

Priority Determination for Higher Education Strategic Planning Using Balanced Scorecard, FAHP and TOPSIS (Case study: XYZ University)

This content has been downloaded from IOPscience. Please scroll down to see the full text.

2016 IOP Conf. Ser.: Mater. Sci. Eng. 105 012040

(<http://iopscience.iop.org/1757-899X/105/1/012040>)

View [the table of contents for this issue](#), or go to the [journal homepage](#) for more

Download details:

IP Address: 80.82.77.83

This content was downloaded on 01/04/2017 at 12:03

Please note that [terms and conditions apply](#).

Priority Determination for Higher Education Strategic Planning Using Balanced Scorecard, FAHP and TOPSIS (Case study: XYZ University)

Uky Yudatama¹ and Riyanarto Sarno²

¹Departemen of Informatics, Universitas Muhammadiyah Magelang, Indonesia

²Departemen of Informatics, Institut Teknologi Sepuluh November Surabaya, Indonesia

E-mail: ¹uky.yudatama@mail.com, ²riyanarto@if.its.ac.id

Abstract. The process of strategic planning is needed by a higher education in some cases, especially in preparing to face the challenges and competition. The results of strategic planning will help the higher education to provide a framework for achieving a competitive advantage as well as determine the direction of future policy in accordance with the desired objectives. In recent decades, the Balanced Scorecard has been applied in the field of information technology as a very popular tool and is used extensively, because it is a model that can explain between information technologies with "Business Objectives" in a comprehensive manner. This study uses 4 perspectives in the Balanced Scorecard and 7 standards in higher education quality assessment as sub-criteria. Fuzzy AHP and Fuzzy TOPSIS are used to determine the priority as making strategic policy recommendations in a higher education. The final result of this research shows the score of Customer Perspective 0.35365 is higher than other perspective, while the score in Research and Student Affairs gains significant score when compared with the others, namely 0.69753948 is also higher. This means that both of them get very serious attention as a strategic planning basis for policy making.

1. Introduction

Along with the changing times and the need of education for the community, coupled with increasingly stringent government regulations, encouraging universities to conduct good and right strategic planning. The process of strategic planning is advantageous for a university in some cases, especially in preparing to face the challenges and competitions. The results of strategic planning will help the university to provide a framework for achieving a competitive advantage as well as determine the direction of future policy in accordance to the expected objectives. All components will engage and interact synergistically, actively participate and work together to achieve goals and to improve understanding of the organization / institution.

Strategic planning through strategic management process must be applied systematically and methodologically. For strategic planning, universities need to adjust a different business strategic

Corresponding author. Tel: +62-293-362082; fax: +62-0293-361004

E-mail address: uky.yudatama@mail.com



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

model since it is different from business strategy of a company. A university strategic planning customarily takes 5 years or more.

In recent decade, the Balanced Scorecard has been applied in the field of information technology as a very popular tool and is used extensively, because it is a model that can explain information technologies with "*Business Objectives*" in a comprehensive manner.

This research using the criteria determining perspectives in the balanced scorecard. This perspectives is very important as aligning business strategy which became the basis of the reference. As a real issue, whether in the run up to evaluate are in accordance with the parameters or standards that exist in the higher education quality assessment. Therefore, the existing standards in higher education quality assessment is used as a sub-criterion, as the elaboration of criteria that is in the aspects of the balanced scorecard. Fuzzy AHP is used to determine the weights criteria and Fuzzy TOPSIS is used to determine the priority as making a strategic policy recommendations in a higher education.

2. Basic Theory

There is one key aspect that needs to be considered in carrying out the whole process of higher education institutions accreditation. The Aspect is accreditation standard that is used as benchmark in evaluating and assessing quality of performance, condition and state of education of a higher education institution.

