Human Capital Production Function

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***Abstract*— In many organizations the labor workforce is the single most important factor for business performance, but also the most difficult to analyze. Traditional analyzing and forecasting methods do not explain the phenomenon how human capital affects business economics, and therefore they are not too widely used in strategic management. This article introduces Human Capital Production Function (HCPF) as an analyzing method that combines the tangible and intangible assets of human capital with financial scorecards in a way that explains the meaning of human resources for business performance. Intangible assets can be measured using tacit signal method which can be connected to organization system intelligence. The article studies HCPF validity in longitudinal business case data and tests the use of HCPF in scenario-analyzing in a statistical average business services company in the Singapore region.**

Keywords-component; production function, business intelligence, performance, HRM-P, human capital, human resources, tacit signal, quality of working life.

I. INTRODUCTION

Business objectives are usually stated in terms of revenue, profit, profitability and return on investment. Human resource targets and strategy should be consistent with business objectives and guide to proactive actions in case HR data forecast problems. Forecasting is used for setting targets and creating business plans. The company's past outcomes, for example the revenue capacity per employee, gives realistic foundation for planning the future. If the target is to increase the revenue there should be necessary labor capacity to sell and produce the increased revenue. In addition, investments in technology and organization development may increase the revenue creating performance. In other words, the management should be able to identify the factors that threaten the business objectives and that create new opportunities to improve the performance (Keat & Young 2003).

One way to learn more about the firm's resources and what they mean to business performance is scenario analyzing. Scenario analyzing includes causal relationships between selected variables which together form different realistic business outcomes. Scenario analyzing can be seen as one effective strategic technique which is valuable as a learning process as well as in providing analyzing results (Grant 2010). In strategic planning the executives first analyze the company's strategic situation considering economic, political, demographic, competitive and technological trends (Dessler 2007).

A basic model for aligning HR strategy with business strategy is to set HR policies and activities to support the selected business strategy (Walker & MacDonald 2001). Dessler (2007) states that company's internal strengths and weaknesses should be considered before a strategic plan is formulated.

The production function is used in economic calculations for analyzing the relationship between organization resources (inputs) and output that is the result from using the resources. The most simple formula of production function is Q = f(L, K), where Q is production quantity, L is labor and K is the capital. One of the most commonly used production functions is the Cobb-Douglas (1928) production function. Its foundation lies in the idea that labor and capital are related so that the equation returns to scale are constant according to the following formula $Q = a L^{b} K^{(1-b)}$. In the majority of industries a constant returns to scale appears to dominate (Moroney 1967).

The Cobb-Douglas production function has been criticized because it does not serve the needs of individual firms but rather the aggregations of industries or even the whole economy (Keat & Young 2003). Some studies reveal that industry specific factors determine roughly 8% to 19% of a firm's profitability, whereas firm specific factors determine an average of 42% of the companies' return on assets (McGahan & Porter 1997, Huwawin et al. 2003, Roquebert et. al. 1996, Misangyi et al. 2006).

II. HUMAN CAPITAL PRODUCTION FUNCTION

Firm specific Human Capital Production Function (HCPF) should be based on existing HR and business data, and in addition, include the possibility that business performance may increase or decrease due to changes in human intangible assets. Furthermore, it should explain the value creation phenomenon, and hence advise how to improve the inputs and therefore help in business planning. Kesti (2012ab) has studied human capital business effects in practical case studies and found a possible explanation for human resources development and business performance (HRM-P theory). The principles of this theory are further studied to form a simplified Human Capital Production Function.

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For simplicity, the following HCPF includes only the most important human related factors that affect business performance. In this function, revenue presents total production capacity. HCPF indicates the revenue that the organization can achieve in an estimated market situation. After revenue is known, traditional cost analysis can be used for calculating profit. Operating profit can be calculated in terms of EBITDA (earnings before interest, taxes, depreciation and amortization), which is revenue deducted by variable costs, staff expenses and fixed costs. Typically variable costs are related to revenue and staff costs to number of workers. When estimating costs, the cost index changes should be considered due to inflation and salary increase.

To illustrate what human resources mean to business performance, let us take a look at a case example of a Singaporean Business Service Company of 100 employees. The initial data for HCPF analyzing is as follows:

Yearly working time	2288 h	Staff size 100
Vacations	6.0%	Revenue $17 018 991
Absence	4.3%	Staff costs $3 369 292
Maternity leave	2.1%	Variable costs $1 998 206
Training and HRD	2.2%	EBITDA $3 487 135
Orientation	5.4%	
Quality of working life	75.0%	

Human intangible assets are identified by human competencies, representing the staff collective quality of working life (QWL and QW). In this article the quality of working life is the factor that determines how human intangible assets are utilized for organization basic function - making revenue. These QWL-competencies can be measured for example by using a tacit signal method (Kesti 2012ab). Figure 1 shows a simplified human capital production function, where human intangible capital, human labor resources, and business outlook are linked together with causal connection.

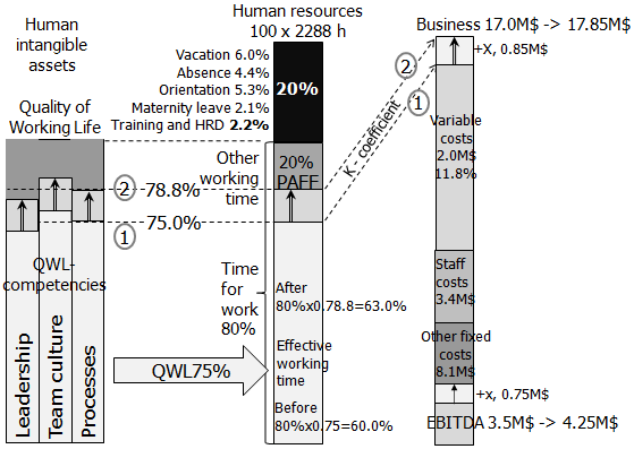

Figure 1. Case example: using human capital production function in a Singaporean firm.

