

# **Estimation of risks of investment in development of human capital of enterprise**

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## **Abstract**

Our research aims to define, classify and estimate risks of investment in development of human capital of enterprise and to determine reasons for their occurrence.

In the paper we presented a model for estimation of risks of investment in development of employees. This model is based on the Analytic Hierarchy Process. According to the model, the risk can be estimated by assessing the main factors that influence it. Each factor is assigned a weight by experts and for each possible investment strategy different values are given to each factor. By combining these parameters in the hierarchy we calculate the index of risks of investment in development of employees.

A separate emphasis in the research is also put on the risks, that arise, when the enterprise declines to invest in its human capital or when the investment policy is not efficient.

Obtained conclusions are applicable for optimization of allocation of human capital of enterprise, management of organization development and defining strategic directions of the investment policy. They are also important for the evolution of human capital management in countries with transition economies and developing countries in view of intensification of globalization processes, competition and international migration of high quality labor force.

**Key words:** risk; investment; human capital development; Analytical Hierarchy Process

## **Introduction**

The importance of effective human capital management is increasing in the circumstances of knowledge-based post-industrial economy, which is based on information technologies and a crucial role of intellectual resources. Because the most significant value of the enterprise and the whole society lies not in money, facilities or equipment, but in people with their mentality, knowledge, professional skills and personal qualities, manifesting in labor activity. Effective performance of each organization is determined by the level of its personnel's development, because all other assets are passive resources that need human actions' application to produce value. That is why in conditions of fast obsolescence of employee knowledge and practical skills the ability of an organization to constantly increase professional level of its staff is one of the main factors of good performance, competitiveness and growth of productivity.

Investment in human capital is a necessary prerequisite for its development and effective

usage. Moreover, assuming that human capital of a firm is a strategic asset, which can be a source of competitive advantage (Becker & Huselid, 1998), the role of effective investment policy is constantly growing.

Meanwhile, the task of efficient allocation of the limited resources of a company demands application of risk analysis of such kind of investment. One of the distinctive features of investment in human capital of enterprise is that unlike the human capital of a country, for which almost every kind of investment brings general positive effect, the benefits for the enterprise are impacted by the relative utility of it in the limited economical spheres, as well as by the possibility of employees' movement in the labor market.

Investment as an economic category is tightly related to risk. Investment in human capital, unlike investment in other assets, has additional level of uncertainty, complicating its evaluation and management, connected with unpredictable human behavior.

According to a new international survey conducted by the Economist Intelligence Unit<sup>1</sup> in 2007 human capital risk were seen by respondents as being more significant than threats from reputation risk, information technology risk, political risk and regulatory risk.

Despite acknowledging the importance of the skills issue, just 32% of the survey respondents say that they effectively manage human capital risk. As a whole the only risk areas where the respondents feel less confident are risks associated with terrorism and climate change. "The survey shows that human capital risks have emerged as the most threatening that companies now face," said John Keogh, Chief Executive Officer, ACE Overseas General. "Yet few respondents think that they are managing these risks effectively. There is still much work that needs to be done in understanding and establishing an approach to deal with risks associated with issues such as skills shortages, succession issues and loss of key personnel."

Nowadays the majority of managers understand the necessity of investment in human capital, but due to lack of appropriate theoretical base they have no means to assess and analyze related risks.

There are many scientific works exploring the conception and role of human capital starting from Adam Smith (1771), the first classical economist, who included this kind of capital in his definition of capital; continued by the group of researchers, who are considered as the human capital concept founders and its first significant explorers (Becker, 1962; Mincer, 1958; Schultz, 1961; Blaug, 1976). Nowadays numerous studies are devoted to different aspects of human capital, investment in it and its development (Garavan, Morley, Gunnigle & Collins, 2001; Grishnova, 2001; Dobrynin, Dyatlov & Tsyrenova, 1999; Laroche, Merette & Ruggeri, 1999).

Jac Fitz-enz who is considered to be the father of human capital benchmarking and performance assessment, with his book "The ROI of human capital" (2000) provided a breakthrough methodology for measuring the bottom-line effect of employee performance.

Yet one issue in the field of strategic human resource management of the enterprise – estimation and management of risks connected to human capital development – has not been fully covered in research. By now the only works on the topic include the analysis of the possibility of application of the real option theory framework to estimation of risks under the premise, that certain HR practices generate opportunities for the firm by creating "options" for its human capital management (Bhattacharya & Wright, 2000; Foote & Folta, 2002). These HR options are viewed as to help ensure stability of returns from human capital and thus sustain competitive advantage (Bhattacharya & Wright, 2000).

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<sup>1</sup> [http://www.eiu.com/report\\_dl.asp?mode=fi&fi=1131994298.PDF](http://www.eiu.com/report_dl.asp?mode=fi&fi=1131994298.PDF)

Nevertheless, there is still a gap in quantitative approaches to risk evaluation. In this paper we suggest a method that allows to quantitatively estimate risks of investment in development of human capital of a firm. The method is based on the Analytic Hierarchy Process, developed by Thomas Saaty.

The paper consists of three parts: the first introduces Analytic Hierarchy Process as it is; the second one discusses risks, that occur by investing in human capital development and factors that influence them; and in the third part the model is presented, which combines all the outlined risks to calculate the general index of risks of investment in human capital of enterprise, in particular in employees.

Finally, it should be noted, that the calculated index of risks of investment in human capital development constitutes insufficient input for the management to arrive at a decision on how much resources to allocate to this activity in the current market situation for the firm. The complimentary risk of not investing in human capital development, which is influenced by economic factors, partially independent of those, that impact the risk of investment in it, should also be taken into account. Only by weighting these two indices together in the context of the firm's development strategy can a rational management decision be taken. In the future research we aim to build a model for estimating this second risk with the methodology, presented in this article.

