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BAHÇEŞEHİR UNIVERSITY

A FUZZY AHP WEIGHTED DECISION SUPPORT SYSTEM FOR HUMAN RESOURCES OF A BANK

Master's Thesis

ALI ZAHID SARIYER

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ABSTRACT

A FUZZY AHP WEIGHTED DECISION SUPPORT SYSTEM FOR HUMAN RESOURCES OF A BANK

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In human resources management that transforms from a cost center to a critical, strategic business partner, with the need of making detailed analyses from the obtained data, Industrial Engineers becoming a natural part of the HR team

Decisions made in human resources departments directly affect people. And the effects of decisions made about people widely vary from person to person. Decisions made generally rely on subjective evaluation. Thus human resources departments need decision support systems to help them make objective evaluations.

In our study an employee evaluation system where employees' evaluated under five titles, is examined. In the framework of this study sub-titles under every single titles, are weighted using Fuzzy AHP method and according to the scores of sub-titles a score is created for every title. These five titles have been modeled by Fuzzy AHP method that can be weighted relatively special with the topic to create a concluding evaluation score. Thus a decision support system to help compare with objective criteria have been made for decisions made in the human resources. Aforementioned system can be used to rank employees in the company in general while also having the ability to compare two different employee.

Key words: Fuzzy AHP, Employee Evaluation, Employee Selection, Human Resources.

ÖZET

BİR BANKANIN İNSAN KAYNAKLARI YÖNETİMİ İÇİN BULANIK AHP İLE AĞIRLIKLANDIRILMIŞ KARAR DESTEK SİSTEMİ

Ali Zahid Sarıyer

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Bir harcama merkezinden, firmalar için kritik bir stratejik iş ortağına dönüşen insan kaynakları yönetiminde, elde edilen verilerden ayrıntılı analizler yapılması ihtiyacı, endüstri mühendislerini insan kaynakları departmanlarında sıklıkla görülür hale getirmiştir. İnsan kaynakları departmanlarında alınan kararlar doğrudan insanı etkilemektedir. Ve insanlarla ilgili alınan kararların etkileri, kişiden kişiye çok değişkenlik göstermektedir. Alınan kararlar ise genellikle sübjektif değerlendirmelere dayanmaktadır. Bu sebeple insan kaynakları departmanlarının objektif değerlendirme yapmalarına yardımcı olacak karar destek sistemlerine ihtiyaçları vardır.

Bu araştırmamızda çalışanların beş ana başlıkta değerlendirilmesinin yapıldığı bir çalışan değerleme sistemi ele alınmıştır. Bu çalışma çerçevesinde her bir başlığın altında belirlenen alt başlıklar, Bulanık AHP tekniği kullanılarak ağırlıklandırılmış ve alt başlıklardan oluşturulan skorlar çerçevesinde her bir başlık için bir skor oluşturulmuştur. Bu beş ana başlık ise nihai bir değerlendirme skoru oluşturmak için, değerlendirilecek konu özelinde farklı ağırlıklar verilebilecek bir Bulanık AHP tekniği ile modellenmiştir. Bu sayede insan kaynaklarında verilecek kararlarda çalışanları objektif değerlerle kıyaslamak için bir karar destek sistemi oluşturulmuştur. İlgili sistem iki farklı personeli kıyaslamada kullanılabileceği gibi, firma genelinde personelleri sıralamak için de kullanılabilecektir.

Anahtar Kelimeler: Bulanık AHP, Personel Değerleme, Personel Seçimi, İnsan Kaynakları

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1. INTRODUCTION

1.1 CONVERSION OF THE HUMAN RESOURCES ROLES

In late sixties human resources has been seen as function that was only an expense. HR employees are generally chosen among people who couldn't do any harm. Behind this perspective, there are two main cause these are; first one is HR employees believed and accepted that they are nothing more than an expense center. Even some of them try to avoid that perspective but they are overwhelmed by system of that time. And the second one is they have been unaware of the value they creating for organization, because they don't have any tool for talking about it. Every think they present are qualitative, subjective and questionable.

Respectively at seventies productivity and eighties process quality and competitive advantage became the main issue for companies. Both decade commonly have been relied numbers for state the degrees of change. Even in that decades HR directors don't think the involving at the initiatives are their issue. Besides that during seventies for managing the expenses and generating something, experimenting with basic cost, time and quantity measurements has been started to seen at HR. Following that at eighties, HR started to create measurable values, as an example fist national benchmark published in USA at the nineteen eighty five, with this benchmark marketing model for HR functions has begun to form. After millennium, HR had advanced their methodology at calculating the return on investments of employee. Essentially, HR department shifted the managing human capital of organization to, using standard arithmetic functions for managing. And this shift opened up the HR analytics era which will carry us the future.

And now we are living in the era of analytics. Statistics are bias free like as arithmetic, and have a large scale of areas to use. It can be used for small, localized issues or used as support company-wide issues. With usage of advanced statistics our attention grabbing to forecasting the future, and forecasting based management.

1.2 MOTIVATION

With the conversion which mentioned above, Industrial Engineers becoming a natural part of the HR team. Industrial engineers generally positioned as compensation analyst, system developer and report analyst. Besides that responsibilities there are quite niche areas where industrial engineers can create value, but these areas are hard to work on, and generally not popular in the priority scope of managers.

As an example, decisions which include or effects employee might be differentiate because of the difference between the humans. And for that reason decision makers couldn't find objective evaluation criteria for some decisions. As an industrial engineering application, system which can generate objective evaluation criteria can be modelled. Even this kind of system cannot create absolute solution for HR decisions but it can be used as decision supportive system for HR decision makers.

2. LITERATURE REVIEW

In this part studies about human resources decision making process has been examined.

2.1 EMPLOYEE SELECTION AS AN MULTI-CRITERIA DECISION MAKING PROBLEM

Selecting the right employee is one of the key role for success at the companies (Cooper, D., Robertson, I. T., & Tinline, G. 2003). Lots of human resources departments (HR) still uses conventional methods for employee selection problems. (Taylan, O, Alidrisi, H, & Kabli, M, 2014) Employee selections is a growing multi-criteria decision problem. There are lots of MCDM method described in the Zeydan, M. & Çolpan, C. (2009). However, deterministic data are hard to model real-life problems. Because human perception and selections are often ambiguous and difficult to create model with exact numerical values. For that reason Taylan and others (2014) prefer fuzzy model, since "ratings and weights of the criteria in a real life problem can be assessed by means of fuzzy linguistic variables instead of deterministic numerical values." They said.

2.2 IMPORTANCE OF DECISION SUPPORT SYSTEMS

Necessary application of Decision Support Systems (DSS): In some cases the decision maker, in order to make a qualified decision can trust his own experience or maybe doesn't feel the necessity of another source than that has been retrieved by Managerial Information System (MIS). Especially decision makers from tactical and strategically positions frequently face situations where synthesis of complex factors are so hard so that these factors are beyond the human capabilities. These situations are appropriate for the application of DSS'. These DSS' are more flexible than MIS' and can also offer help support for various occasions; all decision steps, decision types and different structuralized problems can be dealt with. (Yildiz, O, Dağdeviren, M, & Çetinyokuş, T, 2008)

2.3 MULTI ATTRIBUTE DECISION MAKING TECHNIQUES FOR PRIORITIZATION

For appraising a collection of selections according to collections of criteria which have different units, multi attribute decision making techniques can be used. One of the biggest

advantage of multi attribute decision making techniques over traditional decision support techniques is whole criteria does not have to be converted in same unit. Besides that capability of analyzing both qualitative and quantitative criteria is a major advantage between them. Most frequently used multi attribute decision making techniques are TOPSIS, outranking and AHP.

2.3.1 TOPSIS

TOPSIS is a method which was developed by Ching-Lai, H., & Yoon, K. (1981). Multi attribute decision making problems which have m alternatives are approached as geometric system which include m points in the n-dimensional space. The method is based on the concept that the chosen alternative should have the shortest distance from the positive-ideal solution and the longest distance from the negative-ideal solution. TOPSIS create an index named similarity (or relative closeness) to the positive ideal solution and the remoteness from the negative-ideal solution. And finally the alternative with the maximum similarity to the positive ideal solution has been selected by method. (Yoon, K. P., & Hwang, C. L., 1995)

2.3.2 Outranking

The outranking decision support methods compare all set of actions. They determine actions which are preferred among others by comparing them on each criterion, instead of creating complex utility functions. Numerical results created by the comparisons, show the concordance and/or the discordance between the actions, after that it allow to make selection or sort the compared actions.

2.3.3 AHP

In literature, most popular method among them is AHP. It developed by Developed by Saaty (1980), complicated systems are divided as elements of hierarchical system. Elements of each hierarchy is compared pair wise. Then, comparisons are quantified to establish a comparison matrix, after which the eigenvector of the matrix is derived, signifying the comparative weights among various elements of a certain hierarchy. Finally, for measure to consistency ratio of the comparative matrix eigenvalue is used.

2.4 MULTI ATTRIBUTE FUZZY DECISION MAKING

As stated by Manoharan, T, Muralidharan, C, & Deshmukh, S (2011) human mind have a tendency to evaluate and forecast situations and individuals qualitatively rather than a

quantitative approach. By this means individuals prefer to express their feelings with verbal expression. With Fuzzy linguistic models we are able to analyze verbal expressions as numerical ones. Solving the ambiguity caused by verbal expressions with quantitative approach for each individual criterion represents the power of the fuzzy logic. It is convenient to use AHP to quantify and formalize a complex problem with hierarchical structure, it also utilizes paired comparisons. Developed by Saaty (1980), the AHP is a simple decision-making tool to cope with complex, unstructured and multi-attributed problems. The problem of assigning weights to PA factors is an unstructured and multi-attributed problem (Golec and Kahya 2007) and is overcome by FAHP.

2.5 FUZZY AHP APPROACHES FOR HUMAN RESOURCES TOPICS

Fuzzy AHP is used at various models and systems. Some problems of human resources managers frequently met in practice are, applicant selection for vacancy, compliance of employees to requirements of employer, succession plans, career, selection of key employees, awarding compensation etc. some of these problems can be analyzed with Fuzzy logic. But in general Fuzzy used for performance evaluation and recruitment decisions. As a personnel evaluation and selection criteria Fuzzy set theory have been proposed by various researchers such as Miller and Feinzing (1993), Karsak (2001), Capaldo and Zollo (2001) and Jessop (2004). Albayrak and Erensal (2004) in order to determine the weights for different management styles that improves human performance, have used FAHP. Also Chen and Cheng (2005) put forward a fuzzy clustering support system for decision making using FAHP to solve data system in personnel selection problem.

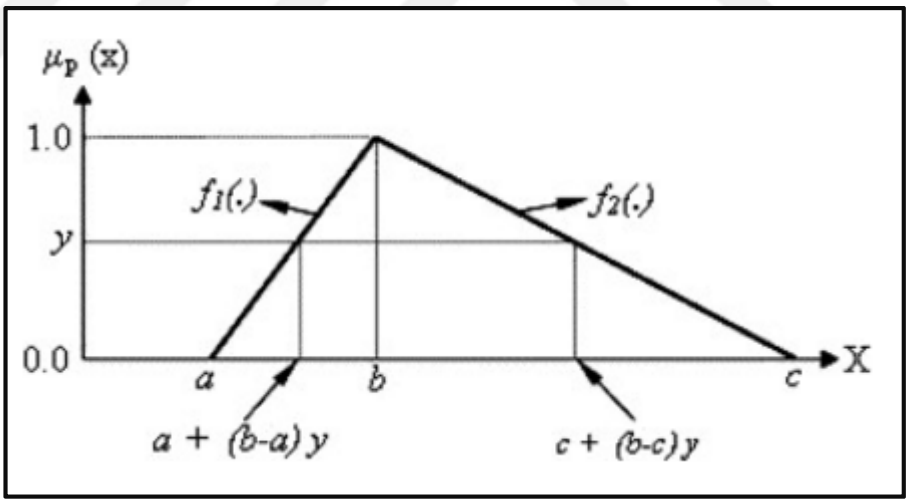
Personnel selection seems the most important role at controlling the human source and quality in Human Resources (Hooper, R. S. and others, 1998). Selecting a personnel effectively is one of the key component of a company's success. Personnel selections process was formed as collecting and evaluating information about applicants and choosing who are suitable for company and predefined job in the best way (Akhlaghi, E., 2011). There are lots of heuristic method studies for personnel selection problems. Personnel selection system based on fuzzy AHP was developed by Güngör and others (2009).

