

Correspondence of paper on title **Fuzzy Inference System to Predict HE's Performance in**  
International Journal of Information and Education Technology (IJIET)

| No | Activity                                                                                                                                                                         | Date          |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1  | Submitted paper to 2018 Conference on Energy, Electrical, and Power Plant (CEEPE 2018) Soul, Korea                                                                               | 16/04/2018    |
| 2  | The paper notification was reviewed by the CEEPE2018 Committee                                                                                                                   | 19/04/2018    |
| 3  | Passed first review by CEEPE2018 editor                                                                                                                                          | 24/04/2018    |
| 4  | Received the Technical Committee Invitation Letter by CEEPE2018                                                                                                                  | 25/04/2018    |
| 5  | Reviewing 4 articles from CEEPE2018 participants                                                                                                                                 | 27/04/2018    |
| 6  | Accepted for oral presentation and publication on CEEPE 2018 Soul                                                                                                                | 06/05/2018    |
| 7  | Received an invitation for publication in the International Journal of Information and Education Technology (IJIET)                                                              | 08/05/2018    |
| 8  | Fill out the Copyright transfer form from CEEPE2018 to IJIET                                                                                                                     | 15/05/2018    |
| 9  | Receive a notification of the Conference Abstract by the CEEPE2018 Committee                                                                                                     | 31/05/2018    |
| 10 | As a presenter at the CEEPE2018 International Conference in Soul, South Korea                                                                                                    | 15-18/06/2018 |
| 11 | Request from IJIET to revise the paper: write in full the identity of the author and biography of the first author and the format of the writing according to the IJIET template | 08/10/2018    |
| 12 | Revise according to IJIET's request                                                                                                                                              | 09/10/2018    |
| 13 | Request for a second revision by IJIET related to keywords                                                                                                                       | 27/11/2018    |
| 14 | Revise the addition of keywords and submit the final paper                                                                                                                       | 28/11/2018    |
| 15 | Notification by IJIET regarding the publication of IJIET volume 9 number 6                                                                                                       | 08/05/2019    |

|               |      |            |             |           |
|---------------|------|------------|-------------|-----------|
| Submission 47 | Help | Conference | <b>News</b> | EasyChair |
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## CEEPE 2018 Submission 47

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| Submission 47   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title           | Fuzzy Inference System to Predict HE's Performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Paper:          |  (Apr 16, 15:03 GMT)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Author keywords | Higher education<br>Predicting performance<br>Balanced scorecard<br>Fuzzy inference system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Abstract        | The article discusses a methods to predict Higher Education or HE's performance based on 4 perspectives of Balanced Scorecards. The methods is developed using fuzzy inference system. There are 12 predictors variable are developed as Key Performance Indicator's of BSC. The expert were chosen from qualified national assessor to evaluate the membership function of the predictive variable, and to develop the inference rules from predictor variable to output variable. Based on confirmation and validation model design to the expert, the model can be used to predict the HE's performance. |
| Submitted       | Apr 16, 15:04 GMT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Last update     | Apr 16, 15:04 GMT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Authors    |           |                     |           |                            |                                                             |                |
|------------|-----------|---------------------|-----------|----------------------------|-------------------------------------------------------------|----------------|
| first name | last name | email               | country   | affiliation                | Web page                                                    | corresponding? |
| I Nyoman   | Sutapa    | mantapa@petra.ac.id | Indonesia | Petra Christian University | <a href="http://www.petra.ac.id">http://www.petra.ac.id</a> | ✓              |
| Zeplin     | Tarigan   | zeplin@petra.ac.id  | Indonesia | Petra Christian University |                                                             | ✓              |
| Jenny      | Djundjung | jennymd@petra.ac.id | Indonesia | Petra Christian University |                                                             | ✓              |
| Jani       | Rahardjo  | jani@petra.ac.id    | Indonesia | Petra Christian University |                                                             | ✓              |

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kepada saya, zeplin, jennymd, jani

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Dear I Nyoman Sutapa, Zeplin Tarigan, Jenny Djundjung and Jani Rahardjo,

Thanks for your submission to CEEPE2018!

Your submission which is entitled "Fuzzy Inference System to Predict HE's Performance" has been well receive

Now your paper is given a paper ID: **CEEPE2018-347**, Please kindly remember this ID.