In the figure above, the company invests 2.2% from total working time to organization training and HRD, and as a consequence the QWL-competencies improved from 75% to 78.8%. As the direct result of improving human intangible assets, the company increased the revenue by 0.85 million and profit 0.75 million. When this phenomenon is described mathematically, the human capital production function for calculating revenue is formed by the following equation (1):

$$R = L\ K\ T_{TW}\ [QW_{N-1}(1 - Aw) + QW_{N-1}(D_{QOD} - D_{QLN})].$$

$$= L\ K\ T_{TW}\ QW_{N-1}(1 - Aw + D_{QOD} - D_{QLN}). \quad (1)$$

R = revenue [$]
K = coefficient for effective working time revenue relation
L = number of employees in full time equivalent [pcs]
T_{TW} = theoretical yearly working time [h]
QW_{N-1} = labor quality of working at the beginning (0…100%)
Aw = auxiliary working time share of total theoretical working time [%]
D_{QOD} = organization development effect on the quality of working life [%]
D_{QLN} = new staff (staff increase and turnover) decreasing the effect on the quality of working life [%]

The quality of working life (QW) for the next cycle is calculated in the following equation (2):

$$QW_N = QW_{N-1} + QW_{N-1}(D_{QOD} - D_{QLN}) \quad (2)$$

$$= QW_{N-1}(1 + D_{QOD} - D_{QLN})$$

Coefficient K is the relation between effective working time and revenue. It describes firm's current revenue creating capability with the utilized business model, stating how much revenue can be obtained with effective working time. Equation (3) describes how coefficient K is calculated:

$$K = R_0 / (L_0 * T_{TW0} * (1 - Aw_0) * QW_0). \quad (3)$$

R_0 = revenue from the latest financial report [$]
L_0 = number of employees (FTE) (pcs)
T_{TW0} = theoretical working time [h]
Aw_0 = auxiliary working time share of the total theoretical working time [%]
QW_0= staff quality of working life (0…100%)

This business coefficient varies quite a lot between different business branches. For example, in the process industry it can be six times more than in the service business due to investments in process technology. A typical aim of strategic business innovations is to improve this business coefficient. On the other hand, the Cobb-Douglas principle states that the full utilization of capital investment also requires improvements in the human resources of an organization.

Auxiliary working time, as shown in the following equation (4), is labor time included in theoretical working time (paid time), but which can't be used for actual work:

$$Aw = V + Ab + M + Tr + OD + O \quad (4)$$

Aw = percentage of auxiliary working time of theoretical working time [%]
V = percentage of vacations of theoretical working time [%]
Ab = percentage of absences of theoretical working time [%]
M = percentage of maternity leaves of theoretical working time [%]
Tr = percentage of training time of theoretical working time, for maintaining working skills [%]
OD = percentage of organization development of theoretical working time (for implementing workplace innovations) [%]
O = percentage of new staff orientation of theoretical working time [%]

In fact, only the most essential factors are included, which is why there may be a firm specific auxiliary time that is not included in the equation (4), for example, possible traveling during working hours. Work orientation time (O) has to be calculated, because it is difficult to measure by means of working time recording (see equation 5). The principle is that during orientation period, new worker contribution is half compared to an experienced worker. Furthermore, orientation time is calculated for yearly periods. For instance, if full orientation period is 10 months and the percentage of new workers is 12.9%, the percentage of orientation time of theoretical working time is 12.9%*(10/12)*0.5 = 5.4%.

$$O = L_n * T_{fo} / 12 * 0.5 \quad (5)$$

L_n = percentage of new workers [%]
T_{fo} = single worker full orientation period [months]

Organization development means practical improvements in labor working quality. Kesti's (2012b) studies show that optimal workplace innovations will improve human intangible assets verified by tacit signal competence inquiry. In addition, the organization development process efficiency coefficient (C_D) can be measured; it means that certain time spent in workplace development (OD) will contribute to workplace innovations and improve human competencies (QW).
The most difficult factor in human capital production function is the quality of working life because it describes the human intangible assets and determines the effective working time of the time used for work. There are several possibilities for estimating or measuring the quality of working life. One possibility is to study the statistics of companies in the same business branch regarding coefficient K. For instance, if statistics reveal that average revenue per employee in business branch is greater with the same working time, it may indicate that competiveness could be improved through better quality of working life.
Kesti (2012ab) has developed a tacit signal method for measuring human competencies, which represent the human intangible assets and thus the quality of working life. This method includes the phenomenon of inverted U-curve which is a fundamental characteristic for human performance utilization (Yerkes & Dodson 1908, Goleman 2006). U-curve is formed when pressure increase (creative tension) first improves performance but then it starts to decline. This happens when pressure turns to harmful stress. Tacit signals measure the side that persons feel they are in related to the competencies that form the quality of working life.
When quality of working life is at a high level the workplace development requires more effort than what is needed for improving the lower level competencies. Therefore, organization development increases nominal working time along the sin-curve, which mathematically represents the U-curve pressure-performance relation (Kesti 2012b). In this case, the sin-curve is divided into 8 segments, meaning that over 4% of the development time of the theoretical working time will not improve competencies but reduce them instead.
Organization development time (OD) is the same factor that is included in the auxiliary working time, thus reducing the time for work. Indeed, it is essential to know the organization development efficiency: how much does the labor work quality improve by the time invested in development? The nominal effect of organization development (OD) on the quality of working life can be calculated in the following equation (6):

$$D_{QOD} = ((C_D*\mathrm{Sin}(OD*100*(Pi/8))*(1 - QW_{N-1})) \quad (6)$$

D_{QOD} = organization development (OD) effect on the quality of working life [%]
C_D = organization development efficiency coefficient
OD = percentage of organization development time (for implementing workplace innovations) [%]
QW_{N-1} = labor quality of work at the beginning (0…100%)

Obviously, there are also other HR related practices (for instance training and flexible working time) that may improve the quality of working life, but for the sake of simplicity and the lack of adequate evidence they are not elaborated here. Besides factors that improve work quality, there are also factors that affect the opposite way, thus increasing the wasted labor time and reducing the quality of working life. One of the main negative factors causing organization fuss is the changes in personnel structure.