2.6 FUZZY SETS AND NUMBERS

For performing decision analysis with probability theory, data has to be adequately objective. Unfortunately, in real life, enough data to perform decision analysis are not encountered frequently. For that reason experts' knowledge in modelling intellectual capital and its components becoming a need of decision makers. To deal quantitatively with imprecision or uncertainty, fuzzy set theory is primarily concerned with vagueness in human thoughts and perceptions (Beskese, A., Kahraman, C., & Irani, Z. 2004)

To capturing the uncertainty of the parameters specific forms of LR-type fuzzy numbers used, these are triangular and trapezoidal. These type of fuzzy numbers arithmetic calculations mentioned in Zimmermann, H. J. (2001). Triangular fuzzy numbers will be used in this study for dealing the fuzziness of measurement criteria. Triangular fuzzy numbers are nominated as $P = (a, b, c)$. Its graphical description is shown in Figure 2.1 where $f_1(\cdot)$ representing the left side and $f_2(\cdot)$ representing to right side of the triangular fuzzy numbers.

Figure 2.1: A triangular fuzzy number



2.7 CRITERIA FOR HUMAN CAPITAL MEASUREMENTS

Human capital is composition of employee's problem solving capabilities, common and professional knowledge, abilities to lead and risk perception. It's not possible to define human capital in certain framework. Bontis (1998) describes human capital as "The firm's collective capability to extract the best solutions from the knowledge of its individuals." For maximizing the human capital at a firm, there are five main attributes (Becker, B. E., Huselid, M. A., & Ulrich, D. 2001). These attributes are talent, integration, enabling a

performance based culture, capability and leadership. Bozbura, F. T., Beskese, A., & Kahraman, C. (2007) included talent and leadership at their model like proposed by Becker et al (2001) but changed the "integration" concept and named it as "strategical integration" and same thing applied to "enabling a performance based culture" and it named as "cultural relevance". As a final attribute, they prefer to use "knowledge management" instead of "capabilities". Sub-attributes of these five main attributes are mentioned below;

Firstly starting with Talent, talented employees at a firm must be chosen and their engagement has to be strengthen. Making investment in employees for increasing their visions, capabilities and experience is one of the key success factor for successful companies. For that reason growing the talent pool, reaching the high potential development and reducing turnover are highly critic for managing the human capital. With that information main attribute talent is characterized over four sub-attributes: growing the talent pool; high potential development; select, assimilate and retain key talent; reduce turnover.

Secondly Strategical integration, it is characterized over three sub-attributes: organizational strategy; industry trends; integrated human capital technology infrastructure.

The third one cultural reverence, Building connection between employees and organizational mentality has to be part of a firm's culture. For that reason cultural reverence has two sub-attributes: relationship building, and coordination of human capital systems to build organizational mentality.

The fourth main attribute is knowledge management. The firm generates value from what it knows through the organizational processes of knowledge creation, knowledge transfer and knowledge utilization (Choo, C. W., & Bontis, N., 2002). For that reason knowledge management has been characterized over three sub-attributes: knowledge creation; knowledge transfer and knowledge utilization.

Last but not least attribute is leadership has been characterized over two sub- attributes: organizational leadership, and social responsibility.

There are fifty three efficiency criteria are defined by Becker et al (2001) for measuring to human resources efficiency at a firm. On the other hand Abeysekera, I., & Guthrie, J. (2004) discribe human capital with twenty five indicators. Bontis, N., Chua Chong Keow, W., & Richardson, S. (2000) lists twenty indicators for human capital.

In this study we establish a model with five main criteria and under them there are eighteen sub criteria. Indicators are not used in this study because our sub criteria are directly giving outcome and most of them is not directly affected by others data. In case of indicators we use coefficients for establishing sub criteria scores.

2.8 HUMAN BEHAVIOR AND PERFORMANCE EVALUATION

In his paper Gbadamosi (2012) concludes that human behavior is complicated and complex which makes it harder to make use of it in a deterministic performance evaluation environment. In order to overcome this hardship one has to go beyond the mastery of rhetoric and untested concepts. Studies and data that has been done in a single country most of the time doesn't have much strength because it opens up small opportunity of comparison or generalization because of the small amount of data obtained in a single country. Therefore this kind of research has to expand beyond borders and be made world widely.

According to Aktepe and Ersoz (2012), there are debates on the employee performance evaluation in literature. They also point out reasons as "it is mostly based on subjective evaluations" and also current models do not give us an elaborate medium that which is applicable. For that reason ın this study we try to develop a data based, objective decision support system for employee evaluation. Their studies purpose is to "bridge the gap" in the topic of interest by producing an organic (continually improving) methodology that bases a performance management process model given by Pulakos (2009). In their work they also used Barutçugil's (2002) quantitative perspective.

Bennett, K, Frain, M, Brady, M, Rosenberg, H, & Surinak, T (2009) discuss in their paper that the view of the work quality and performance evaluation can have various perspectives that can give different results. They compare the evaluation of the employee for himself and the evaluation made by the supervisor and/or employer for the employee by which he states that employer might have a tendency to see the mistakes and the parts of the job that hasn't been done correctly or maybe the employee might be

"overconfident" of his abilities. Their study and discussion shows the ambiguity in the field of employee evaluation.

2.9 LOYALTY AND EMPLOYEE SATISFACTION:

Matzler and Renzl Concluded that studies have shown the strong inter effectivity of organizational commitment and loyalty with employee satisfaction. (e.g. Mak & Sockel, 2001; Martensen & Gronholdt, 2001) Tekleab, A. G., Takeuchi, R., & Taylor, M. S. 2005) also conludes that the employee satisfaction is negatively related to turnover and also Muchinsky, P. M. (1977) sees this cross effect with absenteeism in his research. Griffeth, R. W., Hom, P. W., & Gaertner, S. (2000) also correlates the employee turnover with employee satisfaction that which includes job satisfaction and facet satisfaction as strong predictors for the matter. With all these supports Matzler, K, & Renzl, B (2006), concludes that Employee Satisfaction is positively related to employee loyalty.

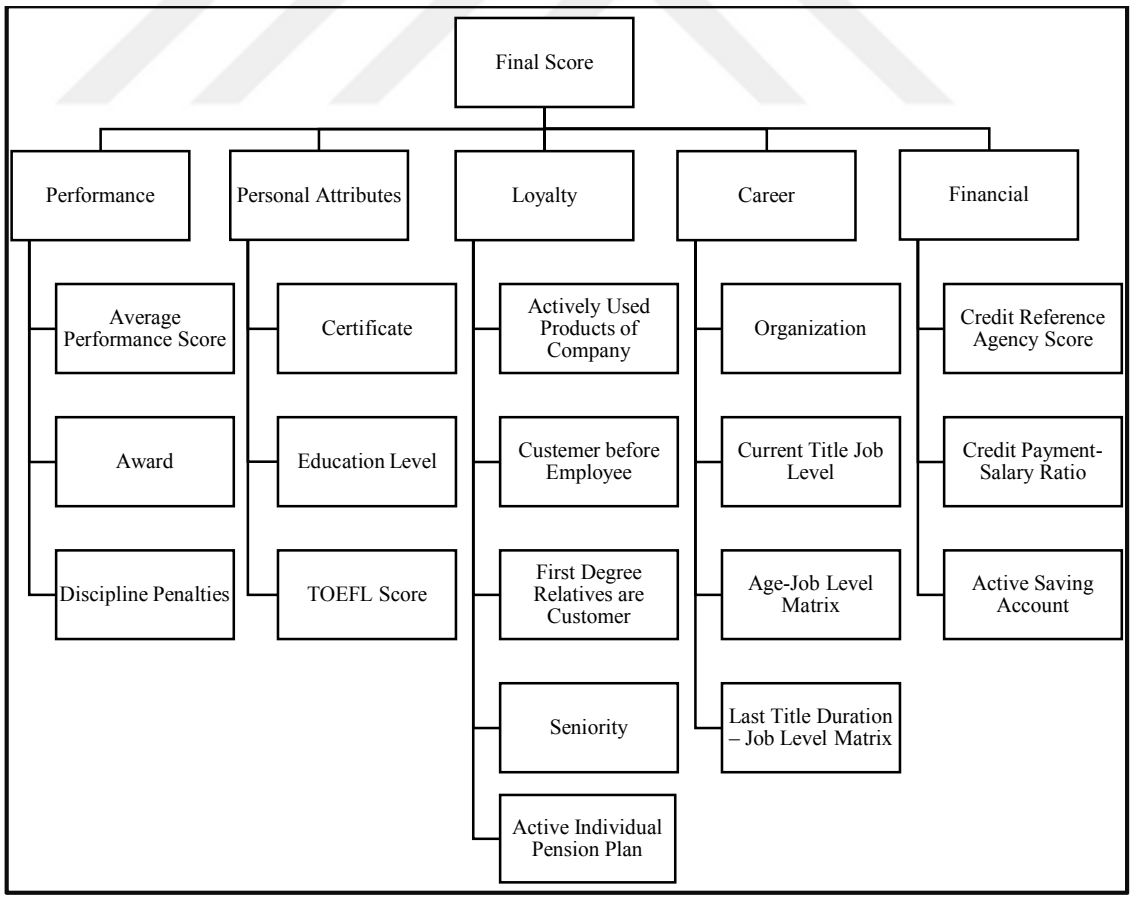
Benevolence have been defined as of three actions: Taking care of the employees' needs and interests, protecting the employees' benefit and avoiding to be unjust in a sense that preventing one's benefit becoming superior to another. Researchers have concluded that this kind of managerial loyalty supports and increases the trust between manager and employee. (Matzler, K, & Renzl, B 2006)

3. DATA AND METHODOLOGY

3.1 CRITERIA

At the starting point of the study, all the data which can be measured about to employee has been listed, there are hundred and fourteen different data. After that we eliminate them according to effect and health of the data. At last there are eighteen data left and they are grouped at five different criteria. In this groups called as main criteria and eighteen data called as sub criteria. With the methods discussed at header 3.2 and 3.3, we calculated weight of sub criteria. Our main criteria are performance, loyalty, career, financial and personal attributes, all of them and their sub criteria will be explained at below. Every main criteria has hundred points and these points distributed among sub criteria according to their weights.

Figure 3.1: Criteria and sub criteria hierarchy figure



3.1.1 Performance.

Performance evaluation is performed with advanced systems most of the corporate companies. Employee's career, compensation, bonus etc. effected by their performance scores. Besides that, studies shown that, job satisfaction and performance have strong positive relationship (Imran, Arif, Cheema and Azeem, 2014). In the banks with the advanced performance evaluation system, there is two supportive system with it, discipline and awards. That supportive systems used as sub criteria for Performance score.

