Full Length Research Paper

Human Resources Performance Analysis based on a Hybrid Method

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Improving human resources performance (HRP) is the most important task of the century. However, we have few measures or management interventions to make such improvement possible; although we cannot identify the pattern to be followed by human resources because systems and processes in an organization are often regarded as a kiss of death to encouraging creativity. For improving human resource performance, at first, HRP needs to be measured and then the future of HRP needs to be defined. Therefore, in this paper, we seek to present a hybrid method for measuring and predicting the HRP, which can be used in human resources development. A hybrid method is created through a two-phase algorithm for measurement and prediction of HRP as the Human resources performance console (HRPC). HRPC calculates and predicates HRP in any period, thus it has been created to help managers. Nevertheless, the Hybrid method is tested and validated in Alupan company.

Key words: Human resources performance (HRP); Time series analysis; human resources performance console (HRPC)

INTRODUCTION

Performance is a key determinant for any organization success. Work on the performance of the human resources has barely begun. In terms of actual work on human resources performance, in 2000 we are roughly in the same place as we were in 1950 for the performance of the manual worker (Drucker, 1999). Today, majority of activities in knowledge-based organizations depend on knowledge significance (Davenport, 1998); therefore, human resources performance in organization is of utmost importance and with the biggest challenge (Drucker, 1999).

Human resources performance (HRP) has been studied in various views, evaluated and predicted by various methods, for example human resources performance assessment (Antikainen and Lönnqvist, 2006) and performance prediction (Yun, 2004).

HRP can be calculated and presented in different sections, and they can be studied as a continuous series. According to HRP series, the prediction in future would be possible. There are many methods for predicting. One of them is Time series analysis (Meeker, 2006).

Measurement of HRP is calculated by output/input, and it was validated in Turkish organizations (Antikainen and Lönnqvist, 2006).

In this paper, we will try to present a hybrid method which calculates and predicts HRP. Predicting HRP behaviour will be used for future strategic planning, it defines knowledge management goals for organizations, and it creates learning organization. HRPC calculates and predicates HRP in any period by time series analysis and simulates the behaviour of HRP in future.

Knowledge work and human resources

All workers use knowledge, but some use it much more than others. Human resources have high degrees of education or expertise. Their primary objective is creation, distribution or application of knowledge (Afrazeh et al., 2003). Figure 1 presents segmentations of human resources in various levels and work with different complexity.
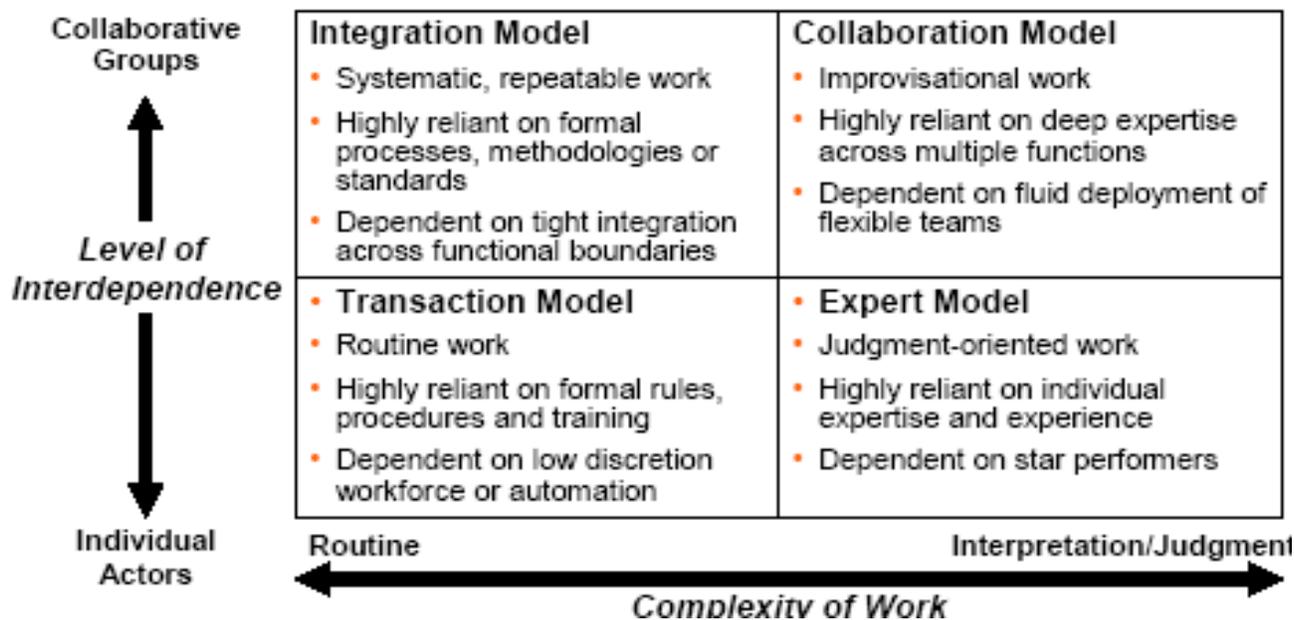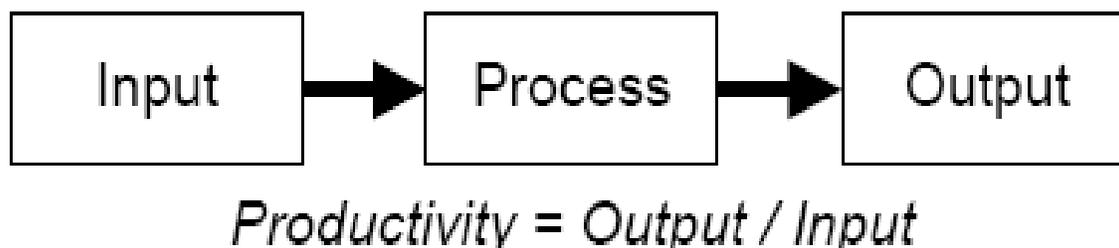
Figure 1. Segmentations of human resources.