Accreditation standard of undergraduate study program includes the standards of commitment to undergraduate study programs of institutional capacity (*institutional capacity*) and a commitment to the effectiveness of educational programs (*educational effectiveness*), which is packed in 7 (seven) accreditation standards: Standard 1 (vision, mission, goals and objectives, and achievement strategy); Standard 2 (supervisor management, leadership, management systems and quality assurance); Standard 3 (Students and graduates; Standard 4 (human resources); Standard 5 (curriculum, learning, and academic atmosphere); Standard 6 (financing, infrastructure, and information systems); Standard 7 (research and service / dedication to community, and collaboration).

2.1. Balanced Scorecard

The Balanced Scorecard (BSC) is a methodology to conduct management strategy consisting of 4 perspectives:

- a. Financial Perspective (FP),
- b. Customer Perspective (CP),
- c. Internal Process Perspective (IPP) and
- d. Learning and Growth Perspective (LGP).

2.2. Fuzzy AHP

Analytical Hierarchy Proses is a multi-criteria decision technique proposed by saaty (1980) to solve problems of planning needs and management of scarce resources that, in time has become one of the most widely used technique in decision making processes on multi criteria.

Introduced the theory of fuzzy sets in 1965 to model the concept of vagueness, characteristis of human thought. Fuzzy numbers allow to face problems in which the criteria are not precisely defined. Therefore, fuzzy AHP (FAHP), a fuzzy extension of AHP, can be used to solved hierarchical fuzzy problems. FAHP applications can be found in diverse areas such as selection of operating system, recruitmen of staff, risk assessment projects in information technology, selection of ERP system.

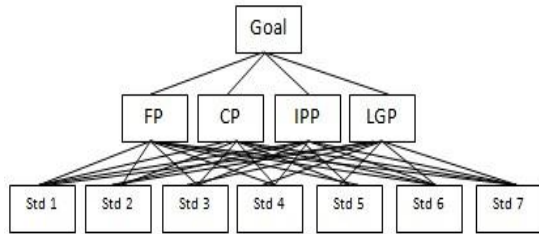


Figure 1. The structure of the hierarchy problem.

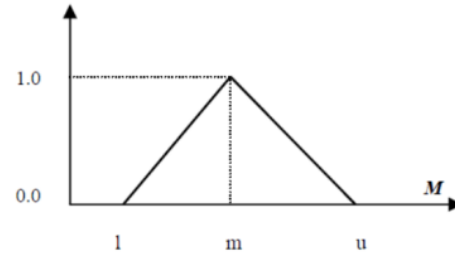


Figure 2. Triangular Fuzzy Numbers

Triangular fuzzy numbers in Table 1 are denoted by $M = \{l, m, u\}$, where M is a set of fuzzy numbers consisting of l , m and u which respectively express the smallest possibility value, the most closest value, and the greatest possibility value.

If $X = \{x_1, x_2, x_3, \dots, x_n\}$ it denotes a set of objects, and $G = \{g_1, g_2, g_3, \dots, g_n\}$ it denotes a set of goals. If there is a number of m criteria that will be used for analysis, then it is obtained $M_{gi1}, M_{gi2}, M_{gi3}, \dots, M_{gim}$. $m_i = 1, 2, \dots, n$, where j $M_{gij}(j=1, 2, \dots, n)$ is a fuzzy triangular numbers. The steps used to analyze further is as follows:

Step 1: It is defined as fuzzy synthetic extent value (S_i) with criteria to i by equation 1.

$$S_i = \sum_{j=1}^m M_{gi}^j x \left[\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1} \quad (1)$$

to get $\sum_{j=1}^m M_{gi}^j$, a fuzzy value summation operation of m value on matrix using equation 2 is conducted

$$\sum_{j=1}^m M_{gi}^j = (\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j) \quad (2)$$

To get $\left[\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1}$, a fuzzy summation operation of M_{gij} values ($j = 1, 2, \dots, n$) by using equation 3 is conducted

$$\sum_{j=1}^n \sum_{j=1}^m M_{gi}^j = (\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j) \quad (3)$$

Then inversion of the vector in the above equation using equation 4 is calculated.

$$\left[\sum_{j=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1} = \left(\frac{1}{\sum_{j=1}^n l_j}, \frac{1}{\sum_{j=1}^n m_j}, \frac{1}{\sum_{j=1}^n u_j} \right) \quad (4)$$

