International Education Studies; Vol. 6, No. 9; 2013
ISSN 1913-9020 E-ISSN 1913-9039
Published by Canadian Center of Science and Education

Fuzzy Failure Analysis: A New Approach to Service Quality Analysis in Higher Education Institutions

(Case study: Vali-e-asr University of Rafsanjan-Iran)

Salim Karimi Takalo[1], Ali Reza Naser Sadr Abadi[2], Seyed Mahdi Vesal[3] &Amir Mirzaei[1] & Khaled Nawaser[4]

[1] Department of Management, Vali-e-asr University of Rafsanjan, Rafsanjan, Iran

[2] Faculty of Management and Economics, Yazd University, Yazd, Iran

[3] Department of Management, University of Nooretouba, Tehran, Iran

[4] Marketing Management (SIOM) & International Business (AIMS), University of Pune, India

Correspondence: Seyed Mahdi Vesal, Department of Management, University of Nooretouba, Tehran, Iran. Tel: 98-915-306-3376. E-mail: mehdi.vesal@gmail.com

Received: June 5, 2013 Accepted: July 2, 2013 Online Published: August 29, 2013

doi:10.5539/ies.v6n9p93 URL: http://dx.doi.org/10.5539/ies.v6n9p93

Abstract

In recent years, concurrent with steep increase in the growth of higher education institutions, improving of educational service quality with an emphasis on students' satisfaction has become an important issue. The present study is going to use the Failure Mode and Effect Analysis (FMEA) in order to evaluate the quality of educational services in Vali-e-asr University of Rafsanjan in form of case study. In The traditional FMEA method the risk priority number (RPN) index was used for rating the failure items, which is the product of three risk factors: occurrence of failure, severity of failure and detectability of failure. In this traditional method, the weights of risk factors weight are not taken into account such that the same weight value is assumed for each of those factors. To overcome this weakness, much research has been performed, recently. This paper uses Wang and colleagues model to assess and prioritize risks of educational services quality by incorporating Yue model in a Fuzzy Environment. The results illustrate that one of the most significant failure items is students' lack of readiness to get job opportunity because of efficiency absence of theoretical and practical courses presented in university.

Keywords: educational service quality, failure mode and effect analysis, fuzzy logic

1. Introduction

In recent years, rapid growth of higher education institutions has led to many complex issues. The main issue was that of maintaining the quality of education provided by these institutes (Viswanadhan, 2009). The product of education is often intangible and difficult to quantify because it is reflected in the transformation of individuals in their knowledge, their characteristics and their behavior. Higher education should help individuals develop creative, critical and analytical skills. Higher education is not a rigorous learning process of obtaining necessary professional qualifications but is also an intellectual development of an individual, which will have an enduring impact on one's life (Mukaddes et al. 2012).

The higher education system as a dynamic, intelligent and purposeful system has two dimensions: qualitative and quantitative. Its permanent development requires an appropriate and balanced growth in both qualitative and quantitative dimensions in parallel. The mere quantitative development in higher education system regardless of its qualitative dimension leads to some problems such as educational failure, scientific dependency, brain drain and lack of entrepreneurship and weakness of science production. Universities are under increasing pressure to prove their participation in development of societies, so accountability to realization of educational goals has become a necessity (Johnson, 2004).

The challenge that managers of the higher education institutes confront is, on one hand, whether students will have the essential scientific ability for employment after graduation (Karapetrovic, 1998). On the other hand, the concept of competition, which was considered a financial concept in higher education institutes in past, is considered as a stimulating and motivating force in such institutes today (Oldfield, et al, 2000). Therefore, improvement of quality in higher education is among the main concerns of higher education system and has received increased attention in many higher education systems and universities of world in last two decades. In recent years, concurrent with rapid growth of higher education institutions, improving of educational service quality with an emphasis on students' satisfaction has become an important issue. The more qualitative the services presented by higher education institutes are, the more qualitative their graduates will be (Pakarian, 1369). For this reason, the evaluation of educational quality is one of the essential steps in designing quality improvement programs (Lim & Tang, 2000).

Brochado (2009) stated that formulating appropriate and efficient evaluation strategies is the solution of educational quality improvement and points out that without performing an efficient evaluation, quality cannot be determined. In fact using an appropriate measurement tool would help managers to assess quality of services provided by their institutions and plan for presenting better services (Borochado, 2009). In this regard, Vali –e-Asr University of Rafsanjan is no exception and evaluation of the quality of its training services in order to understand the existing status and improvement of its educational services is considered as a top priority and of importance to managers.

There are several effective factors in measuring the quality of educational services such as professors, students, the university educational facilities and educational system. The indexes relating to the professors and educational facilities were applied in this study.

2. Theoretical Framework

2.1 Educational Service Quality

Different definitions have been presented for service (and goods) quality. The majority of these definitions focus on customers and their satisfaction. Quality of services is assessed by comparing customer expectations and his/her perceptions. Customer's expectations mean what the customer expects or feels should be present in received services. Customer's perceptions mean his/her judgment about existence of certain characteristics and features of the service they receive (Zitmal et al, 2004). Sometimes, presence of certain features, characteristics or properties in received services, that customer expects them, is defined as services performance. As Sahni et al have analyzed, if the customers' expectations are higher than their perceptions or performance of received services, it shows that the service quality is low and will definitely result in the customers' dissatisfaction (Zeithaml, et al. 1985).

Education quality refers to the characteristics of education elements and using capabilities and potentials of those elements, explicit and implicit expectations and needs of educational customers can be met and their satisfaction can be obtained. Educational service quality is an ambiguous, discussable and controversial (Cheng and Tam, 1995). In other definition, education quality is a set of elements in the input, process, and output of the education system that provides services that completely satisfy both internal and external managers by meeting their explicit and implicit expectations (Jusoh et al, 2004). Additionally the definition offered by Gordon and Partigon characterized the general approach to education quality: "The success with which an institution provides educational environments which enable students effectively to achieve worthwhile learning goals including appropriate academic standards" (Gordon and Partigon, 1993)

Despite the sever disputes in methods of defining and evaluating of educational services, all emphasize its necessity and importance. In recent decades, many studies have been performed on students' evaluation of quality of educational services, since this fact justifies the performances and improves the educational services as well.

2.2 Failure Mode and Effect Analysis (FMEA) in Fuzzy Environment

Failure mode and effects analysis (FMEA) is known as a systematic and structured way for detecting system failure modes and evaluating the effects and consequences of failure modes (Teng and Ho, 1996). Also Spath and Hickey (2003) stated FMEA is an evaluation technique used to identify and eliminate known and/or potential failures, problems, and errors from a system, process, and/or service before they actually occur. The purpose of FMEA is to prevent errors by attempting to identify all the ways a process could fail, estimate the probability and consequences of each failure, and then take action to prevent the potential failures (Hughes, 2003). This method usually begins in review processes of product or system design. Along with the product or system design changes and also gathering information about the product or system performance by testing before manufacturing and field experiences, the results evolved over time. This method is used in decision-making during the designing phase of the product or system. It is also used to develop guidelines for product or system maintenance methods, to improve safety systems and also to conduct activities for improving reliability. This method usually begins with defining a specified analysis range for the system considering failures. This method can be implemented in different levels of product or system (Rezaie et al., 2003).

FMEA turns back to early 1950s, when this technique was used to design flight control systems. In 1960s, FMEA was introduced as a formal method in the aerospace and defence industry in the USA. In 1974, the US Navy developed the MIL-STD-1629 Standard including FMEA. In the late 1970s, those US car companies which were suffering from poor reliability that led to poor competitive capabilities started using FMEA to improve the design and production processes of their products (Maleki and Sadaat, 2013).