3.1.1.1 Average performance score

Performance score is final outcome of performance systems. In some banks it include competence some not. And some of them make evaluation two times a year, some of them four. In this study we put only end of year evaluation scores into perspective. Performance scores can increase or decrease year to year for that reason in this study we decided to use average and the development of the last three years performance score and effects of the to minimize the effect of change. Final performance scores and coefficients shown in Table 3.1.

Table 3.1: Average Performans Score Coefficients

Av. Perf.	Coefficient	Av. Perf.	Coefficient	Av. Perf.	Coefficient	Av. Perf.	Coefficient	Av. Perf.	Coefficient
1.0	0.00	**2.0**	0.17	**2.8**	0.30	**3.7**	0.50	**4.5**	0.83
1.3	0.00	**2.2**	0.17	**3.0**	0.33	**3.8**	0.60	**4.7**	0.90
1.5	0.00	**2.3**	0.17	**3.2**	0.33	**4.0**	0.67	**5.0**	1.00
1.7	0.00	**2.5**	0.23	**3.3**	0.40	**4.2**	0.67		
1.8	0.17	**2.7**	0.27	**3.5**	0.50	**4.3**	0.73		

3.1.1.2 Discipline penalties

Discipline penalties can be given as warning and/or punishment, there are different kind of discipline penalties and different kind of effects of them. Cause of discipline penalties vary performance decrease to violation of policies. Like the effect of coming to the job late and damaging company financially is different we differentiate the weights of discipline penalties. There are 5 discipline penalties we weighted, they are, warning,

written warning, censure, heavy censure, demotion of title and/or level. Their weights are one, two, three, four and five respectively. For calculating discipline penalties score we sum up weights of every active discipline penalties. Coefficients of total discipline penalties score is shared at Table 3.2. This criterion works reversely, with the total discipline penalties increase score gained from this criterion is decreased.

Table 3.2: Discipline Penalties Score Coefficients

Total Discipline Penalties Score	Coefficient
0	1.0
1	0.9
2	0.8
3	0.5
4	0.3
5	0

3.1.1.3 Award

Most of the corporate company and banks have several award programs for employees. These awards can be given for outstanding performance, team play or ethical behavior of employee. In our study we divide award into three group, which are, achievement award, team award and project award. Their weights are one, two and three respectively. Coefficients of total award score is shared at Table 3.3.

Table 3.3: Award Score Coefficients

Total Award Score	Coefficient
6+	1.0
4-5	0.9
3	0.7
2	0.4
1	0.2
0	0

3.1.2 Loyalty

Employee loyalty is personal faith in to organization, feeling that they are bounded not only for mutual advantage, sense of responsibility and affection to organization. Loyalty or employee engagement generally measured with surveys. But other than the surveys there are measurement for loyalty, but it can be changed by company to company. For some company, preferring their products defining as loyalty, for some company investing as shareholder. In this study we use five sub criteria for measuring loyalty of employees, these are, "how many company product they use actively", "are they customer before they become employee?", "are their first degree relatives customer?", seniority and "are they use individual pension which provided by company".

3.1.2.1 Number of actively used company products

Most of the companies expect their employee prefer their product. Generally employee engagement surveys have questions about usage of company products. In this study we use the number of actively used different products of company, some major of them are listed at Table 3.6. Score calculation is start with one product and one product don't gain any score, because all employee receiving salary from company, everyone have at least one active bank account. After that all scores distributed according to number of employee whom uses that number of product, score coefficients shown in Table 3.4.

Table 3.4: Active Product Count Coefficients

Active Product Count	**Score Coefficients**
Active Product Count > 5	1.00
Active Product Count = 5	0.90
Active Product Count = 4	0.83
Active Product Count = 3	0.52
Active Product Count = 2	0.21
Active Product Count = 1	0.00

3.1.2.2 Becoming customer before employee

Customers are always valuable for companies, because they prefer them among their rivals. If someone preferring company before she became employee she have more

valuable and loyal from employee became customer after getting to job. In some cases candidates opening account before they apply the job, for eliminating that kind of things we consider only the account creation date is min six month before starting date of employment. If an employee opened their firs account before six month, she gain score according to weight of this sub criterion in loyalty criterion.

3.1.2.3 Are the first degree relatives of employee customer?

Using a product and recommending it is result of a different degree of engagements. Suchlike this if an employee convince her relatives to use company products, she is more engaged to company then who is not convinced her relatives. For gaining score at this sub criteria at least one of the employee's relatives which are defined at HR system have an active account.

3.1.2.4 Seniority

Long serving employees which gave 10 or more year to the company is becoming like the family member for company regardless to her title. Even long serving security staffs are revered among other employees and management most of the time. For including this sign of respect in our study we added seniority as a sub criterion. Seniority sub criterion divided in six groups of score coefficient according to distribution (Figure 3.1) of employees' seniorities shown in Table 3.5

Figure 3.2: Distribution of Seniority

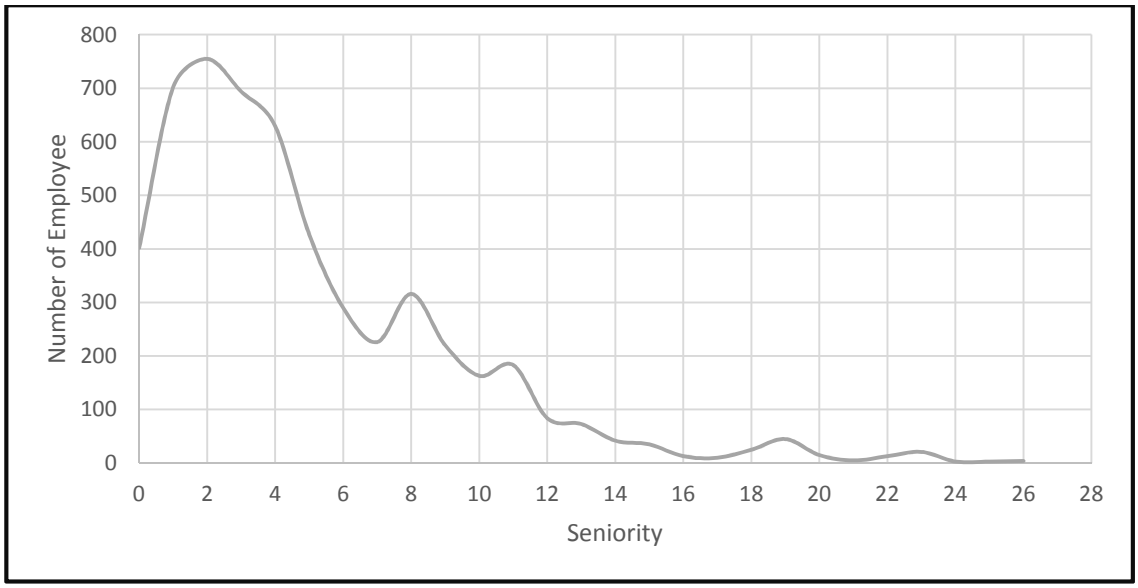


Table 3.5: Seniority Groups Score Coefficients

Seniority Group	Score Coefficients
13≤Seniority	1.00
8≤Seniority<13	0.70
4≤Seniority<8	0.50
2≤Seniority<4	0.33
Seniority<2	0.00

3.1.2.5 Having an individual pension plan

Most of the companies have a special individual pension plan for their employee. In this plan if employee pays minimum amount according to her base salary to plan, company pays according to base salary as supplementary contribution. For deserving that supplementary savings employee have to work at least five year after individual pension plan started. Having an individual pension is counts as loyalty criteria because of that five year waiting time. If employee have active individual pension plan on HR system gain score according to weight of the sub criterion.

Table 3.6: Products Activation Conditions

Product	Condition for Activation
Bank Account (different currencies count as different product)	Have an active account with any amount of money
Saving Account (different currencies count as different product)	Have an active saving account with significant amount of money
Credit Card (2 different type cart all count as different product)	Minimum 5 time usage in last 6 month
Consumer Credit	Have an active payment plan
Bill Payment Order	Minimum 1 active order
Deposit Box at Branch	Have active deposit box

3.1.3 Career

Career is basically person's life, it includes person's education, training, charity or professional job life, family etc. In this study we take career as employee's history and current status at current organization. If we divide career as history and current, history is employee's seniority, promotions, old departments etc. and current is ongoing title, organization etc. There are four sub criteria under Career which are, Current Organization, Current Title Job Level, Age-Job Level Matrix, Last Title Duration – Job Level Matrix.

3.1.3.1 Current Organization

There are lots of different organization at the corporate companies. Every one of them have different responsibilities. Even every one of them has a vital part of the company, their roles are differentiated. Like their roles, employee qualification are differentiated, for example employee at call centers even can be high school graduated, IT employees should have bachelor's degree.

For that reason ın this study we divided organizations at three groups. In first group there are organizations which have highly qualified employees and working on analytics or critic information. As an example of that organizations, whole IT departments, strategic project managers, analytical banking etc. In second group there are mid qualified employees and departments which work on less analytical jobs but still as a position as decision makers. And at the last group, there are operation management departments, like call center, and payment operations. This grouping applied at branches too, but not according to organizations but in responsibilities of employees. Employees which are work at Corporate Sales in group one, Commercial, SME and Retail Sales are in group two and Branch Operations be positioned in group 3. Score coefficients of groups are shown in Table 3.7.

Table 3.7: Organization Group Coefficients Table

Organization Groups	Score Coefficients
Group 1	1.00
Group 2	0.59
Group 3	0.10

3.1.3.2 Current title job level

All employees have responsibilities at companies and this responsibilities are increasing in parallel with their titles. With increasing responsibilities, in any case of leave filling that positions is getting harder. For that reasons title of employees are important for decisions which involving them. For example if there is a specific and expensive education and limited participation companies generally prefer senior employees for participate. But title may change department to department, for comparing apples to apples we gave every title a level, and use that levels as in our study. Levels are starting with 10 (Attendant, Security) and end with 70 (Manager) above the Manager title is not included in the study. Score coefficients of Job Title Levels are shown in Table 3.8

Table 3.8: Current Title Job Level Score Coefficients

Job Title Level	Score Coefficients
Job Level 70	1.00
Job Level 60	0.83
Job Level 50	0.62
Job Level 40	0.41
Job Level 30	0.31
Job Level 20	0.21
Job Level 10	0.10

3.1.3.3 Age-Job Level Matrices

In a professional life, some people create miracles, and their career develop like a rabbit and some people carrier develop like turtle. And absolutely their careers have different values in the eyes of management. For example one employee became manager in her twenty eight and another employee still waiting for became supervisor at her thirty five, absolutely first one is brighter than the other in the eyes of management. For including this point of view in our study we develop a coefficient matrices be formed with, age groups and job level. The matrix shown in Table 3.9.

Table 3.9: Age-Job Level Matrix

Age Group \ Job level	10	20	30	40	50	60	70
20-25	0.5	0.6	0.5	0.9	1.0	1.0	1.0
26-27	0.5	0.5	0.4	0.7	0.9	1.0	1.0
28-29	0.5	0.3	0.3	0.5	0.7	0.8	1.0
30-35	0.5	0.1	0.1	0.3	0.5	0.7	0.9
36-40	0.5	0.1	0.1	0.1	0.2	0.5	0.8
40+	0.5	0.1	0.1	0.1	0.2	0.3	0.7

3.1.3.4 Last Title Duration – Job Level Matrix

Seniority in a company is important regardless to the title, besides that duration at the current title of the employee have importance. Importance of that duration differentiated according to job levels because staying as junior positon in ten years is not a preferable situation besides that staying in managerial position in ten years is preferable situation. For including this situations our study we develop a coefficient matrices be formed with, last title duration and job level. The matrix shown in Table 3.10.

