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Full Length Research Paper

Development of performance evaluation scale for forest engineers using confirmatory factor analysis method

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Managers of forest enterprises, as managers of many other enterprises and organizations want to know the performance levels of their employees. For this reason, many enterprises use various methods to determine the performance levels. The primary purpose of this study is to develop a Performance Evaluation Scale (PES) in order to determine the performances of the forest engineers who are currently working at the forest enterprises in Aegean Region, and then to investigate the validity and reliability of the scale. This study was conducted within the 23 forest enterprises of Denizli, Izmir and Mugla Forest Regional Directorates in the Aegean region of Turkey. A total of 52 criteria were determined for performance evaluation as a result of focus group meetings and individual interviews conducted with the experienced forest engineers. These criteria were scored by 85 forest engineers by using a questionnaire designed according to the nine-grade Likert scale. Appropriateness of the data was evaluated via the t test, the Bartlett Sphericity test and the Kaiser-Meyer-Olkin (KMO) test. Then, the data were converted into the factors which are less and significant and independent of each other, with explanatory factor analysis method. Thus, the six factors describing 68.67% of the total variance were obtained. Each of the factors was named according to the factor loads and the criteria and then, the scale was formed. Finally, confirmatory factor analysis was performed and five-factor structures with an acceptable level of goodness of fit indices were created.

Key words: Aegean region, confirmatory factor analysis (CFA), forest engineer, performance evaluation scale, Turkey.

INTRODUCTION

According to modern management concept, employees are considered as important elements like other elements such as production, financing, marketing, R&D activities to achieve the goals in an enterprise. In this way, the enterprises accept the human resources departments as important units and supports performance improvement programs.

There are undertaking tasks that employees at all levels in an enterprise have to fulfill effectively according to job description. All the responsibilities of employees with particular characteristics in a business remain within the boundaries of the job description. An employee uses the knowledge and the skills within job descriptions and reaches the economic and social benefits in exchange according to the business opportunities. In this context, incompetence or competence of the individual performance of the business staff is considered as factor, that reduces or increases the performance of enterprises.

Performance measurement and management are very important in every type of enterprises. Employee's knowledge, skills, abilities and professional competence in general are increased with the help of performance management. Thus, organizational goals, corporate performances within the framework of plans and policies can be improved (Tutar and Altınöz, 2010).

Enterprises and organizations want to know who the best performer is or which department in their organizations. Enterprises use rating method to determine the performance of the employees. Performance ratings are useful for determination of performance of the units or whole enterprises and comparison all of them. The performance ratings are also useful for the promoting the employees (Anon, 2001).

For identification and management of performances in

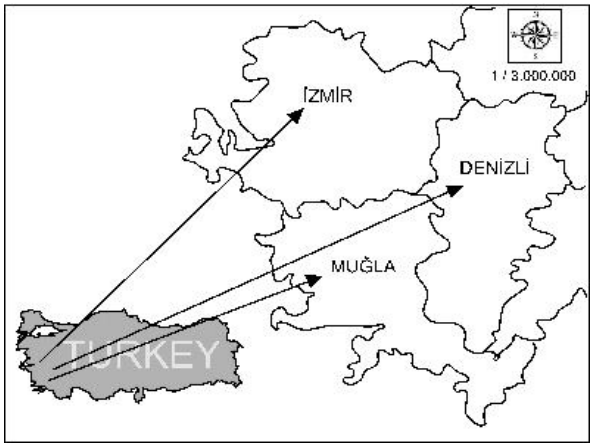

Figure 1. Study area.

the businesses, measurable performance criteria must be determined at first. In this context, there is a lot of research studies conducted on the determination of performance criteria for measurement of the employee performances (Palmer, 1993; Holzer and Yang, 2004; Gary et al., 2005; Yener, 2007; Jafari et al. 2009).

About 99% of Turkey's forests are public property. Forestry activities, that are focused on to maintain functions of forests such as social, cultural, economic, protection and environmental functions are carried out by state-forest enterprises and sub units. Therefore, these management units have critical importance for forest resource management.