However, in the traditional approach, for rating potential failure states the RPN index was calculated which is the product of three risk factors: Severity of Failure, Probability or Frequency of Occurrence of Failure and Detection Capability of Failure (Segismundo et al., 2008). Severity is the importance of an event, often with respect to some hazard, Probability is the likelihood of the occurrence of an event and fault detection is a method to signal that an error event has occurred. If detection and recovery are successful, the effect of the error event will be prevented (Krouwer, 2004). A numeric ranking (1–10) of each failure mode including severity, probability and detection capability is used. The bigger number shows the worse effect. The main core of the method is human's feeling and mind, thus we are facing a vague and undetermined issue and it is not possible to dedicate a fixed quantitative value for the triplet parameters. It seems that Fuzzy method is able to categorize the factors mathematically.

2.3 Background

Evaluation and assessment of quality of goods have been performed for many years. However, evaluation of quality of services began from 1970's and is in its evolution path since then (Akbaba, 2006).

Conceptual model of service quality was first introduced in 1985 by Parasuraman et al. By introducing a concept called service quality gap in gap analysis model. They defined service quality as the gap between expectations and perceptions of the customers of received services. Therefore Parasuraman et al. introduced a measuring tool for service quality based on previous studies and conceptual model of gap analysis. This tool has been introduced in literature as SERVQUAL model. It contains standardized elements which are used for measuring customer's expectations and perceptions (Parasuraman et al., 1988). Thus, it one of the most widely used models for evaluation of customers' expectations and perceptions of service quality. Conceptual foundation for the SERVQUAL scale was derived from the works of a handful of researchers who have examined the meaning of service quality (Sasser, Olsen and Wyckoff, 1978; Gronoos, 1982; Lehtinen, 1982) and from a comprehensive qualitative research study and defined service quality and illuminated the dimensions along which consumers perceive and evaluate service quality (Parasuraman et al., 1985).

In view of the fact that all of studies have used SERVQUAL model for measurement of educational service quality, all of them have studied the perception and expectations of students about qualitative elements of educating and have considered the factors with the maximum gap between perception and expectations. But other important issues needed to be considered are the detection capability and power of prevention of presenting educational services with poor quality, frequency of occurrence of low-quality services in a qualitative element and severity of dissatisfaction which is created by a qualitative element. Therefore, the FMEA technique has various important uses in promotion of products quality. However, less attention has been paid to it in services area, but with above explanations it can provide a more precise basis for development of service quality improvement programs.

2.4 Prioritization of Educational Service Quality Items in a Fuzzy Environment

There have been lots of discussions stating that risk factors (occurrence of failure O, severity of failure S, and detection capability of failure D) are not easy to evaluate precisely. Since verbal evaluation is done by individuals approximately, it could be said that triangular and trapezoidal membership functions is suitable to confront the ambiguity in these evaluations and efforts for achieving more exact values are impossible and unnecessary (Delgado, 1998). Some researchers have shown that Fuzzy membership function can reflect the relative importance of verbal concepts in our minds (Dyer and Sarin, 1979). Thus, we can follow the Fuzzy membership function to convert verbal concepts into numeral ones in interval scale (Hsiao, 2007). Table 1 shows the verbal concepts and corresponding Fuzzy numbers which are used to evaluate the educational service qualitative factors in this research. These concepts and their corresponding fuzzy numbers which are similar to the concepts in traditional FMEA are based on study of Wang et al. in 2009. However, in the present study these concepts have been attributed to the Fuzzy triangular - trapezoidal numbers which are superior to the definite numbers.

Table 1. Verbal terms and Fuzzy numbers for evaluation of educational services quality items

Occurrence of Failure		Severity of Failure		Detection Capability of Failure	
Verbal term	Fuzzy number	Verbal term	Fuzzy number	Verbal term	Fuzzy number
Very high	(8 ،9 ،10،10)	Highly risky without alarm	(9 ،10 ،10)	Absolutely impossible	(9 ،10 ،10)
High	(6 ،7 ،8 ،9)	Highly risky with alarm	(8 ،9 ،10)	Very impossible	(8 ،9 ،10)
Medium	(3 ،4 ،7،6)	Very high	(7 ،8 ،9)	Impossible	(7 ،8 ،9)
Low	(1 ،2 ،4،3)	High	(6 ،7 ،8)	Very low	(6 ،7 ،8)
Very low	(1 ،1 ،2)	Medium	(5 ،6 ،7)	Low	(5 ،6 ،7)
		Low	(4 ،5 ،6)	Medium	(4 ،5 ،6)
		Very low	(3 ،4 ،5)	Almost high	(3 ،4 ،5)
		Trivial	(2 ،3 ،4)	High	(2 ،3 ،4)
		Very trivial	(1 ،2 ،3)	Very high	(1 ،2 ،3)
		Non-risky	(1 ،1 ،2)	Absolutely possible	(1 ،1 ،2)

The traditional FMEA suffers from several shortcomings; most importantly it was criticized because it did not consider the relative important of risk factors (Tay & Lim, 2010). In other words the same weight value was assumed for each of those factors. In order to solve this problem, in present study the relative importance of risk factors is calculated. Since it is not easy to evaluate risk factors, we will use verbal terms and their corresponding Fuzzy numbers to evaluate relative important of weight of risk factors. Those numbers and concepts are summarized in table 2.

Table 2. Fuzzy weights for relative importance of risk factors

Verbal terms	Fuzzy Number
Very low	(0 ،0 ،0.25)
Low	(0 ،0.25 ،0.5)
Medium	(0.25 ،0.5 ،0.75)
High	(0.5 ،0.75 ،1)
Very high	(0.75 ،1 ،1)

Assume that n failure items $FM_{i(1,\dots,n.)}$ that have been evaluated by an FMEA team including m members $TM_{j(1,\dots,m.)}$ are evaluated and ranked.

Consider $\tilde{R}^{O}_{ij} = \left(R^{O}_{ijL}, R^{O}_{ijM1}, R^{O}_{ijM2}, R^{O}_{ijU}\right)$, $\tilde{R}^{S}_{ij} = \left(R^{S}_{ijL}, R^{S}_{ijM}, R^{S}_{ijU}\right)$ & $\tilde{R}^{D}_{ij} = \left(R^{D}_{ijL}, R^{D}_{ijM}, R^{D}_{ijU}\right)$ as the Fuzzy degree of i-th failure item in the risk factors, O, S, and D, relatively. Furthermore, consider $\tilde{w}^{O}_{j} = \left(w^{O}_{jL}, R^{O}_{jM}, R^{O}_{jU}\right)$, $\tilde{w}^{S}_{j} = \left(w^{S}_{jL}, R^{S}_{jM}, R^{S}_{jU}\right)$ & $\tilde{w}^{D}_{j} = \left(w^{D}_{jL}, R^{D}_{jM}, R^{D}_{jU}\right)$ as the Fuzzy weights of three risk factors which have been presented by j-th member of FMEA team (TM_j), and consider $h_j\,(j = 1,\dots,m)$ as the relative importance of each member's weight in FMEA team such that $\sum_{j=1}^{m} h_j = 1$ & $h_j > 0\ \ (j = 1,\dots,m)$ is satisfied. Based on the above assumptions, n failure items can be ranked using the following steps.

Step 1: obtain sum of ideas of members of FMEA team is using relations 1 to 6.