Table 3.10: Last Title Duration – Job Level Matrix

Last Title Duration \ Job Level	10	20	30	40	50	60	70
0 ≤ LTD < 2	0.1	1.0	1.0	1.0	1.0	0.2	0.2
2 ≤ LTD < 4	0.2	1.0	1.0	1.0	1.0	0.3	0.3
4 ≤ LTD < 6	0.4	0.6	0.6	0.6	0.7	0.5	0.5
6 ≤ LTD < 8	0.7	0.2	0.2	0.2	0.5	0.8	0.8
8 ≤ LTD	1.0	0.1	0.1	0.1	0.2	1.0	1.0

3.1.4 Financial

Employee's financial status and habits effect their job performance (Garman, Leech and Grable, 1996) and for some cases employee's distressed financial status become risky for job. Especially in banking business, employee's financial status controlled regularly. In Turkey banks making that control over KKB (Credit Reference Agency) score of the employee. In this study, we use KKB score as one of the sub criteria, besides that we use active Saving Account and Credit payment – salary ratio as sub criteria as total of three.

3.1.4.1 Credit reference agency (KKB) score

In Turkey credit reference agency form a score for every citizen which are used at least one financial service. Score is a numerical indicator calculated for foreseeing the repayment performance of a consumer compared to another consumer for the credit received or will be received from a KKB member institution. Score is a decision supporting product generated by using a statistical model. KKB score is integer starting with 0 and end with 1900, 1900 is the best score. Scores grouped in five risk groups. These groups, their score ranges and coefficients are shared at Table 3.11 respectively.

Table 3.11: KKB Score Groups & Coefficients

	High Risk	Medium Risk	Low Risk	Good	Very Good
Range	0 – 799	800 – 1299	1300 – 1499	1500 – 1699	1700 – 1900
Coeff.	0	0.25	0.50	0.80	1.00

3.1.4.2 Active saving account

Have a saving account is an indication of balanced or less risky financial life. For that reason when an employee has an active saving account (activation conditions shown in Table 3.4) gain scores at this criterion.

3.1.4.3 Credit Payment / Salary Ratio

Urge of having a house, car or other expensive good, drive the salaried employee to use credit. Besides that within today's consumption habits force employees to use credit card and making tally trade. For that reasons credit payments and credit card receipts can climb over the employee's salary. With these climbed over payments, employees get trapped by debt and become demotivated and depressed. For implicating these situation to our

analysis credit payment / salary ratio added as sub criteria. At the most of the companies salary is classified information for that reason we use average salary for positions. Using average salary have a disadvantage for employee which have higher salary than average affected negatively in this sub criteria. For that reason our coefficients (shown in Table 3.12) designated as widely ranged through high ratio.

Table 3.12: Credit Payment / Salary Ratio Coefficients

Credit Payment / Salary Ratio	Coefficient
Credit Payment / Salary Ratio <=0.2	1.00
0.2> Credit Payment / Salary Ratio <=0.3	0.86
0.3> Credit Payment / Salary Ratio <=0.5	0.71
0.5> Credit Payment / Salary Ratio <=0.7	0.57
0.7> Credit Payment / Salary Ratio <=1	0.30
1.0> Credit Payment / Salary Ratio <=2	0.20
2.0> Credit Payment / Salary Ratio <=3	0.14
Credit Payment / Salary Ratio >3	0.00

3.1.5 Personal Attributes

Personal Attributes are specialty that creates characteristic of a person. It's about who is the women, and they are independent from company or working area. For this study, certificates, education level, university rating and TOEFL score put in the perspective.

3.1.5.1 Certificates

Having a certificates about related topic of working area increase the value of employee. Relevance of certificates have to store in database and must be grouped, for example basic banking certificate and project management certificate needed to different effects. In our study we divide certificates into four group, which are irrelevant, slightly relevant, relevant and strongly relevant. Their weights are zero, one, two, three and four respectively. Coefficients of total certificate score is shared at Table 3.13.

3.1.5.2 Education level

Education level and job satisfaction have positive relations between them (Gürbüz, 2011). Besides that higher educated employees creates environment of confidence for managers and company. In addition to that, in banking there are some jobs which have to be done by employees who have min bachelor's degree or higher. For that reasons education level

has important for comparing employees. Coefficients for education levels in this study are shown in Table 3.14.

Table 3.13: Total Certificate Score Coefficients

Total Certificate Score	Coefficient
8	1.0
7	0.9
6	0.8
5	0,7
4	0.6
3	0.4
2	0.2
1	0.1
0	0

3.1.5.3 English proficiency exam score

Employees' English knowledge is important for foreign capital banks and banks which have international organizations. Some of the banks even prepare benefit package for English knowledge. For that reason ın this study we use TOEFL score as an sub criterion. We separated coefficients into three groups which shown in Table 3.15

Table 3.14: Education Level Score Coefficients

Education Level	Score Coefficient
Doctorate	1
Master	0.75
Bachelor's Degree	0.60
Associate's Degree	0.25
High School	0.10
Elementary School & Below	0.00

Table 3.15: TOEFL Score Coefficients

TOEFL Score	Score Coefficient
Score ≥ 100	1.0
100 > Score ≥ 80	0.7
100 > Score ≥ 70	0.5
No Score	0

3.2 AHP METHOD

At the starting point of our study, we use AHP method, via surveying to HR managers for defining weight of the criteria. For our AHP model we use 1-9 scale at survey they shown in Table 3.16. Despite the fact AHP able to reflect human opinions mostly, it generally incapable of appropriately intrinsic uncertainty. For that reason we improve our study with using Fuzzy AHP (FAHP)

Table 3.16: AHP linguistic vs numeric scale table

Linguistic Scale	Numeric Scale
Equally important	1
Weakly important	3
Essentially important	5
Very Strong important	7
Absolutely important	9
Intermediate Values	2, 4, 6 ve 8

3.3 **FAHP**

There are several FAHP methods for prioritization, selection and justification problems. Basic information and comparisons shown in the Table 3.17. Some of that method, comparisons and information about them can be found Bozbura and Beskese (2007).

Table 3.17: The comparison of different fuzzy AHP methods

Sources	**The main characteristics of the method**	**Advantages (A) & disadvantages (D)**
Van Laarhoven, P. J. M., & Pedrycz, W. (1983).	• Direct extension of Saaty's AHP method with triangular fuzzy numbers • Lootsma's logarithmic least square method is used to derive fuzzy weights and fuzzy performance scores	(A) The opinions of multiple decision-makers can be modeled in the reciprocal matrix
		(D) There is not always a solution to the linear equations
		(D) The computational requirement is tremendous, even for a small problem
		(D) It allows only triangular fuzzy numbers to be used
Buckley, J. J. (1985).	• Extension of Saaty's AHP method with trapezoidal fuzzy numbers • Uses the geometric mean method to derive fuzzy weights and performance scores	(A) It is easy to extend to the fuzzy case
		(A) It guarantees a unique solution to the reciprocal comparison matrix
		(D) The computational requirement is tremendous
Boender, C. G. E., De Graan, J. G., & Lootsma, F. A. (1989).	• Modifies van Laarhoven and Pedrycz's method • Presents a more robust approach to the normalization of the local priorities	(A) The opinions of multiple decision-makers can be modeled
		(D) The computational requirement is tremendous
Chang, D. Y. (1996).	• Synthetical degree values • Layer simple sequencing • Composite total sequencing	(A) The computational requirement is relatively low
		(A) It follows the steps of crisp AHP. It does not involve additional operations
		(D) It allows only triangular fuzzy numbers to be used
Cheng, C. H. (1997).	• Builds fuzzy standards • Represents performance scores by membership functions • Uses entropy concepts to calculate aggregate weights	(A) The computational requirement is not tremendous
		(D) Entropy is used when probability distribution is known
		(D) The method is based on both probability and possibility measures

Büyüközkan, G., Kahraman, C., & Ruan, D. (2004)

We prefer Buckey's (1985) FAHP method for determining the weight of the main and sub criteria. The reason we prefer Buckey's method is, it is simple to develop to the fuzzy and certainly create unique solution to the comparison matrix (Bozbura and Beskese, 2007)

In this study we have five main and eighteen sub criteria for our hierarchical model as can be seen in Figure 3.1. Sub criteria's weights are calculated according to surveys and fixed as constant weight at FAHP of five main criteria. On the other hand, main criteria's weight is not constant, we create a dynamic survey excel which can be edited for different cases of decisions. For example weight of loyalty criterion can be different for assigning a branch manager than assigning employee to expensive education. Data collected from surveys are from linguistic scale, we convert them to Triangular Fuzzy Numbers (TFNs) as shown in Table 3.18.

Table 3.18: Lingusitic Scale for TFN Weight Matrix

Linguistic Scale	**Numeric Scale**
Just Equal	(1,1,1)
Equally important	(1,1,3)
Weakly important	(1,3,5)
Essentially important	(3,5,7)
Very Strong important	(5,7,9)
Absolutely important	(7,9,9)
Note: Adapted from Kahraman and Cebi (2009)	

These surveys are combined as decision matrices as below;

$$\tilde{A} = \begin{vmatrix} \mathbf{1} & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & \mathbf{1} & & \tilde{a}_{2n} \\ \vdots & & \ddots & \\ \tilde{a}_{m1} & \tilde{a}_{m2} & \cdots & \mathbf{1} \end{vmatrix} \quad \textbf{(3.1)}$$

Where $\tilde{a}_{ij}$ stand for the TFN for comparing criteria *i* and *j*'s according to surveys. When creating matrices according to surveys, TFN values used as like as below;

$$\tilde{a}_{ij} = \begin{cases} \boldsymbol{i > j}, & \boldsymbol{(1,1,3),(1,3,5),(3,5,7),(5,7,9),(7,9,9)} \\ \boldsymbol{i = j}, & \boldsymbol{(1,1,1)} \\ \boldsymbol{i < j}, & \boldsymbol{\left(\frac{1}{3},1,1\right),\left(\frac{1}{5},\frac{1}{3},1\right),\left(\frac{1}{7},\frac{1}{5},\frac{1}{3}\right),\left(\frac{1}{9},\frac{1}{7},\frac{1}{5}\right),\left(\frac{1}{9},\frac{1}{9},\frac{1}{7}\right)} \end{cases} \quad \textbf{(3.2)}$$

i>j means that criterion *i* is more important than criterion *j, i=j* means that *i* and *j* criteria are exactly equal, and *i<j* means that criterion *j* is more important than criterion *i*.

After that, the fuzzy weight matrix is computed according to Buckley's Method as adaptation on Kahraman and Cebi (2009) as shown below;

$$\boldsymbol{r_i} = \sqrt[n]{\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \cdots \otimes \tilde{a}_{in}} \quad \textbf{(3.3)}$$

$$\boldsymbol{\varpi_i} = \boldsymbol{r_i} \otimes (\boldsymbol{r_1} \oplus \boldsymbol{r_2} \oplus \cdots \oplus \boldsymbol{r_n})^{-1} \quad \textbf{(3.4)}$$

Where $\tilde{a}_{ij}$ stand for the fuzzy's comparing criteria *i* and *j*'s, $\boldsymbol{r_i}$ is the geometric mean of fuzzy comparison value of criterion *i* to each criterion, $\boldsymbol{\varpi_i}$ is the weight of criterion *i,* and $\oplus$ is the fuzzy addition sign.