Kesti (2012b) found that adding new workers in the working society seems to reduce human competencies, thus causing additional development needs in the group (for instance orientation and reorganization of work). Employee training is essential for maintaining working skills and may also improve the coefficient C_D.
Obviously, new workers increase total labor capacity but also create challenges in terms of maintaining the performance level. The effect is two-sided, because orientation time increases the auxiliary working time (Aw) and new workers will increase the wasted labor time (wasted time due to internal failures). Certainly, there are also other factors that reduce the quality of working life. DQLN in the following equation (7) is one of the most important factors:

$$D_{QLN} = L_n * C_n \quad (7)$$

D_{QLN} = staff structural changes decreasing effect to staff quality of working life [%]
L_n = percentage of new workers in the working groups [%]
C_n = coefficient of how new workers reduce the quality of work (cause presenteeism)

III. Evaluating Effective Organization Development

Employee development is one of the most important issues for the success of organizations, but it is also one of the worst managed issues (Fitz-Enz 2000). This problem seems to be due to that many managers do not have the knowledge or possibilities to evaluate HR development efficiency and its effect on business (Cascio and Boudreay 2008). Furthermore, HR experts conducting human resource development (HRD) are seldom business oriented enough to proceed in the development evaluation beyond the behavioral objectives based on the participants' reactions to the training or intervention (Wang and Wilcox 2006). Despite HR-information systems are improved lately, the evaluation of human capital business value can be time-consuming and therefore rather unpleasant activity for the HRM and HRD personnel (Mankin 2009). Several studies indicate that the impact of HRD investments payback in business is not properly evaluated and therefore the decision-making lacks the necessary information for improving development the HRD interventions (Wang and Wilcox 2006; Swansson 2005; Bunch 2007; Kim and Cervero 2007).

All in all, there are many reasons why HRD's effectiveness is not evaluated properly from the organization and business point of view. Many HRM and HRD specialists do not have the right mindset for evaluating business effectiveness and feel they lack the confidence to do so (Wand and Wilcox 2006; Swansson 2005). The problem is a complex one, as human related issues usually tend to be. Too often the HRD experts evaluate only the participants' reactions after the training. This is not nearly enough since research indicates that reactions have no correlation with the performance outcome measures (Swansson and Holton 2001; Laird 2003). However, even though recommendations for evaluating training and organization learning have been introduced long ago, they have not been implemented in organizations. One of the classical approaches is the Kirkpatrick model from 1959, where four evaluation levels are recommended. Hamblin (1974) added a fifth level to Kirkpatrick's model, so the levels are as follows:

1. Reaction
Evaluate participants' reactions at the end of the training. Were they happy with the training?
2. Learning
Evaluate what the participants learned. Were the learning objectives achieved?
3. Behavior
Evaluate the change in behavior in the work. Did the participants change their working behavior based on what was learned?
4. Results
Evaluate the effect on the organization. Did the HRD activities have a positive effect on the organization?
5. Ultimate value, ROI (Hamblin 1974)
Evaluate ultimate economic value. Did the HRD activities give added value from the economic point of view?

Totterdill et al. (2002) noticed that the development payback time was usually difficult to measure and exceeded by several years. Thus, it can be argued that in many cases the development effort may not be a profitable investment. The experiences gained from Kesti (2012b) research indicate that when the HR-development is done effectively and in favorable business circumstances it is possible to gain measurable payback time that is relatively short, even less than half year. This evidence seems to be possible in both companies and municipal organizations. A study of four municipal working units showed that calculated total payback for organization development investment was 4.4 in one year. This was based on monitored total working time of the staff and the increase of the effective working time. The external costs and the costs for the working time consumption of the staff's development were reduced from the value of effective working time increase. In this particular case the staff productivity reward system was used; a collective reward was received when the working group could verify they had successfully implemented three agreed improvements at their workplace.

IV. Tacit Signal Method at Evaluating Quality of Working Life

Tacit signals refer to personal guiding opinions that can be used in improving human competencies and organization performance (Kesti 2005). In working societies, the employee guiding opinions help solving problems which is important for the quality development and is a fundamental element of effective management. It seems that collective emotional intelligence is characteristic of top performing teams (Wheelan 2005).

The tacit signal method is based on the inverted U-curve dichotomy scale, consisting of two interrelated forces. The principle of interrelated and opposing factors affecting organizations is raised also in The Knowledge Creating Company by Nonaka and Takeuchi (1995). They have observed that there seems to be a multitude of dichotomies – such as tacit vs. explicit, mind vs. body (or matter), self vs. others – that are affecting organization knowledge creation. These dichotomies are not different coins, but rather the opposite sides of a coin as they are mutually complementary of one another (Nonaka and Takeuchi 1995). This approach of two interrelated guiding forces is also visible in Asian philosophy of yin and yang (Xinnong 1999). It seems that the same approach is included in the Yerkes-Dodson's (1908) law of tension-performance relation (inverted U-curve) which is verified important basis of human performance and knowledge utilization (Goleman 2006).

High performance organizations prevent possible problems in advance (Mankin 2010; Blanchard and Thacker 2004; Fenwick 2006). This seems to require certain organization culture where social awareness triggers the improvement actions for preventing possible problems. Blanchard and Thacker (2004) point out that a performance problem may or may not actually exist; it is enough that one or more decision makers believe it does. Fenwick (2006) argues that usually an observed problem, like task being carried out incorrectly, can't be solved simply by means of training. The performance problem – observed or suspected – can be due to a wide range of factors and therefore it is difficult to isolate what is causing it (Wexley and Latham 2002; Gilley et al. 2002; McClernon 2006).

