Fuzzy Analytical Hiererachy Process Based Model For Influencing Factors In Academic Performances Of Engineering Students

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Abstract

Nowadays students of Engineering are affected by strain and troubled due to different reasons like social tension, race, electronic gadgets and physical appearance etc., Student's stress level is an unavoidable and observable fact which holds back individual development, social interactions, peer influence and adolescence. Identifying the stress level of the student is a not easy task and it leads to vagueness. Fuzzy set theory-based model is very excellent output over vagueness. Analytical hierarchy process (AHP) is a multi-criteria decision-making process which gives very clear statement over uncertainty. This current work is based on the wide-ranging analysis of the engineering student stress factor. Through literature survey here we considered several factors which will influence the students stress and used as input in our model for analysis. Here we identify the influencing factors using Fuzzy Analytic hierarchy process (FAHP) model, with the purpose of improve the student's academic performances and it is an appropriate model to get more satisfactory results.

Keywords: *Fuzzy Analytical Hierarchy Process, Influencing Factors, Academic Performances.*

1. Introduction

Normally entering into the first year, students are novice and surrounded by new social group. They are expected to form a new group but are alone in performances. Obviously, there are many factors associated with the level of success. More skillful students are essential benefit for any educational institute. Therefore, the social and economic improvement of the country is directly linked with learner academic achievement and plays a vital role in make the best merit graduated who will become great organizer and manpower for the country. (Mushtaq, S, N, K, 2012). Students have variation in their personality behaviors and also the approach how they understand things. It is repeatedly argued that variation in personality mandatory for people to be well-off in their career. An academic performance is important because it directly decides the positive outcome of learning. It is the level of attainment of person to pursue the academic performances by satisfying an amount of purpose. Generally, in all educational institution students' attainment is calculated by academic performances. Students meet a lot of pressures and challenges in academic environment to keep up the best performances in the academic program. Academic attainment is made up of six components such as academic achievement, satisfaction, acquirement of skills , gaining of competencies, character, achievement of learning objectives and career achievement.(York Travis T, Charles Gibson Susan Rankin).Student's performance is "associated with students' profile like his attitude towards class attendance, time allocation of studies, parent's level of

earnings and parent's education" (Amitava Raychaudhuri, ManojitDebnath, SaswataSen and Braja Gopal Majumder).The environment in engineering colleges is mainly defined by its circumstances. Engineering students feel the stress which leads to mental harassment. The adverse effects of stress on physical health of students that include a sudden consistent performance in academic, other weakness, sadness, restlessness and violence challenges. Stress can cause by some complications that exist such as problems at school, financial issues, family issues and problems in their society. Stress and anxiety condition affect the students in academically and change the way the individual thinks and activities throughout the college or time spent in studying (Rajaprakash, S, Ponnusamy, R, Jaichandran, K, Karthik, K, Somasundaram, K). Multi criteria decision making is a phenomenon encountered frequently in all human activities. It is about ranking the criteria based on the comparison between the criteria. This process is measured to be very complicated one for decision makers because of uncertainty and vague. There are several methods of multiple-criteria decision making (MCDM) to evaluate and to achieve a certain objective. In recent days applications in artificial intelligence for accepting the human thought process and transmit it to practical environment come into appreciation. The fuzzy logic-based models pave the approach for expressing constant vague concepts mathematically and is also regarded as an artificial intelligence process and it has developed into one of the very most appropriate methods in the solution of judgment problems. A Fuzzy Analytical Hierarchy Process (FAHP) is used to solve a number of complex decision problems. Previously lots of research has been done on academic performance of the students. They reached on various conclusion and lots of different factors were studied. This study has approached the problem in different way by applying FAHP method. There are several factors which involve the academic performance of students in higher education institutions, so in our study, we explore eight factors that affect student's academic performances. These factors are curriculum structure, faculty involvement, teaching methods, parental involvement in academic, family issues and instability, peer relationships, learning environment, assessment. This research will be helpful for the parents and also the faculties to guide them to achieve their goals properly as per their abilities.