After the computed the fuzzy weights, defuzification and normalization were performed simultaneously by formula (5):

$$\boldsymbol{\omega_r} = \frac{\boldsymbol{\varpi_r}}{\sum_{i=1}^{n} \boldsymbol{\varpi_i}} = \frac{\boldsymbol{\omega_{rl}} + \boldsymbol{\omega_{rm}} + \boldsymbol{\omega_{ru}}}{\sum_{i=1}^{n} \boldsymbol{\varpi_i}} \quad \textbf{(3.5)}$$

Where the importance weight of the rth criterion, ω_r, is a crisp number and n is the total number of criteria.

3.4 NUMERICAL EXAMPLE

HR Analytics model was developed for Turkish Bank and it is using actively. In this example case we compare two department manager candidate in company. As an example firstly we calculate weights of sub criteria's under performance main criteria. Other weights calculations are shared at appendix. After that, we share the specifications of our test employees and calculate their main criteria scores with them.

3.4.1 Calculation of Weights

For calculating the weights of sub criteria we built pair-wise comparison matrices for sub criterions, shown in Table 3.19

Table 3.19: Pair-wise comparison matrix for sub criteria of performance

Sub Criteria	Average Performance Score	Discipline Regulations	Award
Average Performance Score	(1,1,1)	(1,1,3)	(3,5,7)
Discipline Regulations	(1/3,1,1)	(1,1,1)	(1,3,5)
Award	(1/7,1/5,1/3)	(1/5,1/3,1)	(1,1,1)

With the values at matrix, r_i values are calculated according to equation (3.3).

Performance Score	Discipline Regulations	Award
$r_{1l} = \sqrt[3]{1 \times 1 \times 3} = 1.44$	$r_{2l} = \sqrt[3]{\frac{1}{3} \times 1 \times 1} = 0.69,$	$r_{3l} = \sqrt[3]{\frac{1}{7} \times \frac{1}{5} \times 1} = 0.31$
$r_{1m} = \sqrt[3]{1 \times 1 \times 5} = 1.71$	$r_{2m} = \sqrt[3]{1 \times 1 \times 3} = 1.44$	$r_{3m} = \sqrt[3]{\frac{1}{5} \times \frac{1}{3} \times 1} = 0.41$
$r_{1u} = \sqrt[3]{1 \times 3 \times 7} = 2.76,$	$r_{2u} = \sqrt[3]{1 \times 1 \times 5} = 1.71,$	$r_{3u} = \sqrt[3]{\frac{1}{3} \times 1 \times 1} = 0.69.$
$\boldsymbol{r_1}$ **= (1.44, 1.71, 2.76);**	$\boldsymbol{r_2}$ **= (0.69, 1.44, 1.71);**	$\boldsymbol{r_3}$ **= (0.31, 0.41, 0.69);**

With calculated r_i values, weights of the sub criteria are calculated according to Equation (3.4);

Performance Score	Discipline Regulations	Award
$\varpi_{1l} = \frac{r_{1l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{1.44}{2.76 + 1.71 + 0.69}$ $= 0.28$	$\varpi_{2l} = \frac{r_{2l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.69}{2.76 + 1.71 + 0.69}$ $= 0.13$	$\varpi_{3l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.31}{2.76 + 1.71 + 0.69}$ $= 0.06$
$\varpi_{1m} = \frac{r_{1m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.71}{1.71 + 1.44 + 0.41}$ $= 0.48$	$\varpi_{2m} = \frac{r_{2m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.44}{1.71 + 1.44 + 0.41}$ $= 0.41$	$\varpi_{3m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{0.41}{1.71 + 1.44 + 0.41}$ $= 0.11$
$\varpi_{1u} = \frac{r_{1u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{1.44}{1.44 + 0.69 + 0.31}$ $= 1.13$	$\varpi_{2u} = \frac{r_{2u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{1.71}{1.44 + 0.69 + 0.31}$ $= 0.70$	$\varpi_{3u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{0.69}{1.44 + 0.69 + 0.31}$ $= 0.28$
$\boldsymbol{\varpi_1} = (\mathbf{0.28}, \mathbf{0.48}, \mathbf{1.13})$	$\boldsymbol{\varpi_2} = (\mathbf{0.13}, \mathbf{0.41}, \mathbf{0.70})$	$\boldsymbol{\varpi_1} = (\mathbf{0.06}, \mathbf{0.11}, \mathbf{0.28})$

Defuzzificated and normalized crisp values are calculated according to Equation (3.5);

$$w_1 = \frac{0.28 + 0.48 + 1.13}{0.28 + 0.48 + 1.13 + 0.13 + 0.41 + 0.70 + 0.06 + 0.11 + 0.28} = 0.527$$

$$w_2 = \frac{0.13 + 0.41 + 0.70}{0.28 + 0.48 + 1.13 + 0.13 + 0.41 + 0.70 + 0.06 + 0.11 + 0.28} = 0.346$$

$$w_3 = \frac{0.06 + 0.11 + 0.28}{0.28 + 0.48 + 1.13 + 0.13 + 0.41 + 0.70 + 0.06 + 0.11 + 0.28} = 0.127$$

All the sub criteria weights calculated similarly. Weights of all sub criteria shared at Table 3.20

Table 3.20: Sub Criteria Weights

PERFORMANCE		PERSONAL ATTRIBUTES		FINANCIAL	
Sub Criteria	**Weight**	**Sub Criteria**	**Weight**	**Sub Criteria**	**Weight**
Average Performance Score	0.527	Education Level	0.705	Credit Reference Agency Score	0.488
Discipline Penalties	0.346	TOEFL	0.225	Active Saving Account	0.305
Award	0.127	Certificate	0.070	Credit Payment - Salary	0.207
CAREER		**LOYALTY**			
Sub Criteria	**Weight**	**Sub Criteria**	**Weight**		
Organization	0.473	Actively Used Products of Company	0.050		
Current Job Level	0.319	Customer Before Employee	0.187		
Age - Job Level Matrix	0.102	First Degree Relatives Are Customer	0.122		
Last Title Duration-Job Level	0.105	Active Individual Pension Plan	0.438		
		Seniority	0.203		

3.4.2 Candidate Employee Data

We have two example employee who are working at HR. In this example we use our system for calculating scores of every sub & main criteria and draw a comparison graph. Data of examples are shown in

Table 3.21. With the data provided we calculate sub criteria scores with using equation (3.6). Calculated scores are shared at Table 3.22

$$\textbf{Value Coefficient} \times \textbf{Sub Criteria Weight} \quad \textbf{(3.6)}$$

Table 3.21: Candidate Employee Data

CRITERIA	Candidate 1	Candidate 2
PERSONAL ATTRIBUTES		
Education Level	Bachelor's Degree	Master
TOEFL SCORE	85	95
Certificate	5	0
FINANCIAL		
Credit Reference Agency Score	1835	1809
Active Saving Account	Yes	No
Credit Payment - Salary Ratio	0.35	0.40
CAREER		
Organization	HR	HR
Current Title Job Level	60	40
Age - Job Level Matrix	34 - 60	25 - 40
Last Title Duration-Job Level Matrix	2.33 - 60	1.58 - 40
LOYALTY		
Actively Used Products of Company	5 +	3
Customer Before Employee	No	Yes
First Degree Relatives Are Customer	Yes	No
Seniority	10.6	3.4
Active Individual Pension Plan	Yes	Yes
PERFORMANCE		
Average Performance Score	3.5	4
Discipline Penalties	0	0
Award	2	0

Table 3.22: Candidate Employee Sub Criteria Coefficient & Score Table

CRITERIA	Weight	Cand 1 Value Coefficient	Cand 2 Value Coefficient	Candidate 1 Score	Candidate 2 Score
PERSONAL ATTRIBUTES				**62.950**	**68.625**
Education Level	0.705	0.60	0.75	42.300	52.875
TOEFL SCORE	0.225	0.70	0.70	15.750	15.750
Certificate	0.070	0.70	-	4.900	-
FINANCIAL				**93.997**	**63.497**
Credit Reference Agency Score	0.488	1.00	1.00	48.800	48.800
Active Saving Account	0.305	1.00	-	30.500	-
Credit Payment - Salary Ratio	0.207	0.71	0.71	14.697	14.697
CAREER				**84.133**	**80.142**
Organization	0.473	1.00	1.00	47.334	47.334
Current Title Job Level	0.319	0.83	0.41	26.502	13.092
Age - Job Level Matrix	0.102	0.70	0.90	7.134	9.172
Last Title Duration-Job Level Matrix	0.105	0.30	1.00	3.163	10.545
LOYALTY				**66.819**	**63.678**
Actively Used Products of Company	0.050	1.00	1.00	4.990	4.990
Customer Before Employee	0.187	-	1.00	-	18.740
First Degree Relatives Are Customer	0.122	1.00	1.00	12.162	12.162
Seniority	0.438	0.67	0.17	29.320	7.439
Active Individual Pension Plan	0.203	1.00	1.00	20.347	20.347
PERFORMANCE				**66.030**	**69.909**
Avr. Performance Score	0.527	0.50	0.67	26.350	35.309
Discipline Penalties	0.346	1.00	1.00	34.600	34.600
Award	0.127	0.40	-	5.080	-

Table 3-23: Candidate Employee Main Criteria Coefficient & Score Table

	Weight	Cand. 1 Sub Criteria Score	Cand. 2 Sub Criteria Score	Cand. 1 Criteria Score	Cand. 1 Criteria Score
Performance	0.381	62.950	68.625	24.014	26.179
Loyalty	0.208	93.997	63.497	19.531	13.193
Career	0.091	84.133	80.142	7.650	7.287
Financial	0.032	66.819	63.678	2.139	2.038
Personel Attributes	0.288	66.030	69.909	19.004	20.121
		Final Score		**72.338**	**68.818**

4. DISCUSSION AND CONCLUSION

Decision supportive system need of HR decision makers are discussed at introduction. As a solution of this need, fuzzy AHP derived HR analytical employee selection tool proposed. In this study there are five main criteria, and under them eighteen sub criteria has been modelled as AHP. Hierarchy relations between criteria shown at Figure 3.1. These main criteria are as follow;

I. Performance
II. Loyalty
III. Personal Attributes
IV. Financial
V. Career

These criteria and/or sub criteria can be changed according to company needs. For some companies personal attributes can be dispensable, since sub criteria under personal attributes can be unnecessary for some companies.

In this study sub criteria grouped under five criteria, and every criteria have hundred point, these point distributed to sub criteria according to weight calculated with FAHP. Final score calculated over thousand, and this points distributed according to weights of criteria calculated with FAHP but different then sub criteria, main criteria FAHP is not static, it can be modifiable according to decision which the system used. From now on every main criteria will be briefly summarized and some observed difficulty will be shown.

4.1 PERFORMANCE

Under performance criterion there are three criteria, performance score average, discipline regulations and award. Performance main criterion is generally have greater weight than other criteria even under different modifications for different decisions. Among the sub criteria of performance, average performance score have highest weight, and most of the company have data. Discipline regulations are commonly encountered at most of the companies, it can be adjusted according to type of discipline regulations.

Awards are rare occasions for some company, but it has to make difference in employee score. Sub criteria of performance can be enhance with different outcomes of supportive systems of performance at company.

4.2 PERSONAL ATTRIBUTES

One of the most difficult part of the classification in this study is personal attributes, because even there are lots of data which directly attached the employee personal life, we cannot collect or process that data. For that reason some companies might want to remove the main criterion personal attributes and move education to career main criterion. Evaluating the data pool we end up with three sub criteria for personal attributes. They are certificate, education level and TOEFL score. Education level is important for some job groups, but it might have been not usable for some companies. For example a company which have lots of blue collar employee cannot use education level criterion because it was not important for their job. But at the same time maybe they add special certifications related to their job area.

