**International Journal of Academic Value Studies (Javstudies)**

*ISSN:2149-8598* | *Vol: 4, Issue: 18, pp. 39-53*

*www.javstudies.com* | *Javstudies@gmail.com*

*Disciplines: Business Administration, Economy, Econometrics, Finance, Labour Economics, Political Science, Public Administration, International Relations*

# JOB CHOICE IN A FUZZY ENVIRONMENT: ACCORDING TO CEOS, WHAT IS THE OPTIMUM ENTITY TO START PROFESSION?

## *Bulanık Bir Ortamda İş Seçimi: CEO'lara Göre Mesleğe Başlamak İçin En Uygun Kurum Nedir?*

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Noorzad, M.F. (2018). "Job Choice In A Fuzzy Environment: According To Ceos, What Is The Optımum Entıty To Start Professıon?", Vol:4, Issue:18; pp:39-53 (ISSN:2149-8598)

**ARTICLE INFO**

**Article History**

Makale Geliş Tarihi
Article Arrival Date
18/12/2017
Makale Yayın Kabul Tarihi
The Published Rel. Date
15/01/2018

**Anahtar Kelimeler**

Bulanık Topsis, Çok Kriterli Karar Verme (MCDM), İş Seçimi

**Keywords**:

Fuzzy Topsis, Multi-Criteria Decision Making (MCDM), Job Choice

**ÖZ**

İş seçimi veya belirli bir mesleği bir kurumda seçmek, problemli bir konudur ve bunu yapmak kolay değildir. Çünkü bir yandan, objektif ve sübjektif kriterler ve iş arayan kişisel tercihleri etkileyen faktörler olarak, öte yandan da; farklı alternatiflerin (işletmelerin veya istihdamın kaynağı) bulunması, bir kişi kendi mesleğine başlamak için nerede bulunacağı konusunda karmaşık hale getirilmiştir. Bu nedenle iş seçimi, çok kriterli karar verme problemidir ve birçok faktörden etkilenmektedir. Bu çalışmanın temel amacı, üç alternatiften (kamu sektörü, özel sektör ve kendi işini kurması) iş seçiminde en uygun olanın beş kritere (ücret düzeyi, iş güvenliği, saygınlık ve toplumdaki itibar, iş ortamı ve esnek çalışma zamanı fırsatı) göre hangi olduğunu belirlemektir. Bu problemi çözmek için, bu makalede iyi bilenen çok kriterli karar verme (MCDM) yöntemlerinden Fuzzy TOPSIS tekniğini kullanılmıştır. Nitekim, bulanık mantığa dayalı uzman sistem iş seçimi sürecinde uygun bir yaklaşımdır; çünkü insan düşüncelerinin sayısal değil, dilsel terim olduğu mantığında geliştirilmiştir. Bu çalışmada, Konya şehrinde bulunan üç şirketten üç CEO, iş arayana iş seçiminde yardımcı olan karar vericiler olarak seçilmiştirler. Bu yaklaşım iki adımdan oluşturulmuştur. Birinci aşamada, iş seçmek için belirlenen kriterler karar vericiler tarafından ağırlıklandırılmıştır. İkinci adımda, karar vericiler alternatifleri kriterlere karşı ağırlıklandırılmıştır. Bu araştırmanın sonucu, bir iş kurmanın veya kendi işini kurmanın, iş seçimi sürecinde en uygun alternatif olduğunu göstermektedir.

**ABSTRACT**

Job choice or choosing a specific profession in an entity is something problematic issue and is not easy to do it. Because, on the one hand, objective and subjective criteria and a job seeker's personal preferences as affecting factors, on the other hand, availability of different alternatives (entities or source of employment), have made it more complicated for a person to make choice where to start his/her profession. As result, job choice is a multi-criteria decision making problem, which means it can be affected by many factors. Therefore, the main objective of this study is to determine which entity is the optimal one for the job choice from the three alternatives (public sector, private sector and one's own business) against five criteria (level of wage, job security, respectability and reputation in the society, job environment and flexible working time opportunity). To solve this problem, this paper used Fuzzy TOPSIS technique, which is one of the well-known Multi-Criteria Decision Making (MCDM) methods. In fact, expert system based on the fuzzy logic is suitable approach for the job choosing process since it has been developed on the logic that human thoughts are not numbers, but linguistics terms. In this paper, three CEOs from the three companies located in Konya city, are the decision makers to help the job seeker in her/his job choice. This approach is composed of two steps. In step one; the decision makers weighted the criteria for the job choice. In the second step, decision makers weighted the alternatives against the criteria. The result of this research shows that setting up a business or one's own business is the optimum alternative in job choice process.

## 1. INTRODUCTION

Job choice or career choice, being the most affecting factor in a person's life, is one of the most crucial decisions. It is the decision of a person about which occupation is the most appropriate for him/her. Meanwhile, the term, job choice, refers to selecting the optimal type of entity in which one decides to practice his/her profession. As occupations are different from the viewpoint of required qualities and provided opportunities, deciding on choosing a job in specific sectors means facing real and potential opportunities and threats.

To make a decision to work in a specific sector despite many available alternatives, in case of many criteria as affecting factors of that decision, is something problematic issue. Clearly, the crucial

decision-makings affect the entire life of either individuals or entities in terms of their existence, productivity, and success. Here, it denotes to the importance of a process of choosing an optimal alternative from the available ones defined as a decision-making problem. Recently, using of the decision makers' judgements in models of decision-making has dramatically risen (Önüt and Soner, 2007), which, in turn, enabled each one of them to play role and take part in decisions. As mentioned before, a process to find the best one among existent alternatives is called decision-making process. In today's complicated life, comparing the alternatives in order to choose the suitable one is not something subject to one criterion to make decision about. In simple words, there may be more than one criteria in decision-making problems in order to compare the alternatives. Recently, some techniques have been developed to help decision makers to solve such problems. Multi-criteria decision making (MCDM) methods is widely used when alternatives are ranked in terms of more than one criteria (Hashemi & Amiri, 2013) or in case of existence of a vast number of conflicting criteria during process of decision making (Santos & Camargo, 2010). Of the MCDM problems solving methods, Topsis is well-known one developed by Hwang and Yoon in 1981.

## 2. THEORETICAL FRAMEWORK

### 2.1. Literature Review

According to literature reviews, there are many studies using Topsis method in making decisions on different problems. For example, selection of warehouse location in one of the five cities against fifteen criteria (Ashrafzadeh et.al, 2012), an evaluation model of E-service quality by applying hierarchical fuzzy TOPSIS method (Lee et.al, 2012), evaluation of travel website service quality (Kabir & Hasin, 2012), selection of plant location by fuzzy Topsis (Yong, 2006). Furthermore, there are other studies such as using Topsis for scholarship selection (Uyun and Riadi, 201), supplier selection in supply chain management with TOPSIS (Tabar & Charkhgard, 2012, Liao and Kao, 2011), project selection for oil fields (Amiri, 2010), risk analysis for critical infrastructures (Yazdani et al, 2012), evaluating the competitive advantages of shopping websites (Sun & Lin, 2009). In addition to these, Sun and Lin used Topsis method for determining strategy priorities by SWOT analysis, (Ghorbani et.al, 2011), and Ataei for plant layout design (Ataei, 2013). All the forgoing studies are done beyond the Turkey. Here are some studies done inside of Turkey: For example, Küçük and Ecer in 2007 did a study under the name of "Assessing suppliers using fuzzy TOPSIS and an application in Erzurum City Turkey". In addition to these, Önüt et al in (2009) did a research on long term supplier selection, a case study for a telecommunication company using Topsis and Tırmıkçıoğlu worked on facility location selection, an application in banking sector (Tırmıkçıoğlu, 2010), choosing the place of shopping center ( Soba et.al, 2015). Yavuz and Deveci in 2014 used Topsis method to determine the location of shopping center in the Province of Erzincan in which there have been five alterantive ranked based on fifteen ctriteria.

