BSC Technique Research Employment National Cartographic Center of Iran to identify and classify the Human Resources Performance Indicators in Fuzzy AHP Environment

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Abstract

This investigation was exercised to identify the human source's key indicators of National Cartographic Center as a provider of map and spatial data infrastructure, taking into account the balances scorecard approach and analyzing the fuzzy hierarchal process. The investigation is in a descriptive form and the way of collecting the information is in library-ground form. Balanced scorecard (BSC) establishes balance between financial previous indicators and provident indicators (the other three aspects) to assess the organizational performance. In this research first the compliance inquiries evidence and documentaries (National Cartographic Center) about human source' indicators has been collected then, indicators was set in hierarchal structure using the alternative purposes of BSC spectrum and scales was specified for every indicators coefficient. For nominating the efficiency importance, AHP questionnaire with fuzzy framework were used. The results showed that human force expense costing, job satisfaction, coverage the educational requirement, and the percentage of educated human source are the most important key performance indicators (KPI) that specified in human source distinct.
Key words: balanced score card, key performance indicators, fuzzy AHP, National Cartographic Center.

1. Introduction

Human sources management is considered as a critical factor for organization [6]. At present, organizations use synthetic ways and techniques to evaluate and compare human sources activities efficiency and to measure the human capitation [5]. These below methods are used to asses staff activities: management based on MBO purposes, human sources auditing, beneficiaries satisfactory measurement , the key performance indicators identification and analysis, balanced scorecard approach ,fund return costing calculation methods [10], and finally in present novel ways as analyzing the neurological networks in human sources performance [21] and fuzzy models [9]. Meanwhile the balanced scorecard is like a scientific management tool in organization that can be used for human core activities assessment using purposes and key performance indicators. Balanced scorecard (BSC) was used as determination tool in the level of strategic managers for organizational purposes realization; plotted by David Norton and Robert Kaplan in early 1990 [3]. Balanced scorecard not only measures the results of past financial performance in helping the financial standards, but also in every section of time (customer view, internal process, growth and learning) there are some ingredients measured to identify the organization future returns [17]. In balanced card the human sources card is used to evaluate the human source success adjustment and ratio, this method facilitates human forces to increase his role as strategic property in a organization [2]. Most studies related to organization success key factors and their performance has bed done using the descriptive statistics or regression' analysis, and there are researchers who applied the hierarchal analytic process for doing this [5]. According to the distinguished indicators the AHP method is used to determine and discriminate one alternative case among others [27].

2. Research theories basis

By using key performance indicators one firm is able to be informed of present activities (financial, customer satisfaction, and internal process and the results) and its effort for process improvement, provocation, staff education and informational system improvement (firm ability to improvement) [1]. Key performance indicators of human sources needs to indicate the certain structure for supervision and analyzing the information related to staff, specifying the criterion and module the returns inside and outside the firm, recognizing the progress procedure which shows the firm achievement to its purposes [23]. Formann developed the performance key indicators by hierarchal analysis process; using the questionnaire AHP to discriminate the key indicators performance was introduced by Kaplan and Norton [12]. In 2007 Ugwua and Haupt essayed the performance key indicators to evaluate functional organization in South Africa, using hierarchal analysis of process tendency [26]. Suryadi [2007] prioritized the performance key indicators to asses scientific institute returns. Bozbura et al (2007) prioritized the key indicators of human asset applying fuzzy AHP model [4]. Sorayayee [2006] used the fuzzy AHP model for ranking the priorities of assessment indicators of human forces [20]. Stewart introduced a model in which balanced scorecard evaluate the IS/IT projects applying hierarchal analysis and multi standards idealistic [22]. Under the BSC structure Khalid Hafeez et al [2002] used the fuzzy AHP to asses organization key capabilities and perfect abilities [13]. Main purpose of the research is identifying key indicators of human sources performance, considering the unified approach of human sources balanced score card and hierarchal analytic process in fuzzy environment. And the research question: what is human sources key indicators performance prioritization? Which ones have more important indicators than others?