Relation (1): $\tilde{R}^{O}_{i} = \left(\sum_{j}^{m} h_j R^{O}_{ijL}, \sum_{j}^{m} h_j R^{O}_{ijM1}, \sum_{j}^{m} h_j R^{O}_{ijM2}, \sum_{j}^{m} h_j R^{O}_{ijU}\right), \ i = 1,\dots,n,$

Relation (2): $\tilde{R}_i^S = \left(\sum_j^m h_j R_{ijL}^S, \sum_j^m h_j R_{ijM}^S, \sum_j^m h_j R_{ijU}^S \right), \ i = 1, \ldots, n,$

Relation (3): $\tilde{R}_i^D = \left(\sum_j^m h_j R_{ijL}^D, \sum_j^m h_j R_{ijM}^D, \sum_j^m h_j R_{ijU}^D \right), \ i = 1, \ldots, n,$

Relation (4): $\tilde{w}^O = \sum_{j=1}^m \tilde{w}_j^O = \left(\sum_j^m h_j w_{jL}^O, \sum_j^m h_j w_{jM}^O, \sum_j^m h_j w_{jU}^O \right),$

Relation (5): $\tilde{w}^S = \sum_{j=1}^m \tilde{w}_j^S = \left(\sum_j^m h_j w_{jL}^S, \sum_j^m h_j w_{jM}^S, \sum_j^m h_j w_{jU}^S \right),$

Relation (6): $\tilde{w}^D = \sum_{j=1}^m \tilde{w}_j^D = \left(\sum_j^m h_j w_{jL}^D, \sum_j^m h_j w_{jM}^D, \sum_j^m h_j w_{jU}^D \right),$

Such that $\tilde{R}_i^O = \left(R_{iL}^O, R_{iM1}^O, R_{iM2}^O, R_{iU}^O \right)$, $\tilde{R}_i^S = \left(R_{iL}^S, R_{iM}^S, R_{iU}^S \right)$, $\tilde{R}_i^D = \left(R_{iL}^D, R_{iM}^D, R_{iU}^D \right)$, are the sum of degree of failure occurrence (O), severity of failure (S) and detection capability of failure (D) for failure item FM_i , and $\tilde{w}_i^O = \left(w_L^O, w_M^O, w_U^O \right)$, $\tilde{w}_i^S = \left(w_L^S, w_M^S, w_U^S \right)$, $\tilde{w}_i^D = \left(w_L^D, w_M^D, w_U^D \right)$, are the sum of Fuzzy weights of three risk factors O,S and D, respectively.

Step 2: Determine Fuzzy risk priority number (FRPN) for each educational service quality item using the following equation.

Relation (7) for geometric mean:

$$FRPN_i = \left(\tilde{R}_i^O \right)^{\frac{\tilde{w}^O}{\tilde{w}^O + \tilde{w}^S + \tilde{w}^D}} \times \left(\tilde{R}_i^S \right)^{\frac{\tilde{w}^S}{\tilde{w}^O + \tilde{w}^S + \tilde{w}^D}} \times \left(\tilde{R}_i^D \right)^{\frac{\tilde{w}^D}{\tilde{w}^O + \tilde{w}^S + \tilde{w}^D}}, \ i = 1, \ldots, n.$$

Since FRPN are Fuzzy numbers, they can be calculated using Alpha-cut sets.

Step 3: Determine Alpha-cut sets of FRPN for each failure items of educational service quality is by solving the following LP models:

Model (1):
$$\begin{aligned} (\tilde{y}G)_\alpha^L &= \text{Min} \prod_{i=1}^n (\tilde{x}_i)^{\frac{w_i}{\sum_{j=1}^n w_j}} \\ \text{s.t.} \quad & (w_i)_\alpha^L \le w_i \le (w_i)_\alpha^U, \quad i = 1, \ldots, n, \\ & (x_i)_\alpha^L \le x_i \le (x_i)_\alpha^U, \quad i = 1, \ldots, n, \end{aligned}$$

Model (2):
$$\begin{aligned} (\tilde{y}G)_\alpha^U &= \text{Max} \prod_{i=1}^n (x_i)^{\frac{w_i}{\sum_{j=1}^n w_j}} \\ \text{s.t.} \quad & (w_i)_\alpha^L \le w_i \le (w_i)_\alpha^U, \quad i = 1, \ldots, n, \\ & (x_i)_\alpha^L \le x_i \le (x_i)_\alpha^U, \quad i = 1, \ldots, n, \end{aligned}$$

Given the nonlinearity of the above models, they will be rewritten as follow:

Model (3):
$$\begin{aligned} (\tilde{y}G)_\alpha^L &= \text{Min} \ \exp\left(\frac{w_i \ln (x_i)_\alpha^L}{\sum_{j=1}^n w_j} \right) \\ \text{s.t.} \quad & (w_i)_\alpha^L \le w_i \le (w_i)_\alpha^U, \quad i = 1, \ldots, n, \end{aligned}$$

Model (4): $$(\tilde{y}G)^U_\alpha = \text{Min}\ \exp\left(\frac{w_i \ln(x_i)^U_\alpha}{\sum_{j=1}^{n} w_j}\right)$$
$$\text{s.t.}\quad (w_i)^L_\alpha \le w_i \le (w_i)^U_\alpha, \quad i=1,\ldots,n,$$

In the above models, exp ( ) is an Exponential function.

Based on the above models, if $z = 1 \big/ \sum_{j=1}^{n} w_j$ and $u_i = zw_i\ i = 1,\ldots,n$, models 3 and 4 become LP models below which can be solved easily.

Model (5):
$$\begin{aligned}
&\text{Min } z_1 = u_1 \ln\left(R_i^O\right)^L_\alpha + u_2 \ln\left(R_i^S\right)^L_\alpha + u_3 \ln\left(R_i^D\right)^L_\alpha \\
&\text{s.t.}\quad u_1 + u_2 + \ldots + u_n = 1,\quad i = 1,\ldots,n, \\
&\left(w^O\right)^L_\alpha . z \le u_1 \le \left(w^O\right)^U_\alpha . z,\quad i = 1,\ldots,n, \\
&\left(w^S\right)^L_\alpha . z \le u_2 \le \left(w^S\right)^U_\alpha . z,\quad i = 1,\ldots,n, \\
&\left(w^D\right)^L_\alpha . z \le u_3 \le \left(w^D\right)^U_\alpha . z,\quad i = 1,\ldots,n, \\
&z \ge 0,
\end{aligned}$$

Model (6):
$$\begin{aligned}
&\text{Max } z_2 = u_1 \ln\left(R_i^O\right)^U_\alpha + u_2 \ln\left(R_i^S\right)^U_\alpha + u_3 \ln\left(R_i^D\right)^U_\alpha \\
&\text{s.t.}\quad u_1 + u_2 + \ldots + u_n = 1,\quad i = 1,\ldots,n, \\
&\left(w^O\right)^L_\alpha . z \le u_1 \le \left(w^O\right)^U_\alpha . z,\quad i = 1,\ldots,n, \\
&\left(w^S\right)^L_\alpha . z \le u_2 \le \left(w^S\right)^U_\alpha . z,\quad i = 1,\ldots,n, \\
&\left(w^D\right)^L_\alpha . z \le u_3 \le \left(w^D\right)^U_\alpha . z,\quad i = 1,\ldots,n, \\
&z \ge 0,
\end{aligned}$$