## **Research Method – the Analytic Hierarchy Process**

The Analytic Hierarchy Process (AHP) is a structured technique for dealing with complex decisions. A hierarchy is a system of ranking and organizing people, things, ideas, etc., where each element of the system, except for the top one, is subordinate to one or more other elements. Based on mathematics and psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. In our research we use the AHP because it helps capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team thus reducing bias in decision-making. Moreover, the AHP provides a comprehensive and rational framework for structuring a problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. In a field of strategic human resource management the AHP analysis helps to determinate and study different factors that influence personnel motivation and performance.

Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. It consists of an overall *goal*, a group of options or *alternatives* for reaching the goal, and a group of factors or *criteria* that relate the alternatives to the goal. The criteria can be further broken down into sub-criteria, sub-sub-criteria, and so on, in as many levels as the problem requires.

Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time. What is applicable to estimation of risks of investment in development of human capital of enterprise is that in making the comparisons either objective data or judgments about the hierarchy elements can be used.

The AHP converts these evaluations to numerical values that can be processed and compared. In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action.

According to the AHP it is supposed that the value function has the form:

$$v(y) = \sum_{i=1}^q w_i y_i$$

if  $w_i = 0$ , the corresponding outcome  $y_i$  can be deleted from consideration. Thus, is assumed that  $w_i > 0, i=1,2,\dots,q$ .

Weight ratio is defined by  $w_{ij} = \frac{w_i}{w_j}$ . Note that, for any  $i, j, k$  indexes  $w_{ij} = w_{ji}^{-1}$ ,  $w_{ij} = w_{ik} w_{kj}$ . The matrix of weight ratios is defined as  $W = [w_{ij}]_{q \times q}$ :

$$W = \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \frac{w_1}{w_3} & \dots & \frac{w_1}{w_q} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \frac{w_2}{w_3} & \dots & \frac{w_2}{w_q} \\ \frac{w_3}{w_1} & \frac{w_3}{w_2} & \frac{w_3}{w_3} & \dots & \frac{w_3}{w_q} \\ \dots & \dots & \dots & \dots & \dots \\ \frac{w_q}{w_1} & \frac{w_q}{w_2} & \frac{w_q}{w_3} & \dots & \frac{w_q}{w_q} \end{pmatrix}$$

A matrix  $W$  is called consistent if its components satisfy the equalities  $w_{ij} = w_{ji}^{-1}$ ,  $w_{ij} = w_{ik} w_{kj}$  for any  $i, j, k$ .

Since each row of  $W$  is a multiple of the first row, the rank of  $W$  is one, and thus there is only one non-zero eigenvalue which is  $q$ . This due to the fact that  $w_{ij} = 1$  and that the sum of all eigenvalues is equal to the trace of  $W$  (i.e.  $\sum_{i=1}^q w_{ii} = q$ ).

It can be easily check that  $Ww = qw$ , therefore  $w$  must be the eigenvector of  $W$  corresponding to the maximum eigenvalue  $q$ .

Human perception and judgment are subject to change when the information inputs or psychological states of the decision make change. A fixed weight vector is difficult to find. T. Saaty proposed the following to overcome this difficulty: estimate or elicit the weight ratio  $w_{ij}$  by  $a_{ij}$  and let  $A = [a_{ij}]_{q \times q}$  be the matrix of components  $\{a_{ij}\}$ . Each  $w_{ij} > 0$ , is expected and assumed that all  $a_{ij} > 0$ . Furthermore, as  $w_{ij} = w_{ji}^{-1}$ , T. Saaty suggested that in practice, only  $a_{ij}, j > i$  need to be assessed. Since  $A$  is found as an approximate for  $W$ , when the consistency conditions are almost satisfied for  $A$ , one would expect that the normalized eigenvector corresponding to the maximum eigen vector of  $A$ , denoted by  $\lambda_{\max}$ , will also be close to  $w$ .

If we have  $q$  objectives and we want to construct a scale, rating these objectives as to their importance with respect to the decision, as seen by the analyst, we ask the expert to compare the objectives in paired comparisons. If we are comparing objective  $i$  with objective  $j$ , we assign the values  $a_{ij}$  and  $a_{ji}$  as follows  $a_{ij} = a_{ji}^{-1}$ . If objective  $i$  is more important than objective  $j$  than  $a_{ij}$  gets assigned number as follows:

**Table 1: The fundamental scale for pairwise comparisons**

Intensity of importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another, its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensives of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance		

Aside from determining the relative weight the overall consistency should be checked. The normalized principal eigenvector is also called *priority vector*. Since it is normalized, the sum of all elements in priority vector is 1. The priority vector shows relative weights among the things that we compare. To measure consistency, which is called *Consistency Index (CI)* as deviation or degree of consistency we use the following formula:

$$CI = \frac{\lambda_{\max} - n}{n - 1}.$$

Then the *Consistency Index* should be compared with the *Random Consistency Index (RI)*, that is received by random generation of reciprocal matrix using scale 1/9, 1/8, ...1/2, 1, ..., 8, 9 (similar to the idea of Bootstrap). The average random consistency index of sample size 500 matrices is shown in the table below:

**Table 2: Random Consistency Index RI**

<i>n</i>	1	2	3	4	5	6	7	8	9	10
<i>RI</i>	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

So the *Consistency Ratio (CR)*, which is calculated by the following formula, is a measure of consistency of the concrete data.

$$CR = \frac{CI}{RI}$$

For it to be considered acceptable  $CR \leq 0.1$ .

