European Online Journal of Natural and Social Sciences 2013;
vol.2, No. 3 (s), pp. 875-880 ISSN 1805-3602

Weighting indicators of employee performance evaluation using Taguchi experimental design approach

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Abstract

Performance evaluation is a prerequisite for many activities in the field of human resource whose accurate implementation results in efficiency and effectiveness of performance feedback, training and development, employee promotion, human resource planning, etc. So accurate weighting of evaluation indicators is of great importance and can affect evaluation results. Therefore, using Taguchi experimental design, this study tries to weight indicators realistically taking into account interaction and synergy force among indicators. Moreover, differences in the importance of different levels of indicatorswere investigated. The result of using Taguchi experimental design as weight indicators showed that this approach can be a proper way to weight performance evaluation indicators.

Keywords: Employee performance evaluation, Weighting performance evaluation indicators, Taguchi experimental design.

Introduction

Performance evaluation is one of the most important issues in the field of human resource management which is defined as the process of evaluating and communicating in the way of performing a task and setting up improvement plan. Therefore, performance evaluation not only allows employees to know how their performance is, but also affects their level of efforts and future career (Byars and Rue, 2008).

Performance evaluation usually is done aiming to feedback performance, training and development, employee promotion, human resource planning, etc. hence since it is a prerequisite for many activities its accurate implementation is of great importance (Jafari et al, 2009). One issue that most of the organizations encounter in the implementing performance evaluation accurately is the way to weight and determine the importance of indicators of employee performance evaluation. In different studies,different methods are used by the authors. For example, Sepehri Rad et al (2012) used FAHP, Movahedi et al (2011) AHP, Bordbar et al (2011) Shannon entropy and Jafari et al (2009) SAW to weight employee performance evaluation indicators. Moreover, it seems that two points are not considered in most of the studies:

1. Considering interaction and synergy force among indicators: when several indicators are considered for an employee along with each other, they can bring a synergistic force that exceeds the sum their forces. For example, if the speed and delicacy of an employee in performing a job is considered in combination, it can show a higher competency than when considered separately. Moreover, one or several indicators in an employee influence other indicators and decrease or increase their importance and effectiveness. This issue is neglected in many weighting methods.

2. Difference in the importance of different levels of an indicator: an indicator can be presented by a person in different levels such as low, moderate and high. For example, the importance levels of low, moderate and higher innovation and creativity of a bank cashier can be given the scores of 3, 6 and 6 respectively. This means that the moderate levels of this indicator can also be acceptable for a proper performance of cashier and differs, not from the highest level. This can help banks to determine employee recruitment conditions precisely.

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Considering these two points, one of the best techniques to obtain a realistic weight for the importance of each indicator is Taguchi experimental design. This approach, which is used widely to optimize engineering processes, employs a simple experiment to study the main effects of each indicator and to model some of the most important interactions. Therefore, the influence of each indicator is specified more realistically in contrast to the other indicators (Golec and Kahya, 2007).

Research question

Since the aim of the study is to weight indicators of performance evaluation of these bank cashiers, the research questions can be specified as follows: How each cashier performance indicator can be weighted using Taguchi experimental design?

Review of related literature

Taguchi experimental design

Taguchi method is one of the strongest methods which was innovated by Genichi Taguchi in 1986. Compared to the traditional approach of "one factor at a time", Taguchi can test all of the operational variables at the same time and provide an effective and efficient method both optimize factors simultaneously and extraction of great quantitative information only with a few experiments (Hong, 2012). The Taguchi method uses special tables named orthogonal array table to plan experiment conditions. Using these tables ensures that experiment designs are straightforward and reliable. The number of variables and their levels determine the use of appropriate orthogonal table proposed by Taguchi in experiment design. Based on the selected orthogonal table, a number of experiments with specific levels will be done and the results will be expressed to specify optimized levels of each indicator (Chien& Tsai, 2003).

Taguchi method also delineates and investigates interaction effects of controllable factors and expands space for possible researches. Determining the share contribution of each factor in experiment result is one of the capabilities of this method. Considering interaction effects of factors, Taguchi method specifies the contribution of each factor in experiment result. Therefore, takes their synergy force into account in weighting them. This capability that obtains through an ANOVA table for experiment data helps the decision maker to rank factors based on their importance (Wang & Hong, 2007).

Methodology

Population and sample

In order to show the implement of the proposed method, a case study in the field of banking was used. The population of those who answer the questionnaires of this study were all of bank employees with more than 20 years of job experience in Larestan. Some researchers believed that a number of opinions were considered sufficient. Therefore, 15 questionnaires were distributed randomly among managers, experts and experienced employees of 5 banks. Finally, 12 questionnaires were given back.