2. Influencing factors

Analyzing the influencing factor is essential to improve student's academic performances. The qualitative descriptions were collected from the expert's opinion. There are several factors are affected but few factors were considered as important factors and analyzed using FAHP. The following factors were used as input values in our model.

- Curriculum Structure
- Faculty Involvement
- Teaching Methods
- Parental Involvement in Academic
- Family Issues and Instability
- Peer Relationships
- Learning Environment
- Evaluation

2.1 Curriculum Structure

In this usual approach, professors educated the content by repetition, making students' state or inscribe the same thing repetitively which made class less interesting. To facilitate students, feel more secure, educators necessitate planning classes and curriculums. Educators can also state the objectives of a course at the commencement of a semester. Today, on the other hand, core curriculum developers should know the significance of developing educational goals and instruction methods in order to practice students for their future careers. Set up core curriculum to be associated with the real world can support student contribution, their enthusiasm and understanding for the scholastic subjects, as well as practicing them for future life. Additionally, educational curriculums designed in a way that allows college students to master knowledge and be aware of core academic disciplinary knowledge. Also, this curriculum be supposed to provide students to make knowledgeable decisions that practice them to face the challenges in the global community and put forward them the opportunity to be successful in the workplace. Students need more skills to facilitate their achievements and promote cognitive processes and the creation of knowledge that prepares them to be booming in their future careers. As a result, teachers must apply brilliant strategies and techniques for teaching these skills because there is not one definite strategy or model to achieve this goal**. (Halah Ahmed Alismail, atrick McGuire 2015).** The professor involved in curriculum organization has many responsibilities. Always faculties wish to enjoy in teaching by applying different techniques and watching their developments, subject interest and skills in their interested area. It is require creating lesson plans and syllabi within the structure of the specified curriculum since the teacher's responsibilities are to execute the curriculum to meet up student requirements **(Merfat Ayesh Alsubaie,2015).**

2.2. Faculty Involvement

Faculties who have optimistic interaction with their students build classroom environments more useful to culture and congregate students' developmental, emotional and learning needs. Interactions between student- faculties are very essential for the progress of the students' educational self-concept and enhancing their enthusiasm and achievement. Positive interaction can be defined by understanding, affection, confidence, hope, respect, care and support. The correlation between student and faculties plays a most important role in the path of a student's educational success and social enlargement. Establishing a positive relationship with their faculties helps a student feel more comfortable and secure in their classroom environments. As a consequence, students are more expected to contribute enthusiastically in class room and challenge themselves academically.

2.3. Teaching Methods

Students are more expected to maintain their motivation in education if educators apply different teaching methods. That creates multiplicity and avoids students from getting bored. Students in a particular class are expected to have different approaches of learning. One more important aspect, especially when it comes to girls in subjects is ensuring that the skills learned can be practically applied in real life. One of the emphasized objectives in each education organization is to enlarge and progress learners' thinking skills and such takes place through the integration of these concepts in the curriculum **(MortezaKarami, HamidehPakmehr and AlirezaAghili 2012)**. Student academic performance includes academic achievement, achievement of learning objectives, gaining of desired ability and competencies, happiness, persistence and post-university performance. The collaborative knowledge such as conversation forums, peer-tutoring and video conferencing have an outcome on student education as well as support in

achieving advanced thinking skills. The uses of technology are not intended to replace the conventional classroom setting but to afford new opportunities and an innovative environment for interaction between students and their educators. (**Ahmed O. A. Ismail, Ahmad K. Mahmood, Abdelzahir Abdelmaboud 2018**). The teaching methodology is to be characterized as a practice based on manual and frequently trained by teachers with an inadequate profile to present content associated to the epistemological dimension of the process of knowledge generation. (**Daniel Carlos Gutiérrez, Elia Guadalupe Villegas 2015**)

2.4. Parental Involvement in academic

Motivation is a significant component influencing learning and achievement. Parental habits can indirectly influence the motivation of children, intrinsic motivation in particular. This includes the activities like showing interest in the child's learning material, questioning about their daily activities, enthusiastically listening, helping with particular tasks or skills taught at college, attending parent meetings, encouraging children to complete project work and study for a test. Another practice that's been proven to improve motivation, is reading. Parental motivation is an important element influencing education and attainment. It is understood parental involvement affects human behavior in a various aspect such as education knowledge, belief, observations, creativeness, and way of thinking (**Ubale 2015**).