Forest enterprises have to produce services and goods that the society expects from forest ecosystems. Forest enterprises, worked predominantly in producing of wood production before, have produced services and goods in different quantity and quality and maintained its activities with the ecosystem approach at present. For instance, forest functions have become important gradually such as water production, carbon fixing, ecotourism and non-wood forest products which forests fulfill. This study is carried out with the aim of determining function priorities relating to forest resources in Turkey, it is stated that environmental functions have sticked out (Geray et al., 2007; Yılmaz et al., 2010). On the other hand, forest resources have multiple uses and purposes. Forest managers have not only economic objectives, but also those of amenity and non-market values of recreation and nature conservation (Ok et al., 2011). Furthermore, non-wood forest products have specific importance concerning both their use and non-use values for nature conservation (Ok and Okan, 2011). This situation has revealed different sources and reference groups across forest enterprises which it should manage and has made the management and planning of forest resources more complex (Yılmaz et al., 2004).

Turkish forest manager have to cope with various jobs and therefore performanc of the enterprise and also employee has critical importance in forest sector. Several studies were performed to measure the performance of the Turkish forest enterprises and personnel (Geray, 2001; Daşdemir, 1996, 2002; Yavuz, 2007a; Koçak, 2009; Şafak and Okan, 2010). In this research, firstly, the problems were identified and then a variety of methods were developed to determine the performance. The purpose of this study is to develop a scale to evaluate the performance of forest engineers working in the forest enterprises and sub-units. In this context, first the criteria were determined, and then appropriateness of these criteria was evaluated with CFA based on exploratory factor analysis and structural equation modeling.

Structural Equation Model (SEM) is a powerful tool, which compares the causes of relationships among variables using observational data (Iriondo et al., 2003). SEM is basically used to explain the relationships among variables and to test the model statistically (Williams et al., 1999). SEM consists of two parts, which are measurement and structural models. Measurement model indicates the relationships between latent variables and indicators by the similar procedure used in factor analysis. Structural model, on the other hand, determines the causal relation-ships among latent variables using a procedure similar to the linear regression (Toma and Mathijs, 2005). CFA, path analysis and regression are put out as special cases of SEM. SEM is often confirmatory rather than descriptive a technique. SEM, instead of finding a suitable model, focuses on the validity of the model. SEM is a modeling chain with multivariate statistical analysis methods such as regression, factor analysis and variance (covariance) analysis. Causal processes in SEM are indicated with a set of structural equations (regression equations). These structural relations are modeled by means of figures for the conceptualization of the theory more clearly.

The potentiality of this method in forestry and its disciplines has only been recently explored, and a number of applications in these fields are steadily increasing (Laughlin and Grace, 2006; Schuster et al., 2006; Toma and Mathijs, 2005; White et al., 2008; Maguire et al., 2005; Dedrick, 1999; Juanda and Wasrin, 2002; Williams et al., 1999; Iriondo et al., 2003). CFA was not used in forestry research before in Turkey. This study is important in two ways: The first one is to develop various criteria for performance measurement in forest enterprises. The second one is to determine these criteria by using CFA.

MATERIALS AND METHODS

Study area

The research was conducted within the 23 forest enterprises under the responsibility of Denizli, Izmir and Mugla Forest Regional Directorates in the Aegean region of Turkey (Figure 1).

Sample size and data collection toll

Sample size, means the number of forest engineers determined by

the proportional sample size formula (Yavuz, 2007b).

$$n = \frac{Z^2 \times N \times p \times q}{N \times D^2 + Z^2 \times p \times q}$$

There are a total of 369 forest engineers currently working at Denizli, Izmir and Mugla Forest Regional Directorates. According to this formula, the universe of the research (N) is 369 (10% sampling error (D); 95% confidence interval (Z); p = 0.5; q = 1 - p) and the minimum sample size is calculated as 76.21. However, the research was conducted with randomly selected 85 forest engineers.