Figure 2. Measurement method of human resources performance.

Human resources performance

Today, one of the most challenging works of organizations is improving the human resource's performance. No doubt, human resources performance process is also the result of an interaction and combination among various factors. Since human resources performance is not an abstract issue and should be considered from a practical point of view, the organization management plays a significant role in providing a suitable ground for its improvement and institutionalization. As such, the human resources collaboration is of utmost importance. This is because paying attention to human benevolence as a strategic element in different organizational aspects can determine the human resources destiny. Paying increasing attention to this element, directing the activities and providing the required grounds for flourishing their potential capabilities must be given the highest priorities. Definitely, success in knowledge management programs can perfect the

human resources' performance. On the other hand, the knowledge work is in itself highly sophisticated; clarifying and paying attention to and providing the required facilities for its performance is an effective step in improving the human resources performance. In this way, organization and human resources are located in line with performing the same job.

MATERIALS AND METHODS

There are two approaches to human resources performance measurement in organizations: Macro view and Micro view. In macro and micro views, human resources performance measurements could be qualitative and quantitative. In Macro view, it measures total human resources performance in an organization but micro view measures the performance in any level (Fatahi and Afrazeh, 2005; Afrazeh, 2005). One of the quantity methods for human resources performance measurement is the relationship between outputs and inputs (Figure 2) similar to Human resources performance method.

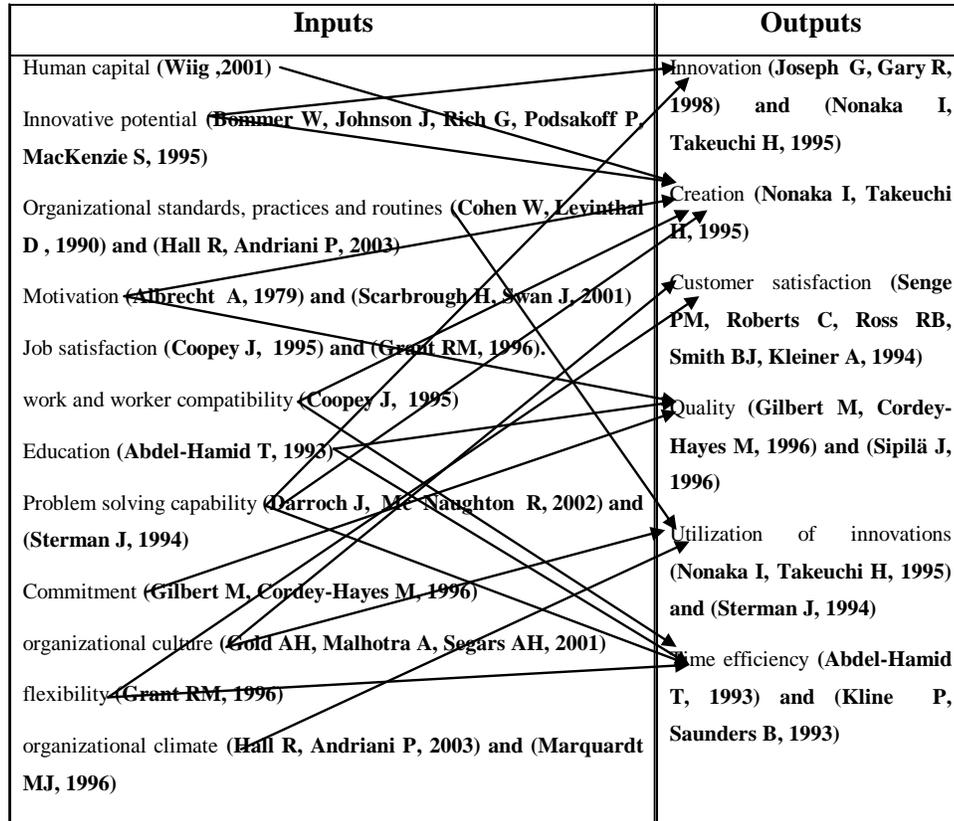Here, the effective factors on human resources performance are

Inputs	**Outputs**
Human capital **(Wiig ,2001)**	Innovation **(Joseph G, Gary R, 1998)** and **(Nonaka I, Takeuchi H, 1995)**
Innovative potential **(Bommer W, Johnson J, Rich G, Podsakoff P, MacKenzie S, 1995)**	Creation **(Nonaka I, Takeuchi H, 1995)**
Organizational standards, practices and routines **(Cohen W, Levinthal D , 1990) and (Hall R, Andriani P, 2003)**	Customer satisfaction **(Senge PM, Roberts C, Ross RB, Smith BJ, Kleiner A, 1994)**
Motivation **(Albrecht A, 1979) and (Scarbrough H, Swan J, 2001)**	Quality **(Gilbert M, Cordey-Hayes M, 1996) and (Sipilä J, 1996)**
Job satisfaction **(Coopey J, 1995) and (Grant RM, 1996)**	Utilization of innovations **(Nonaka I, Takeuchi H, 1995) and (Sterman J, 1994)**
work and worker compatibility **(Coopey J, 1995)**	Time efficiency **(Abdel-Hamid T, 1993) and (Kline P, Saunders B, 1993)**
Education **(Abdel-Hamid T, 1993)**	
Problem solving capability **(Darroch J, Mc Naughton R, 2002) and (Sterman J, 1994)**	
Commitment **(Gilbert M, Cordey-Hayes M, 1996)**	
organizational culture **(Gold AH, Malhotra A, Segars AH, 2001)**	
flexibility **(Grant RM, 1996)**	
organizational climate **(Hall R, Andriani P, 2003) and (Marquardt MJ, 1996)**	