3. Research structure and accomplishment

In this research descriptive methods (padding) was used depending on its subject and descriptive purposes. The scope library information collective method, Interview with the managers, National Cartographic Center, specialists and experts viewpoint about research, introducing questionnaire is to identify the Importance measure of every human sources indicators. In this paper key performance indicators; and scorecard of human sources applied to be classified by fuzzy AHP. At initial stage the first questionnaire about human sources indicators was designed (fig 1). Then taking to account the four aspect of balanced score card (fig 2), the second questionnaire (AHP) was designed about scale identification of human sources indicators.
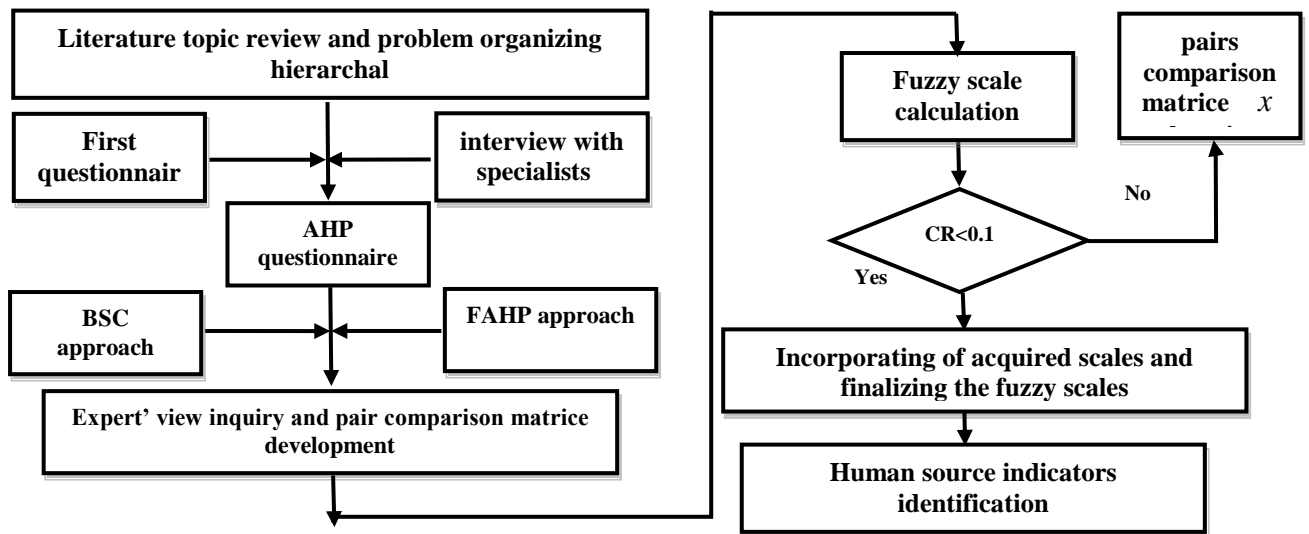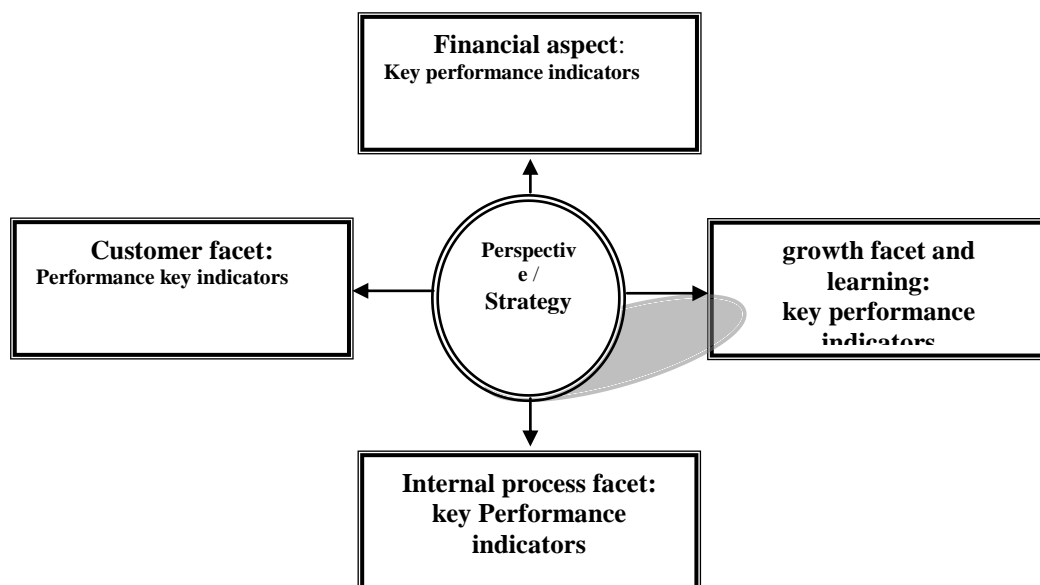

Figure1. Research structure

Figure2. Balanced score card (Kaplan and Norton, 1996)

20 of managers and specialists who participated in organization human sources part were invited to implement the related questionnaire, which finally was analyzed in the fuzzy environment for human sources key indicators identification using the EXPERT CHOICE software and hierarchal process analyzing.

4. Fuzzy AHP technique

Many of problems managers face with today's are multi standards determination problems with qualified and quantified criteria. A most appropriate way to solve these problems is to apply hierarchal AHP assessment method [28]. A serious stage in this method is to assess pair comparison with preferred components adjustment identification with higher level standards. But using the exact numbers to identify the preferences is difficult and often mixes with error and mistakes. Fuzzy concept in classical AHP method indirectly was considered without using fuzzy series. As a matter of fact (table 1) in this method conceptual fuzz is interfered for pair comparison matrix identification by using the phrasal terms [14].