### 2.2. Job Choice

Career is collection of the progress and actions that a person takes over span of his/her life, particularly one's occupation-related actions. In a broad meaning career is not just referring to one's position, but it includes held jobs, earned titles and accomplished works during life span. Therefore, job choice being a part of career choosing, is considered as a decision-making problem that one may make a choice from the available choices (Bas et al. 2011). There are three affecting factors over a person's making decision on choosing to work in a firm (Schreuder, 2006). They are:

✓ Objective factor theory: Assuming of the applicant being rational, this theory suggests that a person will choose a job after objective assessment of its tangible benefits. These objective factors (benefits) are including the salary, other monetary benefits, location, promotion etc.

✓ Subjective factor theory: It suggests that there are some social and psychological affecting factors over process of decision-making. It means that social and psychological factors, which play significant roles during decision-making, include job status, organizational reputation, image, and other similar factors.

✓ Critical contact theory: This one suggest that an applicant's observations during interaction with authorities and recruiters of an organization influences his/her decision-making. For instance, recruiters' way of dealing with applicants, prompt response and similar factors and so on are influencing factors. It is worth mentioning that this one is more valid with experienced professionals.

✓ Candidates freely choosing of their employer and career are other assumptions of the mentioned theory. However, in real life, the scarcity of employment opportunities and tough competition between applicants to gain desired jobs, skews the decision making process. Even in some markets, workers were forced to accept whatever work was available to them1. Beside the factors discussed above, in time of choosing a career to fit an applicant well, other factors will play important role as well. Of them, intrinsic talents, working style, social interaction, balance between work and life, comfortability in the public eyes, dealing with stress or not, level of payment are well known issues. In today's life, once a career is chosen necessarily does not mean to continue with career up to end of life. Instead, one can reevaluate the path of her/his career and can change to adjust to her/his long-term objectives2.

### 2.3. Multi-Criteria Decision Making (MCDM)

People always have to make decisions at all stages of their personal and professional lives. In individual issues, a person who faces a problem, may attempt to find solutions by using either his/her personal information, knowledge and values or can take advantage of advices and sources others provide. Indeed, choosing a solution (making decision), here is a choice whereby a person reach a given situation. Consequently, make a decision on choosing a specific solution leads to a course of action or behavior what a person has to do and not to do. Therefore, decision-making can defined as an opting one course of action from the two or more alternative course of action or simply it is the action of choosing one of the options; however, choosing is not a big part of decision-making but rather small part of it (Daft, 2003). According to Jones (1962), "decision-making is a solution selected after examining several alternatives chosen because the decider foresees that his/her selected course of action will bring more benefits to goals than other courses of action and will lead to less objectionable outcomes than any other course of action".

The problems on which individuals have to make decision aiming to solve them, can be either very simple or can be very complicated one being affected by many factors (Rue & Byers, 2003). As mentioned before, attempts towards finding the best option among suitable alternatives is called decision making process. However, distinguishing the best option is not far easily recognizable. It means that there may be more than one criteria in decision-making problems in order to compare the alternatives aiming to find the best option. In such cases, multi-criteria decision making (MCDM) methods are the very best solutions as they are used in cases of existence of vast number of criteria which usually conflict with each other during the decision making process (Santos & Camargo, 2010) or when alternatives are ranked in terms of more than one criteria (Hashimi and Amiri, 2013). These methods evaluate the alternatives based on criteria values by which decision maker can list and make a choice from the alternatives. In MCDM problems, the decision makers make their choices according to the variables and the alternatives. Here, the options that are going to be listed or made choice among are called alternatives and the qualities upon which these alternatives' assessment will be done by decision makers are called decision variables or criteria. As mentioned before, usually alternatives (potential solutions for a problem) specified by decision makers are ranked based on more than one conflicting criteria and values (Genç and Masca, 2013).

There are many techniques for solving MCDM problems. Of them, the technique for order preference by similarity to ideal solutions (TOPSIS) method is well-known one, developed by Hwang and Yoon in 1981. In TOPSIS method, it is expected that a selected alternative be closer to positive ideal solution and farther from negative ideal solution. By using these two values, the closeness coefficient (CCi) of alternatives are calculated and ordered from highest to the lowest. As result, the alternative with the highest closeness coefficient value is the best one- positive ideal solution (Selçuk and Özkan, 2015).

### 2.4. Criteria

#### 2.4.1. Level of Wage

Wage is very important from the viewpoint of employees. As an essential source of life, it meets the basic physiological and psychological requirements of employees. Playing the role of providing assurance and the means of developing the living standards, employees are extremely sensitive

[1] http://www.wikizero.org/index.php?q=aHR0cHM6Ly9lbi53aWtpcGVkaWEub3JnL3dpa2kvQ2FyZWVyI2NpdGVfcmVmLTY

[2] https://money.usnews.com/money/blogs/outside-voices-careers/2010/12/06/how-to-choose-a-career-thats-best-for-you

regarding to payment (the wage). Meanwhile, for the employees, wage means money that can maintain the daily and future lives of both themselves and their families. Definitely, it is clear that wage is equal to money in today's live by which employees try to meet her/his basic needs such as eating, dressing, housing, health and recreation etc. (Şimşek & Öge, 2015).

As mentioned before, wage is a monetary compensation, remuneration or personnel expenses paid by an employer to a worker in exchange for work done. Payment may be in form of a fixed amount (a task wage or piece rate), or at an hourly or daily rate, or based on quantity of work done3. The difference between wage and salary is the payment of salary on by employer in an arranged amount at steady intervals (such as a week or month) without considering the hours worked. As it is pointed out in the above, one of the most important aspects of a job for most workers is the wage it pays. Wages allow workers to make a living from their labor. However, the gross salary is not the best criteria to pick a career4.

### 2.4.2. Job Security

This term means the probability that a worker will keep the taken job and the chance of unemployment would be small. As clear for all, providing a stable income and lower probability of becoming unemployed, the government jobs are commonly recognized as a more secured type. It is because the government jobs are protected by merit based system by which employees receive statutory protections that differ from those of the private sector, including more robust limits on when they can be removed or demoted. It mean that those being hired in the public jobs can not be dismissed without proper legal procedures.

As a result, there is a major distinction between the public and other sectors in terms of security of tenure. Indeed, it, the due process of law, imposes restrictions on any means to dismiss public employees (Woodard, 2005). However, due to lack of such protecting system in the for-profit and non-profit sectors, the job security is lower than public jobs. Because of that, workers may quit their jobs or the employers can dismiss their workers without incurring any expense like post-employment obligations.

Not only the workers in the USA have showed a strongest attraction to job security and stability of the government jobs (Buelens et.al, 2007), but also it is something applicable in other countries like, but not limited to, Canada, Switzerland, Australia, Taiwan and Japan. Consequently, similar motivational impacts were discovered. For instance, based on a study done by Cacioppe and Mock (1984) on Australian government employees and private company workers, they found that those individuals who are managers in public sectors are more attractive to job security while private sector's workers are more attractive to higher economic rewards.

### 2.4.3. Respectability in the Society

The term respectability in the society or reputation; refers to the observers' collective judgments of a company based on its social/environmental impacts and financial assessments attributed to the organization over time. Some agencies or companies publicly assess and audit the reputations of organizations. Few points should be considered while going over the respectability or organizational reputation: Firstly, this term may be the generalized favorability (perceptions or judgments of the overall organization as good, attractive, and appropriate) of the company. Secondly, it may refers to being known for something (perceived predictability of organizational outcomes and behavior relevant to specific audience interests). Thirdly, reputation may be the generalized awareness or visibility of the firm or prominence of the firm in the collective perception (Lange et. al, 2011).

Based on a research covering 527 MBA students, done in 12 top business schools in the United States, Europe and Asia, 96% of these students said that reputation was an important factor in their choice of potential employer5. In addition to this; based on a study in 2012 by Corporate Responsibility (CR) Magazine and COMMIT! Forum covering 1000 employed and unemployed Americans, shows that 87% of them would consider leaving their current job if a company whose corporate reputation has been excellent, offers them jobs. Meanwhile, in 2012 another study by Corporate Responsibility (CR)

[3] https://kolayik.com/ikutuphane/bordrolama/ucret-ve-ucret-cesitleri-nelerdir

[4] http://www.careerizma.com/blog/salary-importance-in-career-choice/

[5] https://sloanreview.mit.edu/article/how-much-does-a-companys-reputation-matter-in-recruiting/

Magazine, in cooperation with Allegis Talent2 found that 75% of Americans would not opt to take job in a company that had a bad reputation, even if they were unemployed. Moreover, if a company that had a bad reputation offers them more money, 58% of Americans would take a job with that company6.