Such that $\left[\ln\left(R_i^O\right)^L_\alpha, \ln\left(R_i^O\right)^U_\alpha\right]$, $\left[\ln\left(R_i^S\right)^L_\alpha, \ln\left(R_i^S\right)^U_\alpha\right]$ and $\left[\ln\left(R_i^D\right)^L_\alpha, \ln\left(R_i^D\right)^U_\alpha\right]$ are logarithms of $\left[\left(R_i^O\right)^L_\alpha, \left(R_i^O\right)^U_\alpha\right]$, $\left[\left(R_i^S\right)^L_\alpha, \left(R_i^S\right)^U_\alpha\right]$ and $\left[\left(R_i^D\right)^L_\alpha, \left(R_i^D\right)^U_\alpha\right]$ respectively, which $\tilde{R}_i^O$, $\tilde{R}_i^S$, $\tilde{R}_i^D$ are the Alpha-cut sets of occurrence of failure (O), severity of failure (S) and detection capability of failure (D), for each failure item $FM_{i(1,\ldots,n)}$ .Also $\left[\left(w^O\right)^L_\alpha, \left(w^O\right)^U_\alpha\right]$, $\left[\left(w^S\right)^L_\alpha, \left(w^S\right)^U_\alpha\right]$ and $\left[\left(w^D\right)^L_\alpha, \left(w^D\right)^U_\alpha\right]$ are the Alpha-cut sets of the summed weights of risk factors $\tilde{w}^O$, $\tilde{w}^S$ and $\tilde{w}^D$, respectively.

The above LP models must be solved for each failure item. Consider z_1^* and z_2^* as the appropriate answers for models 5 and 6. It this case, $\left(FRPN_i\right)^L_\alpha = \exp\left(z_1^*\right)$, $\left(FRPN_i\right)^U_\alpha = \exp\left(z_2^*\right)$. With different values of Alpha, different Alpha-cut sets will be obtained for FRPNi, which can be expressed as follow;

Relation (7): $FRPN_i = \bigcup_\alpha \alpha \left[\left(FRPN_i\right)^L_\alpha, \left(FRPN_i\right)^U_\alpha\right],\ 0 < \alpha \le 1,$

Step 4: The failure items should be categorized based on the $\tilde{R}_i$. Since the $\tilde{R}_i$ values for each item and in each Alpha-cut are interval numbers, in the present research, Yue model has been used in order to categorize those interval numbers (Yue, 2010). The basis of this method is degree of greatness probability of one interval number comparing to another one. If we consider a and b as two interval numbers $a = \left[a^l, a^u\right]$, $b = \left[b^l, b^u\right]$ so that $l_a = a^u - a^l$ and $l_b = b^u - b^l$, the degree of greatness possibility a and b is defined as:

Relation (8): $p(a \ge b) = \max\left\{1 - \max\left(\frac{b^u - a^l}{l_a + l_b}, 0\right), 0\right\}$

In order to rank the interval risk such as $\bar{R}_j = \left[R_j^l, R_j^u\right] (j = 1,2,\dots,n)$, we should first compare each $\bar{R}_j = \left[R_i^l, R_i^u\right]$ with all $\bar{R}_i = \left[a_j^l, a_j^u\right] (j = 1,2,\dots,n)$, for each Alpha-cuts using relation (8). For convenience, we consider p_{ij}^{α} as the degree of greatness possibility for $\bar{R}_i^{\alpha}$ on $\bar{R}_j^{\alpha}$ in Alpha-cut. ie $p_{ij}^{\alpha} = p\left(\bar{R}_i^{\alpha} \geq \bar{R}_j^{\alpha}\right)$. Then we form the matrix $p^{\alpha} = \left(p_{ij}^{\alpha}\right)_{n \times n}$ for each Alpha-cut so that relations $p_{ij}^{\alpha} \geq 0, p_{ij}^{\alpha} + p_{ji}^{\alpha} = 1, p_{ii}^{\alpha} = \frac{1}{2} p_{ij}^{\alpha}, i, j = 1,2,..n.$ are satisfied in this matrix. Then calculate the sum of the elements in each line of the matrix using relation (9).

Relation (9): $p_i^{\alpha} = \sum_{j=1}^{n} p_{ij}^{\alpha}, i = 1,2,\dots,n.$

Finally the degree of greatness probability for each failure item is calculated using the following relation.

Relation (9): $p_i = \sum_{\alpha=0}^{1} p_i^{\alpha}, i = 1,2,\dots,n.$

Ultimately, the failure items of educational service quality are ranked in descending manner of p_i. In other word, the item with higher p_i will have higher rank.

3. Research Methodology

This study has an applied approach; longitudinal research strategy and single-section run time. The implementation steps of failure mode and effect analysis technique in educational services quality merely, from the students view point are as follows:

First step: Definition of qualitative failures in the system: the first step in failure mode and effect analysis is determination of potential failure cases which the system may face. The items of educational service quality were identified based on SERVQUAL model. According to the mentioned model, the educational service quality has 26 items and 5 dimensions consist of Assurance, Accountability, Empathy, Reliability and Tangibles.

Second step: Measuring of triple factors for failure priority: the participants of this study are the students in Vali-e-asr University of Rafsanjan. This statistical universe consists of 8894 students. In order to determine the volume of the sample, Morgan table has been used. Based on the table, the volume of the sample is estimated 368. When sample volume was determined, 386 questionnaires (in three formats) were distributed, of which 351 were returned (return rate= 95%). Distribution of questionnaires was performed based on their necessary information of respondents.

A) Measuring severity of failures: in order to measure the severity of failure effect on students' satisfaction, a questionnaire was designed and distributed to the students. The evaluation scale in this questionnaire was the vocal concepts (terms) in table 1.

B) Measuring probability of occurrence of failure: in order to estimate the probability of failure occurrence, the second section of questionnaire asked the participants to determine the numbers of times they have faced with that failure during their education period.

C) Measuring detection capability of failure: since this scale is professional, the questions in this section are asked from elites and professionals.

Third step: Measuring the failure risk priority number (FRPN): by multiplying the above indices (of severity of failure, occurrence of failure and detection capability of failure), the risk priority number for each educational service quality failure will be determined in form of Fuzzy number based on non-provision of students' expectation.

Fourth step: implementation of the proposed model of the research: in order to calculate the values of FRPN, the developed Fuzzy model will be used in this study. After determining the values of FRPN, Yue (2010) method will be used in order to prioritize the failure items.

4. Research Findings

In this section, the results of implementation of the proposed model for evaluation of educational service quality items in Vali-e-asr University of Rafsanjan are presented. Using collected data and Fuzzy numbers in tables 1 and2 and the relations 1 to 6, the Fuzzy value for each failure item for risk factors is calculated in table 3.