Some methods can be mentioned introduced by kahraman 2004 [11]. In this research fuzzy AHP was used in a way of analytic development.

Table 1. fuzzy numbers in pairs comparison

Phrasal terms for preference identification	Triangle fuzzy number	Phrasal terms for preference identification	Triangle fuzzy number
Unimportant preference	(3,1.2,2)	Perfect and implicit preference or importance	(5.2,3,7.2)
About equal importance or preference	(1.3,1,2.2)	Very strong preference or importance	(2,5.2,3)
Exact importance or preference	(1,1,1)	Stronger importance or preference	(3.5,2,2.2)

If $X = \{x_1, x_2,...,x_n\}$ is the aim series and $U = \{u_1, u_2,...,u_n\}$ is an desired series then according to this and considering every purpose, development analysis can be done for all (g_i) will. So m values of development analysis for every purpose is as follow:

$$M_{g_i}^1, M_{g_i}^2,..., M_{g_i}^m \qquad i=1,2,...,n$$

$$\begin{vmatrix} M_{g_1}^1 & M_{g_1}^2 & \cdots & M_{g_1}^m \\ M_{g_2}^1 & M_{g_2}^2 & \cdots & M_{g_2}^m \\ \vdots & \vdots & \vdots & \vdots \\ M_{g_n}^1 & M_{g_n}^2 & \cdots & M_{g_n}^m \end{vmatrix}$$

Where all $M_{g_i}^j$ are triangle fuzzy number which can be stated like (l, m, u). Beneath figure shows fuzzy triangle number.
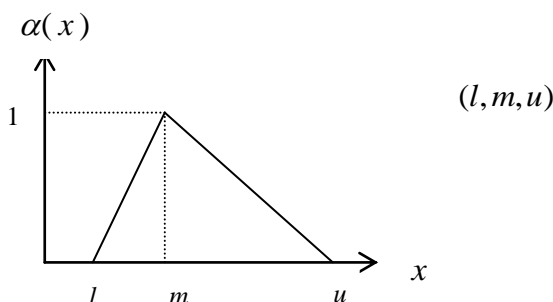
Development analysis process is as follows [20] : first stage, attain the composite fuzzy expansion for each purpose if $M_{g_i}^1, M_{g_i}^2, \ldots, M_{g_i}^m$ is the values of development analysis for each purpose lieu m ideal then composite fuzzy expansion m ideal for i purpose is as follows

$$S_i = \sum_{j=1}^m M_{g_i}^j \otimes [\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j]^{-1}$$

If $M_{g_i}^j = (l_{ij}, m_{ij}, u_{ij})$ then $\sum_{j=1}^m M_{g_i}^j$ by using fuzzy summation performer on developer analysis m is defined as follows[11]:
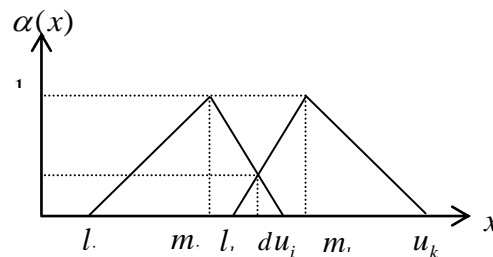
Stage 1:

$$\sum_{j=1}^j M_{g_i}^j = (l_{i1}, m_{i1}, u_{i1}) \oplus (l_{i2}, m_{i2}, u_{i2}) \oplus \ldots \oplus (l_{im}, m_{im}, u_{im})$$
$$= (\sum_{j=1}^m l_{ij}, \sum_{j=1}^m m_{ij}, \sum_{j=1}^m u_{ij}) = (l_i', m_i', u_i')$$

Stage 2: calculating preference degree (probabilities degree) S_i on S_k: if $S_i = (l_i, m_i, u_i)$ and $S_k = (l_k, m_k, u_k)$ then preference degree is showed by V, and defined like $V(S_i \geq S_k) = \underset{x \geq y}{SUP}(\min\{\alpha_{S_i}(x), \alpha_{S_k}(y)\})$ which is equal as follows for fuzzy triangle numbers :

$$V(S_i \geq S_k) = \alpha_{S_i}(d) = \begin{cases} (m_i \geq m_k) & \text{if} & 1 \\ (l_k \geq u_i) & \text{if} & 0 \\ \dfrac{l_k - u_i}{(m_i - u_i) - (m_k - l_k)} \end{cases}$$

Where d is symmetrical with the biggest crossover point between α_{S_i} and α_{S_k} following figure shows d point:

stage 3:calculating preference degree of $V(S_i \geq S_k)$ (probabilities degree) is convex fuzzy number of S ,and bigger than K fuzzy convex number $S_i; i = 1,2,\ldots,k$ is defined as follows:

$$V(S \geq S_1, S_2, \ldots, S_K) = (V((S \geq S_1), (S \geq S_2), \ldots, (S, S_K))$$
$$= \min(V((S \geq S_1), (S \geq S_2), \ldots, (S, S_K)) = \min V(S \geq S_i) \ i = 1,2,\ldots,k$$

If for every $k \neq i \ k = 1,2,\ldots,n$ assume $d'(A_i) = \min V(S_i, S_k)$ then scale vector is attained as $W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))$.