Figure 3. Key Factors of human resources performance.

organized in two parts of input and output, according to Figure 3. Human resources performance method (HRPM) is a method which can be used to measure the performance of human resources subjectively. It focuses on the actors of human resources performance and brings about the opinion of workers themselves. HRPM is constructed to enable performance measurement in human resources. It is essentially a preparative tool for the observation of the state of HRP at a certain time and planning and monitoring organizational infrastructures for management. For calculating human resources performance, figuring out input and output are necessary. The input variable and output variable are presented in Figure 3. Here, the input variables and the related calculating formula are thus presented:

1. Human capital: I_1
2. Innovative potential: I_2
3. Organizational standards, practices and routines: I_3
4. Motivation: I_4
5. Job satisfaction: I_5
6. Work and worker compatibility: I_6
7. Education: I_7
8. Problem solving capability: I_8
9. Commitment: I_9
10. Organizational culture: I_{10}
11. Flexibility: I_{11}

Input is measured by formula 1:

$$input = \sum_{i=1}^{11} a_i * I_i,$$ (1)

a_i are weighted vectors (between 0 and 1), $a_1+a_2+...+a_{11}=1$.

Here, the output variables and the related calculating formula are presented:

1. Innovation: O_1
2. Creation: O_2
3. Customer satisfaction: O_3
4. Quality: O_4
5. Utilization of innovations: O_5
6. Time efficiency: O_6

Output is measured by formula 2:

$$output = \sum_{i=1}^{6} c_i * O_i,$$ (2)

c_i are weighted vectors (between 0 and 1) , $c_1+c_2+...+c_6=1$.

Using formula 1 and 2, we can calculate HRP in formula 3:

$$Knowledge\ worker\ productivity\ (kwp) = \frac{output}{input} = \frac{\sum_{i=1}^{6} c_i * O_i}{\sum_{i=1}^{11} a_i * O_i}$$ (3)

According to the aforementioned formula and considering their quality-baseness, the human resources' parameters need an algorithm for measuring the human resources' performance. What follows is a presentation of the mentioned algorithm based on
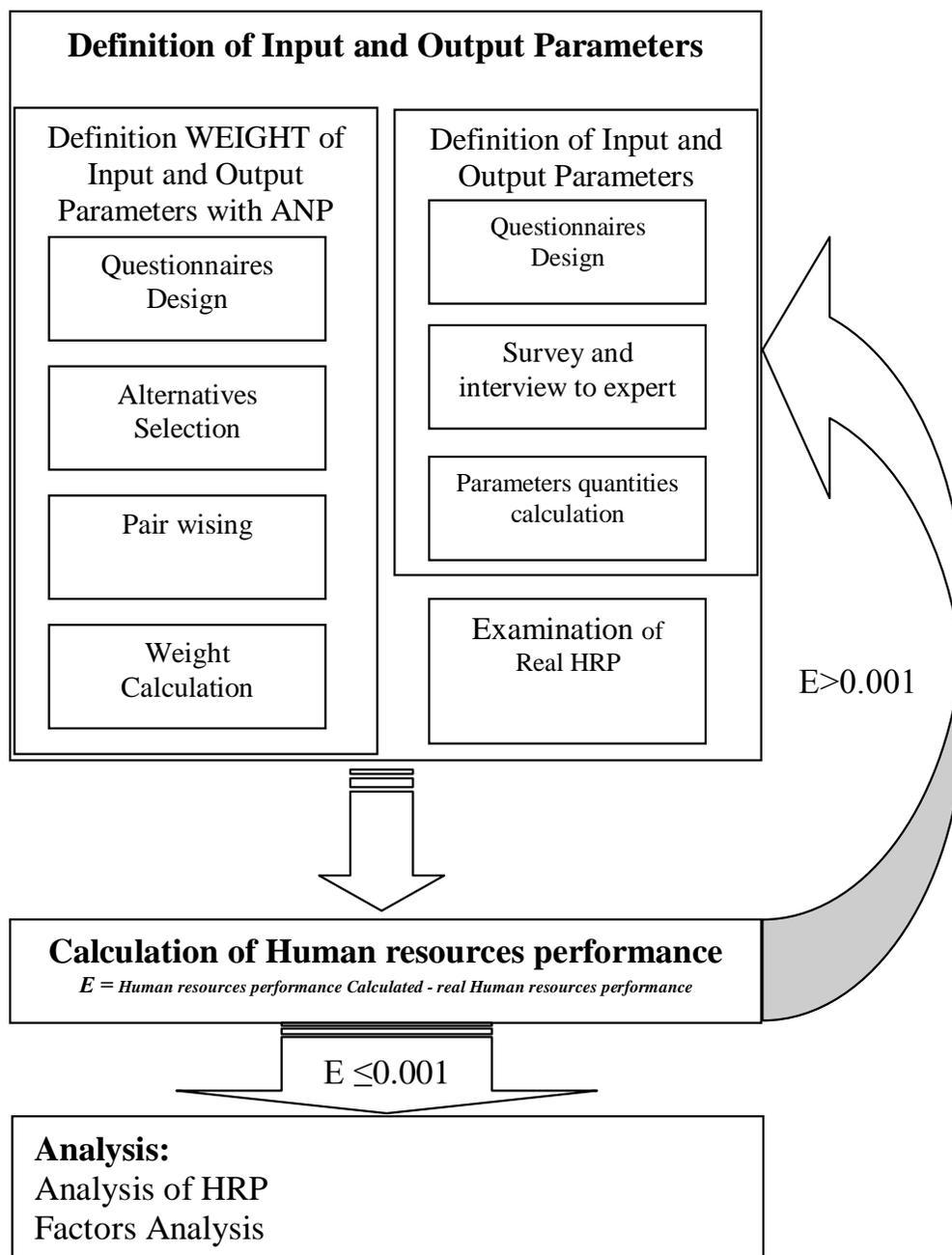
Figure 4. The phases of HRPM.