Step 2: calculate the degree of possibility, where $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ are two fuzzy triangular numbers, so that the degree of possibility $M_2 = (l_2, m_2, u_2) \geq (l_1, m_1, u_1)$ is obtained from equation (5) and (6)

$$V = M_2 \geq M_1 = \text{hgt} (M_2 \cap M_1) = \mu_{M_2} \quad (5)$$

$$= \begin{cases} 0, & \text{if } m_2 \geq m_1 \\ 1, & \text{if } l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{otherwise} \end{cases} \quad (6)$$

Step 3: to compare the degree of possibility among criteria and among fuzzy numbers $M_{1=(i=1,2,...,k)}$ through equation (7).

$$\begin{aligned} & V(M \geq M_1, M_2, \dots, M_k) \\ &= V[(M \geq M_1)] \text{ and } (M \geq M_2) \text{ and } \dots \text{ and } (M \geq M_k)] \\ &= \min V(M \geq M_i), i = 1, 2, \dots, k \end{aligned} \quad (7)$$

By assuming $d(A_i) = \min V(S_i \geq S_k)$ for $k=1,2,...,k; k \neq i$. so that the value of weight vector in equation (8) is obtained.

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T \quad (8)$$

After the weight vector in equation (8) is normalized, the normalized weight vector is obtained which is shown in equation (9).

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T \quad (9)$$

Where W is not a fuzzy numbers.

2.3. Fuzzy TOPSIS

After the weight values for each criterion are obtained, then calculation using TOPSIS method that has been fuzzier is done. Contrastwith TOPSIS method which directly determines the value of the criteria for each alternative .After each criteria of alternative is rated, then the integral total value for each alternative using equation (10)is calculated.

$$x = I(F) = 1/2(ac + b + (1-\alpha)a) \quad (10)$$

With α is h the degree of optimism with a value between 0 and 1. After the integral total value on each criterion is obtained, normalization through equation (11) is conducted.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (11)$$

Then the calculation to get normalized weight matrix through equation (12) is conducted.

$$v_{ij} = W_{ij} * r_{ij} \quad (12)$$

Then positive ideal solution value and negative ideal solution value is calculated using equation

$$\begin{aligned} A^+ &= \{v_1^+, v_2^+, \dots, v_n^+\} \\ A^- &= \{v_1^-, v_2^-, \dots, v_n^-\} \end{aligned} \quad (13)$$

The disparity between the alternative with positive ideal solution is calculated with equation (14).

$$D_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad (14)$$

While alternative disparity with negative ideal solution is calculated by equation (15).

$$D_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad (15)$$

By comparing the disparity with positive and negative ideal solutions, then the preference value for each alternative is obtained by equation (16).

$$CC_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (16)$$

CC_i value obtained from equation (16) is the final value used to determine the ranking of some alternatives that will be selected with the value of initial rank order starting from the biggest CC_i value.

3. The Proposed Method

Research model was designed as shown in figure 3. Stages of research are described based on research model.

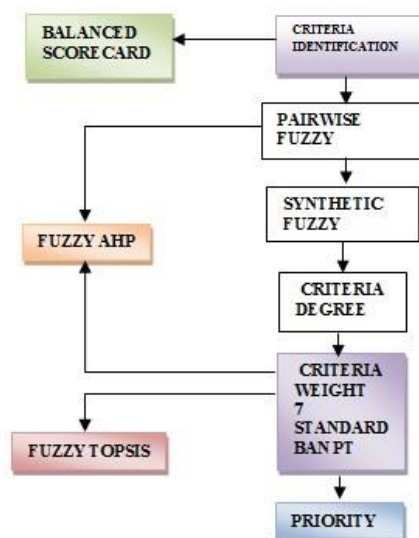


Figure 3. Research model.

4. Result

The first stage in conducting this research is to determine the criteria by considering 4 balanced scorecard perspective. After comparing all criteria/attribute exists, a matrix as shown in table 1 is obtained.