Stage 4: normalizing W' vector and attaining normalized scale vector of W.

$$W = (d(A_1), d(A_2), \ldots, d(A_n))$$

5. Key indicators for human sources performance

To build a unified structure of AHP and BSC to identify the KPI identification, first the hierarchal structure should be distanced specifying standards and indicators for BSC facets. BSC can create a change in organization if purposes will be nominated for its facets [18]. Kaplan and Norton stated that main purpose in a financial view is to get beneficiary, asset turn and income, to get customer satisfaction, customer loyalty and retention; internal qualification process, production increase and productivity, and the last is growth facet and learning to increase proficiency, human force science and abilities [19]. Becker and others counted following purposes for human sources scorecard [2]:

To supervise and evaluate the human force units activities in organization, indicators seems to be an important tools. Using models and methods to hoard indicators in accomplished studies and research in this context, proposed indicators was derived to measure human source management in National Cartographic Center and some of them will be mentioned later. In a research done by Guard and Gao [2008], human sources indicators includes following [2]: human force development, information asset indicators, invention indicators, and organizational asset indicators. Four facets of scorecards of human sources include capabilities, performance, effectiveness, and human sources systems which its human sources indicators was identified in research was done by Ebrahimi 1380 [7]. Existed indicators in balanced preferential cards of human sources can be found in this figure (done by human source management society) [16].

Financial aspect
1.Stockholder values increase
2.human assets increase
3.human sources expense reduction

Customer facet
1. human force commercial cooperation
2.organization comparison and sanitary progress
3.skills, capabilities and force guidance

Balanced score card

Internal process facet
1. solution to increase human force effectiveness
2. human force schedule adjustment with commercial priorities
3. progress plan increasing and development

Growth and learning facet
1. human force capabilities and abilities (increase)
2. Organizational environment and culture based on performance
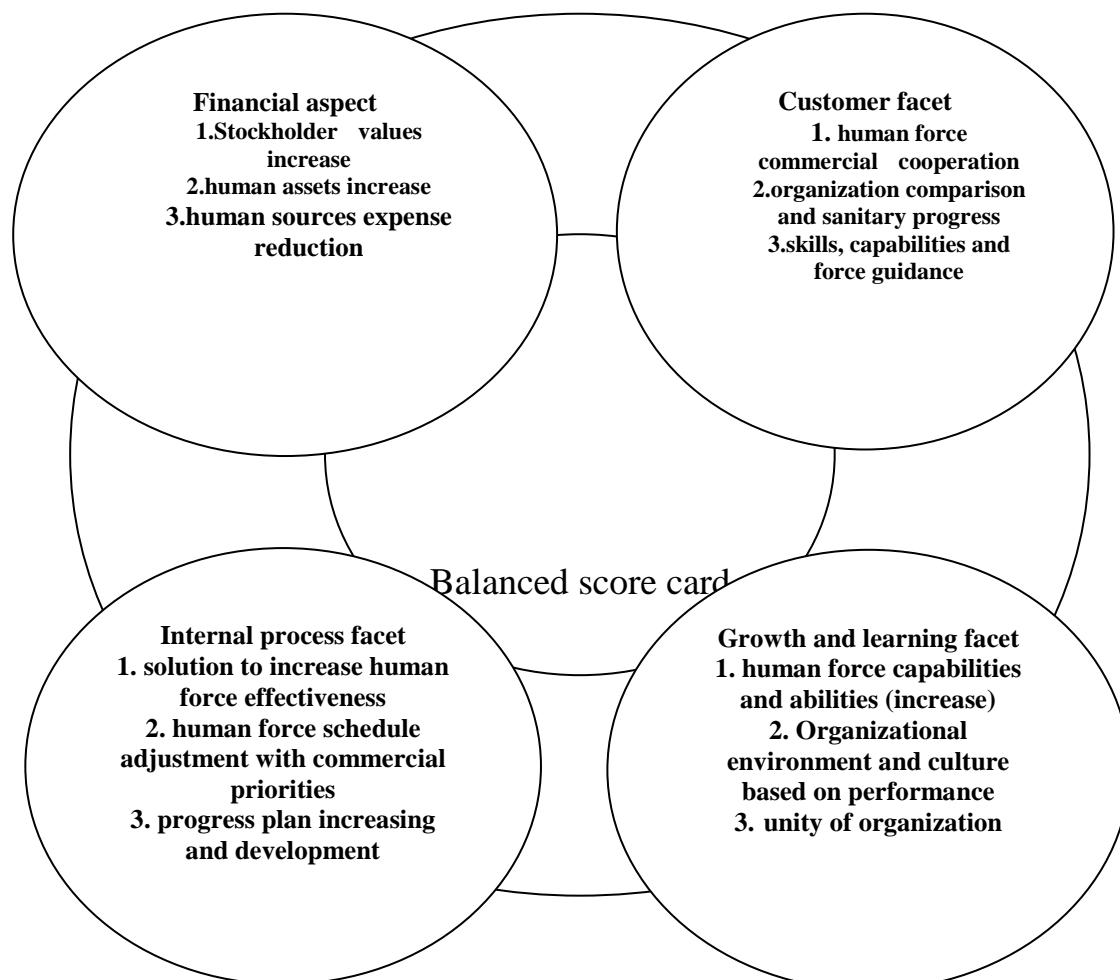3. unity of organization