## Risks and factors

Human capital (HC) refers to the stock of skills and knowledge embodied in the ability to perform labor so as to produce economic value. This skills and knowledge are gained by a worker through education and experience. Moreover, some economists (Jac Fitz-enz, 2000) add to standard definition of human capital personal qualities of employee (mentality, energy, positive thinking, reliability, loyalty), learning skills and ability to share gained information with others (the last two being the capabilities of a person's participation in the process of HC creation and reproduction).

According to general approach, investment in human capital of enterprise is any action that enhances the skills, abilities, motivation and other factors that eventually increase productivity of workers or reduce costs, related to personnel. Thus, investment in HC includes the costs of supporting health, facilitating general and special education and training, cost of corporate culture development, improvement of recruitment process, relocation, providing other social benefits etc. Investments in HC also include the lost earnings during training, costs of personnel adaptation, managing career plans and human capital reserves formation. Besides mentioned above directions every firm can utilize additional leverages to heighten performance and efficiency, which can be considered as investment in this context.

Investment by its nature implies current expenditure for the sake of receiving profit in the future, and therefore is associated with some uncertainty and risk. There are many definitions of risk that vary by specific application and situational context. In general terms *risk* is a probability of negative impact to some characteristic of value that may arise from a future event.

Risk of investment in human capital of a firm is an uncertainty caused not only by external unpredictable conditions, such as economic and political situation, but also by firm's performance and what is the most distinctive – by employee's abilities and behavior. The carrier of human capital, regardless the sources of investment, is a person. This adds significant difficulty to assessing risks, associated with this kind of investment.

In the framework of classic investment management theory the standard approach to see if investment project is profitable is to calculate return of investment (*ROI*). This indicator shows ratio between gain and loss. So, if  $ROI > 1$  – project is profitable, and if  $ROI < 1$  – expected losses are higher than gains. So, *ROI* for human capital can be calculated using the following formula (Jac Fitz-enz, 2000):

$$HumanCapitalROI = \frac{Revenue - (Expences - [Pay + Benefits])}{Pay + Benefits}$$

Risk-based evaluation can be considered a complementary alternative to ROI-based one, as in some situations (like assessing a single employee) it is not feasible to calculate revenue associated with some investment, while risks can generally be estimated more easily (because the estimation may be performed indirectly).

Based on real options theory, Bhattacharya & Wright 2000 conceptualize the following types of risks and uncertainties associated with the management of HC: uncertainties of returns or performance, uncertainties of volume and uncertainties of costs and combinations.

In this paper we will focus only on investment in development of human capital of enterprise. In our opinion, it is the most common direction of investment in HC of enterprise. Other mentioned above directions, such as health, social benefits etc. can be analyzed according with the presented scheme and will be a topic of our further search.

Thus we highlighted 4 main risks of investment in development of human capital of a firm, which underlay quantitative analysis:

**1. Risk of premature leaving** – risk that an employee, trained by the enterprise, will leave it before the invested resources will be recovered.

Human capital, unlike physical capital, is a thing (value) that every day comes home with its carrier – employee. Mostly it comes back next day, but sometimes it happens that employees find other (better) work, go straightforward to competitors, move to another place, or have other personal reasons. It is almost impossible to predict and manage truly personal reasons, such as family or intimate life, although according to the human resourcing practice, there exists some correlation between “general level” of employee and his possible actions and performance. This

“general level”, which also includes a set of required competencies such as achievement and customer orientation, teamwork and cooperation, learning skills, integrity etc., can be measured during the selection process and recognized by experienced interviewer.

Besides personal reasons, that have impact on employee leave, there are some other that can be determined and managed. We marked out the following factors and sub-factors that influence risk of premature leaving:

- Level of employee motivation: wages, social benefits, work engagement, career opportunities, corporate culture;
- Employee performance results: assessment of achievements, work commitment, time with company;
- Employee competencies: learning skills, achievement and customer orientation, team work and cooperation;
- Labor market and general economic conditions: work conditions, offered by competitors, labor market situation, economic situation.

Unplanned expenses on resourcing, recruiting, training and adaptation period of a new employee should as well be taken into account with this kind of risk. It is also important to note, that this risk is the most significant and dangerous for an enterprise in the framework of human resource management because it can lead to substantial losses.

**2. Risk of wrong development strategy** – risk that enterprise will choose the inappropriate employee development plan, which will have only short-term effect or will not give competitive advantages.

We consider two factors that influence this kind of risk:

- Consistency in general firm’s strategy and HR policy – development program should correspond to general target and strategies that the firm has.
- How development plan is created? It must be based on employees' real needs and use their assessment results.

Generally, this kind of risk is characterized with relatively small losses, because, as a rule, the fact of the event of development anyway has a positive network effect on the personnel.

**3. Risk of ineffective training** – risk that personnel of enterprise will not reach the target results of training. Typically, the reason in this case is insufficient level of learning skills and partly motivation of employees. Although, it also can refer to the poor HR or external provider performance. In this study we omit risk of external provider and argue that it is a task of purchasing department to analyze and manage it. Moreover, we rely on purchasing department and assume that the majority of employee development products are of a reasonable quality and comply with “price–quality” ratio. Further, if this kind of risk will be considered more important, our model can be extended to accommodate it.

We highlight two main factors that influence risk of ineffective training:

- Learning skills of an employee
- Level of HR performance (in case of in-house trainings).