### 2.4.4. Job Environment

The working environment or workplace are not only the physical conditions of a place, which are office temperature or equipment, but also it is related to factors such as work procedures or processes. In addition, the concept of the surrounding conditions under which workers operate is described as work environment7. The term, work environment, also involves the physical geographical location as well as the immediate surroundings of the workplace, such as a construction site or office building. The characteristics such as noise level, quality of the air and extra benefits, for example; free coffee or facility of parking and so on also comes under the heading of the working environment8. Unhealthy working environment, for example; poor ventilation or using gases and chemical materials will lead to sick building syndrome which is a group of mucosal, skin, and general symptoms that are temporally related to working in particular buildings9.

It is noteworthy that the term, work environment, has an unphysical (friendly and hostile environment) facet as well. It means that the term also covers the social interactions with co-workers, seniors and juniors. In another words, friendly or ideal working environment exist whenever workers, despite having diverse traits, could freely interact with either their top managers or subordinates without any harassment. However, if the working environment is full of negative and unfriendly conditions like intimidating and offensive that hinder freely interacting of worker with each other, it can be claimed that a hostile work environment exists.

### 2.4.5. Flexible Working Time Opportunity

Flexi time working schedules have appeared as an alternative of 9-5 or traditional working arrangement. There is a rise in flexible working time, enabling workers to have flexibility to make decision on when, where and the hours to work. In another words, generally it is employees' freedom to define a working schedule to support their lifestyle, in forms of either working part-time, job sharing, working from home or having another kind of flexi time arrangement10. Despite organizations, increasingly, are recognizing the advantages of flexi time working arrangements, but it is traditionally arranged to the needs of parents and caretakers11.

As mentioned before, a flexible working time gives workers the opportunity to select the hours they prefer to work. However, the employers usually set some specified limits. It means that, on a flexible schedule set by employers, employees may work either a condensed workweek or regular workweek. It means that workers who have a condensed week may work four ten-hour days instead of five eight-hour days. Employees who work a five-day week may work hours other than the usual 9-5 (Hörning et. al, 2015).

## 2.5. Alternatives

### 2.5.1. Public Sector

In a country, it is a part of national economy that provides people with those goods and services that may or cannot be maintained by private sector. This part, being a big source of jobs for the job seekers, is composed of national and local governments and its agencies. However, the structure and composition of the public sector differs by countries; but most often in all countries, this sector covers the services such as security, infrastructure, public transportation, public education, health care services and so on. As mentioned before, the services and the goods are provided publically, the non-payer individual can not be excluded from the using them. Contrary to private sector such as business

[6] https://www.prnewswire.com/news-releases/unemployed-americans-will-not-consider-working-for-companies-with-tarnished-corporate-images-170163676.html
[7] https://www.money-zine.com/definitions/career-dictionary/work-environment/
[8] http://www.businessdictionary.com/definition/work-environment.html
[9] https://www.medicinenet.com/script/main/art.asp?articlekey=13142
[10] https://jobs.theguardian.com/article/why-now-s-the-time-to-embrace-flexible-working/
[11] https://www.cipd.co.uk/knowledge/fundamentals/relations/flexible-working/factsheet

sector intending to earn a profit and voluntary sector like charity organizations, most of the public sector owned by public, can be in the forms of the following types (Brown et. al, 1990):

Directly administrating and funding through taxes: These types of public organizations usually do not have to meet the requirements as commercial organizations do, and government makes the decisions.

Publicly owned corporations or state-owned enterprises: Contrary to directly administrating ones, they operate based on commercial criteria, and government does not make the decisions, but the government may set goals for them. State-owned manufacturing company is an example of them.

Partial outsourcing: Refers to a condition in which private sector takes the non-core functions of the public organizations, for example; IT services, food service, waste management, data management, pension management and construction while public organization keep the core functions such as tax collection, security services, law enforcement and so on12.

A borderline form: It is complete outsourcing or contracting out with a private company that provides services on behave of government. Furthermore, it may mean a mixed of private sector operates with assets publicly owned.

### 2.5.2. Private Sector

In simple words, anything that does not belong to public sector is private sector. While all the provided goods and services by public sector are free, private sector provides goods and services for those who pay for them. It is the part of economy run by individuals and enterprises to earn profit or it covers all for-profit businesses not being operated or owned by public sector. However, the intention to earn profit is not a sharp distinguishing character. This is because the charities and non-profit organizations, sometimes as a third segment or as the volunteer sector, are part of private sector too13. Since this sector encompasses the biggest part of a national economy, it provides the biggest employment opportunities as well. In recent years, there is a tendency of transformation of publically run companies to private sector or private citizens, which is known as privatization and vice versa including municipalization and nationalization (Lynch, 1989).

### 2.5.3. One's Own Business

As mentioned before, the main source of employment opportunities are public and private sectors for job seekers. However, a job seeker may be interested in setting up and starting his/her own business. This job seeker as an entrepreneur is in search of and recognition of opportunity to make subsequent decision to exploit the opportunity. Actually, it is entrepreneurship called the process of designing a new business and usually conflates with small business. Moreover, the small business is owned by one person or it is sole proprietor with small number of workers (Hasan and Harris, 2009).

As of forgoing discussion, as a sole ownership/proprietorship is run by one natural person, therefore, legally distinguishing between the owner and the entity (business) is impossible. It means that, on the one hand, the owner has complete and direct control over business, receives all profits and signs contracts in his/her own name, on the other hand, he/she legally has unlimited responsibility for paying loans, debts, loss and so on. In case of insufficient solvency to pay debts of the business, the owner has to pay debts by her/his own money14.

## 3. RESEARCH METHODOLOGY

As mentioned before, this study is about group decision-making (three decision makers DM1, DM2, DM3) regarding job choice as a decision-making problem. This problem is provided with three assumed alternatives source of employment (solutions) including public sector (A1), private sector (A2) and one's own business (A3). The alternatives are evaluated according to five assumed criteria such as wage level (C1), job security (C2), respectability in the society (C3), job environment (C4) and flexible working time opportunity (C5). The question (as a research question of this study) is, of the three entities (source of employment) which one would be the most optimum to make a choice. This complicated decision making problem is shown in the following figure:

[12] https://www.sourcefit.com/outsourcing-solutions-industries/government
[13] https://www.investopedia.com/terms/p/private-sector.asp
[14] https://www.nolo.com/legal-encyclopedia/business-debts-personal-liability-29905.html

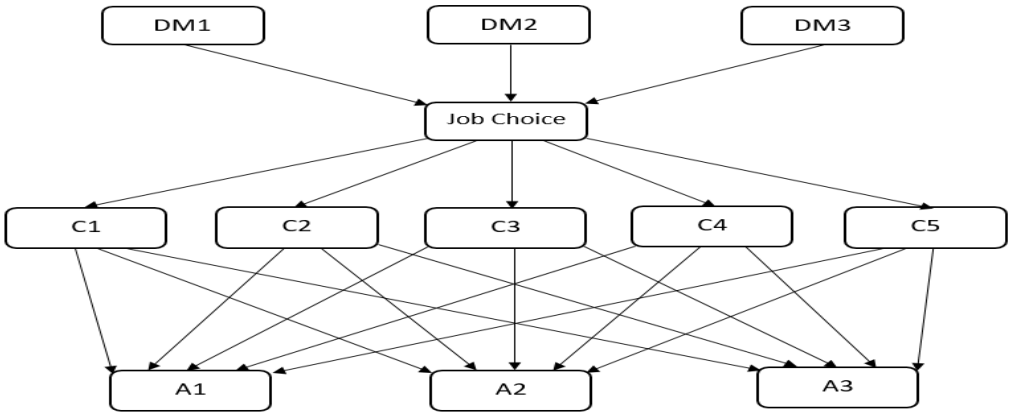


Figure-1: Hierarchy Decision Structure

### 3.1. Fuzzy Topsis

To provide an optimal solution for ongoing decision-making problem (job choice), despite of many methods of the MCDM, TOPSIS is a well-known one developed by Hwang and Yoon (1981). In this method, the most appropriate solution that is closest to the positive ideal solution and furthest to the negative ideal solution are determined. As the relations between criteria and alternative cannot be defined in exact values in MCDM, researchers developed the fuzzy values as a solution for this problem. In other words, fuzzy numbers are developed to replace the numeric values, as they were unable to reflect individual's judgements (choices and often uncertainties). To solve that problem Chen extended TOPSIS method and suggested Fuzzy Topsis method with the usage of fuzzy numbers (Chen, 2000). In this research, the Fuzzy Topsis method is used which includes the following steps:

**Step 1**

Create an evaluation matrix consisting of m alternatives and n criteria, with the intersection of each alternative and criteria given as $X_{ji}$, we therefore have a matrix $(X_{ji})m \times n$.