Table 3. Average of fuzzy values for risk factors of each educational service item

No	Failure Item	Detection	Severity	Occurrence
	Assurance			
1	Discussion about subject matter is not facilitated by teacher	(4.9 , 5.9 , 6.9)	(4.55 , 5.52 , 6.50)	(3.66 , 4.58 , 5.88 , 6.78)
2	Lack of readiness of students to get job opportunity given the presented theoretical and practical courses in university	(4.45 , 5.45 , 6.45)	(5.62 , 6.61 , 7.54)	(4.95 , 5.90 , 7.13 , 7.83)
3	Lack of time allocation to respond and explain by teacher in extra time (outside the class)	(4.65 , 5.65 , 6.65)	(3.91 , 4.83 , 5.79)	(3.35 , 4.19 , 5.26 , 6.12)
4	Lack of sufficient academic resources to increase specialized knowledge	(4.4 , 5.4 , 6.4)	(5.15 , 6.10 , 7.04)	(4.52 , 5.44 , 6.66 , 7.45)
5	Lack of specialized knowledge of teachers	(3.45 , 4.45 , 5.45)	(5.22 , 6.20 , 7.12)	(4.48 , 5.40 , 6.57 , 7.32)
	Accountability			
6	Inaccessibility of advisers when students need them	(4.3 , 5.3 , 6.3)	(4.82 , 5.78 , 6.71)	(4.32 , 5.20 , 6.29 , 7.06)
7	Inaccessibility of managers for students to transfer their ideas and suggestions about educational issues	(4.05 , 5.05 , 6.05)	(4.82 , 5.78 , 6.74)	(4.50 , 5.43 , 6.61 , 7.40)
8	Comments of students are not applied about educational issues in training programs	(4.6 , 5.6 , 6.6)	(4.97 , 5.94 , 6.88)	(4.09 , 4.99 , 6.15 , 6.96)
9	Failure to provide proper resources for further studies	(4 , 5 , 6)	(4.54 , 5.48 , 6.43)	(4.19 , 5.12 , 6.36 , 7.18)
10	Lack of sufficient time for referring the professors to solve educational problems	(4.2 , 5.2 , 6.2)	(4.48 , 5.43 , 6.40)	(3.66 , 4.51 , 5.64 , 6.50)
	Empathy			
11	Irrelevant and inappropriate assignments	(4.7 , 5.7 , 6.7)	(4.38 , 5.29 , 6.25)	(3.49 , 4.28 , 5.25 , 6.10)
12	Teachers are inflexible in the face of special conditions that may occur for each student	(4.65 , 5.65 , 6.65)	(4.65 , 5.59 , 6.53)	(3.91 , 4.81 , 5.97 , 6.79)
13	Inappropriate time of classes	(4.45 , 5.45 , 6.45)	(4.71 , 5.66 , 6.61)	(4.42 , 5.30 , 6.39 , 7.18)

14	Lack of quite environment for studying inside the University	(4.4 , 5.4 , 6.4)	(5.10 , 6.03 , 6.96)	(4.53 , 5.42 , 6.54 , 7.29)
15	Unsuitable behavior of educational staff to students	(3.9 , 4.9 , 5.9)	(4.9 , 5.82 , 6.74)	(3.56 , 4.40 , 5.51 , 6.32)
16	teachers' impolite behavior toward students	(3.6 , 4.6 , 5.6)	(4.26 , 5.11 , 6.02)	(3.61 , 4.39 , 5.34 , 6.13)
	Reliability			
17	Failure to provide materials of lessons in a regular and relevant manner	(4.473 , 5.473 , 6.473)	(4.25 , 5.13 , 6.09)	(3.51 , 4.33 , 5.41 , 6.26)
18	Students don't become aware of assignment assessments	(4.75 , 5.75 , 6.75)	(4.57 , 5.52 , 6.46)	(4.12 , 5.04 , 6.29 , 7.12)
19	Failure to present material in a manner that is understandable for students	(4.9 , 5.9 , 6.9)	(4.97 , 5.95 , 6.88)	(4.65 , 5.60 , 6.79 , 7.56)
20	Incapability in getting better marks despite more effort by student	(5.2, 6.2, 7.2)	(5.2 , 6.14 , 7.04)	(4.31 , 5.18 , 6.26 , 7.00)
21	students' academic records are not maintained without fault and mistake	(4.05 , 5.05 , 6.05)	(3.80 , 4.66 , 5.62)	(3.04 , 3.85 , 4.93 , 5.82)
22	Lack of easy access to the research resources available at the University	(3.8 , 4.8 , 5.8)	(4.33 , 5.24 , 6.2)	(4.38 , 5.30 , 6.44 , 7.23)
23	Failure to perform activities when promised by the teacher	(4.5 , 5.5 , 6.5)	(4.54 , 5.48 , 6.45)	(3.42 , 4.31 , 5.53 , 6.43)
	Tangibles			
24	Unattractive physical facilities (class building, lounge, chairs)	(4.7 , 5.7 , 6.7)	(4.64 , 5.58 , 6.54)	(4.40 , 5.29 , 6.44 , 7.21)
25	Inefficient and old educational equipments (e.g. internet, overhead library, etc.) in school.	(4.55 , 5.55 , 6.55)	(5.07 , 6.02 , 6.94)	(4.55 , 5.45 , 6.60 , 7.38)
26	Lack ofphysicalattractiveness ofitems that can beused byteachersin training(books, pamphletsand etc)	(4.65 , 5.65 , 6.65)	(4.54 , 5.46 , 6.41)	(3.55 , 4.41 , 5.58 , 6.45)
Importance of Risk Factors		(0.42 , 0.67 , 0.87)	(0.61 , 0.86 , 0.98)	(0.48 , 0.74 , 0.74 , 0.95)

After determining the Fuzzy scores of educational service quality, in order to calculate FRPN, models 5 and 6 were used. The results of these models for the Alpha-cut are shown in table 4. In order to find the results in table 4, 572 linear programming models were solved.