We will forward your paper to be reviewed and inform you the first review result in 7 work days.

Best regards

Kotak Masuk ✕

Kam, 19 Apr 2018



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Kotak Masuk

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CEEPE2018-347--First Review Result Kotak Masuk x

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**ceepe** <ceepe@saise.org>  
kepada saya, zeplin, jennymd, jani

Sel, 24 Apr 2018,

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Dear I Nyoman Sutapa, Zeplin Tarigan, Jenny Djundjung and Jani Rahardjo,

Greetings from CEEPE2018!

We would like to inform you that your paper **CEEPE2018-347** which entitled "Fuzzy Inference System to Predict the Effect of the Number of Patients on the Waiting Time in the Emergency Department" has passed the first review process.

We will forward your paper to be further reviewed and inform you the final review result around May 5th, 2018.

Should you have any question, please feel free to contact me.

Best regards

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Technical Committee Invitation Letter--Dr. I Nyoman Sutapa Kotak Masuk x

ceepe <ceepe@saise.org>

kepada saya

25 Apr 2018

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Technical Committee Invitation Letter

Dear Dr. I Nyoman Sutapa,

Greetings from CEEPE2018!

I am delighted to inform you that, owing to your expertise and achievement, you are one of the very nomination list of Technical Committee of **2018 Conference on Energy, Electrical and Power Engi 2018**), which will be held in Seoul, South Korea during June 15-18, 2018.

On behalf of the conference committee, I am very pleased to write to you and invite you to join our

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kepada saya

27 Apr 2018

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Dear Dr. I Nyoman Sutapa,

Thanks for your positive reply. We are so glad that you can be the technical committee member.

Then please kindly review attached papers, and fill your comments in the review form.

We will very appreciate that you can give us the feedback before May 3rd.

Best regards

**Ms. Yanira Young**  
*Conference Secretary of CEEPE*

Website: <http://www.ceepe.net/>  
Tel: +86-18215575102

## ***Acceptance Notification and Invitation Letter***

2018 International Conference on Energy, Electrical and Power Engineering  
(CEEPE 2018)

Seoul, South Korea

June 15-18, 2018

<http://www.ceepe.net/index.html>

**I Nyoman Sutapa, Zeplin Tarigan, Jenny Djundjung and Jani Rahardjo**

Petra Christian University, Indonesia

Email: mantapa@petra.ac.id; zeplin@petra.ac.id; jennymd@petra.ac.id; jani@petra.ac.id

**Dear I Nyoman Sutapa, Zeplin Tarigan, Jenny Djundjung and Jani Rahardjo,**

We are pleased to inform you that, after our blind peer review, your full paper identified below has been accepted for oral presentation and publication by 2018 International Conference on Energy, Electrical and Power Engineering (CEEPE 2018) to be held in Seoul, South Korea during June 15-18, 2018.

**Paper ID: CEEPE2018-347**

**Paper Title: Fuzzy Inference System to Predict HE's Performance**

If the above paper is registered on time, it will be published in the ***International Journal of Information and Education Technology (IJIET)***. Indexed by IET Inspec, Google Scholar, etc.

Yours sincerely,  
CEEPE Organizing Committees  
May 5, 2018



# Registration Instruction

There are 5 steps to complete your registration:

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3. Download and complete the Registration Form.

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4. Finish the payment of Registration fee. (The information can be found in the Registration form)

Please see the attached file with the email.

- 5, Fill the copyright form:

<http://www.ijiet.org/IJiet.Copyright.doc> (please download)

5. Send your final papers (both doc and pdf format), filled registration form (doc format), copyright form and the scanned payment proof\* to [ceepe@saise.org](mailto:ceepe@saise.org) (**Before May 15th, 2018**)

**\*If you pay by on-line Credit Card Payment, please fill your confirmation number in the registration form after paying.**

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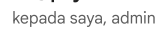


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**EasyChair** <noreply@easychair.org>  
kepada saya

Sen, 16 Apr 2018,

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Dear I Nyoman Sutapa,

I Nyoman Sutapa <[mantapa@petra.ac.id](mailto:mantapa@petra.ac.id)> submitted the following paper to CEEPE 2018:

### Fuzzy Inference System to Predict HE's Performance

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kepada saya, zeplin, jennymd, jani

Rab, 8 Mei 2019

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Dear I Nyoman Sutapa,  
  
Greetings from CEEPE2018!  
  