**Step 2**

The matrix $(X_{ji})m \times n$ is then normalized to form the matrix. $R = (r_{ij})$, using the normalization method $r_{ij} = \frac{x_{ji}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = 1,2 \dots, m, j = 1,2, \dots, n$

**Step 3**

Calculate the weighted normalized decision matrix $T = (t_{ij}) = (w_j r_{ij})m \times n, i = 1,2, \dots, m$

Where $w_j = W_j / \sum_{j=1}^{n} W_j, = 1,2, \dots, n$ so that $\sum_{j=1}^{n} w_j = 1$ and $W_j$ is the original weight given to the indicator $v_j, j = 1,2, \dots, n.$

**Step 4**

Determine the worst alternative $(A_w)$ and the best alternative$(A_b)$ :

$A_w = \{(\max(t_{ij} | i = 1,2, \dots, m) | j \in J_-), (\min(t_{ji} | i = 1,2, \dots, m) | j \in J_+)\} = \{t_{wj} | j = 1,2, \dots, n\},$

$A_b = \{(\min(t_{ij} | i = 1,2, \dots, m) | j \in J_-), (\max(t_{ji} | i = 1,2, \dots, m) | j \in J_+)\} = \{t_{bj} | j = 1,2, \dots, n\},$

where

$J_+ = \{j = 1,2, \dots, n | j$ associated with the criteria having a positive impact, and

$J_- = \{j = 1,2, \dots, n | j$ associated with the criteria having a negative impact.

**Step 5**

Calculate the L2-distance between the target alternative i and the worst condition $A_w$

$d_{iw} = \sqrt{\sum_{j=1}^{n} (t_{ij} - t_{wj})^2}, \ i = 1,2, \dots, m$ and the distance between the alternative i and the best condition $A_b$

$$d_{ib} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{bj})^2}, \quad i = 1,2, \dots, m$$

where $d_{iw}$ and $d_{ib}$ are L2-norm distances from the target alternative i to the worst and best conditions, respectively.

**Step 6**

Calculate the similarity to the worst condition:

$S_{iw} = d_{iw}/(d_{iw} + d_{ib}), 0 \leq s_{iw} \leq 1, i = 1,2, \dots, m.$

$s_{iw} = 1$ If and only if the alternative solution has the best condition; and

$s_{iw} = 0$ If and only if the alternative solution has the worst condition.

**Step 7**

Rank the alternatives according to $s_{iw}(i = 1,2, \dots, m)$.

### 3.2. Applying The Fuzzy Topsis Method

Three CEOs (as decision makers) from the three companies (suggested not to reveal their names) located in Konya City of Turkey participated in this study. They have been given the following questionnaire, first: to weight the importance of five criteria in job choice as shown in Table1, and second to weight three alternatives against the five criteria in Table 2.

Table-1: Questionnaire for Weighting the Importance of Criteria in Job Choice

| Criterions | Terms to Weight The Importance of Criteria in Job Choice | | | | |
|---|---|---|---|---|---|
| | Not important | Slightly Important | Moderately Important | Important | Very Important |
| Wage Level | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job Security | ❶ | ❷ | ❸ | ❹ | ❺ |
| Flexible Working Time | ❶ | ❷ | ❸ | ❹ | ❺ |
| Respectability in the Society | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job Environment | ❶ | ❷ | ❸ | ❹ | ❺ |

Table-2: Questionnaire for Weighting the Importance of Alternatives against Criteria in Job Choice

| Criteria | Alternatives | Terms to Weight The Alternatives Based on Criteria | | | | |
|---|---|---|---|---|---|---|
| | | Very Poor | Poor | Acceptable | Good | Very Good |
| Wage level | Public Sector | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job security | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Flexible working time | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Respectability in the society | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job environment | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Wage level | Private Sector | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job security | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Flexible working time | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Respectability in the society | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job environment | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Wage level | One's Own Business | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job security | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Flexible working time | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Respectability in the society | | ❶ | ❷ | ❸ | ❹ | ❺ |
| Job environment | | ❶ | ❷ | ❸ | ❹ | ❺ |

The three decision makers, as following, have evaluated the questionnaires as shown in Table-3 and Table-4:

Table-3: Weighs of Importance of Criteria from the Viewpoint of the Three Decision Makers

| Criteria | Decisions makers | | |
|---|---|---|---|
| | $D_1$ | $D_2$ | $D_3$ |
| $C_1$ | VI | I | I |
| $C_2$ | I | I | VI |
| $C_3$ | SI | MI | I |
| $C_4$ | I | I | I |

| | | | |
|---|---|---|---|
| $C_5$ | MI | I | MI |

Table-4: Ratings of the Alternatives by Decision Makers against the Criteria

| Alternatives (A) | Decision maker-1 | | | | | Decision maker-2 | | | | | Decision maker-3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
| $A_1$ | A | VG | P | G | A | A | VG | P | A | A | VG | G | A | G | A |
| $A_2$ | VG | P | G | A | A | P | A | P | A | A | A | P | P | A | P |
| A3 | G | G | VG | G | A | VG | G | G | A | A | VG | G | G | A | G |

Then linguistic values shown in Tables 3 and 4 are converted into triangular fuzzy numbers as shown in Table- 5 and 6 respectively to form fuzzy decision matrix in Table-7. The calculations to convert the linguistics values to form triangular fuzzy numbers are given in Appendix-1.

Table-5: Fuzzy Numbers

| | |
|---|---|
| Not Important (NI) | (0, 0, 0.2) |
| Slightly Important (SI) | (0, 0.2, 0.4) |
| Moderately Important (MI) | (0.3, 0.5, 0.7) |
| Important (I) | (0.6, 0.8, 1) |
| Very Important (VI) | (0.8, 1, 1) |

Table-6: Fuzzy Numbers

| | |
|---|---|
| Very Poor (VP) | (0, 0, 2) |
| Poor (P) | (0, 2, 4) |
| Acceptable (A) | (3, 5, 7) |
| Good (G) | (6, 8, 10) |
| Very Good (VG) | (8, 10, 10) |

Table-7: Fuzzy Decision Matrix and Fuzzy Weights of Alternatives

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| $A_1$ | (4.67, 6.67, 8) | (7.33, 9.33, 10) | (1, 3, 5) | (5, 7, 9) | (3, 5, 7) |
| $A_2$ | (2.67, 4.67, 6) | (1, 3, 5) | (2, 4, 6) | (3, 5, 7) | (2, 4, 6) |
| $A_3$ | (7.33, 9.33, 10) | (6, 8, 10) | (6.67, 8.67,10) | (4, 6, 8) | (4, 6, 8) |
| Weights | (0.67, 0.87,1) | (0.667, 0.87,1) | (0.3, 0.5, 0.7) | (0.667, 0.87, 1) | (0.4, 0.6, 0.8) |

The calculation method of forming the Fuzzy Decision Matrix and Fuzzy Weights of Alternative are given in Appendix-1.