The data were collected by the questionnaire technique. The questionnaire form contains a total of 52 criteria. These criteria take into account variables affected by performances of the forest engineers. These include personal, behavioral, technical, functional variables. The 52 criteria were assessed by the Nine-Grade Likert Scale (1, the least importance, 3, weak importance, 5, moderate importance, 7, strong importance, 9, extreme importance, 2, 4, 6, 8 intermediate values) by forest engineers.

Determination variables used in the measurement of performance

In the study, first, performance, performance measurement methods and surveys and performance metrics used in previous studies were browsed (Daşdemir, 1996, 2002; Toma and Mathijs, 2005; Yavuz, 2007a; Yener, 2007; Koçak, 2009). Later, records kept in the forest enterprises were examined and activities, responsibilities, legislation, working conditions, etc. carried out in the forest enterprises issues were identified. Totally, 38 temporary criteria were determined to be used in the performance evaluation of forest engineers (forest enterprise director, deputy director and forest enterprise chief) working in the forest enterprises.

Then, interviews and meetings were organized with forest engineers working under the responsibility of Denizli, Izmir and Mugla Forest Regional Directorates. As a result, some of the criteria were removed, some new criteria were added. Therefore, 52 criteria were developed to be used in the performance evaluation of the forest engineers working in the forest enterprises in Aegean Region. The first 34 of these criteria were related to personality characteristics of the forest engineers, while others were related to the profession of forestry.

Method

In this study, PES for the forest engineers was developed as a result of four stages. In the first stage, appropriateness of the data was investigated by the t test, the Bartlett Sphericity test and KMO test. In the second stage, exploratory factor analysis method was used to establish the performance evaluation scale. In the third stage, reliability of the criteria in the factors was tested with the internal consistency coefficient (α) developed by Cronbach (Cronbach, 1951; Lopez, 2007). At the final stage, the model determined as a result of the second and third stages, was evaluated with confirmatory factor analysis.

In this study, χ^2 (Chi-Square), df (degrees of freedom), χ^2/df, RMSEA (Root Mean Square Error of Approximation), SRMR (Standardized Root Mean Square Residual), GFI (Goodness of Fit Index), CFI (Comparative Fit Index), NFI (Normed Fit Index), NNFI (Non-Normed Fit Index), IFI (Incremental Fit Index) and AGFI (Adjusted Goodness of Fit Index) were taken into consideration for the confirmatory factor analysis (Dedrick, 1999; Williams et al., 1999; Iriondo et al., 2003; Şimşek, 2007; Shiun Lai et al., 2010).

For SEM in this study, the covariance structure generated from the collected data was used, as it is considered to be more robust than the correlation matrix. LISREL 8.51 was employed for the CFA (Jöreskog and Sörbom, 1996). To calculate descriptive statistics, correlations, interitem reliability and the explanatory factor analysis SPSS 16.0 was utilized.

RESULTS AND DISCUSSION

Validity of the data

Appropriateness of the data was investigated by using the Bartlett Sphericity test and the KMO test (Gliem and Gliem, 2003; Treiblmaier and Filzmoser, 2009). Bartlett-Test Value = 3176.517 and p (sign.) = 0.000 <0.05 were calculated. Therefore, H_0 hypothesis was rejected and the alternative hypothesis (H_a) was accepted. So, there are high correlations between the variables and the data come from multi-normal distribution. KMO coefficient was 0.751 and the sample size was sufficient to perform the test. t values ranged from 62.60 to 12.91 were statistically significant. These values show that the data is suitable for factor analysis.

Exploratory factor analysis and reliability of the criteria

Common variance shows that much of the changes in the original variables were explained by common factors (Büyüköztürk, 2002). Common variance was taken into account in order to test the applicability of the factor analysis method. As shown in Table 1, the average of the common variance for the criteria is 0.752 and this value shows that the criteria can be applied to the factor analysis.