Table 1. Comparison Matrix of Balanced Scorecard

Criteria	FP	CP	IPP	LGP
FP	111	1/51/31	135	111
CP	135	111	135	357
IPP	1/51/31	1/51/31	111	135
LGP	111	1/71/51/3	1/51/31	111

Table 2. Fuzzy value Synthetic Extent

	l	m	u
FP	0.0857	0.2174	0.5738
CP	0.1607	0.4891	1.2910
IPP	0.0643	0.1902	0.5738
LGP	0.0628	0.1033	0.2391

The next step is to look for fuzzy value Synthetic extents (Si) using equation (1), so that it will gain matrix as shown in table 2.

Then possibility degree among the criteria is calculated by using equation (3), so that it will gain the degree of criteria possibility as shown in table 3.

Table 3. Value Degree Possibilities

Criteria	FP	CP	IPP	LGP
FP	1	1	1.1407	0.9975
CP	0.8306	1	0.7485	0.2485
IPP	1	1	1	1.161035
LGP	1	1	1	1

Table 4. Value Criteria (W') and Weight Normalized (W)

	FP	CP	IPP	LGP
W'	0.8306	1	0.7485	0.2485
W	0.2937	0.3536	0.2647	0.0879

The weight vector value created from table 3 above, after calculated and normalized for each criteria, then the weight vector value produced will be as shown in table 4. Weight vector values produced from Fuzzy AHP method is used to perform calculations with Fuzzy TOPSIS method. Each criterion of each perspectives in balanced scorecard gives value using triangular fuzzy numbers, as in Table 5.

Table 5. Triangular Fuzzy

Standard	FP			CP			IPP			LGP		
Vision and Mission	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
Good Governance	0.75	1	1	0.5	0.75	1	0.75	1	1	0.75	1	1
Students Affairs	0.5	0.75	1	0.75	1	1	0.5	0.75	1	0.5	0.75	1
Human Resources	0.5	0.75	1	0.75	1	1	0.5	0.75	1	0.75	1	1
Curricula	0.5	0.75	1	0.25	0.5	0.75	0.25	0.5	0.75	0.5	0.75	1
Infrastructure	0.5	0.75	1	0.5	0.75	1	0.75	1	1	0.5	0.75	1
Research	0.5	0.75	1	0.75	1	1	0.5	0.75	1	0.5	0.75	1

Matrix triangular fuzzy values obtained in Table 5 is calculated using the total value of the integral equation (10) to obtain the matrix X as in Figure 5 below.

0.5	0.5	0.5	0.5	0.073936698	0.085513217	0.06655482	0.021275013
0.94	0.75	0.94	0.94	0.139000993	0.128269826	0.125123061	0.039997024
0.75	0.94	0.75	0.75	0.110905047	0.160764849	0.099832229	0.031912519
0.75	0.94	0.75	0.94	0.110905047	0.160764849	0.099832229	0.039997024
0.75	0.5	0.5	0.75	0.110905047	0.160764849	0.099832229	0.039997024
0.75	0.75	0.94	0.75	0.110905047	0.085513217	0.06655482	0.031912519
0.75	0.94	0.75	0.75	0.110905047	0.128269826	0.125123061	0.031912519

Figure 5. Integral Total**Figure 6.** Matrix weight normalized

By using equations (11) and (12) of the matrix in Figure 5, it was found that the normalized weight matrix V in Figure 6.

In the normalized weight matrix in Figure 5, the positive ideal solution value and negative ideal solution value use equation (13), then the disparity between the alternative with positive ideal solution is calculated with equation (14), while the disparity between the alternative and negative ideal solution is calculated with equation (15). By comparing the disparity between the positive ideal solution to the negative ideal solution, then preference value for each alternative on table 6 through equation (16) is obtained.