Figure3. Purpose of human resource score card (Becker et al, 2001)

Finally after reviewing and studying the investigation, evidence and documentaries (existed in National Cartographic Center) about human source indicators was distanced assuming proficient managers and experts views, and key performance indicators for BSC. For scientific validate identification or its durability, based on primary studies exercised by focused discussion group in human source unit and presence of professors in which proficient's certified the application and scientific validate and durability of its indicators. Hierarchy tree for indicators of human sources in BSC facets was drawn in fig 5.
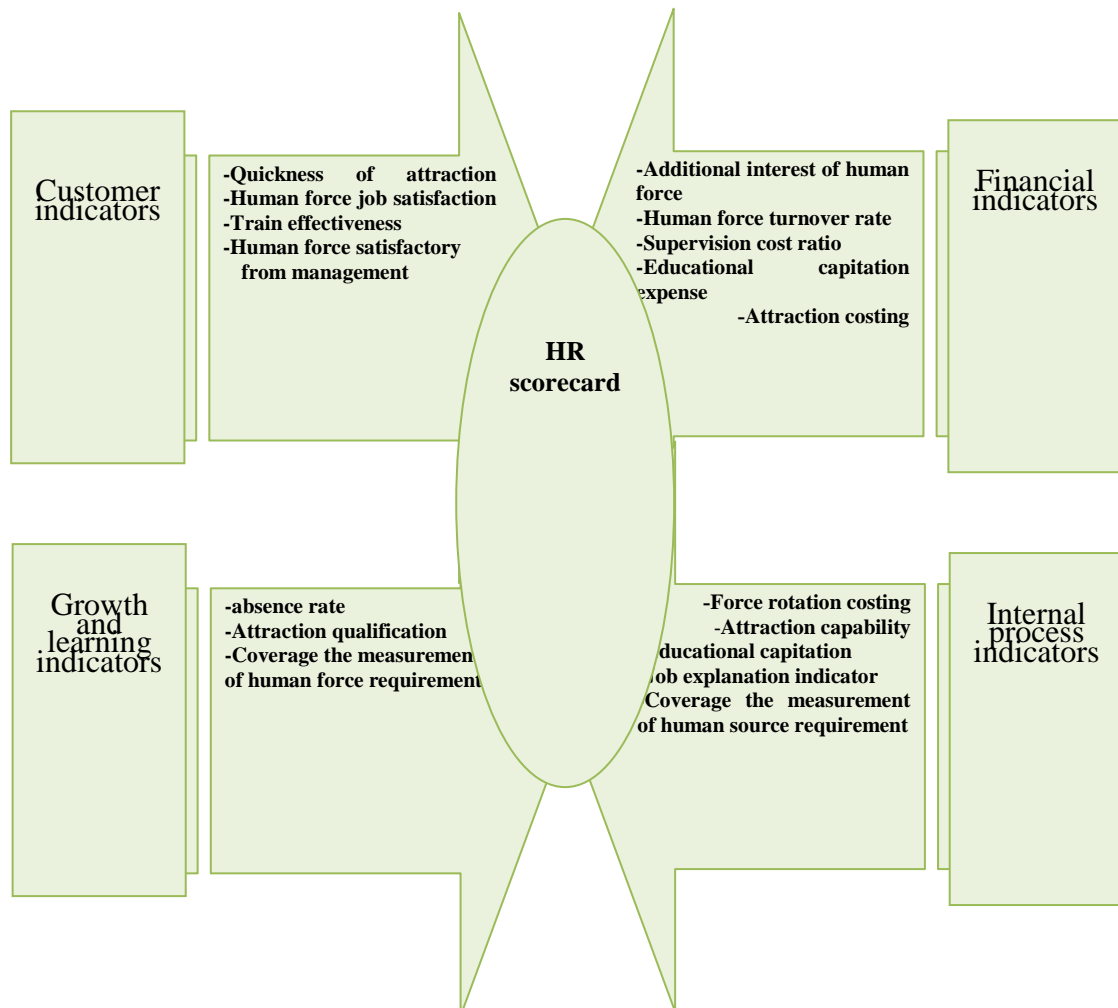