Table-8: Normalized Fuzzy Decision Matrix

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| $A_1$ | (0.3, 0.58, 0.8) | (0.49, 0.81, 1) | (0.03, 0.15, 0.35) | (0.37, 0.67, 1) | (0.15, 0.37, 0.7) |
| $A_2$ | (0.18, 0.4, 0.6) | (0.07, 0.26, 0.5) | (0.06, 0.2, 0.42) | (0.22, 0.48, 0.78) | (0.10, 0.3, 0.6) |
| $A_3$ | (0.49, 0.81, 1) | (0.40, 0.69, 1) | (0.20, 0.43, 0.70) | (0.296, 0.58, 0.89) | (0.20, 0.45, 0.8) |

The calculation to form Normalized Fuzzy Decision Matrix is given in Appendix-2.

Table-9: Weighted Normalized Fuzzy Decision Matrix

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| $A_1$ | (0.38, 0.35, 0.33) | (0.09, 0.09, 0.1) | (0.30, 0.17, 0.14) | (0.40, 0.37, 0.33) | (0.27, 0.24, 0.23) |
| $A_2$ | (0.667, 0.49, 0.44) | (0.67, 0.29, 0.2) | (0.150, 0.12, 0.18) | (0.67, 0.520, 0.43) | (0.4, 0.30, 0.266) |
| $A_3$ | (0.24, 0.25, 0.27) | (0.11, 0.11, 0.1) | (0.045, 0.06, 0.07) | (0.5, 0.43, 0.37) | (0.2, 0.2, 0.2) |

The way of calculations to form Weighted Normalized Fuzzy Decision Matrix, is given in the Appendix - 3:

According to the step four of the Fuzzy Topsis, the positive-ideal solution (FPIS) and the fuzzy negative-ideal solution (FNIS) defined and shown in $A^+$ and $A^-$. Here, it means that they are:

$A^+ = [(1, 1, 1)]$, $A^- = [(0,0,0)]$

After that, the distance ($d^+$and $d^-$) of each weighted alternative from FPIS and FNIS with respect to each criterion is computed and available in the Appendix-4. Then the closeness coefficient CCi that represents the distances to fuzzy positive ideal solution, $A^*$, and the fuzzy negative ideal solution, $A^-$ computed simultaneously. Shortly they are as following:

$CC_1 = \frac{d^-1}{d^+1 + d^-1} = \frac{2.865}{2.575 + 2.865} = 0.527$ $CC_2 = \frac{1.963}{3.414 + 1.963} = 0.313$ $CC_3 = \frac{3.200}{2.345 + 3.200} = 0.577$

The alternative with highest closeness coefficient represents the best alternative and is the closest to the FPIS and farthest from the FNIS. The results of all alternatives' distances from FPIS and FNIS and their closeness coefficients are shown in the following Table-10.

Table-10: Closeness Coefficients and Ranking

| | $d^+_I$ | $d^-_i$ | $CC_i$ | Rank |
|---|---|---|---|---|
| $A_1$ | 2.575 | 2.865 | 0.527 | 2 |
| $A_2$ | 3.414 | 1.963 | 0.313 | 3 |

| | | | | |
|---|---|---|---|---|
| $A_3$ | 2.345 | 3.200 | 0.577 | 1 |

According to the closeness coefficient in the above Table-10, the best alternative is number three, as its closeness coefficient has the highest value ($CC_i$= 0.577). In other words, the third alternative is closer to the FPIS and farther from the FNIS. Therefore, the most optimal job for a person, considering the determined alternatives and criteria, is starting up his/her own business. Moreover, preference to work in public or private sector, based on their closeness coefficient values, comes in second and third rank respectively.

## 4. CONCLUSION

The result of this research emphasizes the third alternative (one's own business) as best one, since it has the highest value of closeness coefficient. In other words, the third alternative is the closest to the FPIS and the farthest from the FNIS. Not to forget that other factors other than those considered in this study, for example; happiness might be very important in job choice of a job seeker. Because of that, it is a must for individuals to evaluate the alternatives carefully according to certain criteria while choosing a job. Meanwhile, this study proved that job choice can be defined as a MCDM problem, which paves the grounds to sequence rank of the alternatives (solutions) considering more than one criteria. For more studies, interested people can consider and work on, beside the five criteria of this research, other psychological and subjective/objective criteria by which to evaluate available alternatives.

## RESOURCES

Amiri, M. P. (2010). Project selection for oil-fields development by using the AHP and fuzzy TOPSIS methods. *Expert Systems with Applications*, *37*(9), 6218-6224.

Ashrafzadeh, M., Rafiei, F. M., Isfahani, N. M., & Zare, Z. (2012). Application of fuzzy TOPSIS method for the selection of Warehouse Location: A Case Study. *Interdisciplinary Journal of Contemporary Research in Business*, *3*(9), 655-671.

Ataei, E. (2013). Application of TOPSIS and fuzzy TOPSIS methods for plant layout design. *World Applied Sciences Journal*, *24*(7), 908-913.

Bas, P., Filler, T., & Pevný, T. (2011). *" Break Our Steganographic System": The Ins and Outs of Organizing BOSS.* Paper presented at the Information Hiding.

Behling, O. (1998). Employee selection: Will intelligence and conscientiousness do the job? *The Academy of Management Executive (1993-2005)*, 77-86.

Brown, C. V., Jackson, P. M., & McLeod, P. (1990). *Public sector economics* (Vol. 176): Basil Blackwell Oxford.

Buelens, M., & Van den Broeck, H. (2007). An analysis of differences in work motivation between public and private sector organizations. *Public Administration Review, 67*(1), 65-74.

Cacioppe, R., & Mock, P. (1984). A comparison of the quality of work experience in government and private organizations. *Human Relations, 37*(11), 923-940.

C. Chen. (2000). "Extensions of the TOPSIS for Group Decision-Making under Fuzzy Environment," Fuzzy Sets and Systems, vol. 114, pp. 1–9.

Chen, C.-T., Lin, C.-T., & Huang, S.-F. (2006). A fuzzy approach for supplier evaluation and selection in supply chain management. *International journal of production economics, 102*(2), 289-301.

Chen, C. A., Hsieh, C. W., & Chen, D. Y. (2014). Fostering public service motivation through workplace trust: Evidence from public managers in Taiwan. *Public Administration, 92*(4), 954-973.

Daft, Richard. (2003). "Management 6th Edition. Thomson South Western.

Genç, T., & Masca, M. (2013). Topsis Ve Promethee Yöntemleri İle Elde Edilen Üstünlük Sıralamalarının Bir Uygulama Üzerinden Karşılaştırılması. *Journal of Economics & Administrative Sciences/Afyon Kocatepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 15*(2).

Ghorbani, M., Velayati, R., & Ghorbani, M. M. (2011, May). Using fuzzy TOPSIS to determine strategy priorities by SWOT analysis. In *International Conference on Financial Management and Economics* (Vol. 11, pp. 135-139).

Hall, D. T., & Moss, J. E. (1999). The new protean career contract: Helping organizations and employees adapt. *Organizational dynamics, 26*(3), 22-37.

Hasan, M., & Harris, E. (2009). Entrepreneurship and innovation in e-commerce. *Journal of Achievements in Materials and Manufacturing Engineering, 32*(1), 92-97.

Hashemi Tilehnoei, M., & Amiri Aref, M. (2013). Temporal Dimension Evaluation by Fuzzy TOPSIS Method. *International Journal of Architecture and Urban Development, 3*(2), 55-60.

Hörning, K. H., Gerhardt, A., & Michailow, M. (2015). *Time pioneers: Flexible working time and new lifestyles*: John Wiley & Sons.

Hwang, C.-L., & Yoon, K. (1981). Multiple criteria decision-making. *Lecture Notes in Economics and Mathematical Systems*.

Jones, M. H. (1962). *Executive decision-making*: RD Irwin.

Kabir, G., & Hasin, M. (2012). Comparative Analysis of Topsis and Fuzzy Topsis for the Evaluation of Travel Website Service Quality. *International Journal for Quality Research*, *6*(3).

Küçük, O., & Ecer, F. (2007). Assessing suppliers using fuzzy TOPSIS and an application in Erzurum. *The International Journal of Economic and Social Research*, *3*(1), 45-65.

Lange, D., Lee, P. M., & Dai, Y. (2011). Organizational reputation: A review. *Journal of Management, 37*(1), 153-184.