4.3 LOYALTY

Employee loyalty or engagement is one of the trend topic of last years, there are tremendous research about its effects on different area of job. Most of the companies measured it with surveys, but in this study we prefer exact data about employee. These data are our sub criteria of loyalty. These are actively used products of company, customer before employee, first degree relatives are customer and active individual pension plan. As a starting point, loyalty is differentiate for nearly every company. For that reason every application of these study, companies has to develop their loyalty criteria and weighted them. In this study we work on bank example, banks are service provider and every people can be use their products. For that reason in our example three out of four criteria is dependent to product usage. Companies which produce value for businesses, or create raw material are not able to use product base loyalty measurement but they might be use entrance and exit hours of employee or maybe internet usage at office etc. Other than the product base criteria Active individual pension plan is becoming popular at companies. This criterion may be positioned under financial but in our example companies supplementary contract changes our mind and it positioned under loyalty.

4.4 CAREER

Career is the history and today of employee at the company. Career main criterion have five sub criteria, these criteria mainly about employee working area and her job level. In this main criterion job level is highly effective because, three out of four sub criteria is related to employees' current job level. This effect is given on a purpose, because for most company, job level is highly effective for decisions. As an example even the least important department manager is more important than the most important department's employee for company. Besides that, age – job level and last title duration – job level matrices are created for modelling value and effect of age and keeping time of a job.

4.5 FINANCIAL

Financial status of an employee has effect on performance and risk level of employee. Unbalanced financial status decrease the performance of an employee and the increase the risk of making mistakes, willingly or unwillingly. Financial status is measurable for banking companies because they have examination tools for customers and they can use them for employee. But on the other hand it might be hard to measure financial data for other companies. In this study, there are three sub criteria under financial criterion, which are, credit reference agency score, credit payment – salary ratio and active saving account. Among them the credit payment – salary ratio is a risky data for us, because some of the employee use credits with the name of their parents or wife, in that situation we can't be sure the data, but event with the current form, it give us an idea and we decided to add this criterion to our model.

4.6 CONCLUTION

In this study more than hundred and thirty different data about employee has been examined. And eighteen of them selected as sub criteria for study. After that these eighteen sub criteria grouped into five main criteria. FAHP has been formed for every group of sub criteria and calculated the weights of sub criteria. Two employee from HR department chosen for testing the system. With our HR analytical employee selection system their data has been processed according to sub criteria's coefficients. After calculation with coefficients, their scores for every main criteria has been formed.

Finally our study generate five main score for every employee at bank, with these five scores HR decision makers can create different final scores for different decisions. Our system is developed with IT support and using actively at Kuveyt Turk Participation Bank Human Resources Department.

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APPENDICES

APPENDICES A.1 MAIN & SUB CRITERIA WEIGHT CALCULATIONS

Appendices A.1.1 Main criteria

Table 0.1: Pair-wise comparison matrix for sub criteria of Main Criteria

Sub Criteria	Performance	Loyalty	Career	Financial	Personel Attributes
Performance	(1,1,1)	(1,3,5)	(3,5,7)	(5,7,9)	(1,1,3)
Loyalty	(1/5,1/3,1)	(1,1,1)	(1,3,5)	(5,7,9)	(1/3,1,1)
Career	(1/7,1/5,1/3)	(1/5,1/3,1)	(1,1,1)	(3,5,7)	(1/7,1/5,1/3)
Financial	(1/9,1/7,1/5)	(1/9,1/7,1/5)	(1/7,1/5,1/3)	(1,1,1)	(1/9,1/7,1/5)
Personel Attributes	(1/3,1,1)	(1,1,3)	(3,5,7)	(5,7,9)	(1,1,1)

With the values at matrix, r_i values are calculated according to equation (3.3).

Performance	$r_{1l} = \sqrt[5]{1 \times 1 \times 3 \times 5 \times 1} = 1.72$	$r_{1m} = \sqrt[5]{1 \times 3 \times 5 \times 7 \times 1} = 2.54$	$r_{1u} = \sqrt[5]{1 \times 5 \times 7 \times 9 \times 3} = 3.94$
Loyalty	$r_{2l} = \sqrt[5]{\frac{1}{5} \times 1 \times 1 \times 5 \times \frac{1}{3}} = 0.80$	$r_{2m} = \sqrt[5]{\frac{1}{3} \times 1 \times 3 \times 7 \times 1} = 1.48$	$r_{2u} = \sqrt[5]{1 \times 1 \times 5 \times 9 \times 1} = 2.14$
Career	$r_{3l} = \sqrt[5]{\frac{1}{7} \times \frac{1}{5} \times 1 \times 3 \times \frac{1}{7}} = 0.41$	$r_{3m} = \sqrt[5]{\frac{1}{5} \times \frac{1}{3} \times 1 \times 5 \times \frac{1}{5}} = 0.58$	$r_{3u} = \sqrt[5]{\frac{1}{3} \times 1 \times 1 \times 7 \times \frac{1}{3}} = 0.95$
Financial	$r_{4l} = \sqrt[5]{\frac{1}{9} \times \frac{1}{9} \times \frac{1}{7} \times 1 \times \frac{1}{9}} = 0.18$	$r_{4m} = \sqrt[5]{\frac{1}{7} \times \frac{1}{7} \times \frac{1}{5} \times 1 \times \frac{1}{7}} = 0.23$	$r_{4u} = \sqrt[5]{\frac{1}{5} \times \frac{1}{5} \times \frac{1}{3} \times 1 \times \frac{1}{5}} = 0.31$
Personel Attributes	$r_{4l} = \sqrt[5]{\frac{1}{3} \times 1 \times 3 \times 5 \times 1} = 1.38$	$r_{4m} = \sqrt[5]{1 \times 1 \times 5 \times 7 \times 1} = 2.04$	$r_{4u} = \sqrt[5]{1 \times 3 \times 7 \times 9 \times 1} = 2.85$

With calculated r_i values, weights of the sub criteria are calculated according to Equation (3.4);

Performance	$\varpi_{1l} = \frac{r_{1l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{1.72}{3.94 + 2.14 + 0.95 + 0.31 + 2.85} = 0.17$	$\varpi_{1m} = \frac{r_{1m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{2.54}{2.54 + 1.48 + 0.58 + 0.23 + 2.04} = 0.37$	$\varpi_{1u} = \frac{r_{1u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{3.94}{1.72 + 0.8 + 0.41 + 0.18 + 1.38} = 0.88$
Loyalty	$\varpi_{2l} = \frac{r_{2l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.80}{3.94 + 2.14 + 0.95 + 0.31 + 2.85} = 0.08$	$\varpi_{2m} = \frac{r_{2m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.48}{2.54 + 1.48 + 0.58 + 0.23 + 2.04} = 0.22$	$\varpi_{2u} = \frac{r_{2u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{2.14}{1.72 + 0.8 + 0.41 + 0.18 + 1.38} = 0.48$
Career	$\varpi_{3l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.41}{3.94 + 2.14 + 0.95 + 0.31 + 2.85} = 0.04$	$\varpi_{3m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{0.58}{2.54 + 1.48 + 0.58 + 0.23 + 2.04} = 0.08$	$\varpi_{3u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{0.95}{1.72 + 0.8 + 0.41 + 0.18 + 1.38} = 0.21$
Financial	$\varpi_{4l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.18}{3.94 + 2.14 + 0.95 + 0.31 + 2.85} = 0.02$	$\varpi_{4m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{0.23}{2.54 + 1.48 + 0.58 + 0.23 + 2.04} = 0.03$	$\varpi_{4u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{0.31}{1.72 + 0.8 + 0.41 + 0.18 + 1.38} = 1.07$
Personel Attributes	$\varpi_{4l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{1.38}{0.52 + 2.04 + 1.38 + 4.36 + 2.04} = 0.14$	$\varpi_{4m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{2.04}{0.31 + 1.11 + 0.64 + 3.16 + 1.45} = 0.30$	$\varpi_{4u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{2.85}{0.23 + 0.65 + 0.38 + 1.72 + 0.8} = 0.63$

Defuzzificated and normalized crisp values are calculated according to Equation (3.5);

$$w_1 = \frac{0.17 + 0.37 + 0.88}{0.17 + 0.37 + 0.88 + 0.08 + 0.22 + 0.48 + 0.04 + 0.08 + 0.21 + 0.02 + 0.03 + 0.07 + 0.14 + 0.3 + 0.63} = 0.381$$

$$w_2 = \frac{0.08 + 0.22 + 0.48}{0.17 + 0.37 + 0.88 + 0.08 + 0.22 + 0.48 + 0.04 + 0.08 + 0.21 + 0.02 + 0.03 + 0.07 + 0.14 + 0.3 + 0.63} = 0.208$$

$$w_3 = \frac{0.04 + 0.08 + 0.21}{0.17 + 0.37 + 0.88 + 0.08 + 0.22 + 0.48 + 0.04 + 0.08 + 0.21 + 0.02 + 0.03 + 0.07 + 0.14 + 0.3 + 0.63} = 0.091$$

$$w_4 = \frac{0.02 + 0.03 + 0.07}{0.17 + 0.37 + 0.88 + 0.08 + 0.22 + 0.48 + 0.04 + 0.08 + 0.21 + 0.02 + 0.03 + 0.07 + 0.14 + 0.3 + 0.63} = 0.032$$

$$w_5 = \frac{0.14 + 0.3 + 0.63}{0.17 + 0.37 + 0.88 + 0.08 + 0.22 + 0.48 + 0.04 + 0.08 + 0.21 + 0.02 + 0.03 + 0.07 + 0.14 + 0.3 + 0.63} = 0.288$$

Appendices A.1.2 Performance

Table 0.2: Pair-wise comparison matrix for sub criteria of performance

Sub Criteria	Average Performance Score	Discipline Regulations	Award
Average Performance Score	(1,1,1)	(1,1,3)	(3,5,7)
Discipline Regulations	(1/3,1,1)	(1,1,1)	(1,3,5)
Award	(1/7,1/5,1/3)	(1/5,1/3,1)	(1,1,1)

With the values at matrix, r_i values are calculated according to equation (3.3).