The tacit signal method for measuring individual guiding development opinions can be described by using the inverted U-curve, which can be mathematically illustrated using unit circle positive sin-curve. Each individual has tacit knowledge about their situation in the inverted U-curve. This opinion can be measured by asking the person's opinion about the development need concerning the essential human competence attribute. For example "working community meeting practices" is one competence attribute in the team culture competence. The person may feel that this competence is not optimally utilized, since meetings are not leading to conclusions and obviously needs development and therefore the opinion is on the left side of the inverted U-curve (see figure).

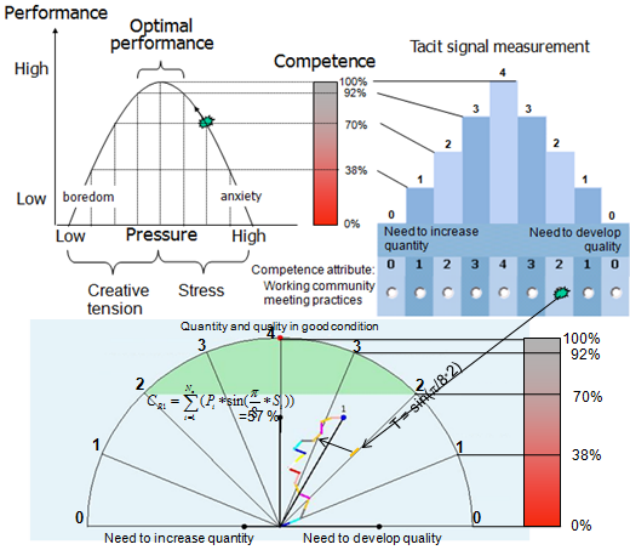

Figure 2. The tacit signal vector-analyze principle and theoretical connection to the inverted U-curve (Kesti 2012.

The tacit signal vector analysis shows that the group's collective development need is below the chosen alarm level (70%), which is the triggering level for competence attribute development. The analysis result in the semicircle depicts the following essential information for development purposes:

1. Competence level (and development need)
2. The homogeneity or heterogeneity of each opinion compared to others
3. The direction of collective development need

The tacit signal opinions are measured and analyzed by the eHRM -tool provided as a service (SaaS). At action research cases the tacit signal method has been found useful for organization development as measured competencies seem to correlate with organization performance (Kesti and Syväjärvi 2010).

V. HUMAN COMPETENCE SYSTEM INTELLIGENCE MODEL

According to Schein (1985) one of the most important tasks of the management is to support the culture in which work communities are able to develop continuously and react positively to constant changes. However, it is common that leaders do not get adequate and truthful information about the problems in the organization's operations (Pfeffer and Sutton (2000). It is also true that even when the management is aware of what should be done to improve the organization's performance they usually have difficulties translating that knowledge into practical improvements. Pfeffer and Sutton (2000) describe the phenomenon as knowing-doing-gap which may lead to wrong decisions and thus prevent the optimal development.

When organization system is in balance it is developing continuously, and can be lead in the direction preferred by the management. Senge (2006) has described the phenomenon by arguing that when the system is in balance, the power vectors inside the organization will be lined in the same direction towards the target. In the model of the system intelligence those internal human power vectors can be seen as the tacit signal competence vectors of each individual working team.

The organization is a complex system which consists of organizational human knowledge based success factors which can be identified as the human competencies of the organization. The system intelligence model is based on five competencies: management, leadership, group culture, skills and processes (Kesti and Syväjärvi 2010).

The management determines the vision and strategy of the organization and provides the necessary conditions for the development of the organization. The management is responsible for the organization structure's suitability for the situation and the staff abilities' adequate balance with strategic objectives. Leaders or foremen organize the operative work and the responsibilities of the workers, and should support the working society's development as a group. Operation culture refers in this context to the internal operation culture of a team or a group and the whole organization. This can be best described with the word solidarity where everyone can experience appreciation, thus wanting to distribute information and know-how among others. Conflicts are identified and solved together. The know-how includes explicit and tacit skills for doing the operative work. The processes in question are the work practices that consist of approaches and methods applied to the work generating value to the customers (internal or external). Management should be able to utilize process information for their decision-making to be able to invest in

the most optimal business improvement actions (Collins 2001; Shigeru and Akao 1994).

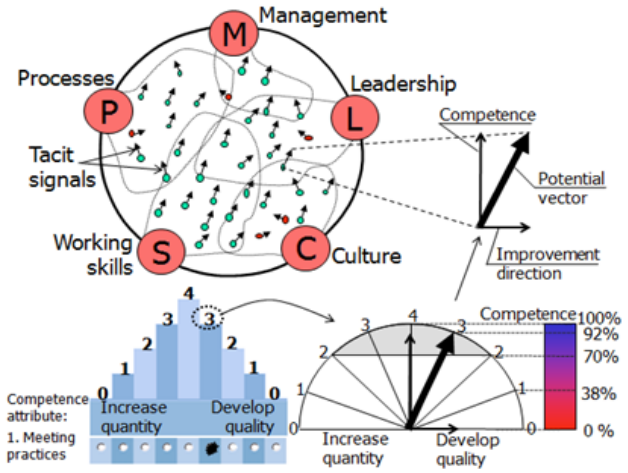

Figure 3. Left is the System intelligence model and tacit signal competence analyzing connection (Kesti and Syväjärvi 2010). Right is the system intelligence mental model of five elements in continuous change.

At this hermeneutic system intelligence model the human competencies are interrelated and mutually interactive. In positive interaction the management supports the leadership and influence on the culture. The leadership builds the team culture and influence on the personal working skills. Shared culture within the team speeds up the skill improvement and affects the processes. Good personal skills help to describe processes and provide initiatives for the management. From effective processes, the management receives high quality information for decision-making, and the clear processes help leadership.