**4. Risk of external changes** – risks that the cost of human capital development will exceed total gains, because of a fast changing market conditions and general economic situation. We highlighted three main factors that influence this kind of risk:

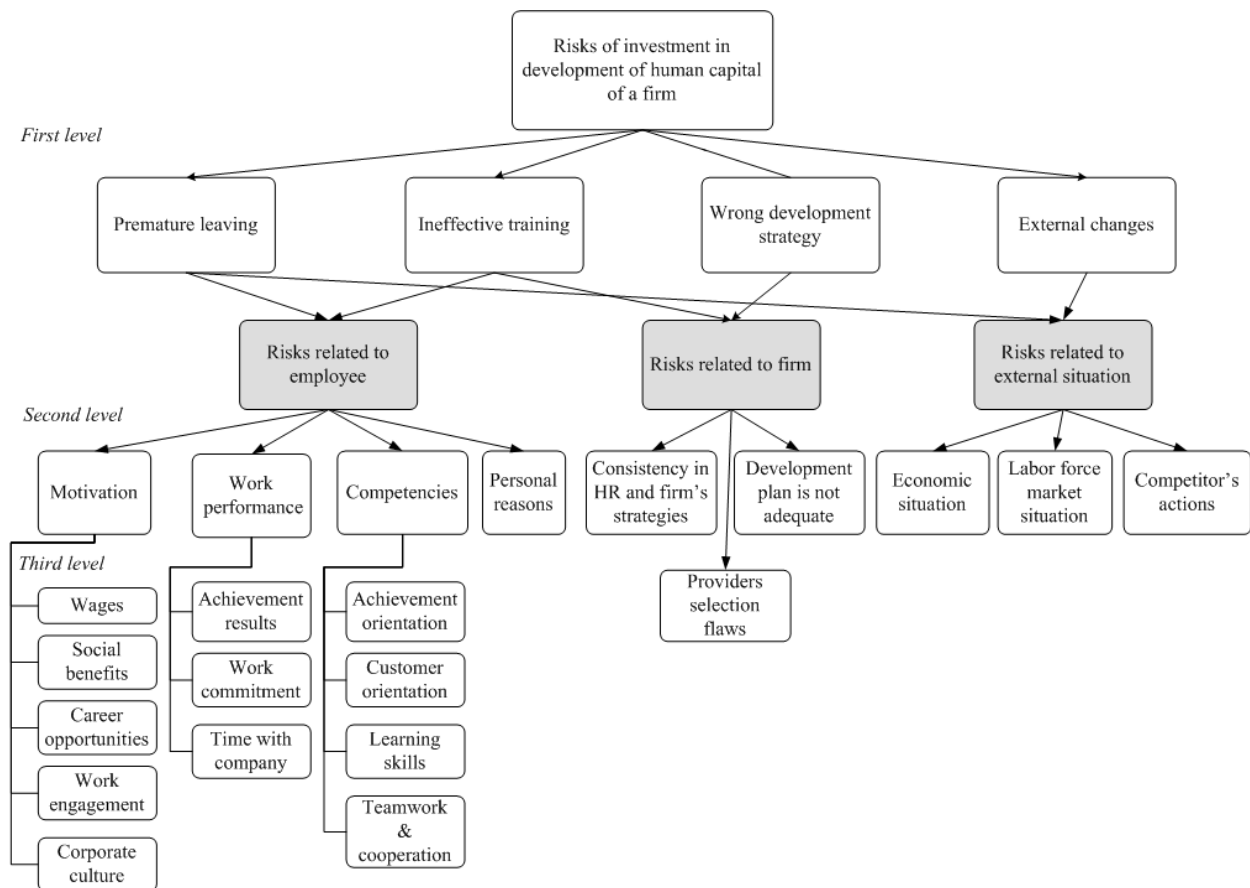
- Economic situation (unemployment rate, inflation, etc)
- Change in labor force legislation
- Competitors activities

It is also important to note that besides risk of investment in human capital there exist risk

of not investing – risk that can occur if enterprise does not invest in development in its HC or investment activity is not sufficient. This kind of risk is very important and demands detailed analysis. As was mentioned above, in this paper we will focus on risks of investment in development of HC. Risk of not investing will be the subject of our further research.

## Model

As was previously declared, to estimate risks of investment in development of human capital of a firm we use the Analytic Hierarchy Process. To build hierarchy we combine the 4 mentioned above risks of investment in development of HC into three groups of risks: risks related to employee (*P1*), risks related to firm (*P2*) and risks related to economic situation and market conditions (*P3*). Our general model for estimation of risks of investment in development of HC of a firm is presented with the three levels hierarchy (Figure 1):



**Figure 1. Risks hierarchy**

At least two targets can be used as alternative of the model:

1. Per-employee estimation of risks.
2. Evaluation of a firm's (or a unit's) development strategy for a certain period or project.

In this article we will focus on and show the example for the estimation of risks of investment in development of employees. So we will consider every employee as an alternative and compare them pairwise in the framework of each highlighted factor and sub-factor. As a

result we will receive a general index of risk, connected with investment in the development of each employee.

The basic formula of estimation of risks of investment in human capital of enterprise is the following:

$$P = Q_1P_1 + Q_2P_2 + Q_3P_3,$$

where  $P$  is the probability of negative investment results according to the mentioned above results classification.

$P1$  (risk related to employee) – the likelihood that employee behavior will lead to negative results of investment or the employee will leave the firm before invested in him resources will be recovered;

$P2$  (risk related to firm) – the likelihood that a firm will not perform optimally in the area of employee development: training programs will not be composed according to real needs of employees and firm strategy; hired employees will not perfectly suit the respective positions and share the firm's values; external training providers and products, selected by the HR division, will be not reliable and qualitative enough.

$P3$  (risk related to external situation) – the likelihood that economic situation, labor market conditions and competitor's actions will influence negatively the investment results.

$Q_1, Q_2, Q_3$  – respective weights of each group of risk received as a result of pairwise comparisons.