Figure 4.

According to Figure 4, in the first step tries to estimate the amount and weight of factors in Figure 3 based on questionnaire, interview and surveys in order to calculate the human resources performance using Formula 4. To obtain factors' amounts, at first the questionnaire is prepared, and then, distributed among professionals and according to their ideas and combination through GAHP method, mentioned in Formula 10, the amounts can be calculated. To obtain the factor weights also, the questionnaire was designed, alternatives chosen, and the professionals consulted with in order to compare the factors, and based on their ideas and their combination through GAHP method, the weight amount was calculated. Considering the weight and amount of factors and using Formula 9, the human resources performance can be measured. However, the real amount of performance is determined using professionals' viewpoints. If the obtained error is less than 0.001, the analysis will be conducted. Otherwise, the system will be repeated until the error (the difference between the human resources' real performance and the human resources' obtained performance) reach a lower value:

$$G = (g_1 * g_2 * \ldots * g_n)^{\wedge} n \tag{4}$$

In Formula 4, the combination of ideas can be done through GAHP,

if n people present their ideas for an issue, the aforementioned formula can be used to add to ideas that come up with a suitable value. The scores which professionals insert into the questionnaire are in Likert scale (1 = very low, 3 = low, 5 = average 7 = high, 9 = very high). For calculating the questionnaire's reliability and validity, the Cronbach alpha was applied.

Here, the human resources' performance has been measured and according to it the factors' weight and values, organization's current state are analyzed and the reasons for the current state are estimated. Based on these, some approaches for improving the organization's current state are presented in line with the human resources' performance enhancement. It is worth mentioning that the earlier mentioned analysis is correctly performed in case all the conditions in the organization are fixed. In a case where the current conditions vary in future, this analysis is not accountable. Thus, the future of human resources' performance should be obtained as will be explained subsequently.

Human resources performance prediction (HRPP)

The prediction method was chosen to be time series method since the human resources' performance relies on the time and can take different values at different times. What follows is the introduction of time series method.

Time series analysis is a series of practical methods for making inferences from data using probability models. The essential characteristic of time series methods is using probability for quantifying uncertainly statistical data analysis.

Time series prediction may be viewed as a regression problem when expressed as formula 5 (without exogenous variables):

$$\hat{y}_t = g\left(y_{t-1}, y_{t-2}, \ldots, y_{t-N+1}, \theta\right)$$
(5)

Here, $\hat{y}_t$ equation estimates the unknown value of the time series at time t, while $y_{t-1}, \ldots, y_{t-N+1}$ are the known, N-1 past values of the series which form the repressor is the set of parameters of the estimator g; the estimator can be linear in the general case.

If the past knowledge on the series is concatenated into N-dimensional vectors of the following form (Formula 6):

$$Y_t = \begin{bmatrix} y_t & y_{t-1} & y_{t-2} & \cdots & y_{t-N+1} \end{bmatrix}$$
(6)

We can define the Normalized Mean Square Error (*NMSE*) on the *NV* data in the validation set as follows (Formula 7):

$$NMSE = \sum_{t=1}^{N_V} (y_t - \hat{y}_t)^2 \Bigg/ \sum_{t=1}^{N_V} (y_t - \bar{y})^2$$
(7)

Weighting the output is shown in formula 8. A straightforward extension of the method is giving a different weight to the quantization of the y_t predictions by building the Y_t vectors as follows:

$$Y_t = \begin{bmatrix} ky_t & y_{t-1} & y_{t-2} & \cdots & y_{t-N+1} \end{bmatrix}$$
(8)

Also, quantization with weighting the input is presented in Formula 9:

$$Y_t = \begin{bmatrix} ky_t & k_1 y_{t-1} & k_2 y_{t-2} & \cdots & k_{N-1} y_{t-N+1} \end{bmatrix}$$
(9)

Weighting the input through building a linear model could be done (Formula 10):

$$\hat{y}_t = a_1 y_{t-1} + a_2 y_{t-2} + \ldots + a_{N-1} y_{t-N+1}$$
(10)

The *ai* coefficients may be considered as the important (weighting) coefficients that variable *yt-I* have in the output. In other words, it is the first partial derivative of the output with respect to a specific input. Therefore, the *ai* coefficients can be considered as a first order approximation of the *ki coefficients*. Of course, the *ai* results from a linear hypothesis, they will be optimum in the sense defined in the previously. To calculate the vector weight, Delphi method is used.