Fig 4. Scorecards of human sources management [16]

Pair's comparison for four facets of balanced scorecard was calculated along to human sources key indicators with fuzzy AHP gregarious considering the development analytic method. All scale models resulted from what mentioned in last chapters and by averaging the numeral from fuzzy numbers. For this purpose in the second level (purposes facets of balanced scorecard) and the third one (human sources key indicators) purpose scale and indicators was attained using pairs comparison and AHP technique.

Table2. Key indicators for human sources performance in BSC facets

Key performance indicators	Facets	key performance indicators (KPI)	Facets
Effectiveness for Job announcement, educational effectiveness, human force job satisfaction from managers, human force satisfaction rate of educational courses.	Customer	Workforce turnover, human force expense costing, welfare expense costing, Education expense costing, human capitation additional costing, human Capitation turn cost.	Financial
	and		
Development rate, attraction quality, absence rate, covering the require measurement of human force, trained human force rate.	Growth learning	Approved status indicators, force rotation expense, attraction Abilities, educational requirement coverage, proficient human Force cost, practitioner cost in patronage things.	Internal processes

Table3. Numeral average of pairs comparison each of the financial facets

Classifying the financial facets purpose	Human capitation return	Human source reduction cost
Human capitation return	(1,1,1)	(0.965,1.260, 1.609)
Human sources reduction cost	(0.621, 0.793, 1.035)	(1,1,1)

At the end, every final scale of human sources key performance indicators was calculated by scale purposes scorecard facet and indicators combination .in continuance we pay attention to the cited calculation. Concerned to table 3 results and fuzzy AHP stages we consider the scale calculation of every financial facet purposes based on AHP approach

First stage: how to get the fuzzy composite expansion for each standard financial facet.

$$\sum_{j=1}^{2} M_{g_1}^{j} = (1, 1, 1) \oplus (0.965, 1.260, 1.609) = (1.965, 2.260, 2.609)$$

$$\sum_{j=1}^{2} M_{g_2}^{j} = (0.621, 0.793, 1.035) \oplus (1, 1, 1) = (1.621, 1.793, 2.035)$$

$$\sum_{i=1}^{2} \sum_{j=1}^{2} M_{g_i}^{j} = (1.965, 2.260, 2.609) \oplus (1.621, 1.793, 2.035) = (3.586, 4.054, 4.644)$$

S1 : human capitation resource

S2 : human sources reduction expanse

$$S_1 = (1.965, 2.260, 2.609) \otimes (0.215, 0.247, 0.279) = (0.423, 0.557, 0.727)$$

$$S_2 = (1.621, 1.793, 2.035) \otimes (0.215, 0.247, 0.279) = (0.349, 0.442, 0.567)$$

Second stage: to calculate preference degree (probability degree) S1 on S2

$$V(S_1 \geq S_2) = 1 \qquad\qquad V(S_2 \geq S_1) = 0.555$$

Third stage: to calculate the preference degree for S fuzzy convex number is bigger than k convex number, i=1,2,...k

$$V(S_1 \geq S_2) = \min(V(S_1 \geq S_2) = 1 \qquad V(S_2 \geq S_1) = \min(V(S_2 \geq S_1) = 0.555$$

Fourth stage: normalizing W' vector to get the W normalized scale vector.

$$W' = (1, .555) \Rightarrow W_N = (0.643, 0.357)$$

Consider to calculation mass the only the purposes importance degree of key performance indicators was calculated in financial facets.