It should be emphasized that each highlighted factor and sub-factor that can influence investment results has to be evaluated in a view of possibility to impact negatively, i.e. lead to undesired outcome. It is the obligatory condition to avoid inconsistency in evaluation of “positive” and “negative” factors and receive correct index. For example, evaluating competencies we will generally assign minimum risk to the employee, who has the highest level of competencies and maximum – to the one, whose competencies are lowest, comparing to the others.

### 1. *Risks related to employee*

This is the main group of risks, associated with the greatest unpredictability. In previous section we have described the factors that influence this kind of risk. In this section we will estimate respective weights of each factor and focus on possible outcomes related to employee behavior. To evaluate  $P1$  we use the following formula:

$$P_1 = W_1X_1 + W_2X_2 + W_3X_3 + W_4X_4,$$

$W_1, W_2, W_3, W_4$  – respective weights of each kind of risk received as a result of pairwise comparisons.

$X_1$  – investment results can be influenced by the motivation of employee.  $X_1$  is determined by a number of sub-factors that can be represented with the formula:

$$X_1 = w_{11}A_1 + w_{12}A_2 + \dots + w_{1m}A_m,$$

where  $A_m$  – sub-factors (variables) used in calculating the risk of type  $X_1$ ,

and  $w_{1m}$  – coefficients of weight (importance) of these sub-factors, that are received after pairwise comparison,  $m = \overline{1,5}$ .

Variables  $A_m$  are likelihoods, that motivation of employee can be influenced by the following sub-factors:

- $A_1$  – wages;
- $A_2$  – social benefits;
- $A_3$  – career opportunities;
- $A_4$  – work engagement level;
- $A_5$  – corporate culture level.

$X_2$  – investment results can be influenced by the work performance of employee.  $X_2$  is determined by three main sub-factors that can be represented with the formula:

$$X_2 = w_{21}B_1 + w_{22}B_2 + w_{23}B_3,$$

where  $B_m$  – sub-factors (variables) used in calculating the risk of type  $X_2$ ,  
 $w_{2m}$  – coefficients of weight (importance) of these sub-factors, that are received after pairwise comparison,  $m = \overline{1,3}$ . Variables  $B_m$  are likelihoods that results of investment in development of an employee can be influenced by the following sub-factors:

- $B_1$  – achievements results;
- $B_2$  – work commitment;
- $B_3$  – time with company.

$X_3$  – investment results can be influenced by the level of employee's competencies. Probability  $X_3$  consists of four main competencies, that is represented with the formula:

$$X_3 = w_{31}C_1 + w_{32}C_2 + \dots + w_{3m}C_m,$$

where  $C_m$  – sub-factors (variables) used in calculating the risk of type  $X_3$ , and  $w_{3m}$  – coefficients of weight (importance) of these sub-factors, that are received after pairwise comparison,  $m = \overline{1,4}$ . Variables  $C_m$  are likelihoods that results of investment in development of an employee can be influenced by the following competencies:

- $C_1$  – achievement orientation;
- $C_2$  – customer orientation;
- $C_3$  – learning skills;
- $C_4$  – teamwork and cooperation.

$X_4$  – investment results can be influenced by personal reasons of employee.

## 2. *Risks related to firm*

To evaluate **P2** we use the following formula:

$$P_2 = S_1Y_1 + S_2Y_2 + S_3Y_3,$$

where

- $Y_1$  – risks, that occur, because the firm's strategies and HR activities are not consistent;
- $Y_2$  – development plans are not composed according to the employee needs;
- $Y_3$  – flaws in selection process of providers for development programs;
- $S_1, S_2, S_3$  – coefficients of weight (importance) of these factors.

### 3. Risks related to external changes

Risks related to macroeconomic situation and labor market conditions are defined as external factors in relationship “employee – firm” and are common for the whole economy. In the framework of our research to estimate **P3**, we will focus on the following factors:

$$P_3 = T_1Z_1 + T_2Z_2 + T_3Z_3,$$

where

- $Z_1$  – economic situation;
- $Z_2$  – labor force market situation;
- $Z_3$  – competitors' actions.
- $T_1, T_2, T_3$  – coefficients of weight (importance) of these factors.

## Practical application

To test our method in practice thoroughly we have launched survey that cover companies from different branches, although by now this survey is not completed. In this paper as an example we use data from the undisclosed Ukrainian telecommunication company that is going to launch new project and for this reason has to train two executive employees. Needed training is specific to the telecommunication field. Cost of training is relatively high and if after obtaining new knowledge employee will leave and move to competitors the company will incur considerable losses. According to the preliminary analysis, five employees have been selected. The task of human resources department and direct supervisors of selected employees is to choose two from five. Besides objective data about the employee, such as performance results, time with company, wages, benefits, etc. we use judgments and assessment of the direct supervisor, who is best acquainted with the employee.

At first, the pairwise comparison matrices are built for the first level of hierarchy to compare the importance of highlighted risks. The matrices, weights coefficients and consistency indices are presented in the following table:

**Table 3: First level of the hierarchy: pairwise assessment of risk**

*1. Risks of investment in development of human capital of a firm*

	Premature leaving	Ineffective training	Wrong development strategy	External changes	<i>m</i>	<i>w</i>
Premature leaving	1	5	6	5	3.5	<b>0.62</b>
Ineffective training	0.2	1	2	3	1.0	<b>0.19</b>
Wrong development strategy	0.17	0.5	1	2	0.6	<b>0.11</b>
External changes	0.2	0.33	0.5	1	0.4	<b>0.08</b>
					<i>CI</i>	<i>0.06</i>

2. Three group of risks of investment in development of human capital of a firm

	Related to employee (P1)	Related to firm (P2)	Related to external situation (P3)	<i>m</i>	<i>w</i>
Related to employee (P1)	1	3	7	2.8	<b>0.67</b>
Related to firm (P2)	0.33	1	3	1.0	<b>0.24</b>
Related to external situation (P3)	0.14	0.33	1	0.4	<b>0.09</b>
				<i>CI</i>	0.00
				<i>CR</i>	0.01