C24 criterion (0.407) with the anti-image correlation coefficient of less than 0.50 and C2, C8 and C34 criteria because of low factor load values which were not used in the analysis. In addition, the criteria (C4, C6, C7, C9-C16, C18, C20-C23, C33, C36, C38, C40 and C43) with a difference smaller than 0.10 in more than one factor were removed from the analysis due to their comorbid criteria. As a result of the factor analysis, six factors with eigen-values over 1, explaining 68.67% of the total variance were obtained. In the factor analysis, the variance ratios between 40 and 60% are considered appropriate. Accordingly, it can be said that the variance obtained is sufficient.

Reliability of the criteria in the factors identified by factor analysis was determined by the value of alpha developed by Cronbach. The alpha coefficient (α) determines the quality of the different criteria, how much mutually complete each other while measuring their quality. C39 criterion with the Item total correlation coefficient of less than 0.30 was removed from the analysis. In addition, any one of the criteria is removed; the alpha coefficient does not change considerably. Cronbach's alpha internal consistency coefficient was calculated as 0.9251 for the 26 criteria in the six factors.

As shown in Table 2, internal consistency coefficient of

Table 1. The developed performance metrics, and common variance.

S/N	Criteria	Communality
1	Knowledge and accomplishment level (promotion exam grades, certificates, etc.)	0.635
2	Specialization degree (specialization on the concerning area, masters degree, etc.)	0.654
3	Fulfillment of orders	0.709
4	Availability of health for the profession	0.775
5	Professional experience (duration of service)	0.743
6	References	0.776
7	Leadership skills	0.757
8	Usage of computer, machines, instruments and tools	0.723
9	Marital status and age	0.658
10	Utilization of time	0.801
11	Organization and planning skills	0.739
12	Gender	0.700
13	Aptness for group work, to work in cooperation and harmony	0.814
14	To be Respected by the colleagues and trustworthiness	0.679
15	Taking responsibility, faithfulness and pursuance to profession	0.777
16	The skills to improve the subordinates	0.785
17	To reflect the family problems to work	0.630
18	The protection of the equipments of the corporation	0.748
19	Disciplinary fines	0.785
20	The level of harmony with seniors and subordinates	0.786
21	The level of handling with stress	0.828
22	The Skills to work in different businesses and subjects and creativity	0.757
23	The level of being calm in critical situations	0.749
24	The number of interest and benefit groups, communicating with them and the skills to meet the customer satisfaction	0.703
25	Overtime working throughout the year	0.765
26	The duration of working on the land	0.808
27	The total number of received and sent documents	0.727
28	Gravity of working area, the number of villages around the forest and population	0.860
29	Working without sufficient number of staff	0.799
30	Job difficulty index of working area	0.755
31	Working in the hardship area	0.797
32	Working for more than five years in the same area	0.745
33	The risky condition of the working area against fire, protection and landslide	0.707
34	The level of the working area to fulfill the minimum social needs	0.770
35	The number of official reports written for forest crimes	0.745
36	The level of rise or loss in the size of the forest inside the responsibility area	0.647
37	The rise in private forests, village forests, afforestation areas	0.753
38	The number of forest fires and the amount of abundant area that is burn	0.642
39	Silvicultural business load, and the success on it	0.732
40	The degree of work made to care for and rehabilitation of the forests	0.808
41	The rise in the demand for the products and services supplied	0.788
42	The level of success on marketing compared to the former term	0.755
43	The degree of informing seniors about occupational matters with both verbal and written ways	0.772
44	Publication of articles about the occupational matters	0.737
45	Production of fuelwood and roundwood	0.719
46	Attaching importance to non-wood forest products	0.712
47	The level of saving and developing the biodiversity	0.803
48	Attaching importance to wildlife	0.829
49	The level of saving and developing the water resources	0.885
50	The level of prevention of erosion, flood and landslides	0.824
51	Attaching importance to nature tourism, recreation, relaxation, etc.	0.764
52	Attaching importance to forage production	0.686
Overall average		0.752

Table 2. Factor analysis results.