Fig 5. Hierarchy tree for indicators of human sources
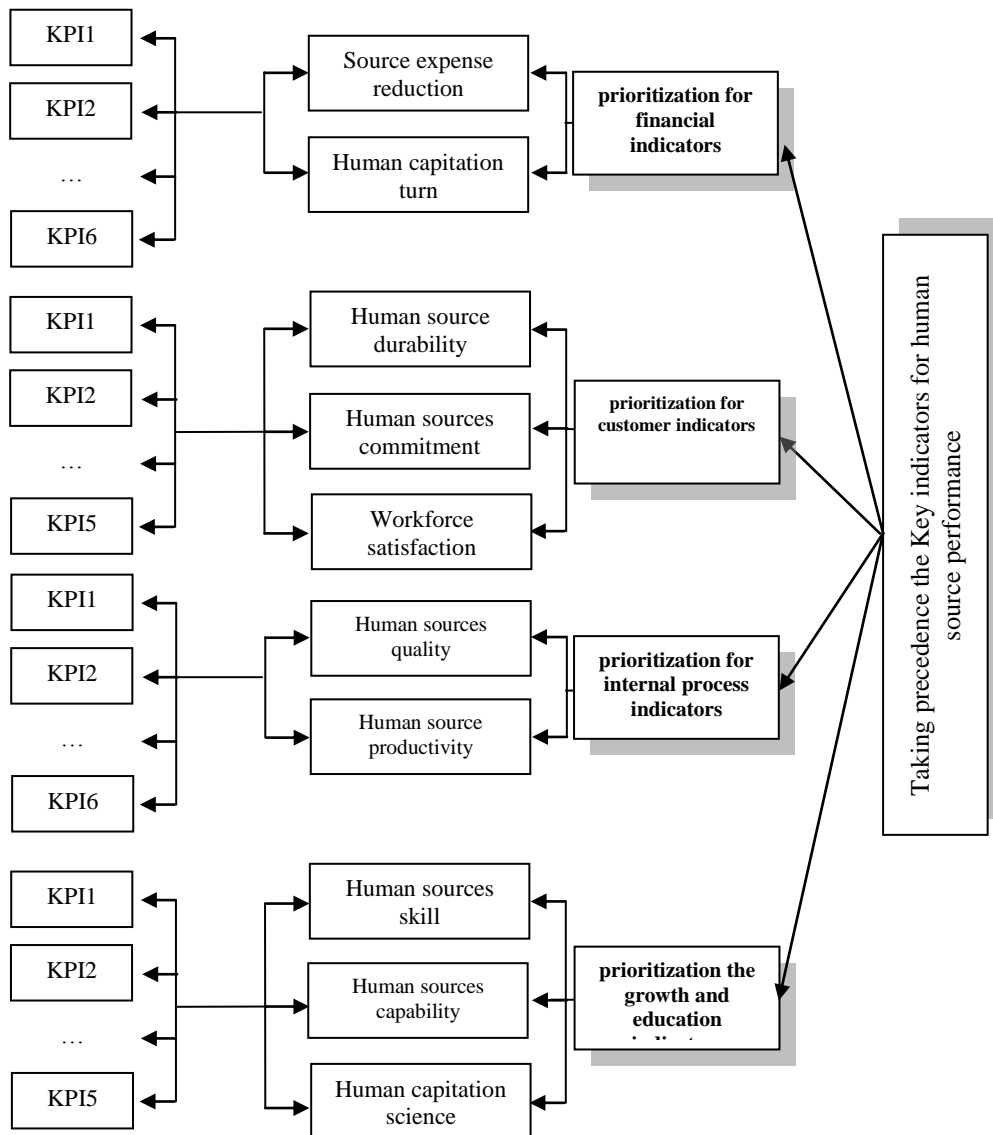
1. Human sources key performance indicators identification

To compare the results, derived from fuzzy AHP method with AHP standards, the second one was used to solve the inquired problems. Concerned to, the average fuzzy comparison, precise matrix comparison was extracted and a problem has been solved by Expert Choice 2000 software which the results is seen in table 5.

Table 4. Ranking the priority of purposes and indicators of human sources

Priority	Final weight (Normalized)	Indicators weight (FAHP)	Purpose weight (FAHP)	Indicators	Purposes	BSC facets
3	0.112	0.075	0.643	workforce efficiency	human capitation return	financial facets
2	0.268	0.180		human capitation return expense costing		
5	0.013	0.009		human capitation additional values		
4	0.099	0.120	0.357	welfare expense costing	human sources expanse reduction	
1	0.495	0.600		training expense costing		
6	0.013	0.016		workforce job satisfaction		
1	0.644	0.522	0.851	job satisfactory	human forces satisfaction	customer facets
2	0.185	0.150		How many of human force have job satisfactory (in percent)		
3	0.148	0.120		human sources satisfaction of human sources management		
5	0.007	0.100	0.049	job announcement effectiveness	human forces retention	
4	0.016	0.108	0.100	education effectiveness	human forces commitment	
1	0.466	0.423	0.656	educational require measurement coverage	Human forces quality	internal process facets
2	0.220	0.200		attraction ability		
6	0.036	0.033		approved status indicators		
3	0.165	0.150		specialist human force expanse		
5	0.052	0.090	0.344	practitioners rate in patronage	human forces productivity	
4	0.060	0.104		force rotation rate		
1	0.475	0.323	0.523	trained human force rate	human forces science	growth and learning facets
5	0.118	0.123	0.342	development rate	human	