We have prior data of human resources performance (initial HRP: HRP measured). Thus, we can use time series analysis to integrate the information about HRP. And, the updated human resources performance can be used to predict HRP in future. Formula 11 gives a prediction for HRP at time t from the observed past values of this parameter. This relation has been developed on the concept that the coefficients $d_1, d_2, \ldots, d_{N-1}$ are the weights given to the past observations and they sum up to one:

$$\hat{kwp}_t = d_1 * kwp_{t-1} + d_2 * kwp_{t-2} + \ldots + d_{N-1} * kwp_{t-N+1},$$
(11)

Figure 5 shows the process of performance prediction model. The initial values for human resources' performance for the past n-1 period can be measured based on the previous section's formula. Then, according to the time series technique (Formula 13, the human resources' performance can be predicted for a period of t. According to the time series analysis based on the comparison between prediction results and current period values, the model error can be obtained through Formula 12. If the error is lower than 0.01, it is confirmable:

$$NMSE\ (N) = \sum \left| HRP_K - \widehat{HRP}_K \right| \Big/ \left(\sum \left| HRP_K - HRP_K \right|^2 \right)$$
(12)

For measuring the level of model capability and its validation, formula 13 can be used:

$$R^2_{HRP} = \sum HRP^2(k) \Big/ \sum \widehat{HRP}^2(k), \quad (k=1, \ldots, N)$$
(13)

Considering that here, this study described both human resources' performance measurement method and its prediction method, it is required that a comprehensive algorithm should be proposed to both measure and predict the human resources' performance and can present a suitable analysis. What follows is the explanation of the mentioned algorithm.

Human resources performance Console or hybrid method

Here, it tries to combine two measurement and prediction methods for human resources' performance and a combined method presented in the form of HRPC which can cover the research objectives. HRPC is able to measure and predict the human resources' performance simultaneously. The human resources performance console is developed to help managers keep track of HRP status in the life cycle of a HRP development as well as incorporating the HRP updated model. Human resources performance console allows managers to discern the true status of performance quickly. HRPC gives a manager a quick current view of HRP which they use to predict the optimum or future view of HRP and the gap analysis between the current and future view. HRPC is shown in Figure 6. According to Figure 6, at first, human resources'
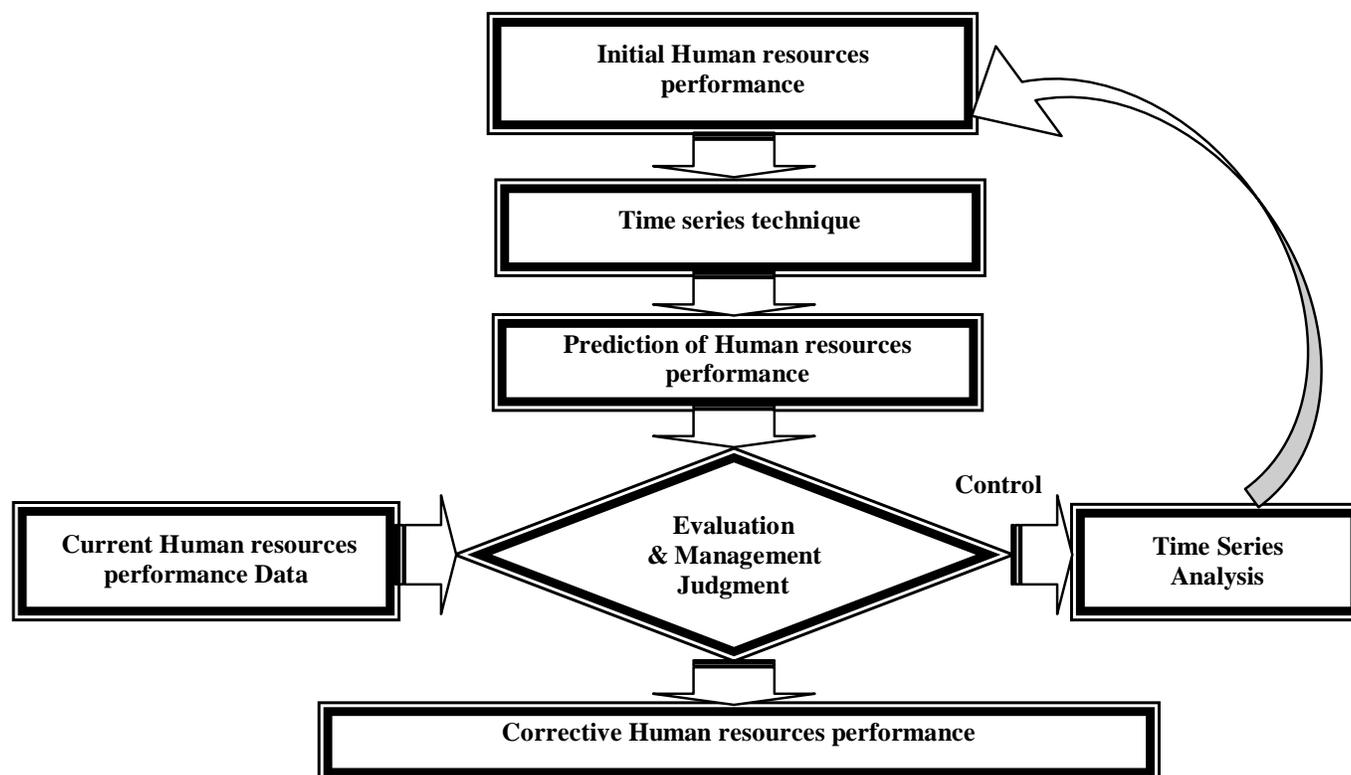
Figure 5. Prediction of Human resources performance.

performance has been measured, then later predicted and at last, based on the final data; the human resources' performance has been obtained through the approaches proposed to the organizational managers.