2.5. Family Issues and Instability

Another influencing factor is the lack of safety at home can negatively impact motivation in academic progress. Students who live with both parents, on average obtain better grades than students who do not. Family conflicts and distraction can result in poor academic performance. This includes divorce, loss of parents, not living with the biological father or mother and often moving from one home to any more. As a result, in certain cases an additional support may be required to assist students with their issues.

2.6. Peer Relationships

The interaction between peer to peer is a foremost stimulant with in college environment and create the support base for achievement at the collegiate level. It has the most influence a positive or negative impact on students. The variety of students and the frequency of communicate among them at public events and provide a level of motivation not seen in other settings. Within these setting students must interact with people who come from different background, socioeconomic status and differing value system. Initially college students require reexamine their previous social role, standards and confidence and replace them with a new set of values formed with in peer environment such as residences, classes and social activities. Even if the new environment fits comfortably, they must direct challenges that are academic, knowledgeable and public in nature. As a result, in all of the transitions to this college, peer relationship is one of the greatest difficult, emotionally tough and challenging parts of integrating oneself into the college setting.

2.7. Learning Environment

College environment is another factor that influences motivation in academic progress. It refers to different norms and system that determine the overall environment in the college. It assists as a facilitator for new relationship that will incorporate the individual students as an essential part of the community at college. Positive environment makes students feel protected and secure, meets their fundamental needs

such as daily meals, and provides an optimal environment for them to make healthy social relationships. Classroom environment provides a structured and expected learning opportunity for students. Depending on the organization type and range the environment will be planned differently and the student's outcomes will also be of a different personality. Adding together an interesting element to lecturing can facilitate to ease the atmosphere and improve motivation and results.

2.8. Evaluation

Lectures should always judge and monitored their students' development through observations, experiments, written assignments, and research projects. Evaluation plays a foremost role in the teaching-learning process. It supports to build a learning programme, attainments and expand upon its effectiveness and also helps learners as well as teachers to improve learning and teaching. Educational evaluation is the regular process of documenting and using observed data on the knowledge, skill and attitudes to refine and improve student learning. This process in learning focuses on the opportunities to increase students' ability to assess them, to make judgments about their own performance and develop upon it. Well-designed evaluation can give confidence active learning, especially when the assessment delivery is innovative. It is capable of focus on the individual student, session, workshop, or other systematized group of beginners and an academic program.

3. Methodology: Fuzzy Analytical Hierarchy Process (FAHP)

The Fuzzy set theory, which was developed by Zadeh in the (1965), and Bellman and Zadeh (1970), expressed the decision-making method in fuzzy environment. Fuzzy sets and logical are powerful mathematical tools vague system in many scientific, economic and social fields. FAHP was applied in several applications such as transportation, facility location (**Sona.P,2018),** logistics, water treatment plant location selection (**Kaleeswari,K 2018),** urban planning, public politics, marketing, finance, education, economics etc,. MCDM is powerful operational model which is used to resolve decision making problems on the basis of different decision criteria**. (ShwetaPanjwani, S Naresh Kumar, LaxmiAhuja 2019)** . This approach has been broadly used in many application fields by the decision makers to solve their problems. The most excellent way of FAHP is that when assessors calculate each environmental output of a design with different criteria and linguistic terms like 'Hot', 'Very hot' and 'Cool' or a fuzzy number can be assigned instead of providing a precise arithmetical value. Triangular fuzzy numbers are used in this article. Triangular fuzzy number $\tilde{N}$ is defined by three real number, expressed as (a, b, c) (**Kaleeswari,K 2018).**