**Table 4: Second level: pairwise assessment of factors**

1. Factors that influence risks related to employee

	Motivation	Work performance	Competencies	Personal reasons	<i>m</i>	<i>w</i>
Motivation	1	2	5	7	2.9	<b>0.50</b>
Work performance	0.5	1	7	5	2.0	<b>0.35</b>
Competencies	0.2	0.1	1	3	0.5	<b>0.09</b>
Personal reasons	0.14	0.2	0.33	1	0.3	<b>0.05</b>
					<i>CI</i>	0.07
					<i>CR</i>	0.08

2. Factors that influence risks related to firm

	Consistency of strategies	Providers selection flaws	Inadequate development plan	<i>m</i>	<i>w</i>
Consistency of strategies	1	0.33	0.5	0.6	<b>0.17</b>
Providers selection flaws	3	1	1	1.4	<b>0.44</b>
Inadequate development plan	2	1	1	1.3	<b>0.39</b>
				<i>CI</i>	0.01
				<i>CR</i>	0.02

3. Factors that influence risks related to external situation

	Economic situation	Labor force market situation	Competitor's actions	<i>m</i>	<i>w</i>
Economic situation	1	2	5	2.2	<b>0.56</b>
Labor force market situation	0.5	1	5	1.4	<b>0.35</b>
Competitor's actions	0.2	0.2	1	0.3	<b>0.09</b>
				<i>CI</i>	0.03
				<i>CR</i>	0.05

**Table 4: Third level: pairwise assessment of sub-factors**

1. Factors that influence risks related to employee

	Wages	Work engagement	Social benefits	Career opportunities	Corporate culture	<i>m</i>	<i>w</i>
Wages	1	5	3	4	7	3.3	<b>0.49</b>
Work engagement	0.2	1	0.33	2	3	0.8	<b>0.12</b>
Social benefits	0.33	3	1	2	5	1.6	<b>0.23</b>
Career opportunities	0.25	0.5	0.5	1	7	0.8	<b>0.12</b>
Corporate culture	0.14	0.33	0.2	0.14	1	0.2	<b>0.03</b>

**Table 4: Continued**

CI	0.04
CR	0.04

*2. Factors that influence work performance*

	Work commitment	Achievement results	Time with company	<i>m</i>	<i>w</i>
Work commitment	1	0.5	7	1.5	<b>0.35</b>
Achievement results	2	1	9	2.6	<b>0.60</b>
Time with company	0.14	0.11	1	0.3	<b>0.06</b>
				CI	0.01
				CR	0.02

*3. Competencies*

	Achievement orientation	Customer orientation	Teamwork & cooperation	Learning skills	<i>m</i>	<i>w</i>
Achievement orientation	1	2	3	2	1.9	<b>0.42</b>
Customer orientation	0.5	1	0.5	0.33	0.5	<b>0.12</b>
Teamwork & cooperation	0.33	2	1	0.5	0.8	<b>0.17</b>
Learning skills	0.5	3	2	1	1.3	<b>0.29</b>
					CI	0.05
					CR	0.06

The next step is building pairwise comparisons of all factors and sub-factors and their possible influence on alternatives – five preliminary selected employees. In this example we do not calculate risks related to firm because in case of employee risk comparison we suggest that this risk is constant for all employees.

It is very important to note that every employee is evaluated in risk prospective, so we assess with points the possibility of impact of every highlighted factor in the model. In other words we evaluate employee sensitivity to risk factors.

Received pairwise comparisons of employees are shown in the Appendix. Below are the results of calculations – total indices of risk of investment in development of selected employees:

**Table 5: Total risk index**

Employee	Risk related to employee	Risk related to external change	Total Risk Index
White	<b>0.09</b>	0.01	<b>0.10</b>
Orange	0.25	0.03	0.29
Smith	0.13	0.02	0.15
Brown	<b>0.13</b>	0.01	<b>0.13</b>
Jackson	0.14	0.01	0.15

According to received results two employees with the lowest Total Risk Index are White and Brown. Thus we propose to choose these employees for obtaining new skills required in the launched project.

**Discussion and Conclusion**

The available evidence shows that human capital is an important factor in firm growth. It can be a source of additional competitive advantage, as well as a potential threat in case of inefficient development and investment policy. In this paper we present the method to estimate

risk of investment in development of employees.

An important advantage of the presented method is a possibility to receive the quantitative measure of risk. It significantly differs the method from other existing theoretical approaches. Furthermore, evaluating factors that influence the risk it can assist in deep analysis of firm's performance in human resource function.

Still several limitations of this study should be mentioned. This limitations provide directions for future research.

First, the output of the AHP – the indices of risk – can be compared only inside the conducted research, not with some acceptable norm of risk. So it is the relative measure. If the risks of investment in development of all considered employees are high, we will be able to select the best from the worst, but we would not know about that. Further research here can be conducted with statistical methods to estimate the normal risks for different industries.

Second, in the study we only researched the risk of investment in HC development. The complimentary risk of not investment should be also studied.

Besides, we present only the example of per-employee evaluation of risk. The per-strategy example should be also developed.

Despite the limitations, discussed above, the contribution of this study includes:

- classification of risks of investment in development of human capital of a firm;
- exploration of risk-based analysis as an alternative approach to the “positive” (quantitive) methods such as ROI and options approach;
- a methodology for estimating risks of investment in development of HC of a firm with the help of the AHP, which is suited to such subjective field, as HC; a discussion about the main factors that influence employee behavior;
- a functional model for estimating risk of investment in development of employees, that despite its relative complexity can be effectively used for specially organized surveys, projects assessment, as well as for regular human capital assessment. In addition, this model can be easily extended with the factors that are important for the certain firm at the certain moment;
- the model can be used for analyzing at least two different investment targets: either investment in certain employee (the lowest level firm's HC investment activity), or the whole firm's investment strategy related to HC (the highest level). There is a possibility to applying it to the intermediate levels as well.