Table 6. Final Value of Risk Alternative and its Rankings

Standard	Point	Priority
Vision and Mission	0.139547712	7
Good Governance	0.584152191	5
Students Affairs	0.69753948	2
Human Resource	0.681360105	3
Curricula	0.274575757	6
Infrastructure	0.274575757	4
Research	0.69753948	1

From the calculation results obtained, it shows that the Research and Student Affairs gains significant score when compared with the others, namely 0.69753948. This shows that official management is very important to note. Although vision and mission get lowest value, it is also need to get serious attention.

5. Conclusion

This research aims to determine priority as recommendation for strategic decision maker in a higher education.. Four perspectives in Balanced Scorecard are used as the criteria in this research. . This perspectives is very important as aligning business strategy which became the basis of the reference. As a real issue, whether in the run up to evaluate are in accordance with the parameters or standards that exist in the higher education quality assessment. Therefore, the existing standards in higher education quality assessment is used as a sub-criterion, as the elaboration of criteria that is in the aspects of the balanced scorecard. Fuzzy AHP is used to determine the weights criteria and Fuzzy TOPSIS is used to determine the priority as making a strategic policy recommendations in a higher education. The final result of this research shows the score of Customer Perspective 0.35365 is higher than other perspective, while the score in Research and Student Affairs gains significant score when compared with the others, namely 0.69753948is also higher. This means that both of them get very serious attention as a strategic planning basis for policy making.

References

- [1] Amg,L.,Wen,C&Ching, J, 2008. A fuzzy AHP and BSC approach for evaluating performance of IT department in the manufacturing industry in Taiwan, *Expert systems with Applications* 34, 94-107.
- [2] Ashtiani, B., Haghighirad, F., Makui, A., Montazer, G.A., 2008.Extension of Fuzzy TOPSIS Method Based on Interval-valued Fuzzy Sets. *Applied Soft Computing*. Vol. 9, No.2, 457-461
- [3] Amiri, M.P., 2010. Project Selection for Oil-felds Development by Using AHP and fuzzy TOPSIS methods. *Expert System with Application*, 37, 6218-6224.
- [4] Manian. Amir, Fathi, M. Reza, Zarchi. M. Karimi, Omidian. Asie, 2011. Performance Evaluation of IT Department using a Modified Fuzzy TOPSIS and BSC methodology (Case study: Tehran Provinces Gas Company), *Journal of management research*, ISSN 1941-899X, Vol 3, No 2:E10, Tehran, Iran.
- [5] BAN-PT, 2008. "Buku I Naskah Akademik Akreditasi Institusi Perguruan Tinggi", Jakarta.
- [6] Balli, S. & Korukoglu, S, 2009. Operating system Selection Using Fuzzy AHP and TOPSIS. *Mathematical and Computational Applications*, 14(2), 119-130.
- [7] Milis and Mercken, K. Milis and R. Mercken. 2004. The use of the balanced scorecard for the evaluation of information and communication technology projects, *International Journal of Project Management* 22, pp. 87–97.
- [8] Sarno. R. 2009, *Strategi Sukses Bisnis dengan Teknologi Informasi, Berbasis Balanced Scorecard & CobiT*. Surabaya: ITS Press.
- [9] Sarno. R.,A. Herdiyanti, 2010. "Information technology policies for enterprise resource planning practices to improve customer orientation and service," *International Journal of Computer Science and Network Security*, vol.10, no..5, pp. 82-94, March.
- [10] Sarno. R.,Haryanto T, 2010 "Comparison of CobiT Maturity Model and Structural Equation Model for Measuring the Alignment between University Academic Regulations and Information Technology Goals", *IJCSNS International Journal of Computer Science and Network Security*, VOL.10 No.6, June.
- [11] Sarno R., Djeni CA., Mukhlash I., Sunaryono D., 2015. Developing A Workflow Management System For Enterprise Resource Planing, 2015, *Journal of Theoretical and Applied Information Technology* 28th February. Vol.72 No.3
- [12] Yudatama. U, Sarno. R. 2015. Evaluation Maturity Index and Risk Management for IT Governance using Fuzzy AHP and Fuzzy TOPSIS (Case Study Bank XYZ), *Intelligent Tecnology and Its Application (ISITIA) 2015 International On*, 323-328, Publisher IEEE.