Step 1. Comparing the performance score

In fuzzy set theory the Triangular Fuzzy Numbers ($\tilde{1}, \tilde{3}, \tilde{5}, \tilde{7}, \tilde{9}$) were used to characterize the relative strength of each pair of elements in the same hierarchy. Linguistic terms and the related triangular fuzzy numbers are given in the following Table.1.1

Table 1.1 Membership Function of Fuzzy Number

Linguistic Variable	Triangular Fuzzy Number
Absolutely Important	(9,9,9)

Very Strongly Important	(6,7,8)
Strongly Important	(4,5,6)
Fairly Important	(2,3,4)
Equally Important	(1,1,1)

Step 2: Constructing the fuzzy comparison matrix

The comparison matrix is $\widetilde{M}$. where $\widetilde{m_{ij}}$ represents the preference (relative importance) of ith criterion over j^{th} criterion, by the use of fuzzy triangular numbers.

Table- 1.2 Pair Wise Comparisons between Criterions

	F1	F2	F3	F4	F5	F6	F7	F8
F1	(1,1,1)	(6,7,8)	(1,1,1)	(1/6,1/5,1/4)	(1/4 1/3,1/2)	(1/8,1/7,1/6)	(1/6,1/5,1/4)	(1,1,1)
F2	(1/8,1/7,1/6)	(1,1,1)	(1/8,1/7,1/6)	(1/4 1/3,1/2)	(1/6,1/5,1/4)	(1/6,1/5,1/4)	(1/4 1/3,1/2)	(1/6,1/5,1/4)
F3	(1,1,1)	(6,7,8)	(1,1,1)	(1/6,1/5,1/4)	(1/4 1/3,1/2)	(1/8,1/7,1/6)	(1/6,1/5,1/4)	(1,1,1)
F4	(4,5,6)	(2,3,4)	(4,5,6)	(1,1,1)	(1,1,1)	(1,1,1)	(1,1,1)	(2,3,4)
F5	(2,3,4)	(4,5,6)	(2,3,4)	(1,1,1)	(1,1,1)	(1,1,1)	(1/4 1/3,1/2)	(2,3,4)
F6	(6,7,8)	(4,5,6)	(6,7,8)	(1,1,1)	(1,1,1)	(1,1,1)	(1,1,1)	(2,3,4)
F7	(4,5,6)	(2,3,4)	(4,5,6)	(1,1,1)	(2,3,4)	(1,1,1)	(1,1,1)	(2,3,4)
F8	(1,1,1)	(4,5,6)	(1,1,1)	(1/4 1/3,1/2)	(1/4 1/3,1/2)	(1/4 1/3,1/2)	(1/4 1/3,1/2)	(1,1,1)

Step 3: Geometric mean of fuzzy comparison values of each criterion

The fuzzy comparison values of each criterion is calculated using geometric mean formula as follows, where $\widetilde{g_i}$ represents Triangular Number.

$$\widetilde{G_i} = \left(\prod_{j=1}^{n} m_{ij}\right)^{1/n}, i = 1,2,\dots\dots n \qquad \dots\dots\dots\dots (1)$$

The geometric mean each criterion is calculated by equation (1). In the above table, $\widetilde{G_1}$ geometric mean of fuzzy comparison values of Curriculum Structure criterion is calculated as follows

$$\widetilde{G_1} = \left(\prod_{j=1}^{n} m_{1j} \right)^{1/n}$$

$$= \left[\left(1 * 6 * 1 * \frac{1}{6} * \frac{1}{4} * \frac{1}{8} * \frac{1}{6} * 1 \right)^{\frac{1}{8}} ; \left(1 * 7 * 1 * \frac{1}{5} * \frac{1}{3} * \frac{1}{7} * \frac{1}{5} * 1 \right)^{\frac{1}{8}} ; \left(1 * 8 * 1 * \frac{1}{4} * \frac{1}{2} * \frac{1}{6} \right.\right.$$

$$\left.\left. * \frac{1}{4} * 1 \right)^{\frac{1}{8}} ; \right]$$

$$= [0.5183;\ 0.5829;\ 0.6722]$$

Table 1.3 Geometric Mean Values for Fuzzy Comparison

	Gi		
F1	0.5183	0.5829	0.6722
F2	0.2147	0.2555	0.3195
F3	0.5183	0.5829	0.6722
F4	1.6818	1.9680	2.2134
F5	1.2968	1.6094	1.9294
F6	2.0297	2.2818	2.5021
F7	1.8340	2.2577	2.6321
F8	0.5946	0.7060	0.8846
Total	8.6883	10.2442	11.8253
Reverse	0.1151	0.0976	0.0846
Increase	0.0846	0.0976	0.1151