For example, it was discovered in the action research that the process development was forced too much in cases where improvement focus should have been in the leadership development. The research indicated that the system intelligence model had both positive and negative interrelated competence connections. In the negative spiral the management does not support the leadership, and poor leadership affects negatively on the team culture. Lack of collaboration within the team does not support knowledge sharing and its effect on the processes and their development is negative. If the know-how is not shared but instead protected, the defensive mechanism hinders innovativeness which is important for the processes and the management. If processes are not in order, the management does not receive high quality information for their decision-making. Furthermore, unclear processes cause mistakes and chaos and have a negative impact on the leadership which is often blamed.

The mental model for the organization system intelligence theory comes from a Chinese acupuncture treatment that utilizes the mental model of the interrelationship between five elements. The interaction between the five elements is used for describing the vital functions of the human organs. The yin and yang of the equilibrium is used for retaining the balance of the human organism.

In acupuncture, the interaction between the five elements is always used together with the equilibrium, yin-yang. In all its complexity, the treatment is simple due to a mental model. All the internal organs of the human being are linked to each other in one controlled system. Every internal organ represents a certain element in the model and the yin and yang describes the balance and the interaction between the elements. When an internal organ of a human being operates hyperactively, it disturbs the operation of the other organs causing disorder that can manifest itself as a certain symptom or an illness.

The tacit signal comprises the yin and yang equilibrium that tells how to retain the optimal balance in an organization system. The research case experiences indicate that the model operates well in the diagnosis of human structured target-oriented complex systems, in other words organizations.

Tacit signal development process for modern knowledge management

Hassard and Kelemen (2002) argue that knowledge can be seen as 'a set of cultural practices situated in and inextricably linked to the material and social circumstances in which it is produced and consumed'. When people face new situations, they evaluate the situation and start the sense-making process based on past experiences and knowledge (Weick 1995). Argyris and Schon (1978) identify single and double loop learning where single loop learning could be seen as a process of correcting the fault using past experience, and double loop learning as preventing the fault from happening again.

Dialogue is definitely the key factor in knowledge development that has been used since the early days, for example by philosophers such as Socrates, Plato and Aristotle. The group individuals should have positive mental attitude towards knowledge sharing and possibilities for open constructive discussion. Nonaka and Konno (1998) describe this with the use of knowledge creating concept of BA.

The study indicates that tacit signals can be linked to effective organization development process and knowledge management with following phases (Kesti and Syväjärvi 2010):

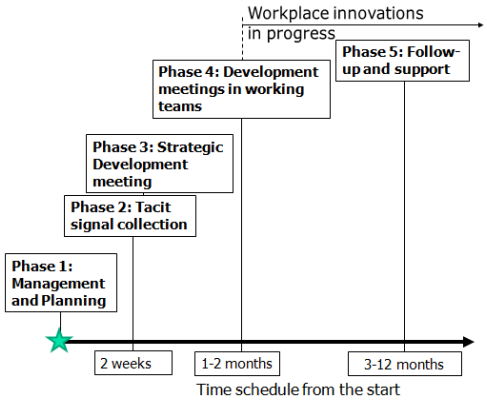

Figure 4. Tacit signal HR development process.

Figure. The tacit signal development process and schedule.

The idea at the tacit signal development process is to innovate and implement the most optimal four improvement actions per team with minimal required development time consumption. Our action research case studies indicate that suitable target is four optimal improvement actions (workplace innovations) at each working team. Each worker spends approximately 1 % working time for collective development.

Research studies indicate that the difference between a great and a mediocre team lies in the way they face conflicts and how they succeed in solving them (Argyris 1985; Senge 2006; Goleman 1998). The experience gained from several cases where the tacit signal process was implemented support the Latane and Darley (1969) findings that sensitivity to intervene in the matters which require attention are learned behavior models. Interference with matters that require attention depends a lot on how the members of the group have learned to intervene in them. Systematic tacit signal development process creates a certain mode of operation that stimulates opportunities for reflection, dialogue, creativity and workplace innovations throughout the organization.

When examining the tacit signal development process, three different phases are found that derive the optimal innovations. First of all there is a strategic planning phase where the performance drivers are identified as competencies. Selected competencies (e.g. leadership, culture and process) are formulated by competence attributes, usually 10 to 15 attributes. Then the tacit signal inquiry collects the development needs which are analyzed for each working society. And finally each group will have development meeting where the group invents multiple development ideas from which the group selects the most optimal ones for implementation.

At the case studies the average team implemented 3.18 improvement actions, among which the successfully carried out tacit signal process is included as one action. Most of the teams (47.7 %) carried out successfully 1 to 2 optimal improvements and 38.6 % of the teams succeeded in 3 to 4 actions and 13.6 % implemented more than 4 optimal workplace innovations. The empirical case studies indicate that these team level improvements derive better business performance and human productivity (Kesti 2012).

VI. Business Case Study

Human Capital Production Function validity is studied at longitudinal research case study in a company of approximately 1,000 employees consisting 19 business units of builders' merchants localized stores with well-trained specialist staff. This research case data was collected at Kesti dissertation study (Kesti 2012b). Company has a strong record of profitability based on efficiency and a low cost base, aiming at profitable growth faster than the competitors. To achieve this goal, each business unit focuses on achieving the best customer service, the best branch staff and preferred vendor relationship.

In this research case, the systematic human resources development process (OD) was carried out yearly for two years (see figure 4). The business scorecards were monitored through the years 2005, 2006, and 2007, during which the represented tacit signal QWL-competencies were measured using the Tacit signal inquiries. The results are analyzed using human capital production function.