4	0.128	0.133		absence rate	forces capability	
2	0.145	0.220		attraction quality	human forces skills	
3	0.133	0.201	0.235	human force require measurement coverage		

As you see the final ranking is similar to fuzzy AHP results; but we should consider compare to standards AHP fuzzy, standards AHP, introduces better modeling rather than determinants' vague ideas; moreover the results of fuzzy AHP methods are more documented and closer to reality. Repugnance rate for indicators is below 1% and this shows the repugnance existence inside the whole hierarchal structure. Chen and Pan [2004] to identify key performance indicators compared the calculated scales considering indicators more than 1 % as key performance indicators [5]. They usually consider 20 to 30 indicators for each 4th dimension balanced scorecard.   Some scorecard critics believe that staff couldn't pay attention to all these indicators [15]. So in these paper indicators which their scales are more than others (maximum to 3 indicators) are considered as human sources key performance indicators. In table 5 human sources key performance indicators concerning AHP standards and AHP phase with related scales are indicated.

Table 5. Key indicators of human sources performance

Fuzzy AHP		Standard AHP		Method	
priority	FAHP	priority	AHP	key performance indicators	Facets
1	49.5%	1	52.3%	human forces expense rate	financial
4	9.4%	2	11.5%	human forces welfare expanses rate	
2	26.8%	3	19%	human capitation return rate	
3	11.2%	5	5.7%	human forces efficiency	
1	64.4%	1	55.8%	human forces job satisfaction	customer
4	1.6%	2	16.6%	educational effectiveness	
3	14.8%	3	16%	human forces satisfactory from human sources management	
2	18.5%	4	6.6%	percent of human forces satisfaction of educational courses	
1	46.6%	1	36.2%	educational require measurement coverage	internal processes
2	22%	2	25.3%	attraction ability	
3	16.5%	3	19.6%	specialists human force rates	
3	13.3%	1	44.9%	Human resource require measurement coverage	growth and learning
5	11.8%	2	14.3%	Development rates	
1	47.5%	3	21.8%	percentage of trained human force	
3	14.5%	4	9.9%	attraction quality	

As you see key performance indicators was prioritized based on four BSC facets. human forces job satisfaction indicators in view of customers is of most important key performance indicators was determined, concerned to AHP and BSC unified tendency.

2. Conclusion

Central axis activities of human sources management should be of staff participation for organization purpose realization, substantial factor to increase organization performance , one should trust that human sources activity units are the ways to organization goals achievement and organization 'services and qualities. For purposes realization human sources management structure should include the associated multiple groups. Human sources activities lie inside organization context and center [15]. For doing third human sources managers should identify the human sources indicators and should distinct their importance. Because human sources indicators are not tangible, unified approach of AHP and BSC can be best methods for this purpose. In this paper to exploit determinants ideas and decisions fuzzy AHP used to identify human sources indicators. In fuzzy AHP methods uncertainty was assumed with triangle numbers. In this paper to interference certain priorities from fuzzy pair's comparison matrices, fuzzy AHP was used as analytic development Chang. Results show that used fuzzy AHP as a technique gives better modeling of vague and probable ideas and results by this methods was more documented and closer to reality. In fact confusing thing which one sees in human behavior and social analysis (like human sources key performance indicators) especially about time and space derived from factors repugnance importance like   mentality, carefulness and carelessness , simplicity ,complexity , trust and uncertainty which to obviation this problem in human sources investigation , one can use fuzzy ideas collection. In these paper human sources key performance indicators were classified and their scale importance was distinguished, using standards and purposes related to 4th dimension balanced scorecard. Results showed that human sources job satisfaction costing in customer view is 64/5 % (in average) which of the most important human sources indicators compare to other indicators in BSC facets, and respect; human forces expense costing (49/5 %),training require measurement coverage, and trained human force percentage are of the most important key indicators performance of human sources. Human forces job satisfaction, in customer view compare to other existed indicators in BSC facets, with 65%   ranked in balanced scorecard facets as first priority of human sources indicators .it indicates that organization regards these indicators importance in its   long term programs and purposes, today all organization found that the increase in human sources job satisfaction, contend customers will increase . So customer job satisfaction retention in higher levels is related directly to organization human forces satisfaction and these indicators also influence the firm output. Human forces expense costing with 49 degree of importance in financial view indicates that firm' strategies of expense reduction and better operation are in better position. In fact organization that acts under expense reduction and better operation, needs human forces to be trained and able to be educated. Education require measurement indicators coverage (36% importance) and trained human forces percentage is the basis of programs effectiveness rate and educational activities in educational training purposes assemble and   by recognizing the important needs, provides appropriate ground and purpose identification basis   to other important components organization, so could make its purposes and programs practical. Regard to observed results of research we expect this unified system could bring invention, and improve customer services and increase service organization' performance especially in National Cartographic Center.

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