Performance Score	Discipline Regulations	Award
$r_{1l} = \sqrt[3]{1 \times 1 \times 3} = 1.44$	$r_{2l} = \sqrt[3]{\frac{1}{3} \times 1 \times 1} = 0.69,$	$r_{3l} = \sqrt[3]{\frac{1}{7} \times \frac{1}{5} \times 1} = 0.31$
$r_{1m} = \sqrt[3]{1 \times 1 \times 5} = 1.71$	$r_{2m} = \sqrt[3]{1 \times 1 \times 3} = 1.44$	$r_{3m} = \sqrt[3]{\frac{1}{5} \times \frac{1}{3} \times 1} = 0.41$
$r_{1u} = \sqrt[3]{1 \times 3 \times 7} = 2.76,$	$r_{2u} = \sqrt[3]{1 \times 1 \times 5} = 1.71,$	$r_{3u} = \sqrt[3]{\frac{1}{3} \times 1 \times 1} = 0.69.$
$\boldsymbol{r_1}$ **= (1.44, 1.71, 2.76);**	$\boldsymbol{r_2}$ **= (0.69, 1.44, 1.71);**	$\boldsymbol{r_3}$ **= (0.31, 0.41, 0.69);**

With calculated r_i values, weights of the sub criteria are calculated according to Equation (3.4);

Performance Score	Discipline Regulations	Award
$\varpi_{1l} = \frac{r_{1l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{1.44}{2.76 + 1.71 + 0.69}$ $= 0.28$	$\varpi_{2l} = \frac{r_{2l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.69}{2.76 + 1.71 + 0.69}$ $= 0.13$	$\varpi_{3l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.31}{2.76 + 1.71 + 0.69}$ $= 0.06$
$\varpi_{1m} = \frac{r_{1m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.71}{1.71 + 1.44 + 0.41}$ $= 0.48$	$\varpi_{2m} = \frac{r_{2m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.44}{1.71 + 1.44 + 0.41}$ $= 0.41$	$\varpi_{3m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{0.41}{1.71 + 1.44 + 0.41}$ $= 0.11$
$\varpi_{1u} = \frac{r_{1u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{1.44}{1.44 + 0.69 + 0.31}$ $= 1.13$	$\varpi_{2u} = \frac{r_{2u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{1.71}{1.44 + 0.69 + 0.31}$ $= 0.70$	$\varpi_{3u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{0.69}{1.44 + 0.69 + 0.31}$ $= 0.28$
$\boldsymbol{\varpi_1} = (\mathbf{0.28}, \mathbf{0.48}, \mathbf{1.13})$	$\boldsymbol{\varpi_2} = (\mathbf{0.13}, \mathbf{0.41}, \mathbf{0.70})$	$\boldsymbol{\varpi_1} = (\mathbf{0.06}, \mathbf{0.11}, \mathbf{0.28})$

Defuzzificated and normalized crisp values are calculated according to Equation (3.5);

$$w_1 = \frac{0.28 + 0.48 + 1.13}{0.28 + 0.48 + 1.13 + 0.13 + 0.41 + 0.70 + 0.06 + 0.11 + 0.28} = 0.527$$

$$w_2 = \frac{0.13 + 0.41 + 0.70}{0.28 + 0.48 + 1.13 + 0.13 + 0.41 + 0.70 + 0.06 + 0.11 + 0.28} = 0.346$$

$$w_3 = \frac{0.06 + 0.11 + 0.28}{0.28 + 0.48 + 1.13 + 0.13 + 0.41 + 0.70 + 0.06 + 0.11 + 0.28} = 0.127$$

Appendices A.1.3 Personal Attributes

Table 0.3: Pair-wise comparison matrix for sub criteria of personal attributes

Sub Criteria	Education Level	TOEFL Score	Certificates
Education Level	(1,1,1)	(3,5,7)	(5,7,9)
TOEFL Score	(1/7,1/5,1/3)	(1,1,1)	(3,5,7)
Certificates	(1/9,1/7,1/5)	(1/7,1/5,1/3)	(1,1,1)

With the values at matrix, r_i values are calculated according to equation (3.3).

Education Level	TOEFL Score	Certificate
$r_{1l} = \sqrt[3]{1 \times 3 \times 5} = 2.47$	$r_{2l} = \sqrt[3]{\frac{1}{7} \times 1 \times 3} = 0.75,$	$r_{3l} = \sqrt[3]{\frac{1}{9} \times \frac{1}{7} \times 1} = 0.25$
$r_{1m} = \sqrt[3]{1 \times 5 \times 7} = 3.27$	$r_{2m} = \sqrt[3]{\frac{1}{5} \times 1 \times 5} = 1.00$	$r_{3m} = \sqrt[3]{\frac{1}{7} \times \frac{1}{5} \times 1} = 0.31$
$r_{1u} = \sqrt[3]{1 \times 7 \times 9} = 3.98,$	$r_{2u} = \sqrt[3]{\frac{1}{3} \times 1 \times 7} = 1.33,$	$r_{3u} = \sqrt[3]{\frac{1}{5} \times \frac{1}{3} \times 1} = 0.41.$
$\boldsymbol{r_1}$ **= (2.47, 3.27, 3.98);**	$\boldsymbol{r_2}$ **= (0.75, 1.00, 1.33);**	$\boldsymbol{r_3}$ **= (0.25, 0.31, 0.41);**

With calculated r_i values, weights of the sub criteria are calculated according to Equation (3.4);

Education Level	TOEFL Score	Certificate
$\varpi_{1l} = \frac{r_{1l}}{r_{1u} + r_{2u} + r_{3u}} = \frac{2.47}{3.97 + 1.32 + 0.40} = 0.43$	$\varpi_{2l} = \frac{r_{2l}}{r_{1u} + r_{2u} + r_{3u}} = \frac{0.75}{3.97 + 1.32 + 0.40} = 0.13$	$\varpi_{3l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}} = \frac{0.25}{3.97 + 1.32 + 0.40} = 0.04$
$\varpi_{1m} = \frac{r_{1m}}{r_{1m} + r_{2m} + r_{3m}} = \frac{3.27}{3.27 + 1.00 + 0.31} = 0.71$	$\varpi_{2m} = \frac{r_{2m}}{r_{1m} + r_{2m} + r_{3m}} = \frac{1.00}{3.27 + 1.00 + 0.31} = 0.22$	$\varpi_{3m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}} = \frac{0.31}{3.27 + 1.00 + 0.31} = 0.07$
$\varpi_{1u} = \frac{r_{1u}}{r_{1l} + r_{2l} + r_{3l}} = \frac{3.98}{2.47 + 0.75 + 0.25} = 1.15$	$\varpi_{2u} = \frac{r_{2u}}{r_{1l} + r_{2l} + r_{3l}} = \frac{1.33}{2.47 + 0.75 + 0.25} = 0.38$	$\varpi_{3u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}} = \frac{0.41}{2.47 + 0.75 + 0.25} = 0.12$
$\boldsymbol{\varpi_1 = (0.4\ 30.71, 1.15)}$	$\boldsymbol{\varpi_2 = (0.13, 0.22, 0.38)}$	$\boldsymbol{\varpi_1 = (0.04, 0.07, 0.12)}$

Defuzzificated and normalized crisp values are calculated according to Equation (3.5);

$$w_1 = \frac{0.43 + 0.71 + 1.15}{0.43 + 0.71 + 1.15 + 0.13 + 0.22 + 0.38 + 0.04 + 0.07 + 0.12} = 0.705$$

$$w_2 = \frac{0.13 + 0.22 + 0.38}{0.43 + 0.71 + 1.15 + 0.13 + 0.22 + 0.38 + 0.04 + 0.07 + 0.12} = 0.225$$

$$w_3 = \frac{0.04 + 0.07 + 0.12}{0.43 + 0.71 + 1.15 + 0.13 + 0.22 + 0.38 + 0.04 + 0.07 + 0.12} = 0.070$$

Appendices A.1.4 Financial

Table 0.4: Pair-wise comparison matrix for sub criteria of personal attributes

Sub Criteria	Credit Reference Agency Score	Active Saving Account	Credit Payment - Salary Ratio
Credit Reference Agency Score	(1,1,1)	(1,1,3)	(1,3,5)
Active Saving Account	(1/3,1,1)	(1,1,1)	(1,1,3)
Credit Payment - Salary Ratio	(1/5,1/3,1)	(1/3,1,1)	(1,1,1)

With the values at matrix, r_i values are calculated according to equation (3.3).

Credit Reference Agency Score	Active Saving Account	Credit Payment - Salary Ratio
$r_{1l} = \sqrt[3]{1 \times 1 \times 1} = 1.00$	$r_{2l} = \sqrt[3]{\frac{1}{3} \times 1 \times 1} = 0.69,$	$r_{3l} = \sqrt[3]{\frac{1}{5} \times \frac{1}{3} \times 1} = 0.41$
$r_{1m} = \sqrt[3]{1 \times 1 \times 3} = 1.44$	$r_{2m} = \sqrt[3]{1 \times 1 \times 1} = 1.00$	$r_{3m} = \sqrt[3]{\frac{1}{3} \times 1 \times 1} = 0.69$
$r_{1u} = \sqrt[3]{1 \times 3 \times 5} = 2.47,$	$r_{2u} = \sqrt[3]{1 \times 1 \times 3} = 1.44,$	$r_{3u} = \sqrt[3]{1 \times 1 \times 1} = 1.00$
$\boldsymbol{r_1} = (1.00, 1.44, 2.47);$	$\boldsymbol{r_2} = (0.69, 1.00, 1.44);$	$\boldsymbol{r_3} = (0.41, 0.69, 1.00);$

With calculated r_i values, weights of the sub criteria are calculated according to Equation (3.4);

Credit Reference Agency Score	**Active Saving Account**	**Credit Payment - Salary Ratio**
$\varpi_{1l} = \frac{r_{1l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{1.00}{2.47 + 1.44 + 1.00}$ $= 0.20$	$\varpi_{2l} = \frac{r_{2l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.69}{2.47 + 1.44 + 1.00}$ $= 0.46$	$\varpi_{3l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.41}{2.47 + 1.44 + 1.00}$ $= 1.18$
$\varpi_{1m} = \frac{r_{1m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.44}{1.44 + 1.00 + 0.69}$ $= 0.14$	$\varpi_{2m} = \frac{r_{2m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.00}{1.44 + 1.00 + 0.69}$ $= 0.32$	$\varpi_{3m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{0.69}{1.44 + 1.00 + 0.69}$ $= 0.69$
$\varpi_{1u} = \frac{r_{1u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{2.47}{1.00 + 0.69 + 0.41}$ $= 0.08$	$\varpi_{2u} = \frac{r_{2u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{1.44}{1.00 + 0.69 + 0.41}$ $= 0.22$	$\varpi_{3u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{1.00}{1.00 + 0.69 + 0.41}$ $= 0.48$
$\boldsymbol{\varpi_1 = (0.20, 0.14, 0.08)}$	$\boldsymbol{\varpi_2 = (0.46, 0.32, 0.22)}$	$\boldsymbol{\varpi_1 = (1.18, 0.69, 0.48)}$

Defuzzificated and normalized crisp values are calculated according to Equation (3.5);

$$w_1 = \frac{0.20 + 0.46 + 1.18}{0.20 + 0.46 + 1.18 + 0.14 + 0.32 + 0.69 + 0.08 + 0.22 + 0.48} = 0.488$$

$$w_2 = \frac{0.14 + 0.32 + 0.69}{0.20 + 0.46 + 1.18 + 0.14 + 0.32 + 0.69 + 0.08 + 0.22 + 0.48} = 0.305$$

$$w_3 = \frac{0.08 + 0.22 + 0.48}{0.20 + 0.46 + 1.18 + 0.14 + 0.32 + 0.69 + 0.08 + 0.22 + 0.48} = 0.207$$

Appendices A.1.5 Loyalty

Table 0.5: Pair-wise comparison matrix for sub criteria of loyalty

Sub Criteria	Actively Used Products of Company	Customer Before Employee	First Degree Relatives Are Customer	Seniority	Active Individual Pension Plan
Actively Used Products of Company	(1,1,1)	(1/7,1/5,1/3)	(1/5,1/3,1)	(1/7,1/5,1/3)	(1/7,1/5,1/3)
Customer Before Employee	(3,5,7)	(1,1,1)	(1,3,5)	(1/5,1/3,1)	(1/5,1/3,1)
First Degree Relatives Are Customer	(1,3,5)	(1/5,1/3,1)	(1,1,1)	(1/5,1/3,1)	(1/5,1/3,1)
Seniority	(3,5,7)	(1,3,5)	(1,3,5)	(1,1,1)	(5,7,9)
Active Individual Pension Plan	(3,5,7)	(1,3,5)	(1,3,5)	(1/9,1/7,1/5)	(1,1,1)

With the values at matrix, r_i values are calculated according to equation (3.3).