The research method is presented based on the aforementioned algorithm. The current research is a descriptive and exploratory type. In an exploratory research, the researchers use interviews or questionnaires to discover the target people's ideas, thoughts, preferences and understandings. Exploratory is a completely defined issue with determined objectives. Information regarding the essence, conditions and the relationship between current events and conditions are gathered. In this research, questionnaire has been used to measure the human resources' performance. Data collection is easily conducted through library research and questionnaires. The target population is the Alupen company which works in the field of aluminium making. In this organization, 40 people are chosen for the sample. Then, they were presented with the questionnaire. The sampling method for this research is the simple random sampling. The data collection instrument is questionnaire. For calculating the reliability and validity of the questionnaire, Cronbach alpha was used. For analyzing the present research's information, both descriptive and inferential statistics were applied. What follows is the explanation of a practical sample of the proposed method.

RESULTS

Alupen company was selected for conducting the research. This company established its large factory for profile production and aluminium door and window manufacturing with the initial capacity of 11000 tons in Alborz Industrial town, Qazvin in a land of 50000 sq.m, 25000 m of which were devoted to production halls. Having more than 30 years of experience, the company is currently one of the largest producers of industrial profile sections, Aluminium door, window نما and spiders using silver and color anodizing method and electrostatic powder outing in the Middle East. Its productions are mostly exported to European countries like Germany, Holland and Spain. By now, it has been awarded two management quality International prizes and has been the member of International Chamber of Commerce. Alupen is the only Iranian company which produces frameless curtain and spider wall under the license of Italian accredited companies like Aluk and Lilli and is allowed to use the brand names of these companies. It is a private company. The numbers of distributed questionnaires are 40, from which 23 were among men and the rest among women. As far as the staff educational level is concerned, 10% were higher than BS, 67.5% BS and 22.5% were holding a high school diploma. 77.5% were lower than 30 and 87.5% were lower than 10 years of experience.100% of the distributed questionnaires returned to us and all 40 questionnaires were used for analysis. According to the human resources' performance console, their performance was measured for one year or 12 periods which is presented
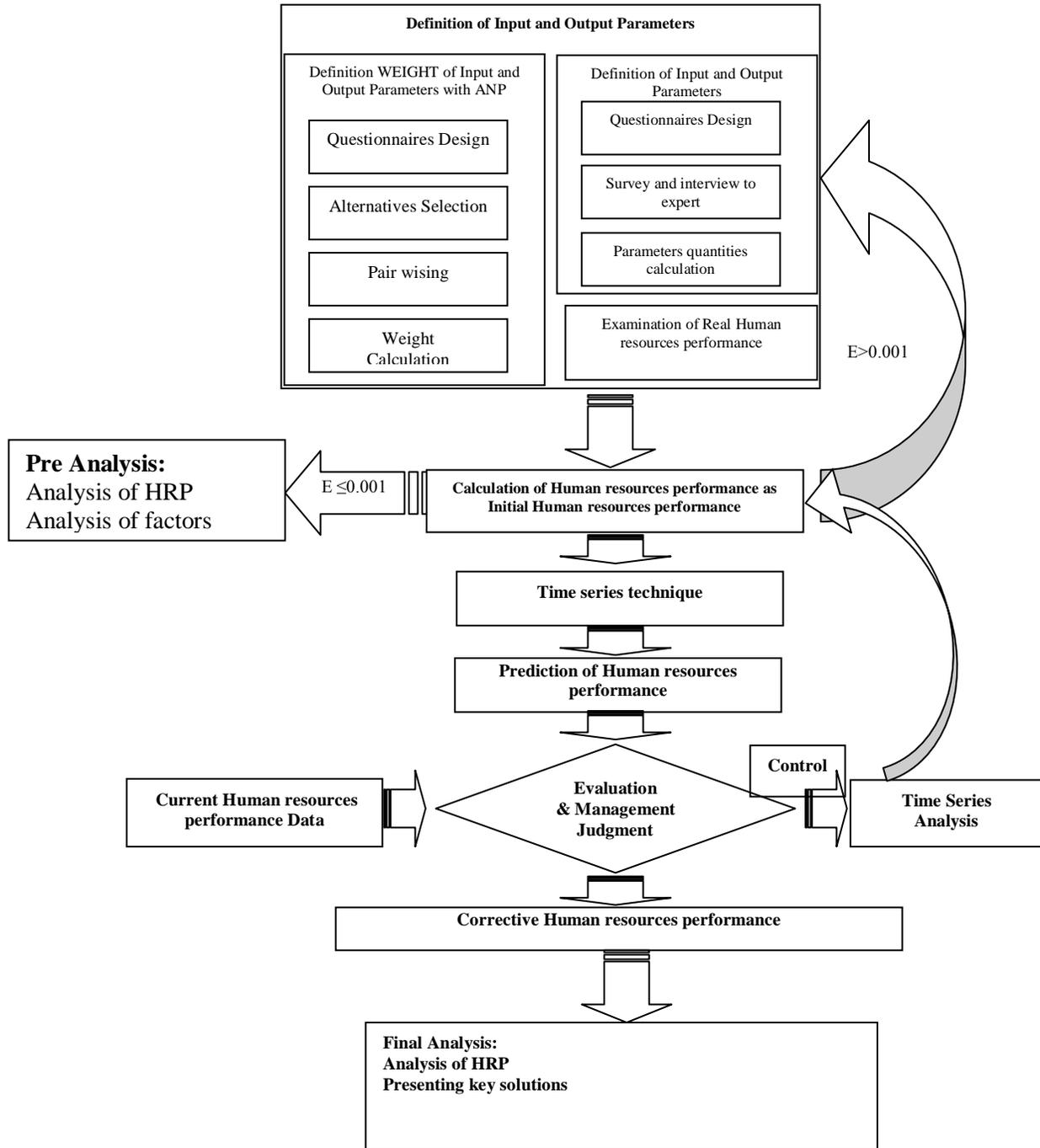
Definition of Input and Output Parameters