Table 4. The results of calculating FRPN for educational service quality items

Failure Item	Alpha-cuts										
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
1	[4.21 , 6.75]	[4.32 , 6.65]	[4.43 , 6.55]	[4.53 , 6.45]	[4.64 , 6.35]	[4.75 , 6.25]	[4.86 , 6.15]	[4.97 , 6.05]	[5.08 , 5.94]	[5.19 , 5.84]	[5.27 , 5.71]
2	[4.91 , 7.44]	[5.02 , 7.34]	[5.13 , 7.24]	[5.24 , 7.13]	[5.36 , 7.03]	[5.47 , 6.93]	[5.58 , 6.82]	[5.69 , 6.72]	[5.80 , 6.61]	[5.91 , 6.50]	[5.98 , 6.35]
3	[3.78 , 6.22]	[3.89 , 6.12]	[3.99 , 6.02]	[4.09 , 5.92]	[4.20 , 5.81]	[4.30 , 5.71]	[4.41 , 5.61]	[4.51 , 5.51]	[4.62 , 5.40]	[4.72 , 5.30]	[4.80 , 5.17]
4	[4.63 , 7.08]	[4.73 , 6.98]	[4.84 , 6.88]	[4.94 , 6.78]	[5.05 , 6.68]	[5.15 , 6.57]	[5.25 , 6.47]	[5.36 , 6.37]	[5.46 , 6.26]	[5.57 , 6.16]	[5.64 , 6.01]
5	[4.22 , 6.85]	[4.34 , 6.74]	[4.45 , 6.63]	[4.57 , 6.52]	[4.68 , 6.41]	[4.80 , 6.30]	[4.91 , 6.18]	[5.03 , 6.07]	[5.14 , 5.96]	[5.26 , 5.84]	[5.34 , 5.69]
6	[4.44 , 6.77]	[4.54 , 6.68]	[4.64 , 6.58]	[4.74 , 6.48]	[4.84 , 6.38]	[4.94 , 6.28]	[5.04 , 6.19]	[5.14 , 6.09]	[5.24 , 5.99]	[5.34 , 5.89]	[5.41 , 5.75]
7	[4.40 , 6.87]	[4.50 , 6.76]	[4.61 , 6.66]	[4.71 , 6.55]	[4.82 , 6.45]	[4.92 , 6.34]	[5.03 , 6.23]	[5.13 , 6.13]	[5.23 , 6.02]	[5.34 , 5.91]	[5.41 , 5.76]
8	[4.47 , 6.86]	[4.57 , 6.77]	[4.68 , 6.67]	[4.78 , 6.58]	[4.89 , 6.48]	[4.99 , 6.39]	[5.09 , 6.29]	[5.20 , 6.19]	[5.30 , 6.10]	[5.41 , 6.00]	[5.48 , 5.86]
9	[4.20 , 6.65]	[4.31 , 6.54]	[4.41 , 6.44]	[4.51 , 6.33]	[4.61 , 6.23]	[4.71 , 6.13]	[4.81 , 6.02]	[4.91 , 5.92]	[5.01 , 5.81]	[5.12 , 5.70]	[5.19 , 5.56]
10	[4.03 , 6.40]	[4.13 , 6.31]	[4.23 , 6.21]	[4.33 , 6.11]	[4.44 , 6.02]	[4.54 , 5.92]	[4.64 , 5.82]	[4.74 , 5.72]	[4.84 , 5.62]	[4.94 , 5.52]	[5.02 , 5.39]
11	[4.03 , 6.38]	[4.13 , 6.28]	[4.23 , 6.18]	[4.33 , 6.08]	[4.43 , 5.98]	[4.53 , 5.88]	[4.64 , 5.78]	[4.74 , 5.69]	[4.84 , 5.59]	[4.94 , 5.49]	[5.02 , 5.36]
12	[4.32 , 6.67]	[4.42 , 6.58]	[4.52 , 6.49]	[4.63 , 6.39]	[4.73 , 6.30]	[4.83 , 6.20]	[4.93 , 6.11]	[5.03 , 6.01]	[5.14 , 5.92]	[5.24 , 5.82]	[5.31 , 5.69]
13	[4.51 , 6.81]	[4.60 , 6.71]	[4.70 , 6.61]	[4.80 , 6.52]	[4.89 , 6.42]	[4.99 , 6.32]	[5.09 , 6.22]	[5.18 , 6.12]	[5.28 , 6.02]	[5.38 , 5.92]	[5.45 , 5.79]
14	[4.62 , 6.98]	[4.72 , 6.89]	[4.83 , 6.79]	[4.93 , 6.69]	[5.03 , 6.59]	[5.13 , 6.49]	[5.23 , 6.39]	[5.33 , 6.29]	[5.43 , 6.19]	[5.53 , 6.09]	[5.60 , 5.95]
15	[3.99 , 6.42]	[4.09 , 6.32]	[4.20 , 6.22]	[4.30 , 6.13]	[4.41 , 6.03]	[4.52 , 5.93]	[4.62 , 5.83]	[4.73 , 5.73]	[4.84 , 5.63]	[4.94 , 5.53]	[5.02 , 5.40]
16	[3.77 , 5.99]	[3.86 , 5.89]	[3.96 , 5.80]	[4.05 , 5.70]	[4.15 , 5.61]	[4.24 , 5.51]	[4.34 , 5.41]	[4.43 , 5.32]	[4.53 , 5.22]	[4.62 , 5.12]	[4.69 , 5.00]
17	[3.96 , 6.29]	[4.05 , 6.20]	[4.15 , 6.10]	[4.25 , 6.00]	[4.35 , 5.90]	[4.45 , 5.81]	[4.55 , 5.71]	[4.65 , 5.61]	[4.75 , 5.51]	[4.85 , 5.42]	[4.92 , 5.29]
18	[4.41 , 6.82]	[4.51 , 6.72]	[4.61 , 6.62]	[4.71 , 6.52]	[4.81 , 6.42]	[4.91 , 6.32]	[5.01 , 6.22]	[5.12 , 6.12]	[5.22 , 6.02]	[5.32 , 5.92]	[5.39 , 5.79]
19	[4.81 , 7.16]	[4.91 , 7.07]	[5.01 , 6.97]	[5.11 , 6.87]	[5.21 , 6.78]	[5.31 , 6.68]	[5.41 , 6.59]	[5.51 , 6.49]	[5.61 , 6.39]	[5.72 , 6.29]	[5.78 , 6.15]
20	[4.80 , 7.09]	[4.91 , 7.00]	[5.01 , 6.91]	[5.11 , 6.82]	[5.21 , 6.73]	[5.31 , 6.64]	[5.42 , 6.55]	[5.52 , 6.46]	[5.62 , 6.37]	[5.73 , 6.29]	[5.79 , 6.16]
21	[3.50 , 5.85]	[3.60 , 5.75]	[3.70 , 5.65]	[3.79 , 5.55]	[3.89 , 5.45]	[3.99 , 5.35]	[4.09 , 5.25]	[4.19 , 5.15]	[4.28 , 5.06]	[4.38 , 4.96]	[4.46 , 4.83]
22	[4.13 , 6.53]	[4.23 , 6.42]	[4.33 , 6.32]	[4.43 , 6.21]	[4.53 , 6.10]	[4.63 , 6.00]	[4.72 , 5.89]	[4.82 , 5.78]	[4.92 , 5.67]	[5.02 , 5.56]	[5.09 , 5.42]
23	[4.02 , 6.46]	[4.12 , 6.37]	[4.23 , 6.27]	[4.34 , 6.17]	[4.44 , 6.08]	[4.55 , 5.98]	[4.65 , 5.88]	[4.76 , 5.79]	[4.86 , 5.69]	[4.97 , 5.60]	[5.05 , 5.47]
24	[4.55 , 6.86]	[4.64 , 6.77]	[4.74 , 6.67]	[4.84 , 6.57]	[4.93 , 6.47]	[5.03 , 6.38]	[5.13 , 6.28]	[5.22 , 6.18]	[5.32 , 6.08]	[5.42 , 5.98]	[5.49 , 5.84]
25	[4.68 , 7.05]	[4.78 , 6.95]	[4.88 , 6.85]	[4.98 , 6.75]	[5.08 , 6.65]	[5.18 , 6.55]	[5.28 , 6.45]	[5.39 , 6.35]	[5.49 , 6.25]	[5.59 , 6.15]	[5.65 , 6.01]
26	[4.11 , 6.51]	[4.21 , 6.42]	[4.32 , 6.32]	[4.42 , 6.22]	[4.52 , 6.13]	[4.63 , 6.03]	[4.73 , 5.94]	[4.83 , 5.84]	[4.94 , 5.74]	[5.04 , 5.65]	[5.12 , 5.52]

After determining the FRPN values to prioritize the failure items in educational service quality, Yue method (2010) was used. The results are reported in table 5. In order to calculate p_i , totally eleven 26×26 matrices were prepared to determine the degree of greatness probability for total risk of failure items for each Alpha. Due to high volume of calculations, we have presented results of p_i and prioritizing of failure items of service quality. The results are presented in table 5.

