY (A3, B3) model. Model As use 5 year average PAV. Model Bs use 3 year average PAV. The following shows each part in table 4.

Table 4. PAV on HCM

Variables	A ₁ :'07-'11	A ₂ :'08-'12	A ₃ :'07<'08-'12	B ₁ :'07-'09	B ₂ :'08-'10	B ₃ :'07<'08-'10
Intercept	3.68E+00 ***	3.81E+00 ***	3.66E+00 ***	3.76E+00 ***	3.38E+00 ***	3.62E+00 ***
Structure of employees						
Temporary worker (%)		-2.06E-02 ○			-2.05E-02 ○	
Employees in 30s		2.27E-01	2.40E-01		2.51E-01	2.10E-01
Structure factor		-6.35E-03		4.68E-03	-4.30E-03	
Female employees factor	5.98E-03	1.07E-02	1.27E-02 *	1.03E-02 ○	1.33E-02 *	1.33E-02 *
Employees liquidity factor	-2.45E-02 ○			-2.20E-02		
Manager generation factor	-2.96E-02 *	3.73E-02 *	2.09E-02	-3.17E-02 *	3.18E-02 *	
Internal systems						
Q TCA ⁺ incentive scheme[1]		-3.31E-02 *	-3.07E-02 *		-3.07E-02 *	-2.51E-02 ○
Special achievement award plan[1]		2.24E-02 ○	1.86E-02		1.39E-02	
Stock option[1]	-1.68E-02	-3.33E-02 *	-3.35E-02 *	-1.44E-02	-3.17E-02 *	-3.43E-02 **
4 system factor{0,1/2,3,4}	3.87E-02 **		3.26E-02 *	4.94E-02 ***		3.65E-02 *
4 system factor{2/3,4}	5.46E-03		4.96E-03			
4 system factor{3/4}	-4.97E-02		-7.00E-02 *			
3 system factor{0,1/2,3}		4.64E-02 **			5.46E-02 ***	
3 system factor{2/3}		2.36E-02				
4 system factor{2,3/4}						-3.58E-02
4 system factor{2/3}						3.41E-02
Paid holiday						
Average days of acquired			1.65E-03 **			7.70E-03 *
Acquisition rate	1.49E-03 **			1.22E-03 *		
Paid holiday factor		2.06E-03 *			1.63E-03 *	
Salary and welfare						
Pay at 22					1.59E-06	
Personnel expenses Per employees	8.12E-03 ***	2.69E-02 ***	1.83E-02 ***	1.02E-02 ***	3.21E-02 ***	2.12E-02 ***
Young employees factor	6.48E-03					
Pay at and over 35 factor	5.47E-03 **		5.44E-03 *	7.31E-03 ***		7.91E-03 ***
Company size						
Number of employees		6.26E-05 ***	6.37E-05 ***		6.10E-05 ***	5.92E-05 ***
Number of directors (scale adjusted)	1.40E-01 ***			1.45E-01 ***	3.85E-02	5.71E-02
Size factor	7.50E-02 ***			6.02E-02 **		
Control variables						
R&D budgets	7.19E-07	-2.48E-06 **	-2.01E-06 *	1.07E-06	-2.67E-06 **	-2.17E-06 **
Advertising expenses	1.38E-05 ***	1.13E-05 **	1.20E-05 **	1.18E-05 ***	1.01E-05 **	1.16E-05 **
Shareholding ratio :						
Major shareholders	-7.64E-02	-1.42E-01	-1.53E-01	-2.64E-02	-1.20E-01	-1.09E-01
Financial institutions	-6.29E-02	1.48E+00 **	1.34E+00 *	-1.71E-01	1.25E+00 *	9.02E-01 ○
Main banks	1.03E-03	1.62E-04	4.74E-04	5.82E-04	-1.98E-04	-1.28E-04
Years since establishment	-1.82E-03	-2.50E-04	-1.00E-03	-2.86E-03	7.94E-04	4.94E-04
Manufacturing / non	-1.27E-02	-2.68E-02 ○	-3.00E-02 *	-1.97E-02	-2.30E-02	-4.58E-02 ***
Initial costs 5 year average	3.43E-07 ***	8.87E-08 ○	5.61E-08			
Initial costs 3 year average				3.36E-07 ***	1.13E-07 *	8.45E-08 ○
Adjusted R ²	7.60E-01	7.34E-01	7.39E-01	7.34E-01	7.57E-01	7.64E-01