Definition WEIGHT of Input and Output Parameters with ANP

Questionnaires Design

Alternatives Selection

Pair wising

Weight Calculation

Definition of Input and Output Parameters

Questionnaires Design

Survey and interview to expert

Parameters quantities calculation

Examination of Real Human resources performance

E>0.001

Pre Analysis:
Analysis of HRP
Analysis of factors

E ≤0.001

Calculation of Human resources performance as Initial Human resources performance

Time series technique

Prediction of Human resources performance

Current Human resources performance Data

Evaluation & Management Judgment

Control

Time Series Analysis

Corrective Human resources performance

Final Analysis:
Analysis of HRP
Presenting key solutions

Figure 6**.** Human resources performance console.

in Table 1.

It is worth noting that the calculation error should be less than 0.001. Here, an initial analysis can be conducted, according to which human resources' performance values are high in early months and this result persists until the ninth period. As we approach the eleventh and twelfth periods, the human resources performance reaches its least value. This is because at

the end of the year there is a large amount of accountancy and reporting job to be completed until the end of the tenth period and to be sent to the income office. Another reason is because a new year is approaching and human resources are reluctant about doing the work. Anyway, the average of human resources' performance is 72.9397% which indicates the high performance of human resources in this company.

Table 1. Human resources performance in Alupan co. (HRP measured, real HRP).

T	Input	Output	HRP measured (%)	Real HRP (%)	E (%)
1	95	93	97.8947	97.8952	0.0005
2	89	88	98.8764	98.8770	0.0006
3	89	75	84.2697	84.2703	0.0006
4	69	32	46.3768	46.3777	0.0009
5	79	75	94.9367	94.9372	0.0005
6	38	31	81.5789	81.5793	0.0004
7	59	48	81.3559	81.3561	0.0002
8	74	64	86.4865	86.4867	0.0002
9	43	33	76.7442	76.7451	0.0009
10	37	21	56.7568	56.7575	0.0008
11	35	12	34.2857	34.2864	0.0007
12	28	10	35.7143	35.7148	0.0005

Table 2. Human resources performance predicted and measured in Alupan co.

T	HRP measured (%)	HRP predicted (%)	NMSE (%)
1	97.8947	57.0000	
2	98.8764	58.0000	
3	84.2697	62.0000	
4	46.3768	63.0000	
5	94.9367	67.0000	
6	81.5789	75.0000	0.0005
7	81.3559	77.0000	
8	86.4865	79.0000	
9	76.7442	82.0000	
10	56.7568	83.0000	
11	34.2857	84.0000	
12	35.7143	97.0000	
Average	72.9397	73.6667	

Of other most important input factors which have an effect on human resources' performance increase are incentive, suitable organizational atmosphere and problem solving capability. Of the most important output factors which have the highest value are innovation application, quality and customer satisfaction.

Therefore, the study goes further to describe the human resources' performance prediction. The prediction value based on the time series technique for the twelfth period is presented in Table 2. Time series analysis is conducted in time series analysis software. The amount of NMSE error is less than 0.01 which shows that the prediction is correct. The amount of R2 for this research is 96.49% which shows the model validity. Figure 7 indicates the measured and predicted performance amount. Parallel with the measured and predicted data, we will have:

Human resources' average performance in the past 12 months will be 72.9397% and in 12 future months will be 73.6667%. These amounts have been decreased by 35% in comparison with the current month's 35.7143%, and by 0.72% in comparison with the past 12 months'. It is worth mentioning that to make up for the increase and decrease in performance, in 12 future months it has tried to perform the scenario efficiently. This efficient scenario is indicator of 70% performance rate according to experts' surveys. Based on the aforementioned figure, it can be mentioned that the human resources' measured performance is high at first and their predicted performance is low at that time, however, as we go on, the measured one comes down and the predicted one raises. Fortunately, the human resources' performance is growing in next periods which indicate the suitable selection of scenarios. Error squares' average reached its minimum (0.0005) using the mentioned function. R2 equals to 96.49 which shows the model's validity.