Data collection

In this study, data collection was done in two steps:In the first step, in order to determine the indicators of cashier performance evaluation, the theoretical literature was studied and experts' opinion, including university professors, bank managers and experts were used. In the second step and to weight indicators, a questionnaire formed based on the Taguchi orthogonal array tablewas used. Therefore, Qualitek software was used to select the appropriate orthogonal array table.

Validity and reliability of data collection

To determine the indicators of performance evaluation, previous studies and different levels, the Taguchi orthogonal array tablewas used. Based on this, the content validity of the questionnaires was confirmed by the experts.

To calculate the reliability of questionnaires, Cronbach's alpha coefficient was used. As will be mentioned in the following performance indicators were categorized in 4 dimensions that to weight indicators of each dimension, a questionnaire was designed. Table 1 shows the calculated Cronbach's alpha for each questionnaire that all of them are conformable.

Results

From the study of past research performance, evaluation indicators were gathered. After summarizing, 28 indicators were given to experts to be eliminated, added or modified and the final indicators wereobtained. Finally, by the experts' opinion 9 indicators were eliminated,and 3 indicators were added. So a number of 22 indicators were de-

termined as the cashier performance evaluation indicators. Then the experts were asked to categorize these indicators. After several modifications, these indicators were categorized in 4 dimensions of professional knowledge and skills, performance task, morality and personality and general characteristics. In this paper weighting indicator of Professional knowledge and skills dimension will be presented as the example. It is clear that this procedure must be applied to the other mentioned dimensions in this study. Table 2 shows the indicators categorized in professional knowledge and skills dimension.

Table 1. Cronbach's alpha coefficient of Questions

Questions	Number of questions	Number of respondents	Cronbach's alpha coefficient
Professional knowledge and skills	9	12	0.897
Performance task	18	12	0.821
Morality and personality	18	12	0.768
General characteristics	18	12	0.783

Table 2. Indicators of professional knowledge and skills dimension

Professional knowledge and skills
Indicator 1 : Ability to make decisions
Indicator 2 : Ability to work with compute
Indicator 3 : Having knowledge about his job
Indicator 4 : Ability to teamwork

After that, in order to use Taguchi experimental design, first a separate questionnaire was formed for the indicators of each dimension based on a Taguchi orthogonal array table. The number of indicators in each dimension and the number of levels of each indicator is two key factors in selecting the appropriate orthogonal array table. For example, in professional knowledge dimension which has 4 indicators, using experts' opinion, 3 levels of high, moderate and low were determined as the levels of each indicator. Therefore, by inserting 4 as the number of as the number of indicators and 3 as the number of levels in Qualitek (operational software for the Taguchi experimental design), proposed Taguchi table including 9 experiments and different combinations of indicators in each experiment was determined. Based on this table, a questionnaire was designed in which for each experiment, a combination of indicators levels was considered. Table 3 shows the questionnaire related to this dimension.

Table 3. Weighting questionnaire of Professional knowledge and skills dimension

Experiment number	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Competency
1	Bad	Bad	Bad	Bad	?
2	Bad	Medium	Medium	Medium	?
3	Bad	Good	Good	Good	?
4	Medium	Bad	Medium	Medium	?
5	Medium	Medium	Good	Good	?
6	Medium	Good	Bad	Bad	?
7	Good	Bad	Good	Good	?
8	Good	Medium	Bad	Bad	?
9	Good	Good	Medium	Medium	?

Then 12 experts were asked to determine the result of each experiment, which is equivalent to the competency of a cashier, by using one of linguistic expressions from very low to very high. For example, in the first experiments in which all of the four indicators were considered at a low level, most of experts determined the competency of a cashier for that dimension specifying the linguistic variable of very low. This means that if a cashier is weak in all four indicators, his competency in the professional knowledge and skills dimension will be very low. Accordingly, competency results of cashiers in different combinations were determined by experts for 8 other experiments.

Since to weight each indicator Qualitek was used, and questionnaire results should be inserted as definite numbers, linguistic variables were converted firstly to fuzzy triangular numbers and then using the center of gravity method two definite numbers. Formula 1 shows the center of gravity method and table 4 shows fuzzy and definite numbers of each linguistic variable.

$$S_j = \frac{a_j + b_j + c_j}{3}, \qquad j = 1, 2, \ldots, m \quad (1)$$

In formula 1, a_j, b_j and c^j are low, moderate and high levels of a fuzzy triangular number respectively.