Code	No.	Variables	Factor load	Eigenvalue	Variance (%)	Reliability (α)
		Factor 1: Forestry Services		9.377	36.065	0.925
C1	49	The level of saving and developing the water resources	0.883			
C2	48	Attaching importance to wildlife	0.850			
C3	47	The level of saving and developing the biodiversity	0.817			
C4	50	The level of prevention of erosion. flood and landslides	0.812			
C5	51	Attaching importance to nature tourism, recreation, relaxation etc.	0.790			
C6	52	Attaching importance to forage production	0.722			
C7	46	Attaching importance to non-wood forest products	0.661			
C8	44	Publication of articles about the occupational matters	0.614			
Factor 2. Forest management				2.782	10.702	0.855
C9	26	The duration of working on the land	0.779			
C10	42	The level of success on marketing compared to the former term	0.737			
C11	25	Overtime working throughout the year	0.733			
C12	41	The rise in the demand for the products and services supplied	0.695			
C13	45	Production of fuelwood and roundwood	0.630			
Factor 3. Work environment and work experience				1.746	6.715	0.766
C14	31	Working in the hardship area	0.779			
C15	32	Working for more than five years in the same area	0.740			
C16	30	Job difficulty index of working area	0.649			
C17	5	Professional Experience	0.577			
Factor 4: Employment eligibility				1.421	5.467	0.705
C18	3	Fulfillment of orders	0.740			
C19	17	To reflect the family problems to work	0.711			
C20	1	Knowledge and Accomplishment Level	0.587			
C21	19	Disciplinary fines	0.489			
Factor 5. Work intensity				1.314	5.055	0.784
C22	28	Gravity of working area. the number of villages around the forest and population	0.869			
C23	29	Working without sufficient number of staff	0.677			
C24	27	The total number of received and sent documents	0.618			
Factor 6. Public relations				1.215	4.672	0.756
C25	35	The number of official reports written for forest crimes	0.878			
C26	37	The rise in private forests, village forests, afforestation areas	0.613			

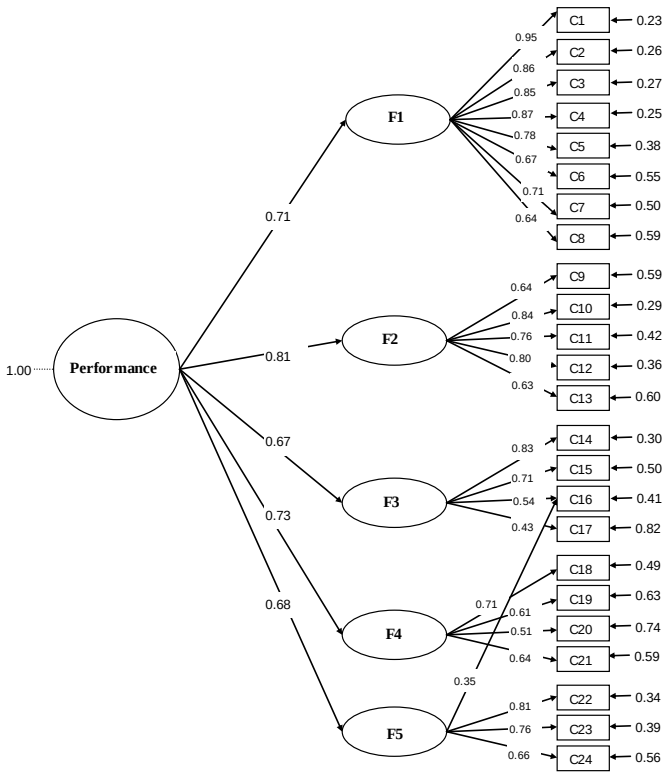

Figure 2. Confirmatory factor analysis results.

each factor was calculated separately and ranged from 0.9253 to 0.7051. In this regard, identified six factors and the criteria in these factors were determined to be reliable.