Actively Used Products of Company	$r_{1l} = \sqrt[5]{1 \times \frac{1}{7} \times \frac{1}{5} \times \frac{1}{7} \times \frac{1}{7}}$ $= 0.23$	$r_{1m} = \sqrt[5]{1 \times \frac{1}{5} \times \frac{1}{3} \times \frac{1}{5} \times \frac{1}{5}}$ $= 0.31$	$r_{1u} = \sqrt[5]{1 \times \frac{1}{3} \times 1 \times \frac{1}{3} \times \frac{1}{3}}$ $= 0.52$
Customer Before Employee	$r_{2l} = \sqrt[5]{3 \times 1 \times 1 \times \frac{1}{5} \times \frac{1}{5}}$ $= 0.65$	$r_{2m} = \sqrt[5]{5 \times 1 \times 3 \times \frac{1}{3} \times \frac{1}{3}}$ $= 1.11$	$r_{2u} = \sqrt[5]{7 \times 1 \times 5 \times 1 \times 1}$ $= 2.04,$
First Degree Relatives Are Customer	$r_{3l} = \sqrt[5]{1 \times \frac{1}{5} \times 1 \times \frac{1}{5} \times \frac{1}{5}}$ $= 0.38$	$r_{3m} = \sqrt[5]{3 \times \frac{1}{3} \times 1 \times \frac{1}{3} \times \frac{1}{3}}$ $= 0.64$	$r_{3u} = \sqrt[5]{5 \times 1 \times 1 \times 1 \times 1}$ $= 1.38$
Seniority	$r_{4l} = \sqrt[5]{3 \times 1 \times 1 \times 1 \times 5}$ $= 1.72$	$r_{4m} = \sqrt[5]{5 \times 3 \times 3 \times 1 \times 7}$ $= 3.16$	$r_{4u} = \sqrt[5]{7 \times 5 \times 5 \times 1 \times 9}$ $= 4.36$
Active Individual Pension Plan	$r_{4l} = \sqrt[5]{3 \times 1 \times 1 \times \frac{1}{9} \times 1}$ $= 0.8$	$r_{4m} = \sqrt[5]{5 \times 3 \times 3 \times \frac{1}{7} \times 1}$ $=1.45$	$r_{4u} = \sqrt[5]{7 \times 5 \times 5 \times \frac{1}{5} \times 1}$ $= 2.04$

With calculated r_i values, weights of the sub criteria are calculated according to Equation (3.4);

Actively Used Products of Company	$\varpi_{1l} = \frac{r_{1l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.23}{0.52 + 2.04 + 1.38 + 4.36 + 2.04}$ $= 0.02$	$\varpi_{1m} = \frac{r_{1m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{0.31}{0.31 + 1.11 + 0.64 + 3.16 + 1.45}$ $= 0.05$	$\varpi_{1u} = \frac{r_{1u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{0.52}{0.23 + 0.65 + 0.38 + 1.72 + 0.8}$ $= 0.14$
Customer Before Employee	$\varpi_{2l} = \frac{r_{2l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.65}{0.52 + 2.04 + 1.38 + 4.36 + 2.04}$ $= 0.06$	$\varpi_{2m} = \frac{r_{2m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.11}{0.31 + 1.11 + 0.64 + 3.16 + 1.45}$ $= 0.17$	$\varpi_{2u} = \frac{r_{2u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{2.04}{0.23 + 0.65 + 0.38 + 1.72 + 0.8}$ $= 0.54$
First Degree Relatives Are Customer	$\varpi_{3l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.38}{0.52 + 2.04 + 1.38 + 4.36 + 2.04}$ $= 0.04$	$\varpi_{3m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{0.64}{0.31 + 1.11 + 0.64 + 3.16 + 1.45}$ $= 0.1$	$\varpi_{3u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{1.38}{0.23 + 0.65 + 0.38 + 1.72 + 0.8}$ $= 0.36$
Seniority	$\varpi_{4l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{1.72}{0.52 + 2.04 + 1.38 + 4.36 + 2.04}$ $= 0.17$	$\varpi_{4m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{3.16}{0.31 + 1.11 + 0.64 + 3.16 + 1.45}$ $= 0.47$	$\varpi_{4u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{4.36}{0.23 + 0.65 + 0.38 + 1.72 + 0.8}$ $= 1.15$
Individual Pension Plan	$\varpi_{4l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}}$ $= \frac{0.8}{0.52 + 2.04 + 1.38 + 4.36 + 2.04}$ $= 0.08$	$\varpi_{4m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}}$ $= \frac{1.45}{0.31 + 1.11 + 0.64 + 3.16 + 1.45}$ $= 0.22$	$\varpi_{4u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}}$ $= \frac{2.04}{0.23 + 0.65 + 0.38 + 1.72 + 0.8}$ $= 1.54$

Defuzzificated and normalized crisp values are calculated according to Equation (3.5);

$$w_1 = \frac{0.02 + 0.05 + 0.14}{0.02 + 0.05 + 0.14 + 0.06 + 0.17 + 0.54 + 0.04 + 0.1 + 0.36 + 0.17 + 0.47 + 1.15 + 0.05 + 0.01 + 0.03} = 0.05$$

$$w_2 = \frac{0.06 + 0.17 + 0.54}{0.02 + 0.05 + 0.14 + 0.06 + 0.17 + 0.54 + 0.04 + 0.1 + 0.36 + 0.17 + 0.47 + 1.15 + 0.05 + 0.01 + 0.03} = 0.187$$

$$w_3 = \frac{0.04 + 0.1 + 0.36}{0.02 + 0.05 + 0.14 + 0.06 + 0.17 + 0.54 + 0.04 + 0.1 + 0.36 + 0.17 + 0.47 + 1.15 + 0.05 + 0.01 + 0.03} = 0.122$$

$$w_4 = \frac{0.17 + 0.47 + 1.15}{0.02 + 0.05 + 0.14 + 0.06 + 0.17 + 0.54 + 0.04 + 0.1 + 0.36 + 0.17 + 0.47 + 1.15 + 0.05 + 0.01 + 0.03} = 0.438$$

$$w_5 = \frac{0.05 + 0.01 + 0.03}{0.02 + 0.05 + 0.14 + 0.06 + 0.17 + 0.54 + 0.04 + 0.1 + 0.36 + 0.17 + 0.47 + 1.15 + 0.05 + 0.01 + 0.03} = 0.203$$

Appendices A.1.6 Career

Table 0.6: Pair-wise comparison matrix for sub criteria of career

Sub Criteria	Organization	Current Title Job Level	Age - Job Level Matrix	Last Title Duration-Job Level Matrix
Organization	(1,1,1)	(1,1,3)	(3,5,7)	(3,5,7)
Current Title Job Level	(1/3,1,1)	(1,1,1)	(1,1,3)	(5,7,9)
Age - Job Level Matrix	(1/7,1/5,1/3)	(1/3,1,1)	(1,1,1)	(1/5,1/3,1)
Last Title Duration-Job Level Matrix	(1/7,1/5,1/3)	(1/9,1/7,1/5)	(1,3,5)	(1,1,1)

With the values at matrix, r_i values are calculated according to equation (3.3).

Organization	$r_{1l} = \sqrt[4]{1 \times 1 \times 3 \times 3} = 1.73$	$r_{1m} = \sqrt[4]{1 \times 1 \times 5 \times 5} = 2.24$	$r_{1u} = \sqrt[4]{1 \times 3 \times 7 \times 7} = 3.48$
Current Title Job Level	$r_{2l} = \sqrt[4]{\frac{1}{3} \times 1 \times 1 \times 5} = 1.14,$	$r_{2m} = \sqrt[4]{1 \times 1 \times 1 \times 7} = 1.63$	$r_{2u} = \sqrt[4]{1 \times 1 \times 3 \times 9} = 2.28$
Age - Job Level Matrix	$r_{3l} = \sqrt[4]{\frac{1}{7} \times \frac{1}{3} \times 1 \times \frac{1}{5}} = 0.31$	$r_{3m} = \sqrt[4]{\frac{1}{5} \times 1 \times 1 \times \frac{1}{3}} = 0.51$	$r_{3u} = \sqrt[4]{\frac{1}{3} \times 1 \times 1 \times 1} = 0.76$
Last Title Duration-Job Level Matrix	$r_{5l} = \sqrt[4]{\frac{1}{7} \times \frac{1}{9} \times 1 \times 1} = 0.35$	$r_{5m} = \sqrt[4]{\frac{1}{5} \times \frac{1}{7} \times 3 \times 1} = 0.54$	$r_{5u} = \sqrt[4]{\frac{1}{3} \times \frac{1}{5} \times 5 \times 1} = 0.76$

With calculated r_i values, weights of the sub criteria are calculated according to Equation (3.4);

Organization	$\varpi_{1l} = \frac{r_{1l}}{r_{1u} + r_{2u} + r_{3u}} = \frac{1.73}{3.48 + 2.28 + 0.76 + 0.76} = 0.24$	$\varpi_{1m} = \frac{r_{1m}}{r_{1m} + r_{2m} + r_{3m}} = \frac{2.24}{2.24 + 1.63 + 0.51 + 0.54} = 0.46$	$\varpi_{1u} = \frac{r_{1u}}{r_{1l} + r_{2l} + r_{3l}} = \frac{3.48}{1.73 + 1.14 + 0.31 + 0.35} = 0.98$
Current Title Job Level	$\varpi_{2l} = \frac{r_{2l}}{r_{1u} + r_{2u} + r_{3u}} = \frac{1.14}{3.48 + 2.28 + 0.76 + 0.76} = 0.16$	$\varpi_{2m} = \frac{r_{2m}}{r_{1m} + r_{2m} + r_{3m}} = \frac{2.63}{2.24 + 1.63 + 0.51 + 0.54} = 0.33$	$\varpi_{2u} = \frac{r_{2u}}{r_{1l} + r_{2l} + r_{3l}} = \frac{2.28}{1.73 + 1.14 + 0.31 + 0.35} = 0.64$
Age - Job Level Matrix	$\varpi_{3l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}} = \frac{0.31}{3.48 + 2.28 + 0.76 + 0.76} = 0.04$	$\varpi_{3m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}} = \frac{0.51}{2.24 + 1.63 + 0.51 + 0.54} = 0.10$	$\varpi_{3u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}} = \frac{0.76}{1.73 + 1.14 + 0.31 + 0.35} = 0.21$
Last Title Duration Job	$\varpi_{5l} = \frac{r_{3l}}{r_{1u} + r_{2u} + r_{3u}} = \frac{0.35}{3.48 + 2.28 + 0.76 + 0.76} = 0.05$	$\varpi_{5m} = \frac{r_{3m}}{r_{1m} + r_{2m} + r_{3m}} = \frac{0.54}{2.24 + 1.63 + 0.51 + 0.54} = 0.11$	$\varpi_{5u} = \frac{r_{3u}}{r_{1l} + r_{2l} + r_{3l}} = \frac{0.76}{1.73 + 1.14 + 0.31 + 0.35} = 0.21$

Defuzzificated and normalized crisp values are calculated according to Equation (3.5);

$$w_1 = \frac{0.24 + 0.46 + 0.98}{0.24 + 0.46 + 0.98 + 0.16 + 0.33 + 0.64 + 0.04 + 0.1 + 0.21 + 0.14 + 0.03 + 0.09} = 0.473$$

$$w_1 = \frac{0.16 + 0.33 + 0.64}{0.24 + 0.46 + 0.98 + 0.16 + 0.33 + 0.64 + 0.04 + 0.1 + 0.21 + 0.14 + 0.03 + 0.09} = 0.319$$

$$w_1 = \frac{0.04 + 0.1 + 0.21}{0.24 + 0.46 + 0.98 + 0.16 + 0.33 + 0.64 + 0.04 + 0.1 + 0.21 + 0.14 + 0.03 + 0.09} = 0.102$$

$$w_1 = \frac{0.14 + 0.03 + 0.09}{0.24 + 0.46 + 0.98 + 0.16 + 0.33 + 0.64 + 0.04 + 0.1 + 0.21 + 0.14 + 0.03 + 0.09} = 0.105$$