Moreover, previously conducted by us research in a field of credit risk estimation provided valuable evidence that obtained results from the AHP application are on par with the results, received by application of other quantitive method (such as in this case – the method of finance coefficients). This proves that the AHP is an objective method, capable of producing the right results in the case of its proper application.

To conclude it should be noted, that along with the more user-friendly application of a model, there is still a great deal of future work to be done in the area of estimation of risks connected with investment in development of human capital. As was declared in the Introduction section, we are planning to continue our research and eventually present a complete method, that will include detailed risk factor analysis in all spheres and would be applicable for risks' estimation in all directions of investment related to human capital: retention, motivation, and development.

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## Appendix – Estimates of pairwise comparisons of alternatives

**Table 1: Employee evaluation results**

*1. Premature leaving*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>	
White	1.0	0.33	0.25	1.0	0.5	0.5	<b>0.08</b>	
Orange	3.0	1.0	4.0	7.0	3.0	3.0	<b>0.47</b>	
Smith	4.0	0.25	1.0	3.0	2.0	1.4	<b>0.22</b>	
Brown	1.0	0.14	0.33	1.0	0.5	0.5	<b>0.07</b>	
Jackson	2.0	0.33	0.5	2.0	1.0	0.9	<b>0.14</b>	
							<i>CI</i>	<i>0.08</i>
							<i>CR</i>	<i>0.07</i>

*2. Personal reasons*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>	
White	1.0	0.2	0.5	2.0	0.5	0.6	<b>0.11</b>	
Orange	5.0	1.0	2.0	3.0	2.0	2.3	<b>0.40</b>	
Smith	2.0	0.5	1.0	2.0	1.0	1.1	<b>0.20</b>	
Brown	0.5	0.33	0.5	1.0	0.5	0.5	<b>0.09</b>	
Jackson	2.0	0.5	1.0	2.0	1.0	1.1	<b>0.20</b>	
							<i>CI</i>	<i>0.02</i>
							<i>CR</i>	<i>0.02</i>

*3. Wages*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>	
White	1.0	0.33	0.25	0.5	0.5	0.5	<b>0.08</b>	
Orange	3.0	1.0	2.0	5.0	3.0	2.5	<b>0.40</b>	
Smith	4.0	0.5	1.0	3.0	2.0	1.6	<b>0.27</b>	
Brown	2.0	0.2	0.33	1.0	0.33	0.5	<b>0.09</b>	
Jackson	2.0	0.33	0.5	3.0	1.0	1.0	<b>0.16</b>	
							<i>CI</i>	<i>0.05</i>
							<i>CR</i>	<i>0.04</i>

*4. Social benefits*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>	
White	1.0	0.25	0.2	0.33	0.5	0.4	<b>0.07</b>	
Orange	4.0	1.0	2.0	1.0	2.0	1.7	<b>0.31</b>	
Smith	5.0	0.5	1.0	0.5	0.5	0.9	<b>0.16</b>	
Brown	3.0	1.0	2.0	1.0	1.0	1.4	<b>0.25</b>	
Jackson	2.0	0.5	2.0	1.0	1.0	1.1	<b>0.20</b>	
							<i>CI</i>	<i>0.05</i>
							<i>CR</i>	<i>0.04</i>

*5. Work engagement*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>	
White	1.0	1.0	0.5	0.5	0.33	0.6	<b>0.11</b>	
Orange	1.0	1.0	0.5	0.33	0.5	0.6	<b>0.11</b>	
Smith	2.0	2.0	1.0	0.33	0.5	0.9	<b>0.17</b>	
Brown	2.0	3.0	3.0	1.0	0.5	1.6	<b>0.28</b>	
Jackson	3.0	2.0	2.0	2.0	1.0	1.9	<b>0.34</b>	
							<i>CI</i>	<i>0.06</i>
							<i>CR</i>	<i>0.05</i>

**Table 1: Continued**

*6. Career opportunities*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	9.0	5.0	3.0	5.0	3.7	<b>0.51</b>
Orange	0.11	1.0	0.2	0.14	0.2	0.2	<b>0.03</b>
Smith	0.2	5.0	1.0	0.5	1.0	0.9	<b>0.12</b>
Brown	0.33	7.0	2.0	1.0	2.0	1.6	<b>0.22</b>
Jackson	0.2	5.0	1.0	0.5	1.0	0.9	<b>0.12</b>
						<i>CI</i>	<i>0.03</i>
						<i>CR</i>	<i>0.03</i>

*7. Corporate culture*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.2	0.5	0.5	0.33	0.4	<b>0.07</b>
Orange	5.0	1.0	4.0	3.0	3.0	2.8	<b>0.46</b>
Smith	2.0	0.25	1.0	2.0	2.0	1.1	<b>0.19</b>
Brown	2.0	0.33	0.5	1.0	0.5	0.7	<b>0.11</b>
Jackson	3.0	0.33	0.5	2.0	1.0	1.0	<b>0.16</b>
						<i>CI</i>	<i>0.06</i>
						<i>CR</i>	<i>0.05</i>

*8. Achievement results*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.5	0.5	0.5	1.0	0.7	<b>0.12</b>
Orange	2.0	1.0	2.0	5.0	3.0	2.3	<b>0.41</b>
Smith	2.0	0.5	1.0	0.5	1.0	0.9	<b>0.16</b>
Brown	2.0	0.2	2.0	1.0	0.5	0.8	<b>0.15</b>
Jackson	1.0	0.33	1.0	2.0	1.0	0.9	<b>0.17</b>
						<i>CI</i>	<i>0.11</i>
						<i>CR</i>	<i>0.10</i>