Each factor obtained from the factor analysis was named according to the criteria contained and factor loads (Table 2). Accordingly, the factors are given as follows:

Forestry Services; there are eight criteria: 1) saving and developing the water resources, 2) attaching importance to hunting and wildlife, 3) saving and developing the biodiversity, 4) prevention of erosion, flood and landslides, 5) attaching importance to recreation activities such as nature tourism, recreation, relaxation, etc., 6) attaching importance to forage (grass and leaf) production, 7) attaching importance to non-wood forest products, 8) Publication of articles about the occupational matters.

Forest management; there are five criteria: 1) duration of working on the land, 2) level of success on marketing compared to the former term, 3) overtime working throughout the year, 4) rise in the demand for the products and services supplied, 5) level of production of fuelwood and roundwood.

Work environment and work experience; there are four criteria: 1) working in the hardship area, 2) working for more than five years in the same area, 3) job difficulty index of working area, 4) professional experience.

Employment eligibility; there are four criteria:1) fulfillment of orders, 2) to reflect the family problems to work, 3) knowledge and accomplishment level (exam score for the rise in the profession, certificate, certificate of appreciation, etc.), 4) disciplinary fines.

Work Intensity; there are three criteria: 1) gravity of working area, the number of villages around the forest and population, 2) working without sufficient number of staff, 3) total number of received and sent documents. Public Relations; there are two criteria: 1) number of official reports written for forest crimes, 2) rise in private forests, village forests, afforestation areas.

Confirmatory factor analysis

C26 criterion was removed from the analysis due to low t-value (0.04) in the first confirmatory factor analysis. Accordingly, C25 criterion at the same factor with C26 criterion was removed from the model to remain single within the factor and the analysis was performed again.

In the analysis, χ^2 value (317.82) was significant at 0.05 levels. Degrees of freedom (df) 247, χ^2/df value of 1.29, RMSEA value of 0.059, SRMR value of 0.081, GFI value of 0.75, CFI value of 0.87, NFI value of 0.71, NNFI value of 0.85, IFI value of 0.87, AGFI value of 0.70 was obtained. In the analysis, fit indicies were lower. Therefore, the modification index recommendations were examined and there was a relationship between Factor 5 and C16 criteria. However, examining the recommendations shows that there are criteria (C5, C6, C9, C10, C11) to be added to the error covariance. The recommendations were considered and the model was tested again.

Chi-square value decreased to 7.51 due to the corrections. This difference is statistically significant ($p=0.023<0.05$). The results of standardized path diagram obtained from the CFA were given in Figure 2. As shown in Figure 2, criteria factor loadings are changing in the range of 0.23 (C1) and 0.82 (C17) and all factor loadings are statistically significant (*P<0.05*).

In the second confirmatory factor analysis, χ^2 value (310.21) was significant at 0.05 level. Degrees of freedom (df) 245, χ^2 /df value of 1.27 RMSEA value of 0.057, SRMR value of 0.076, GFI value of 0.76, CFI value of 0.88, NFI value of 0.72, NNFI value of 0.87, IFI value of 0.88, AGFI value of 0.70 were obtained. When the resulting data are interpreted, it can be said that the new compliance indices are relatively compatible according to the results of the previous analysis. Therefore, the performance scale can be used in the performance evaluations.

Conclusion

The staff must have a defined job primarily, the job must complies with the capabilities of the staff, there should be a standard/indicator showing the degree of achievement

of the job, to be able to promise performance management.

This research was aimed to develop criteria to evaluate the performance of the forest engineers working in the forest enterprises or the forest management units adopted sub-units of the forest enterprises. In this respect, first, criteria were determined, and then appropriateness of the criteria was evaluated with CFA based on the exploratory factor analysis and SEM.

A form called "Performance Evaluation Scale (PES) for forest engineers" has been designed to apply easily and provide an understanding of the criteria developed. The criteria were developed for the forest engineers working in the forest enterprises. Accordingly, the criteria in the scale, evaluate the importance of the forestry services, forest management activities, work environment, work experience, job suitability and intensity.

Improved PES scale cannot be directly applied in the different units of the Ministry of Environment and Forestry. For the implementation of the units, the criteria set must be renewed and accordingly the validity and reliability of the procedures must be repeated.

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