Lee, C. C., Chiang, C., & Chen, C. T. (2012). An evaluation model of e-service quality by applying hierarchical fuzzy TOPSIS method. *International Journal of Electronic Business Management*, *10*(1), 38.

Liao, C. N., & Kao, H. P. (2011). An integrated fuzzy TOPSIS and MCGP approach to supplier selection in supply chain management. *Expert Systems with Applications*, *38*(9), 10803-10811.

Lynch, L. M. (1989). *Private sector training and its impact on the earnings of young workers*. Retrieved from NBER working paper series, working paper No. 2872. National Bureau of Economic Research. Cambridge.

Önüt, S., & Soner, S. (2007). Analysis of energy use and efficiency in Turkish manufacturing sector SMEs. *Energy Conversion and Management, 48*(2), 384-394.

Önüt, S., Kara, S. S., & Işık, E. (2009). Long-term supplier selection using a combined fuzzy MCDM approach: A case study for a telecommunication company. *Expert systems with applications*, *36*(2), 3887-3895.

Rue & Byars. (2003). "Decision Making skills". Management skills and application. McGraw Hill.

Şimşek, M., Şerif. Öge, H., Serdar. (2015). İnsan Kaynakları Yönetimi. 6. Baskı. Eğitim Yayınevi. Konya.

Santos, F. J., & Camargo, H. A. (2010). Fuzzy Systems for multi criteria decision-making. *CLEI Electronic Journal, 13*(3).

Schreuder, A. M. G. (2006). Careers: An Organizational Perspective. p. 187. ISBN 9780702171758.

Schwab, D. P., Rynes, S. L., & Aldag, R. J. (1987). Theories and research on job search and choice. *Research in personnel and human resources management, 5*(1), 129-166.

Selçuk, A., & Özkan, T. K. (2015). Job Choice with Multi-Criteria Decision Making Approach in a Fuzzy Environment. *International Review of Management and Marketing, 5*(3), 165-172.

Soba, M., Şimşek, A., & Bayhan, M. (2015). Bulanık Topsis Yöntemi İle Alışveriş Merkezi Kuruluş Yeri Seçimi: Uşak İlinde Bir Uygulama. *Muğla Sıtkı Koçman Üniversitesi İktisadi ve İdari Bilimler Fakültesi Ekonomi ve Yönetim Araştırmaları Dergisi*, *3*(2).

Sun, C. C., & Lin, G. T. (2009). Using fuzzy TOPSIS method for evaluating the competitive advantages of shopping websites. *Expert Systems with Applications*, *36*(9), 11764-11771.

Tabar, A. A. Y., & Charkhgard, H. (2012). Supplier selection in supply chain managment by using ANP and fuzzy TOPSIS. *International Journal of Applied Physics and Mathematics*, *2*(6), 458.

Tırmıkçıoğlu Çınar, N. (2010). Kuruluş yeri seçiminde Bulanık TOPSIS yöntemi ve bankacılık sektöründe bir uygulama.

Uyun, S., & Riadi, I. (2013). A fuzzy TOPSIS multiple-attribute decision making for scholarship selection. *arxiv preprint arxiv:1306.6489*. Available at: https://arxiv.org/ftp/arxiv/papers/1306/1306.6489.pdf

Woodard, C. A. (2005). Merit by Any Other Name—Refraining the Civil Service First Principle. *Public Administration Review, 65*(1), 109-116.

Yavuz, S., & Deveci, M. (2014). Bulanık TOPSIS ve Bulanık VIKOR Yöntemleriyle Alışveriş Merkezi Kuruluş Yeri Seçimi ve Bir Uygulama/Selection of Shopping Center Location with The Methods of Fuzzy VIKOR and Fuzzy TOPSIS and An Application. *Ege Akademik Bakış*, *14*(3), 463.

Yazdani, M., Alidoosti, A., & Zavadskas, E. K. (2011). Risk analysis of critical infrastructures using fuzzy COPRAS. *Economic Research-Ekonomska Istraživanja*, *24*(4), 27-40.

Yong, D. (2006). Plant location selection based on fuzzy TOPSIS. *The International Journal of Advanced Manufacturing Technology*, *28*(7), 839-844.

**Appendix 1:**

1-a: Calculations to form Fuzzy Decision Matrix

| Criterions | Alternatives | $DM_1$ | $DM_2$ | $DM_3$ |
|---|---|---|---|---|
| $C_1$ | $A_1$<br>$A_2$<br>$A_3$ | A (3, 5, 7)<br>VG (8, 10, 10)<br>G (6, 8, 10) | A (3, 5, 7)<br>P (0, 2, 4)<br>VG (8, 10, 10) | VG (8, 10, 10)<br>P (0, 2, 4)<br>VG (8, 10, 10) |
| $C_2$ | $A_1$<br>$A_2$<br>$A_3$ | VG (8, 10, 10)<br>P (0, 2, 4)<br>G (6, 8, 10) | VG (8, 10, 10<br>A (3, 5, 7)<br>G (6, 8, 10) | G (6, 8, 10)<br>P (0, 2, 4)<br>G (6, 8, 10) |
| $C_3$ | $A_1$<br>$A_2$<br>$A_3$ | P (0, 2, 4)<br>G (6, 8, 10)<br>VG (8, 10, 10) | P (0, 2, 4)<br>P (0, 2, 4)<br>G (6, 8, 10) | A (3, 5, 7)<br>P (0, 2, 4)<br>G (6, 8, 10) |
| $C_4$ | $A_1$<br>$A_2$<br>$A_3$ | G (6, 8, 10)<br>A (3, 5, 7)<br>G (6, 8, 10) | A (3, 5, 7)<br>A (3, 5, 7)<br>A (3, 5, 7) | G (6, 8, 10)<br>A (3, 5, 7)<br>A (3, 5, 7) |
| $C_5$ | $A_1$<br>$A_2$<br>$A_3$ | A (3, 5, 7)<br>A (3, 5, 7)<br>A (3, 5, 7) | A (3, 5, 7)<br>A (3, 5, 7)<br>A (3, 5, 7) | A (3, 5, 7)<br>P (0, 2, 4)<br>G (6, 8, 10) |

$\overline{w_1} = \frac{0.8+0.6+0.6}{3} = 0.667$

$\overline{w_1} = \frac{1+0.8+0.8}{3} = 0.867$

$\overline{w_1} = \frac{1+1+1}{3} = 1$

$\overline{w_3} = \frac{0+0.3+0.6}{3} = 0.3$

$\overline{w_3} = \frac{0.2+0.5+0.8}{3} = 0.5$

$\overline{w_3} = \frac{0.4+0.7+1}{3} = 0.7$

$\overline{w_5} = \frac{0.3+0.6+0.3}{3} = 0.4$

$\overline{w_5} = \frac{0.7+1+0.7}{3} = 0.8$

$\overline{w_2} = \frac{0.6+0.6+0.8}{3} = 0.667$

$\overline{w_2} = \frac{0.8+0.8+1}{3} = 0.867$

$\overline{w_2} = \frac{1+1+1}{3} = 1$

$\overline{w_4} = \frac{0.6+0.6+0.6}{3} = 0.6$

$\overline{w_4} = \frac{0.8+0.8+0.8}{3} = 0.8$

$\overline{w_4} = \frac{1+1+1}{3} = 1$

$\overline{w_5} = \frac{0.5+0.8+0.5}{3} = 0.6$

$\bar{w}$= {(0.667,0.867,1) (0.667,0.867,1) (0.3,0.5,0.7) (0.667,0.867,1) (0.4,0.6,0.8)}