*9. Work commitment*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.5	2.0	0.2	1.0	0.7	<b>0.13</b>
Orange	2.0	1.0	3.0	3.0	3.0	2.2	<b>0.39</b>
Smith	0.5	0.33	1.0	0.5	0.5	0.5	<b>0.09</b>
Brown	5.0	0.33	2.0	1.0	1.0	1.3	<b>0.22</b>
Jackson	1.0	0.33	2.0	1.0	1.0	0.9	<b>0.16</b>
						<i>CI</i>	<i>0.12</i>
						<i>CR</i>	<i>0.10</i>

*10. Time with company*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.2	0.5	0.33	0.5	0.4	<b>0.08</b>
Orange	5.0	1.0	0.33	0.5	0.5	0.8	<b>0.15</b>
Smith	2.0	3.0	1.0	0.33	1.0	1.1	<b>0.20</b>
Brown	3.0	2.0	3.0	1.0	2.0	2.0	<b>0.36</b>
Jackson	2.0	2.0	1.0	0.5	1.0	1.1	<b>0.20</b>
						<i>CI</i>	<i>0.11</i>
						<i>CR</i>	<i>0.09</i>

**Table 1: Continued**

*11. Achievement orientation*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.5	1.0	3.0	2.0	1.2	<b>0.21</b>
Orange	2.0	1.0	3.0	5.0	3.0	2.5	<b>0.42</b>
Smith	1.0	0.33	1.0	2.0	1.0	0.9	<b>0.16</b>
Brown	0.33	0.2	0.5	1.0	0.33	0.4	<b>0.07</b>
Jackson	0.5	0.33	1.0	3.0	1.0	0.9	<b>0.15</b>
						<i>CI</i>	<i>0.02</i>
						<i>CR</i>	<i>0.01</i>

*12. Customer orientation*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	1.0	2.0	5.0	2.0	1.8	<b>0.30</b>
Orange	1.0	1.0	2.0	7.0	3.0	2.1	<b>0.35</b>
Smith	0.5	0.5	1.0	3.0	2.0	1.1	<b>0.18</b>
Brown	0.2	0.14	0.33	1.0	0.33	0.3	<b>0.05</b>
Jackson	0.5	0.33	0.5	3.0	1.0	0.8	<b>0.12</b>
						<i>CI</i>	<i>0.01</i>
						<i>CR</i>	<i>0.01</i>

*13. Learning skills*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.33	1.0	3.0	1.0	1.0	<b>0.16</b>
Orange	3.0	1.0	3.0	7.0	2.0	2.6	<b>0.43</b>
Smith	1.0	0.33	1.0	3.0	1.0	1.0	<b>0.16</b>
Brown	0.3	0.14	0.43	1.0	0.2	0.3	<b>0.05</b>
Jackson	1.0	0.5	1.0	5.0	1.0	1.2	<b>0.20</b>
						<i>CI</i>	<i>0.01</i>
						<i>CR</i>	<i>0.01</i>

*14. Teamwork & cooperation*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	2.0	0.5	2.0	1.0	1.1	<b>0.22</b>
Orange	0.5	1.0	2.0	2.0	1.0	1.1	<b>0.22</b>
Smith	2.0	0.5	1.0	2.0	0.5	1.0	<b>0.19</b>
Brown	0.5	0.5	0.5	1.0	0.33	0.5	<b>0.10</b>
Jackson	1.0	1.0	2.0	3.0	1.0	1.4	<b>0.27</b>
						<i>CI</i>	<i>0.09</i>
						<i>CR</i>	<i>0.08</i>

*15. Economic situation*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.2	0.3	1.0	0.5	0.5	<b>0.08</b>
Orange	5.0	1.0	3.0	2.0	3.0	2.5	<b>0.41</b>
Smith	3.0	0.3	1.0	5.0	2.0	1.6	<b>0.26</b>
Brown	1.0	0.5	0.2	1.0	0.5	0.5	<b>0.09</b>
Jackson	2.0	0.33	0.5	2.0	1.0	0.9	<b>0.15</b>
						<i>CI</i>	<i>0.09</i>
						<i>CR</i>	<i>0.08</i>

**Table 1: Continued***16. Labor force market conditions*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.2	0.2	1.0	0.33	0.4	<b>0.06</b>
Orange	5.0	1.0	3.0	7.0	4.0	3.3	<b>0.50</b>
Smith	5.0	0.33	1.0	2.0	1.0	1.3	<b>0.19</b>
Brown	1.0	0.14	0.5	1.0	0.5	0.5	<b>0.08</b>
Jackson	3.0	0.25	1.0	2.0	1.0	1.1	<b>0.16</b>
						<i>CI</i>	<i>0.03</i>
						<i>CR</i>	<i>0.03</i>

*17. Competitors actions*

	White	Orange	Smith	Brown	Jackson	<i>m</i>	<i>w</i>
White	1.0	0.2	0.2	0.5	0.5	0.4	<b>0.06</b>
Orange	5.0	1.0	3.0	7.0	2.0	2.9	<b>0.45</b>
Smith	5.0	0.33	1.0	3.0	2.0	1.6	<b>0.24</b>
Brown	2.0	0.1	0.33	1.0	0.33	0.5	<b>0.08</b>
Jackson	2.0	0.5	0.5	3.0	1.0	1.1	<b>0.17</b>
						<i>CI</i>	<i>0.06</i>
						<i>CR</i>	<i>0.05</i>