The longitudinal case study was intrinsically interesting from the research point of view (see Fleetwood & Hesketh 2010): the company consists of separate, yet similar business units which all performed the same business process with the same base knowledge resources, similar HRM practices, customer products, and they conducted business in a relatively similar market area. Furthermore, the research was carried out in a steady growing economic situation where the Finnish economy's productivity growth during years 2005-2007 was from 1.5 to 3.1, reducing to -0.4 in the year 2008 (Pasanen 2008; 2010). Therefore, the period of 2005 to 2007 represents a steady growth, as well as minimum sources of errors from the economic point of view. During the research period, the tacit signal development process was the only systematic organization development activity that was performed throughout the whole organization.

Human Capital Production Function was tested with two sample groups to see if production function can sensibly meet the realized revenue and find out possible inconsistencies between the realized data and analysis. Two sample groups were chosen for the test. The first sample group was selected from the stores that increased their human competencies (2005: 74.4%, 2006: 81.0%, 2007: 81.1%). This group consisted of 10 business units and 601 employees. In the other sample group, consisting of 9 units and 364 employees, the human competencies reduced during a two-year period (2005: 84.1%, 2006: 80.2%, 2007: 78.8%). Figure 3 illustrates that in both sample groups the change in human competencies seems to explain the difference in revenue change.

The data in the figure shows that staff increase (percentage) is nearly the same in both groups that were being examined. The better half increased revenue more than the staff increases, which indicates that revenue surplus does not come solely from the increased number of staff, but presumably from competencies improvement (9.3%) as well. It appears that competencies would explain the additional revenue growth. Furthermore, the lower sample group revenue was 4.2% (18.2%-22.4%) less than staff increase, so the competence decrease appears to be in line with this outcome ((84.1-78.8)/84.1 = 6.3%). These research findings meet the theoretical HRM-P orientation that was introduced earlier.

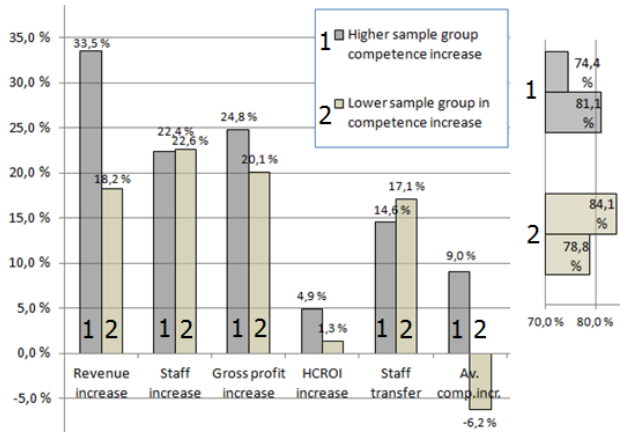

Figure 5. Competence improvement correlation with business improvement in the two chosen sample groups.

The data of both sample groups was input in Human Capital Production Function for calculating the revenue. Starting revenue was the actual revenue; and coefficient K was calculated using equation 3 for starting year and then chosen as constant. Human competencies (QW) were measured using tacit signals inquiry at the end of each year for three years; staff volume was calculated as full time equivalent so that staff costs per employee met the actual value. HR data was partly missing, thus lacking data was filled with realistic estimates (see figure 4). Indeed, the analysis seems to be useful for finding out improvement needs in HR systems.
According to the analysis (figure 4), the higher competencies are achieved using organization development process effectiveness CD=0.8 and additional time spend for organization development OD from 0.3 to 1.0. The negative effect coefficient was Cn=0.1, meaning that new workers are not decreasing the QWL-competencies too much. Using these values the production function gives same revenue values (R (prod func)) and human competencies (QW).

HIGH

	Revenue (real)	R (prod func)	L (FTP)	T_{TW}	K
0	285 400 560	**284 524 246**	601	1 895	400
1	293 385 916	**292 741 603**	629	1 874	400
2	348 919 181	**348 928 272**	715	1 898	400

	Aw	V	Ab	M	Tr	OD	O
0	16,1 %	10,2 %	2,1 %	1,0 %	0,5 %	0,3 %	2,0 %
1	23,2 %	10,1 %	5,9 %	2,9 %	0,8 %	1,0 %	2,6 %
2	20,7 %	10,0 %	4,2 %	1,8 %	0,8 %	0,4 %	3,7 %

	D_{QLN}	Ln	Cn	D_{QOD}	C_D	QW
0	0,8 %	8,0 %	0,1	2,5 %	0,8	74,6 %
1	1,5 %	10,3 %	0,1	7,8 %	0,8	81,0 %
2	2,0 %	14,6 %	0,1	2,1 %	0,8	81,1 %

Figure 7. Human Capital Production Function analysis for sample group 1.

The second sample group analysis shows interesting results (figure 5). It seems that competencies (QW) declined because units did not invest enough in organization development (OD) and failed in new workers (L_{FTP}) recruitment. New workers seem to reduce human competencies too much (see factor Cn=0.4 at year 1). As a result the competencies (QW) reduce from 84.0% to 78.7%, which is in line with the measured competencies in this research case.

LOW

	Revenue (real)	R (prod func)	L (FTP)	T_{TW}	K
0	166 511 384	**166 536 098**	364	1 895	380
1	174 432 650	**173 974 817**	384	1 874	380
2	196 411 942	**196 382 777**	434	1 898	380

	Aw	V	Ab	M	Tr	OD	O
0	24,4 %	10,3 %	7,5 %	3,0 %	0,8 %	0,3 %	2,5 %
1	20,5 %	10,1 %	4,2 %	1,6 %	0,8 %	0,4 %	3,4 %
2	20,3 %	10,0 %	4,0 %	1,2 %	0,5 %	0,3 %	4,3 %

	D_{QLN}	Ln	Cn	D_{QOD}	C_D	QW
0	1,4 %	10,0 %	0,1	1,5 %	0,8	84,0 %
1	5,8 %	13,7 %	0,4	2,1 %	0,8	80,3 %
2	3,4 %	17,1 %	0,2	1,9 %	0,8	78,7 %

Figure 6. Human capital production function analysis for sample group 2 with used factors.