$X_{11} = \frac{3+3+8}{3} = \frac{5+5+10}{3} = \frac{7+7+10}{3}$

$\bar{X}_{11} = (4.67, 6.67, 8)$

$X_{12} = \frac{8+8+6}{3} = \frac{10+10+8}{3}$

$X_{21} = \frac{8+0+0}{3} = \frac{10+2+2}{3} = \frac{10+4+4}{3}$

$\bar{X}_{21} = (2.67, 4.67, 6)$

$X_{22} = \frac{0+3+0}{3} = \frac{2+5+2}{3}$

$X_{31} = \frac{6+8+8}{3} = \frac{8+10+10}{3} = \frac{10+10+10}{3}$

$\bar{X}_{31} = (7.33, 9.33, 10)$

$X_{32} = \frac{6+6+6}{3} = \frac{8+8+8}{3}$

$= \frac{10+10+10}{3}$

$\bar{X}_{12} = (7.33, 9.33, 10)$

$X_{13} = \frac{0+0+3}{3}$

$= \frac{2+2+5}{3}$

$= \frac{4+4+7}{3}$

$\bar{X}_{13} = (1, 3, 5)$

$X_{14} = \frac{6+3+6}{3}$

$= \frac{8+5+8}{3}$

$= \frac{10+7+10}{3}$

$\bar{X}_{14} = (5, 7, 9)$

$X_{15} = \frac{3+3+3}{3}$

$= \frac{5+5+5}{3}$

$= \frac{7+7+7}{3}$

$\bar{X}_{15} = (3, 5, 7)$

$= \frac{4+7+4}{3}$

$\bar{X}_{22} = (1, 3, 5)$

$X_{23} = \frac{6+0+0}{3}$

$= \frac{8+2+2}{3}$

$= \frac{10+4+4}{3}$

$\bar{X}_{23} = (2, 4, 6)$

$X_{24} = \frac{3+3+3}{3}$

$= \frac{5+5+5}{3}$

$= \frac{7+7+7}{3}$

$\bar{X}_{24} = (3, 5, 7)$

$X_{25} = \frac{3+3+0}{3}$

$= \frac{5+5+2}{3}$

$= \frac{7+7+4}{3}$

$\bar{X}_{25} = (2, 4, 6)$

$= \frac{10+10+10}{3}$

$\bar{X}_{32} = (6, 8, 10)$

$X_{33} = \frac{8+6+6}{3}$

$= \frac{10+8+8}{3}$

$= \frac{10+10+10}{3}$

$\bar{X}_{33} = (6.67, 8.67, 10)$

$X_{34} = \frac{6+3+3}{3}$

$= \frac{8+5+5}{3}$

$= \frac{10+7+7}{3}$

$\bar{X}_{34} = (4, 6, 8)$

$X_{35} = \frac{3+3+6}{3}$

$= \frac{5+5+8}{3}$

$= \frac{7+7+10}{3}$

$\bar{X}_{35} = (4, 6, 8)$

1-b: Fuzzy Decision matrix

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| $A_1$ | (4.67, 6.67, 8) | (7.33, 9.33, 10) | (1, 3, 5) | (5, 7, 9) | (3, 5, 7) |
| $A_2$ | (2.67, 4.67, 6) | (1, 3, 5) | (2, 4, 6) | (3, 5, 7) | (2, 4, 6) |
| $A_3$ | (7.33, 9.33, 10) | (6, 8, 10) | (6.67, 8.67,10) | (4, 6, 8) | (4, 6, 8) |
| Weights | (0.67, 0.87,1) | (0.667, 0.87,1) | (0.3, 0.5, 0.7) | (0.667, 0.87, 1) | (0.4, 0.6, 0.8) |

## Appendix 2: Calculations for forming the Normalized Decision Matrix

$\bar{X}_{11} = (\frac{4.667}{10}, \frac{6.667}{10}, \frac{8}{10})$ = (0.467 , 0.667 , 0.8)* (0.667 , 0.867 ,1) = **(0.311 , 0.578 , 0.800)**

$\bar{X}_{21} = (\frac{2.667}{10}, \frac{4.667}{10}, \frac{6}{10})$ = (0.267 , 0.467 , 0.6)* (0.667 , 0.867 ,1) = **(0.178 , 0.405 , 0.600)**

$\bar{X}_{31} = (\frac{7.333}{10}, \frac{9.333}{10}, \frac{10}{10})$ = (0.733 , 0.933 , 1)* (0.667 , 0.867 , 1) = **(0.489 , 0.809 , 1)**

$\bar{X}_{12} = (\frac{7.333}{10}, \frac{9.333}{10}, \frac{10}{10})$ = (0.733 , 0.933 , 1)* (0.667 , 0.867 , 1) = **(0.489 , 0.809 , 1)**

$\bar{X}_{22} = (\frac{1}{10}, \frac{3}{10}, \frac{5}{10})$ = (0.1 , 0.3 , 0.5)* (0.667 , 0.867 , 1) = **(0.067 , 0.26 , 0.500)**

$\bar{X}_{32} = (\frac{6}{10}, \frac{8}{10}, \frac{10}{10})$ = (0.6 , 0.8 , 1)* (0.667 , 0.867 , 1) = **(0.400 , 0.693 , 1)**

$\bar{X}_{13} = (\frac{1}{10}, \frac{3}{10}, \frac{5}{10})$ = (0.1 , 0.3 , 0.5)* (0.3 , 0.5 , 0.7) = **(0.030 , 0.150 , 0.350)**

$\bar{X}_{23} = (\frac{2}{10}, \frac{4}{10}, \frac{6}{10})$ = (0.2 , 0.4 , 0.6)* (0.3 , 0.5 , 0.7) = **(0.060 , 0.200 , 0.420)**

$\bar{X}_{33} = (\frac{6.667}{10}, \frac{8.667}{10}, \frac{10}{10})$ = (0.667 , 0.867 , 1)* (0.3 , 0.5 , 0.7) = **(0.200 , 0.433 , 0.700)**

$\bar{X}_{14} = (\frac{5}{9}, \frac{7}{9}, \frac{9}{9})$ = (0.555 , 0.778 , 1)* (0.667 , 0.867 , 1) = **(0.370 , 0.674 , 1)**

$\bar{X}_{24} = (\frac{3}{9}, \frac{5}{9}, \frac{7}{9})$ = (0.333 , 0.555 , 0.778)* (0.667 , 0.867 , 1) = **(0.222 , 0.481 , 0.778)**

$\bar{X}_{34} = (\frac{4}{9}, \frac{6}{9}, \frac{8}{9})$ = (0.444 , 0.667 , 0.889)* (0.667 , 0.867 , 1) = **(0.296 , 0.578 , 0.889)**

$\bar{X}_{15} = (\frac{3}{8}, \frac{5}{8}, \frac{7}{8})$ = (0.375 , 0.625 , 0.875)* (0.4 , 0.6 , 0.8) = **(0.150 , 0.375 , 0.700)**

$\bar{X}_{25} = (\frac{2}{8}, \frac{4}{8}, \frac{6}{8})$ = (0.25 , 0.50 , 0.75)* (0.4 , 0.6 , 0.8) = **(0.100 , 0.300 , 0.600)**

$\bar{X}_{35} = (\frac{4}{8}, \frac{6}{8}, \frac{8}{8})$ = ( 0.5 , 0.75 , 1)* (0.4 , 0.6 , 0.8) = **(0.200 , 0.450 , 0.800)**

Normalized Fuzzy Decision Matrix

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| $A_1$ | (0.311,0.578,0.800) | (0.489,0.809,1) | (0.030,0.150,0.350) | (0.370,0.674,1) | (0.150,0.375,0.700) |
| $A_2$ | (0.178,0.405,0.600) | (0.067,0.260,0.500) | (0.060,0.200,0.420) | (0.222,0.481,0.778) | (0.100,0.300,0.600) |
| $A_3$ | (0.489,0.809,1) | (0.400,0.693,1) | (0.200,0.433,0.700) | (0.296,0.578,0.889) | (0.200,0.450,0.800) |

## Appendix 3: Calculations to form weighted normalized fuzzy decision matrix.

$\bar{X}_{11} = (\frac{2.667}{4.667}, \frac{2.667}{6.667}, \frac{2.667}{8})$ = (0.571 , 0.400 , 0.333)* (0.667 , 0.867 , 1) = **(0.381 , 0.347 , 0.333)**

$\bar{X}_{21} = (\frac{2.667}{2.667}, \frac{2.667}{4.667}, \frac{2.667}{6})$ = (1 , 0.571 , 0.444)* (0.667 , 0.867 , 1) = **(0.667 , 0.495 , 0.444)**