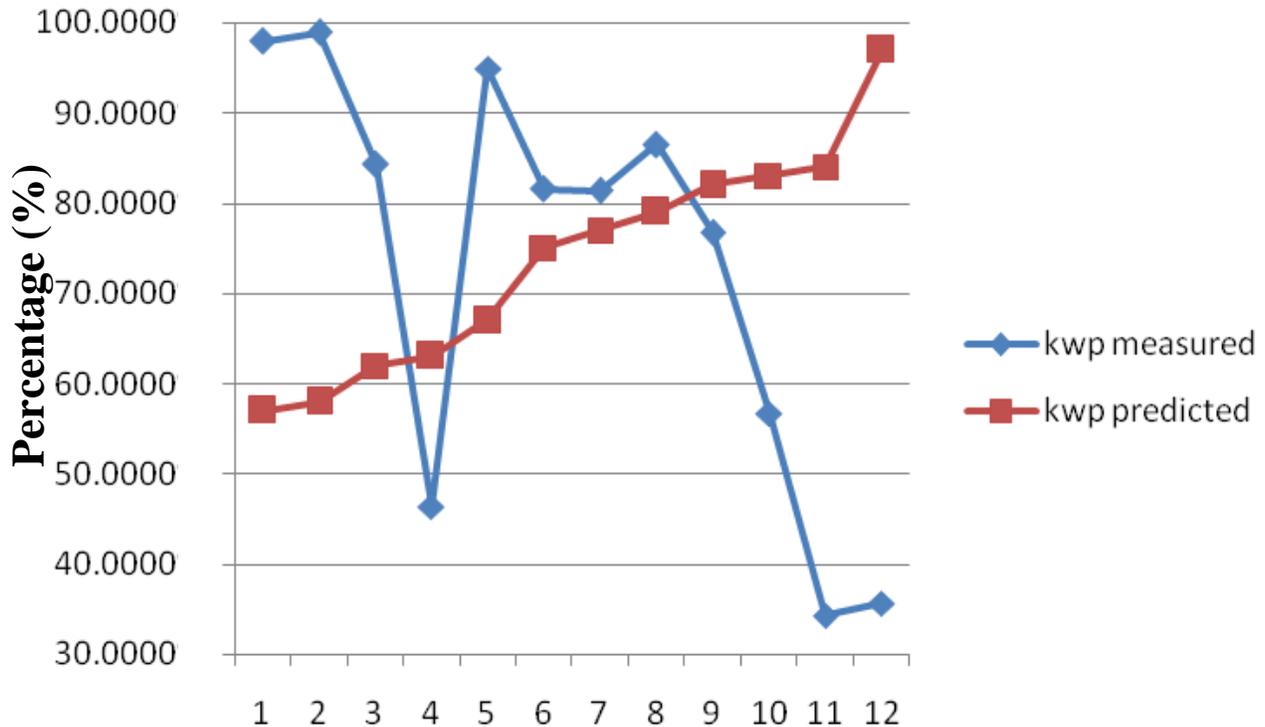Cronbach alpha was calculated to be 98.3 which

Figure 7. Human resources performance predicted and measured in Alupan co.

Table 3. Camparison of methods based on error.

Error %	Approach
0.019	Song - Chissom method
0.0342	Chen's method
0.0178	Markov method
0.0445	Hwang method
0.0005	proposed method

confirm the model's validity. Moreover, a survey was conducted based on Delphi in which 97.28% of the above amounts were confirmed.

DISCUSSION

The combinational method is tested in Alupan company (which is active in the field of Aluminium making). Using Cronbach alpha (whose value is higher than 98.3%), its validation was calculated and confirmed both science based and survey based by 97% of experts and 98% of managing directors and managers. In this research, 40 people were directly involved. The organization's research findings indicated the human resources' high performance level. Reasons like incentives, organizational atmosphere and problem solving capability are of the most important reasons which have a fundamental influence on human resources' productivities. Among the mentioned reasons, suitable organizational atmosphere according to the responsibility awarding to human resources was the best found scenario with the highest effect on the human resources' performance increase. Corresponding with the predicted data and statistical analyses, error squares' average using the mentioned function reached its minimum which is 0.0005, R_2 equals 96.49 and Cronbach alpha equals 98.3% which indicated the model's validity. Furthermore, a survey was conducted based on Delphi which confirmed 97.28% of aforementioned values.

It is worth mentioning that the questionnaire's validity is calculated using the content validation which is mainly based on the survey and the results showed 97.784% of questionnaire validation. To calculate its reliability, Cronbach alpha was used and the result of 98.3% was obtained. These results showed the practical research's reliability and validity.

Comparison with other methods

The obtained results from the proposed method are compared with the results obtained from other methods. Table 3 shows a comparison of these methods, where the human resources' 12 months predicted data were

collected according to the error level. As evident in this table, the proposed method has the lowest error.

Conclusions

In this paper, we explored the possibility of building a hybrid method. Human resources performance console (HRPC) or hybrid method provides the measurement and prediction of human resources performance in organizations. HRPC plays an important role in revaluating the initial human resources performance. Time series analysis shows its strength through the research experiment. In this paper, several objectives have been accomplished. First, a HRPC measurement and prediction hybrid method has been created, which can be used in a human resources development. Second, we have gathered real data to validate HRPC or hybrid method in Alupan company. Thirdly, a HRPC has been created to help managers. Also, it has tried to compare the proposed method with other prediction methods like Song- Chissom, Chen, Hwang and Markov. The results showed that the present method is the most suitable one in terms of prediction with the lowest amount of error. The future extension of this research is conducted to improve the human resources performance in the following aspects:

1. Supporting the time series analysis with fuzzy nonlinear model and fuzzy weighting vectors.
2. One of the interesting extensions of this research is the comparison between the presented method and graphic methods like fuzzy cognitive plans (FCM) and hidden Markov models and Bayesian network in the fields of time series analysis and prediction.

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