This test shows that HCPF can meet the case data, however, the auxiliary time and staff turnover should have been measured more accurately. Generally speaking the case shows that accurate data from human resources is essential for a reliable analysis supporting management decision making. Indeed with high quality HR data the analysis by human capital production function would give valuable information for management decision making.

All in all, human capital production function seems to yield interesting findings and questions, which are useful for management point of view. For example: how come did the higher sample group succeed so well in new staff recruitment and orientation? It also seems that organization development should be organized more effectively so that especially those business units that have lowest human competencies should achieve better results in OD. One interesting question is why business coefficient K is smaller in sample group 2 than in group 1, despite the fact that they are calculated same way (equation 3)? It may be because the first sample group units were better at utilizing their IC technology.

VII. Human Capital Utilization in Singapore Region

Using the Human Capital Production Function in strategic business scenario analyzing has been tested in a practical business case study. The selected business case was a Business Service Company that operates in the Singapore region (see figure 1). A good starting point for human capital scenario analyzing is an overall study conducted of human labor resources utilization in the Singapore region (ref. Dessler 2007).
Staff turnover rate across industries in Singapore is as high as 11.7% meaning that every tenth worker changes employers each year (Puri 2010). For example, in the business services branch the new employee work orientation may take 6 to 12

months. Only after this period can the performance of new workers reach the level of experienced workers. New worker orientation time can be calculated bearing in mind the basic rule that new worker performance is half compared to experienced worker performance during the time of orientation (Kesti 2012). Therefore, as an example in business service branch, new worker orientation takes up 2.5 to 5% of the total working time. There are three main causes for staff turnover: first, desire for more flexible work arrangements; second, desire for shorter working hours (including commuting); and third, desire for better salary (Ministry of Manpower 2011).

In Singapore, total wages in the private sector increased by 6.1% in 2011, which is more than the inflation rate, which has been relatively high (5.2%) for a developed country (Ministry of Manpower 2012). Salary increase together with high staff turnover rate indicates that workers are seeking for better-paid jobs, and companies are competing for skilled workers. Moreover, the wages are increasing due to the fact that lowest wages of cleaners, for example, must be increased to make those jobs more favorable in the future. As people become more educated, the low wage jobs are more difficult to fill. This phenomenon is seen in the northern Europe countries.

Singapore has good international competitive situation considering the theoretical yearly working time that is around 45.9 hours per week for average worker (Ministry of Manpower 2011). In the country with high standard of living this is very competitive. As an example, in Finland it is 36.3 hours per week (1891 hours per year) (Confederation of Finnish Industries 2011). Despite the lowest yearly working hours Finland it is the most competitive country in Europe (Schwab 2012). It seems that the most essential factor is not the quantity but the quality of how the working time is utilized. The Finnish competitive advantages are built from high level of knowledge, technology utilization, effective work procedures and high quality of working life. When the staff is highly educated the quality of working life is a competitive advantage for at least two reasons: firstly, the company will be able to keep skilled workers, and secondly, the staff innovativeness will flourish, resulting in the company's increased productivity and sales.

VIII. Human Capital Production Function Scenario Analyzing

Using the Human Capital Production Function in scenario analyzing has been tested using a Singaporean Business Service Company, which was introduced in figure 1.

The idea of scenario analyzing is to find human related risks and possibilities to create competitive advantage through differentiation in human resources management. Table 1 shows two five-year scenarios using identical initial values and identical company staff growth. In the *high road scenario*, the company doubles the HR-development effort to 1.0% of the theoretical working time, and in the *business as usual scenario*, the HR development effort remains at the same 0.5% level.

Table 1. Human capital production function presenting two realistic scenarios. Costs increases are not considered.

High road scenario (HIGH)

	EBITDA (HIGH)	Variable costs	Staff costs	Fixed costs	R	L	T_{TW}	K
0	**3 487 135**	1 998 206	3 369 291	8 168 368	**17 018 991**	100	2 288	124
1	**4 172 114**	2 089 862	3 369 291	8 168 368	**17 799 634**	100	2 288	124
2	**5 026 252**	2 203 487	3 369 291	8 168 368	**18 767 398**	100	2 288	124
3	**5 754 749**	2 300 399	3 369 291	8 168 368	**19 592 806**	100	2 288	124
4	**7 332 891**	2 555 159	3 706 220	8 168 368	**21 762 638**	110	2 288	124
5	**9 176 315**	2 845 210	4 043 149	8 168 368	**24 233 043**	120	2 288	124

	Aw	V	Ab	M	Tr	OD	O	D_{QLN}	Ln	Cn	D_{QOD}	C_D	QW
0	19,8 %	6,0 %	4,3 %	2,1 %	1,7 %	0,3 %	5,4 %	1,29 %	12,9 %	0,1	1,5 %	0,5	75,0 %
1	19,9 %	6,0 %	4,3 %	2,1 %	1,7 %	**1,0 %**	4,8 %	1,16 %	11,6 %	0,1	5,0 %	0,5	78,8 %
2	19,0 %	6,0 %	3,9 %	2,1 %	1,7 %	**1,0 %**	4,4 %	1,04 %	10,4 %	0,1	4,2 %	0,5	82,0 %
3	18,2 %	6,0 %	3,5 %	2,1 %	1,7 %	**1,0 %**	3,9 %	0,94 %	9,4 %	0,1	3,6 %	0,5	84,6 %
4	19,2 %	6,0 %	3,1 %	2,1 %	1,7 %	**1,0 %**	5,3 %	1,26 %	12,6 %	0,1	3,1 %	0,5	86,4 %
5	18,9 %	6,0 %	2,8 %	2,1 %	1,7 %	**1,0 %**	5,3 %	1,26 %	12,6 %	0,1	2,7 %	0,5	87,8 %