Multiply each $\widetilde{G_i}$ with this reverse vector to find the fuzzy weight of criterion $\widetilde{w_i}$.

Weight of each criterion $= \widetilde{G_i} \oplus \left(\tilde{G} \oplus \widetilde{G_2} \oplus \dots \oplus \widetilde{G_n} \right)^{-1}$

(ie) $\quad \widetilde{w_i} = (Lw_i, Mw_i, Nw_i)$…………………….(2

Now consider the fuzzy weight of C1 criterion $\widetilde{w_1}$ is given by the equation (2)

$$\widetilde{w_1} = [(0.5183 * 0.0846);\ (0.5829 * 0.0976);\ (0.6722 * 0.1151)]$$

$$= [0.0438;\ 0.0569; 0.0774]$$

$$NM_1 = \frac{0.0438 + 0.0569 + 0.0774}{3} = 0.0594$$

In the Table1.4 N_1 is calculated by $\quad N_1 = \frac{NM_1}{\sum_{i=1}^{n} NM_i} = \frac{0.0594}{1.0319} = 0.0575$

Table 1.4 Fuzzy Weight Wi , Non Fuzzy Weight Mi, Normalized Weight Ni

	Wi			Mi	Ni
F1	0.0438	0.0569	0.0774	0.0594	0.0575
F2	0.0182	0.0249	0.0368	0.0266	0.0258

F3	0.0438	0.0569	0.0774	0.0594	0.0575
F4	0.1422	0.1921	0.2548	0.1964	0.1903
F5	0.1097	0.1571	0.2221	0.1629	0.1579
F6	0.1716	0.2227	0.2880	0.2275	0.2204
F7	0.1551	0.2204	0.3030	0.2261	0.2191
F8	0.0503	0.0689	0.1018	0.0737	0.0714
Total				1.0319	

This work was done to understand the college student stress factor through general analysis using fuzzy analytical hierarchy process. In the Table1.5 Hierarchical order of all factors is given based on their scores obtained from the calculated values.

Table 1.5 Results of factors in hierarchy order

Criteria	F1	F2	F3	F4	F5	F6	F7	F8
Weight	0.0594	0.0266	0.0594	0.1964	0.1629	0.2275	0.2261	0.0319
Hierarchical Order	5	7	5	3	4	1	2	6

After analyzing these data using FAHP model the value of the factors was obtained such asF6 =0.2275, F7=0.2261 and F4=0.1964 etc. Based on the ranking we can able to identify which area is affected more for the student's academic performances.

4. Conclusion

Student's performances were influenced by many factors such as public, psychological, monetary, environmental and individual factors. These factors powerfully influence on the student performance but these influencing factors may different from person to person and country to country. This study was conducted to explore the important factors that affect the student's academic performances. Eight different factors were used as input in our FAHP method and ranked based on the comparison value. Based on the calculated value one of the factors F6 (Peer Relationships) obtained as 0.2275. Also, the factor F7 (Learning Environment) obtained 0.2261 and F4(Parental Involvement in academic) obtained as 0. 1964.By using this appropriate model, it is understood that 'peer relationships' factor obtained highest value and it plays a vital role among all. So, it was indicated that the factor peer relationship affects the student's performances in the academic. Hence from the study it was concluded that it is essential to concentrate on more affecting factor peer relationship as well as to consider other factors such as learning environment and parental involvement in academic in order to improve the student's academic performances. This study was more useful for parents as well as faculties to attain the best academic performance of their children

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