Table 5. Results of calculation of p_i and categorization of educational service quality items

p_i^- / Failure Item	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	p_i	Rank
1	12.97	12.98	12.99	13.01	13.03	13.06	13.10	13.16	13.24	13.22	13.23	143.98	15
2	16.66	17.01	17.43	17.94	18.59	19.38	20.33	21.53	22.74	24.09	24.93	220.62	1
3	10.41	10.17	9.87	9.51	9.06	8.48	7.71	6.71	5.57	4.35	3.47	85.32	24
4	14.99	15.18	15.39	15.66	15.99	16.42	16.99	17.67	18.57	19.70	20.66	187.21	5
5	13.26	13.29	13.33	13.37	13.42	13.48	13.56	13.68	13.80	13.83	13.91	148.92	13
6	13.66	13.73	13.80	13.89	13.99	14.13	14.32	14.58	14.84	15.10	15.52	157.56	12
7	13.80	13.86	13.94	14.03	14.14	14.28	14.47	14.74	15.02	15.28	15.69	159.23	10
8	13.98	14.09	14.21	14.37	14.57	14.82	15.16	15.62	16.15	16.86	17.59	167.43	8
9	12.68	12.63	12.58	12.51	12.43	12.31	12.16	11.94	11.61	11.10	10.49	132.44	16
10	11.54	11.41	11.25	11.06	10.82	10.51	10.09	9.50	8.71	7.84	6.78	109.53	20
11	11.48	11.33	11.15	10.92	10.65	10.30	9.84	9.18	8.36	7.46	6.45	107.12	22
12	13.07	13.09	13.11	13.14	13.17	13.22	13.28	13.37	13.46	13.47	13.56	145.95	14
13	13.95	14.03	14.12	14.23	14.37	14.55	14.79	15.12	15.46	15.86	16.31	162.79	9
14	14.74	14.90	15.10	15.34	15.63	16.02	16.53	17.15	17.94	18.98	19.77	182.09	6
15	11.47	11.35	11.20	11.02	10.79	10.49	10.09	9.53	8.77	7.92	6.88	109.52	21
16	9.57	9.25	8.85	8.37	7.76	6.96	5.96	4.83	3.61	2.62	1.68	69.44	25
17	11.02	10.83	10.60	10.33	9.98	9.54	8.95	8.15	7.17	6.05	5.14	97.75	23
18	13.69	13.75	13.83	13.91	14.03	14.17	14.36	14.64	14.95	15.25	15.71	158.30	11
19	15.75	16.00	16.31	16.69	17.15	17.76	18.51	19.43	20.61	21.77	23.14	203.13	2
20	15.56	15.82	16.13	16.52	17.00	17.64	18.41	19.38	20.63	21.84	23.26	202.20	3
21	8.56	8.14	7.63	7.01	6.23	5.27	4.18	3.04	2.07	1.15	0.75	54.02	26
22	12.15	12.04	11.92	11.76	11.56	11.29	10.94	10.42	9.71	8.80	7.67	118.25	18
23	11.69	11.59	11.46	11.31	11.12	10.89	10.57	10.13	9.53	8.81	7.89	115.00	19
24	14.21	14.31	14.43	14.58	14.76	15.00	15.32	15.74	16.22	16.85	17.44	168.87	7
25	15.07	15.26	15.49	15.76	16.11	16.55	17.14	17.84	18.77	19.89	20.88	188.75	4
26	12.07	11.99	11.90	11.78	11.65	11.47	11.24	10.92	10.47	9.90	9.18	122.57	17

5. Conclusion

Prioritizing potential and actual failure items of educational services of Vali-e-asr University revealed their improvement priority very well. This priority was determined based on the risk they can create in provision of students' needs. Such data can be used as a basis for planning improvement of the educational service quality. Reviewing the literature showed that in the traditional FMEA method, the weight of risk factors are not considered, in other words, the same weight value are assumed for each of those factors. However it could not be used in practical application of FMEA. In order to remove this weakness, much research has been done. For example, Bevilacqua et al. has defined RPN as sum of values of 6 parameters (safety, importance of machine for performance, maintenance costs, failure frequency, impediment period, and operational conditions), which will be multiplied by a 7th factor (problem of machine accessibility) and the relative importance of the six factors are estimated through pair comparisons (Bevilacqua et al., 2000). Braglia et al. have presented a multi-measure decision approach which is called the Fuzzy TOPSIS approach for FMECA. TOPSIS method is well-known as a multi-measure decision methodology and is based on the belief that the best strategy for making decision is the one which is near to positive ideal and far from negative ideal. The proposed TOPSIS approach allows three factors of O, S, and D and their relative importance be evaluated using triangular Fuzzy figures (Braglia, 2003). Chin et al. proposed the FMEA approach using a deduction based on the sample group. They used different beliefs of members of FMEA team and categorized failure items in various unreliable conditions such as defective evaluation, unawareness and span related. The risk categorization model was expanded and included identification of risk factors using conceptual structures, combining individual conceptual structures and group conceptual structures, cooperation of group conceptual structure and total conceptual structure, switching the total conceptual structure into the expected risk value and categorization of expected risk values using Mini Max approach (Chin, 2009). Moreover in most of works done in discussion of educational service quality, SERVQUAL model is used that evaluates quality only by one dimension (perceived gap and expectations). However, FMEA model examines three dimensions, which suggests superiority of this model for evaluation of services quality.

To solve this problem Wang et al. (2009) introduced a new definition for Fuzzy RPN using Fuzzy weight geometrical mean (FWGM) given. The Fuzzy RPN can be calculated using Alpha cut sets, the linear programming model and gravity center fixation method. The present article used Wang et al. (2009) and Yue (2010) model in order to evaluate and prioritize the educational service quality risks. The results of evaluation and prioritizing items of educational service in Vali-e-sr University Rafsanjan based on the proposed method show that the most significant failure items are as follows:

1) Students are not ready to get a job opportunity, given the inefficient theoretical and practical courses presented in University.
2) Materials are not presented in an understandable manner for students
3) Students cannot get better score despite more efforts
4) Educational equipments in Faculty are inefficient and old (e.g., the Internet, overhead library, etc.).
5) Lack of sufficient academic resources to increase technical knowledge of students

According to the achieved results in this study, the researcher suggests following items in order to increase educational service quality in Vali-e-asr University:

1) Better relation between Universities with environment (industry, offices, etc.) to familiarize students with work environment. This can happen through lectures of industry practitioners at universities, students' scientific journeys to industrial units, introducing modern industrial issues to students through practical and scientific projects, participation of industrial managers in class discussions in higher education classes etc.
2) Material presentation through audio-visual equipments (PowerPoint) along with realistic examples for better comprehension.
3) Updating libraries with new materials and making contracts with various reliable data bases.
4) Standardizing testing methods and students' assessment.
5) Using teacher training courses for improving quality of teaching.

By offering the above suggestions, this model aims to help correcting planning of this university. Furthermore, it can be said that the mentioned issues are among priorities that should be considered by University management. Upon using FMEA technique, it was found that there are items that, despite of being considered in evaluation of educational quality of university, are of final priority and their influence on education quality is trivial. Therefore, by identifying these trivial items instead of spending time and money for correcting them, management can focus on essential items mentioned to help improve education quality of university. Some of less important items, which are presented in table 5, are as follows:

- Not recording and maintaining precise educational history of students
- Not spending time by teachers for responding and explaining for students outside classroom
- Not presenting materials in regular and related manner

Since these are important issues in this university (especially emphasizing 8 hours presence of teachers in university in each working day), it seems that problem of students is their lack of satisfaction due to issues inconsistent with university's programs for improving education quality.

6. Recommendation

Although the present paper evaluates the quality of educational services but for the measurement of the quality of education all factors such as the professors' quality, University facilities and educational system and the students should be to be considered and that highlights exciting opportunities for future research.

References

Akbaba, A. (2006). Measuring Service Quality in the Hotel Industry: A study in a Business Hotel in Turkey. *International Journal of Hospitality Management, 25,* 170–192.

Almannai B., Greenough R., & Kay J. (2008). A decision support tool based on QFD and FMEA for the selection of manufacturing automation technologies. *Robotics and Computer-Integrated Manufacturing, 24*(4), ICMR2005: Third International Conference on Manufacturing Research, August 2008, pp. 501-507.

Bevilacqua M., Braglia M., & Gabbrielli R. (2000). Monte Carlo simulation approach for a modified FMECA in a power plant. *Quality and Reliability Engineering International, 16*(4), 313–324.