Here I attach the journal pf your published paper, please see the attachment.  
  
Any question, please feel free to contact me.  
  
Best regards  
  
**Ms. Jasmine Nie**  
*Conference Secretary of CEEPE*  
  
Website: <http://www.ceepe.net/>  
Tel: +1-302-444-8432 (USA) / +852-30717761 (HK)

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| Author keywords | Higher education<br>Predicting performance<br>Balanced scorecard<br>Fuzzy inference system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Abstract        | The article discusses a methods to predict Higher Education or HE's performance based on 4 perspectives of Balanced Scorecards. The methods is developed using fuzzy inference system. There are 12 predictors variable are developed as Key Performance Indicator's of BSC. The expert were chosen from qualified national assessor to evaluate the membership function of the predictive variable, and to develop the inference rules from predictor variable to output variable. Based on confirmation and validation model design to the expert, the model can be used to predict the HE's performance. |
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| Last update     | Apr 16, 15:04 GMT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Authors    |           |                     |           |                            |                                                             |                |
|------------|-----------|---------------------|-----------|----------------------------|-------------------------------------------------------------|----------------|
| first name | last name | email               | country   | affiliation                | Web page                                                    | corresponding? |
| I Nyoman   | Sutapa    | mantapa@petra.ac.id | Indonesia | Petra Christian University | <a href="http://www.petra.ac.id">http://www.petra.ac.id</a> | ✓              |
| Zeplin     | Tarigan   | zeplin@petra.ac.id  | Indonesia | Petra Christian University |                                                             | ✓              |
| Jenny      | Djundjung | jennymd@petra.ac.id | Indonesia | Petra Christian University |                                                             | ✓              |
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|                              |                                                                                                                                                                         |
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| <b>Full Name and Surname</b> | I Nyoman Sutapa and Sutapa                                                                                                                                              |
| <b>Title</b>                 | Prof. <input type="checkbox"/> Assoc.Prof. <input type="checkbox"/> Asst.Prof. <input type="checkbox"/> Dr. X Mr. <input type="checkbox"/> Ms. <input type="checkbox"/> |
| <b>Organisation</b>          | Petra Christian University                                                                                                                                              |
| <b>Address</b>               | Jl. Siwalankerto 121-131                                                                                                                                                |
| <b>Postal code</b>           | 60236                                                                                                                                                                   |
| <b>City</b>                  | Surabaya                                                                                                                                                                |
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| <b>Telephone</b>             | +62-312983435                                                                                                                                                           |
| <b>Fax</b>                   | +62-318417658                                                                                                                                                           |
| <b>E-mail</b>                | mantapa@petra.ac.id                                                                                                                                                     |
| <b>Paper Title</b>           | Fuzzy Inference System to Predict HE Performance                                                                                                                        |
| <b>Authors</b>               | I Nyoman Sutapa, Zeplin Tarigan, Jenny Djundjung, and Jani Rahardjo                                                                                                     |
| <b>Paper Pages</b>           | 5                                                                                                                                                                       |

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Yours Sincerely,

Corresponding Author's Full Name I Nyoman Sutapa

Signature



Date May 15<sup>th</sup>, 2018

## ***Acceptance Notification and Invitation Letter***

2018 International Conference on Energy, Electrical and Power Engineering  
(CEEPE 2018)

Seoul, South Korea

June 15-18, 2018

<http://www.ceepe.net/index.html>

**I Nyoman Sutapa, Zeplin Tarigan, Jenny Djundjung and Jani Rahardjo**

Petra Christian University, Indonesia

Email: mantapa@petra.ac.id; zeplin@petra.ac.id; jennymd@petra.ac.id; jani@petra.ac.id

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Yours sincerely,  
CEEPE Organizing Committees  
May 5, 2018



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# Preparation of Papers for International Journal of Information and Education Technology (IJIET)

First A. Author, Second B. Author, and Third C. Author

**Abstract**—These instructions give you guidelines for preparing papers for the International Journal of Information and Education Technology (IJIET). Use this document as a template if you are using Microsoft Word 6.0 or later. Otherwise, use this document as an instruction set. The electronic file of your paper will be formatted further at Journal of Advances in Computer Networks. Define all symbols used in the abstract. Do not cite references in the abstract. Do not delete the blank line immediately above the abstract; it sets the footnote at the bottom of this column.