$\bar{X}_{31} = (\frac{2.667}{7.333}, \frac{2.667}{9.333}, \frac{2.667}{10})$ = (0.364 , 0.286 , 0.267)* (0.667 , 0.867 ,1) = **(0.243 , 0.248 , 0.267)**

$\bar{X}_{12} = (\frac{1}{7.333}, \frac{1}{9.333}, \frac{1}{10})$ = (0.136 , 0.107 , 0.1)* (0.667 , 0.867 , 1) = **(0.091 , 0.093 , 0.100)**

$\bar{X}_{22} = (\frac{1}{1}, \frac{1}{3}, \frac{1}{5})$ = (1, 0.333 , 0.2)* (0.667 , 0.867 , 1) = **(0.667 , 0.289 , 0.200)**

$\bar{X}_{32} = (\frac{1}{6}, \frac{1}{9}, \frac{1}{10})$ = (0.166 , 0.125 , 0.1)* (0.667 , 0.867 , 1) = **(0.111 , 0.108 , 0.100)**

$\bar{X}_{13} = (\frac{1}{1}, \frac{1}{3}, \frac{1}{5})$ = (1, 0.333 , 0.2)* (0.3 , 0.5 , 0.7) = **(0.300 , 0.166 , 0.140)**

$\bar{X}_{23} = (\frac{1}{2}, \frac{1}{4}, \frac{1}{6})$ = (0.5, 0.25, 0.167)* (0.3 , 0.5 , 0.7) = **(0.150 , 0.125 , 0.117)**

$\bar{X}_{33} = (\frac{1}{6.667}, \frac{1}{8.667}, \frac{1}{10})$ = (0.150 , 0.115 , 0.1)* (0.3 , 0.5 , 0.7) = **(0.045 , 0.057 , 0.070)**

$\bar{X}_{14} = (\frac{3}{5}, \frac{3}{7}, \frac{3}{9})$ = (0.6, 0.428, 0.333)* (0.667, 0.867, 1) = **(0.400, 0.371, 0.333)**

$\bar{X}_{24} = (\frac{3}{3}, \frac{3}{5}, \frac{3}{7})$ = (1 , 0.6 , 0.428)* (0.667 , 0.867 , 1) = **(0.667 , 0.520 , 0.428)**

$\bar{X}_{34} = (\frac{3}{4}, \frac{3}{6}, \frac{3}{8})$ = (0.75 , 0.5 , 0.375)* (0.667 , 0.867 , 1) = **(0.500 , 0.433 , 0.375)**

$\bar{X}_{15} = (\frac{2}{3}, \frac{2}{5}, \frac{2}{7})$ = (0.666, 0.4 , 0.286)* (0.4 , 0.6 , 0.8) = **(0.266 , 0.240 , 0.229)**

$\bar{X}_{25} = (\frac{2}{2}, \frac{2}{4}, \frac{2}{6})$ = (1 , 0.50 , 0.333)* (0.4 , 0.6 , 0.8) = **(0.400 , 0.300 , 0.266)**

$\bar{X}_{35} = (\frac{2}{4}, \frac{2}{6}, \frac{2}{8})$ = ( 0.5 , 0.333 , 0.25)* (0.4 , 0.6 , 0.8) = **(0.200 , 0.200 , 0.200)**

Weighted Normalized Fuzzy Decision Matrix

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| $A_1$ | (0.381,0.347,0.333) | (0.091,0.093,0.100) | (0.300,0.166,0.140) | (0.400,0.371,0.333) | (0.266,0.240,0.229) |
| $A_2$ | (0.667,0.495,0.444) | (0.667,0.289,0.200) | (0.150,0.125,0.117) | (0.667,0.520,0.428) | (0.400,0.300,0.266) |
| $A_3$ | (0.243,0.248,0.267) | (0.111,0.108,0.100) | (0.045,0.057,0.070) | (0.500,0.433,0.375) | (0.200,0.200,0.200) |

## Appendix 4: Calculating the Distance For Each Weighted Alternative From FPIS and FNIS.

$d^+_1 = \sqrt{\frac{1}{3}[(1-0.311)^2 + (1-0.578)^2 + (1-0.8)^2]} + \sqrt{\frac{1}{3}[(1-0.489)^2 + (1-0.809)^2 + (1-1)^2]}$
$+ \sqrt{\frac{1}{3}[(1-0.3)^2 + (1-0.15)^2 + (1-0.35)^2]} + \sqrt{\frac{1}{3}[(1-0.37)^2 + (1-0.674)^2 + (1-1)^2]}$
$+ \sqrt{\frac{1}{3}[(1-0.15)^2 + (1-0.375)^2 + (1-0.7)^2]} = \boldsymbol{d^+_1 = 2.575}$

$d^+_2 = \sqrt{\frac{1}{3}[(1-0.178)^2 + (1-0.405)^2 + (1-0.6)^2]} + \sqrt{\frac{1}{3}[(1-0.067)^2 + (1-0.26)^2 + (1-0.5)^2]}$
$+ \sqrt{\frac{1}{3}[(1-0.06)^2 + (1-0.2)^2 + (1-0.42)^2]} + \sqrt{\frac{1}{3}[(1-0.222)^2 + (1-0.481)^2 + (1-0.778)^2]} +$
$\sqrt{\frac{1}{3}[(1-0.1)^2 + (1-0.3)^2 + (1-0.6)^2]} = \boldsymbol{d^+_2 = 3.414}$

$d^+_3 = \sqrt{\frac{1}{3}[(1-0.489)^2 + (1-0.809)^2 + (1-1)^2]} + \sqrt{\frac{1}{3}[(1-0.4)^2 + (1-0.693)^2 + (1-1)^2]}$
$+ \sqrt{\frac{1}{3}[(1-0.2)^2 + (1-0.433)^2 + (1-0.7)^2]} + \sqrt{\frac{1}{3}[(1-0.296)^2 + (1-0.578)^2 + (1-0.889)^2]}$
$+ \sqrt{\frac{1}{3}[(1-0.2)^2 + (1-0.45)^2 + (1-0.8)^2]} = \boldsymbol{d^+_3 = 2.345}$

$d^-_1 = \sqrt{\frac{1}{3}[(0-0.311)^2 + (0-0.578)^2 + (0-0.8)^2]} + \sqrt{\frac{1}{3}[(0-0.489)^2 + (0-0.809)^2 + (0-1)^2]}$
$+ \sqrt{\frac{1}{3}[(0-0.3)^2 + (0-0.15)^2 + (0-0.35)^2]} + \sqrt{\frac{1}{3}[(0-0.37)^2 + (0-0.674)^2 + (0-1)^2]}$
$+ \sqrt{\frac{1}{3}[(0-0.15)^2 + (0-0.375)^2 + (0-0.7)^2]} = \boldsymbol{d^-_1 = 2.865}$

$d^-_2 = \sqrt{\frac{1}{3}[(0-0.178)^2 + (0-0.405)^2 + (0-0.6)^2]} + \sqrt{\frac{1}{3}[(0-0.067)^2 + (0-0.26)^2 + (0-0.5)^2]}$
$+ \sqrt{\frac{1}{3}[(0-0.06)^2 + (0-0.2)^2 + (0-0.42)^2]} + \sqrt{\frac{1}{3}[(0-0.222)^2 + (0-0.481)^2 + (0-0.778)^2]}$
$+ \sqrt{\frac{1}{3}[(0-0.1)^2 + (0-0.3)^2 + (0-0.6)^2]} = \boldsymbol{d^-_2 = 1.963}$

$$d^{-}_{3}=\sqrt{\tfrac{1}{3}[(0-0.489)^2+(0-0.809)^2+(0-1)^2]}+\sqrt{\tfrac{1}{3}[(0-0.4)^2+(0-0.693)^2+(0-1)^2]}$$
$$+\sqrt{\tfrac{1}{3}[(0-0.2)^2+(0-0.433)^2+(0-0.7)^2]}+\sqrt{\tfrac{1}{3}[(0-0.296)^2+(0-0.578)^2+(0-0.889)^2]}$$
$$+\sqrt{\tfrac{1}{3}[(0-0.2)^2+(0-0.45)^2+(0-0.8)^2]}=$$