Business as usual scenario (LOW)

	EBITDA (LOW)	Variable costs	Staff costs	Fixed costs	R	L	T_{TW}	K
0	**3 487 135**	1 998 206	3 369 291	8 168 368	**17 018 991**	100	2 288	124
1	**3 531 734**	2 004 672	3 369 291	8 168 368	**17 074 065**	100	2 288	124
2	**3 658 140**	2 021 488	3 369 291	8 168 368	**17 217 287**	100	2 288	124
3	**3 774 125**	2 036 917	3 369 291	8 168 368	**17 348 701**	100	2 288	124
4	**4 776 500**	2 215 084	3 706 220	8 168 368	**18 866 172**	110	2 288	124
5	**6 004 280**	2 423 236	4 043 149	8 168 368	**20 639 033**	120	2 288	124

	Aw	V	Ab	M	Tr	OD	O	D_{QLN}	Ln	Cn	D_{QOD}	C_D	QW
0	19,8 %	6,0 %	4,3 %	2,1 %	1,7 %	0,3 %	5,4 %	1,29 %	12,9 %	0,1	1,5 %	0,5	75,0 %
1	19,8 %	6,0 %	4,3 %	2,1 %	1,7 %	**0,3 %**	5,4 %	1,29 %	12,9 %	0,1	1,5 %	0,5	75,2 %
2	19,3 %	6,0 %	3,9 %	2,1 %	1,7 %	**0,3 %**	5,4 %	1,29 %	12,9 %	0,1	1,5 %	0,5	75,4 %
3	19,0 %	6,0 %	3,5 %	2,1 %	1,7 %	**0,3 %**	5,4 %	1,29 %	12,9 %	0,1	1,5 %	0,5	75,6 %
4	19,8 %	6,0 %	3,1 %	2,1 %	1,7 %	**0,3 %**	6,6 %	1,58 %	15,8 %	0,1	1,5 %	0,5	75,5 %
5	19,5 %	6,0 %	2,8 %	2,1 %	1,7 %	**0,3 %**	6,6 %	1,58 %	15,8 %	0,1	1,5 %	0,5	75,5 %

In the high road scenario, lines 0 and 1 represent the situations illustrated in figure 1, where organization development improves the quality of working life competencies from 75.0 to 78.8%. The other scenario in table 1 is the business as usual scenario, where organization development (OD) and staff quality of work (QW) remain at the same level.

Comparing the profit of these two scenarios reveals the productivity increase of the high road scenario. Continual and systematic organization human capital development gives M$3.17 more EBITDA, which is over 50% more than in the business as usual scenario.

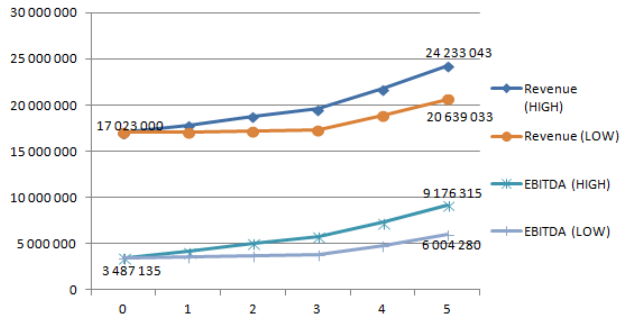

Figure 8. Revenue and profit (EBITDA) comparison between high road scenario (HIGH) and business as usual scenario (LOW). Both scenarios have similar cost structure.

IX. Discussions

From the strategic point of view, the traditional production functions do not have the explanatory power to show the ultimate influence of HR scorecards to the business

performance of companies. Furthermore, the equations do not show the significance of the human intangible capital and the phenomenon of human intangible assets development. Therefore, learning possibilities that would be important for identifying and improving human related competitive advantages are missing. Indeed there seems to be a need for an organization specific production function that utilizes firm specific HR scorecards and that can be used for developing organization human capital.

The Human Capital Production Function validity has been studied in a longitudinal business case where systematic organization human resources development was implemented and changes in business scorecards were followed. In conclusion it seems that HCPF explains how human resources are connected to financial business outcome. Thus it seems that HCPF could be reliable enough for strategic management purposes.

The illustrative case study in the Singaporean Business Service Company indicates that there are great possibilities to improve business performance through human resources development. Effective and continual human intangible assets development seems to be a valuable investment in the growing markets where effective working time determines the revenue. Systematic human resource development seems to be very profitable since the case company may improve EBITDA by 20% in one year, which translates to a $7000 increase per employee (see figure 1). Table 1 show that in the long run, systematic human capital development has great significance for organization productivity, creating competitive advantage.

High quality of working life will reduce wasted labor time and thereby improve the revenue per employee and operating profit. This paper indicates that long term differentiation through better human resources management is significantly more important a factor than what is shown in traditional short notice fiscal analyses, where productivity improvement is based on cost savings.

Human Capital Production Function explains the phenomenon how human resource development may create better performance in economic business scorecards. Effective organization development improves human competencies which form the quality of working life. However, there are also factors that are reducing human competencies, causing waste labor time increase. These factors include organization structural changes and strategic work procedures rearranging without adequate worker participation, for example.

Auxiliary working time (absence, maternity leave, training etc.) may either increase or decrease the time consumed for actual work. Human resources management with effective HR development goals helps to optimize auxiliary working time so that human capital utilization is maximized in the long term. This means, for example, that a certain absence rate is accepted to maintain sustainable good working performance and for preventing work disability. In the same way, continual adequate investments in HRD will reduce absence and staff turnover, and increase effective working time. In fact, organizations should optimize the effective working time in a sustainable way. Indeed, staff intangible assets should be included in strategic HRM as a competitive business advantage that needs to be respected.

The aim of this article is to present plausible and practical theory for HRM connection to business performance. The presented Human Capital Production Function should be studied further to gain more knowledge and to include it in the scientific management literature.

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