Significance level ***:0.1%, **:1%, *:5%, ○:10%

- Structure of employees; Age structure is the only index with reversed sign in '07FY and '08FY. Employee liquidity factor and Manager generation factor reduce PAV in Model A1. It shows that PAV is high, if age distribution of employees is high in '07FY. Therefore, Structure factor causes PAV to decrease in Model A2. It shows that PAV is high, if age distribution of employees is low in '08FY. The Lehman shock in September 2008 may affect companies' strengths related to the structure of employees. It will be necessary to examine the details according to a type of industry. Structure of employees variables are similarity selected in Model A1 and B1. A2 and B2, A3 and B3. Female employee factor is also significant. They increase PAV commonly in these models.
- Internal systems; it shows there both a good and bad system to increase PAV. Stock option and Qualification and technical certification acquisition are statistically significant in all Models. Those are not good to increase PAV. System factor {0+1/2+3+4} and {0+1/2+3} are statistically significant in all Models. Therefore, it suggests that if company has two and more internal systems, it is good for PAV. System factor {2/3+4}, {3/4} and {2/3} are also not statistically significant. However, it suggests that company having just three systems is good for PAV. These indicate that the common three systems are good for PAV. Those are in-house staff recruitment systems, studying in Japan programs and studying abroad program. Index takes time to produce effect. It disappears in model Bs.
- Paid holiday; all indices signs are positive and statistically significant. Japanese employees are considered to be too hard working. This result shows the number of Japanese employee who rested a little more increase the PAV.
- Salary and welfare; Personnel expenses per employees and Pay at and over 35 factor are statistically significant. Those have a close relation to PAV. Personnel expenses per employees appears with high level of significance in all Models. Thus, the most important thing in this part is that not only salary but welfare as well increases PAV.
- Company size; all indices signs are positive. Most of the indices are statistically significant in all models. Thus, Company size indices have a close relation to PAV.
- Comparison model A1 and model A2; at first glance, it seems that A1 and A2 are different. However, those have essentially same structures, except for Structure of employees. As mentioned above, the Lehman shock may affect companies' Structure of employees.
- Comparison model A2 and model A3; those models are almost same. Thus, it is certainly significant to analyze human capital management by using factor analysis result of last year.
- Comparison model A and model B; those are same meaning, except for Internal systems. Thus, it is certainly effective to analyze human capital management by using three year average PAV. However noted above, it is necessary to attention to index which takes time to produce effect.

Managers are able to recognize success or failure of their human capital management when they apply the '07 model or '08 model to their own company's data. The diagonal represents the average of PAV obtained by means of their own company's capitals. Human capital management is recognized to be doing relatively well when their own company is plotted upper than a diagonal. The opposite indicates that it is not. Figure 1 shows that companies are plotted along a diagonal. It also shows that the structure of human capital is common in '07FY and '08FY.

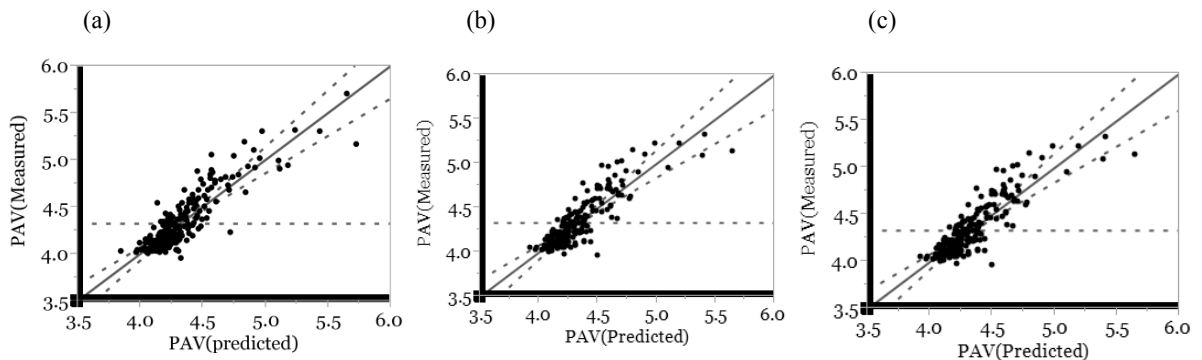


Fig. 1. (a) '07-'11 FY model (part); (b) '08-'12FY model; (c) '08-'12FY score of variables selected in '07-'11 FY model.

5. Concluding remarks

5.1. Achievement of objective

This study constructed the quantitative models to evaluate human capital management. Models use human capital indices which are selected as representing human capital from public information.

5.2. Contributions

Managers are able to recognize success or failure of their human capital management when they apply the proposed model to their own company's data. On the plane of the predicted values of the model (X-axis) and the measured values (Y-axis), the diagonal represents the average of PAV obtained by means of their own company's capitals. Human capital management is recognized to be doing relatively well when their own company is plotted upper than a diagonal. The opposite indicates that it is not.

Sensitivity analyses on these models provide some suggestions. One is "How to increase PAV". The model to evaluate human capital management shows that increasing Paid holidays and Salary and welfare will improve the company's profitability. It also indicates that whole program and system to support employees is not useful to improve profitability. Some programs are useful; other programs like stock option are not good for improving the profitability of Japanese companies. Another one is "How to compare human capital management". The model shows human capital management indices which need to compare with other companies. Managers are able to compare structure of human capital management with other companies by using public information.

The model's user-friendliness is increased by 2 things. One thing is that the model indicates certainly effective to analyze human capital management by using three year average PAV. Another thing is that in the process of constructing the models, important elements were revealed in human capital management. They are constant regardless of the year.

5.3. Limits

Adjustment will be required when managers apply to overseas the model. Because, PAV is assumed simultaneous recruiting of new graduates. Simultaneous recruiting of new graduates is major in Japan.

- Good evaluation is made when public information and the fact are different as unpaid overtime.
- The only available public information, if managers have a more detailed private information.
- Long-term information is truncated if managers use a short PAV average.

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