Table 4. Fuzzy and defused numbers of linguistic variables

Linguistic scale	Fuzzy numbers	Defuzzy numbers
Very Low	(0, 0, 0.2)	0.067
Low	(0.1, 0.2, 03)	0.2
Medium Low	(0.2, 0.35, 0.5)	0.35
Medium	(0.4, 0.5, 0.6)	0.5
Medium High	(0.5, 0.65, 0.8)	0.65
High	(0.7, 0.8, 0.9)	0.8
Very High	(0.8, 1, 1)	0.933

By using an ANOVA table, experts' opinions were inserted to Qualitek, which is the output of this software, for each indicator in the professional knowledge and skills. Table 5 shows the ANOVA table containing indicator weights of this dimension. The indicators weight is shown in the percent column.

Table 5. ANOVA table for Professional knowledge and skills dimension

Indicators	DOF (f)	Sum of squares	Variance (V)	Percent P (%)
Ability to make decisions	2	10.965	5.482	24.668
Ability to work with computer	2	13.188	6.594	28.313
Having knowledge about his job	2	13.124	6.562	29.526
Ability to teamwork	2	7.171	3.585	16.133
Error	3	0.81	0.162	1.36
Total	11	44.451		100 %

As it can be seen, this table contains much information. In this study just the last column data, percent column, will be analyzed. In this column, only 1.36 percent of contributions are dedicated to error factor which is small and can be ignored. In fact, a high error means that there are some factors that affect experimental results but are not considered (Taguchi). Also, this error may be as a result of some contradictory answers in determining the result of each experiment. However, the error in the output table of all four dimensions, less than 5%, can be ignored. On the other hand, this small error confirms the reliability of weighting the results.

After that in order to sum of weights of indicators in each dimension be equal to 1, dimension indicators were normalized using Saaty method. Formula 2, shows normalizing by Saaty method:

$$w = \frac{r}{\sum r} \quad (2)$$

r shows the weight of indicator before normalization.

w is weight of indicator after normalization.

Based on this procedure, the indicator weights of other dimensions can be calculated. It must be considered that weighting questionnaire of each dimension, is designed based on the number of indicators and levels. So the number of experiments and combinations in the questionnaire of each dimension differs from the other dimensions. Table 6 shows the final results of categorizing all indicators and normalized weights of each indicator.

Table 6. Categories and normalized weights of indicators

Normalized weights	Performance tasks	Normalized weights	Professional knowledge and skills
0.161	Ability to handle affairs	0.25	Ability to make decisions
0.166	Working rapidly (quantity)	0.287	Ability to work with Computer
0.181	Working accurately (quality)	0.299	Having knowledge about his Job
0.117	Using available resources Correctly	0.164	Ability to teamwork
0.14	Ability to report expertly		
0.235	Effort to absorb financial Resources		
Normalized weights	**General characteristics**	**Normalized weights**	**Personality and morality**
0.237	Observing administrative Laws	0.23	Responsibility
0.138	Communicate with co-Workers	0.196	Attitude towards costumers
0.101	Creativity and innovation	0.11	Persistence and pursuit
0.263	Job experience	0.103	Incentive and enthusiasm to Work
0.112	Appearance	0.211	Commitment to organization
0.149	Proposing effective offers	0.15	Willingness to progress

As it can be seen having knowledge aboutthe job, effort to absorb financial resources, responsibilityand job experience indicators in the four mentioned dimensions are of the most importance. These results are confirmed by 12 experts.

Discussion and conclusion

In this paper, the Taguchi experimental designwas used to weight employee performance evaluation realistically. This method presents a table based on the number of indicators and their respective levels in each dimension helps to form the order of questions in the questionnaire based on the order of indicators in that table. Using this method, caused interactions and the synergy force between indicators.Also, differentiating importance of different levels of indicators for the organization, indicators are weighted real. This is a feature that is not considered in used methods in past studies like hierarchical analysis, network analysis process, SAW, Shannon entropy, etc.

One of the strengths of this method, a factor error extent in weight indicators may be considered as an equivalent to compatibility index and confirms weighting results. So, a small error factor confirms the weights and a high error factor mean that either the number of indicators and levels is inappropriate or the questionnaire contains contradictory answers. Therefore, the required modifications can be done to reduce the error factor.

The most important weakness of this method is that by increasing the number of indicators in a dimension and an increase in the number of levels,filling the questionnaire needs a lot time and attention.Therefore, in most cases this causes an increase in an error factor in weighting indicators. So it is suggested that indicators be categorized in as more as possible dimensions so the number of questions in each questionnaire to be reduced.

As an applied suggestion, it is suggested that organizations use the combination of this method and evaluation results in prioritizing indicators in deter-

mining training plans for their employees to improve their weaknesses and heighten their strengths.

Also, as a research suggestion, it is suggested that other weighting techniques like hierarchical analysis, network analysis process, TOPSIS,SAW, etc. be used separately or in combination and their weaknesses, strengths and results be compared with Taguchi experimental design.

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