Braglia M, Frosolini M., & Montanari R. (2003). Fuzzy criticality assessment model for failure modes and effects analysis. *International Journal of Quality & Reliability Management, 20*(4), 503-524.

Brochado, A. (2009). Comparing Alternative Instruments to Measure Service Quality in Higher Education. *Quality Assurance in Education, 17*(2), 174.

Cheng, Y. C. (1995). School education quality: conceptualization, monitoring, and enhancement. In Siu, P. K., & Tam T. K. (Eds.), *Quality in Education: Insights from Different Perspectives* (pp. 123-147). Hong Kong Education Research Association, Hong Kong.

Chin K. S., Wang, Y. M., Poon, G. K. K., & Yang, J. B. (2009). Failure mode and effects analysis by data envelopment analysis. *Decision Support Systems, 48*, 246-256.

Ching-Liang Chang, & Chiu-Chi Wei. (1999). Failure Mode and Effects Analysis Using Fuzzy Method and Grey Theory. *Kybernetes, 28*(9), 1072-1080.

Delgado, M., Verdegay, J. L., & Vila, V. (1992). Linguistic decision making models. *International Journal of Intelligent Systems, 7*(5), 479–492.

Dyer, J. S., & Sarin, R. K. (1979). Measurable multi attribute value functions. *Operations Research, 39,* 810-822.

Gordon, G., & Partigon, P. (1993). "Quality in higher education: Overview and update", USDU Briefing Paper Three, USDU, Sheffield, University Staff Development Unit

Gronoos, Christian. (1982). Strategic Management and Marketing in the Service Sector, Helsingfors: Swedish School of Economics and Business Administration.

Hsiao, W. F., Lin, H., & Chang, T. M. (2007). Fuzzy consensus measure on verbal opinions. *Expert Systems with Applications, 35*(3), 836–842.

Ireson, G., Coombs, W., Clyde, F., & Richard, Y. M. (1995). *Handbook of Reliability Engineering and Management(2nd ed).*, McGraw-Hill Professional, New York, NY.

Jahanshahi A. A., Gashti M. A. H, Mirdamadi S. A., Nawaser K. H., & Khaksar S. M. S. (2011). 'Study the effect of Customer Service and Product Quality, on Customer Satisfaction and Loyalty' International Journal of Humanities and Social Science (IJHSS).

John. B. Bowles, & C. Enrique Pelaez. (1995). Fuzzy Logic Prioritization of Failure in a System Failure Mode and Effects Criticality Analysis. *Reliability Engineering and System Safety, 50,* 203-213.

Johnson, R. (1994). Assessment Requirement Practices and Rational in Nait Accredited Baccalaureate Degree Programs. Colorado State University.

Karapetrovic, S. (1998). Quality Assurance in the University System. Retrieved July 6, 2010, from http://umi.com.dissertation/fullcit/NQ31997

Krouwer J. S. (2004). An improved failure mode effects analysis for hospitals. *Arch Pathol Lab Med.Jun, 128*(6), 663-667.

Lim P. C., & Tang N. K. (2000). A study of patients' expectations and satisfaction in Singapore hospitals. *International Journal of Health Care Quality Assurance, 13*(7), 290-299.

Maleki, H., & Saadat, Y. (2013). Comparison of failure mode and effects analysis by using AHP vs. REMBRANDT system. *International Journal of Industrial and Systems Engineering, 14*(1).

Moubray, J. (1992). *Reliability-centered Maintenance*. New York: Industrial Press Inc.

Mukaddes, A., Bagum, N., Anisul Islam, M., & Aziz Khan, M. (2012). The application of quality function deployment to improve the teaching techniques in higher education. *International Journal of Industrial and Systems Engineering, 11*(1).

Oldfield B., & Baron S. (2000). Student perceptions of service quality in a UK university business and management faculty. *QualAssur Educ, 8*(2), 85-95.

Oliveira, O., & Ferrera, E. (2009). Adaptation and application of the Servqual scale in higher education POMS 20th Annual Conference (May 1 to May 4). Relationship Management Approach. (2nd ed)., Wiley, Chichester.

Parasuraman, A., Valarie Zeithaml, & Leonard Berry. (1985). A Conceptual Model of Service Quality and Its Implications for Future Research. *Journal of Marketing (Fall),* 41-50.

Parasuraman, A., Ve Berry, L., & Zeithaml, V. A. (1988). Servqual: A multiple item scale for measuring consumer perceptions of service quality. *Journal of Retailing, 64*(1), 12-40.

Poleshchuk, O. (2011). The determination of students' fuzzy rating points and qualification levels. *International Journal of Industrial and Systems Engineering, 9*(1).

Rezaie, K., Noori, B., & Seiyedi, M. (2003). *Failure Mode and Effects Analysis*. Tehran: Alta Publications.

Ronda G. Hughes. (2008). Patient Safety and Quality: An Evidence-Based Handbook for Nurses, Chapter 44: Tools and Strategies for Quality Improvement and Patient Safety Rockville (MD): Agency for Healthcare Research and Quality (US).

Sasser, W. Earl, Jr., R. Paul Plsen, & D. Daryl Wyckoff. (1978). *Management of Service Operations*: *Text and Cases*, Boston: Allyn and Bacon.

Segismundo, A., Augusto, P., & Miguel, C. (2008). Failure mode and effects analysis(FMEA) in the context of riskmanagement in new product Development,A case study in an automotive company. *International Journal of Quality & Reliability Management, 25*(9), 899-912.

Sezar, E. Akcapinar. (2011). A complimentary fuzzy approach for the assessment of academic performance. *International Journal of Industrial and Systems Engineering, 9*(1).

Smith, M., & Hinchcliffe, G. R. (2004). *RCM-Gateway World Class Maintenance*. Oxford, Elsevier Butterworth-Heinemann.

Spath P. L., & Hickey P. (2003). Home study program: Using failure mode and effects analysis to improve patient safety. *AORN Journal, 78,* 16-21.

Tay K. M., & Lim C. P. (2010). Enhancing the Failure Mode and Effect Analysis methodology with fuzzy inference techniques. *Journal of Intelligent and Fuzzy Systems, 21*(1/2).

Teng, S. H., & Ho, S. Y. (1996). Failure mode and effects analysis: An integrated approach for product design and process control. *International Journal of Quality and Reliability Management, 13*(5), 8–26.

Viswanadhan, K. (2009). Quality indicators of engineering education programmes: A multi-criteria analysis from India. *International Journal of Industrial and Systems Engineering, 4*(3).

Waeyenbergh, G., & Pintelon, L. (2002). A framework for maintenance concept development. *International Journal of Production Economics, 77*(3), 299-313.

Wang, Y. M., Chin, K. S., Poon, K. K. G., & Yang, J. B. (2009). Risk evaluation in failure mode and effects analysis using fuzzy weighted geometric mean. *Expert Systems with Applications, 36*(2), 1195–1207.

Yılmaz, V., Filiz, Z., & Yaprak, B. (2007). Service Quality Measurement in the Turkish higher Education System with Servqual Method. *Anadolu University Journal of Social Sciences, 7*(2), 299-316.

Yue, Z. (2010). An extended TOPSIS for determining weights of decision makers with interval numbers. *Knowledge-Based Systems, 24*(1), 146–153.

Zeithaml, V. A., Parasuraman, A., & Berry, L. L. (1985). A Conceptual model of service quality and its implications for future research. *Journal of Marketing, 49,* 41-50.