**Index Terms**—About four key words or phrases in alphabetical order, separated by commas.

## I. INTRODUCTION

Highlight a section that you want to designate with a certain style, then select the appropriate name on the style menu. The style will adjust your fonts and line spacing. **Do not change the font sizes or line spacing to squeeze more text into a limited number of pages.** Use italics for emphasis; do not underline.

To insert images in *Word*, position the cursor at the insertion point and either use Insert | Picture | From File or copy the image to the Windows clipboard and then Edit | Paste Special | Picture (with “Float over text” unchecked).

JOURNAL OF ADVANCES IN COMPUTER NETWORKS reserves the right to do the final formatting of your paper.

## II. PROCEDURE FOR PAPER SUBMISSION

### A. Review Stage

Submit your manuscript electronically for review.

### B. Final Stage

When you submit your final version, after your paper has

been accepted, prepare it in two-column format, including figures and tables.

### C. Figures

As said, to insert images in Word, position the cursor at the insertion point and either use Insert | Picture | From File or copy the image to the Windows clipboard and then Edit | Paste Special | Picture (with “Float over text” unchecked).

The authors of the accepted manuscripts will be given a copyright form and the form should accompany your final submission.

## III. MATH

If you are using *Word*, use either the Microsoft Equation Editor or the *MathType* add-on (<http://www.mathtype.com>) for equations in your paper (Insert | Object | Create New | Microsoft Equation or *MathType* Equation). “Float over text” should *not* be selected.

## IV. UNITS

Use either SI (MKS) or CGS as primary units. (SI units are strongly encouraged.) English units may be used as secondary units (in parentheses). **This applies to papers in data storage.** For example, write “15 Gb/cm<sup>2</sup> (100 Gb/in<sup>2</sup>).” An exception is when English units are used as identifiers in trade, such as “3½ in disk drive.” Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity in an equation.

The SI unit for magnetic field strength  $H$  is A/m. However, if you wish to use units of T, either refer to magnetic flux density  $B$  or magnetic field strength symbolized as  $\mu_0 H$ . Use the center dot to separate compound units, e.g., “A·m<sup>2</sup>.”

## V. HELPFUL HINTS

### A. Figures and Tables

Because the final formatting of your paper is limited in scale, you need to position figures and tables at the top and bottom of each column. Large figures and tables may span both columns. Place figure captions below the figures; place table titles above the tables. If your figure has two parts, include the labels “(a)” and “(b)” as part of the artwork. Please verify that the figures and tables you mention in the text actually exist. **Do not put borders around the outside of your figures.** Use the abbreviation “Fig.” even at the beginning of a sentence. Do not abbreviate “Table.” Tables

Manuscript received October 9, 2001. (Write the date on which you submitted your paper for review.) This work was supported in part by the U.S. Department of Commerce under Grant BS123456 (sponsor and financial support acknowledgment goes here). Paper titles should be written in uppercase and lowercase letters, not all uppercase. Avoid writing long formulas with subscripts in the title; short formulas that identify the elements are fine (e.g., “Nd–Fe–B”). Do not write “(Invited)” in the title. Full names of authors are preferred in the author field, but are not required. Put a space between authors’ initials.

F. A. Author is with the National Institute of Standards and Technology, Boulder, CO 80305 USA (e-mail: [author@boulder.nist.gov](mailto:author@boulder.nist.gov)).

S. B. Author was with Rice University, Houston, TX 77005 USA. He is now with the Department of Physics, Colorado State University, Fort Collins, CO 80523 USA (e-mail: [author@lamar.colostate.edu](mailto:author@lamar.colostate.edu)).

T. C. Author is with the Electrical Engineering Department, University of Colorado, Boulder, CO 80309 USA, on leave from the National Research Institute for Metals, Tsukuba, Japan (e-mail: [author@nrim.go.jp](mailto:author@nrim.go.jp)).

are numbered with Roman numerals.

Include a note with your final paper indicating that you request color printing. **Do not use color unless it is necessary for the proper interpretation of your figures.**

Figure axis labels are often a source of confusion. Use words rather than symbols. As an example, write the quantity “Magnetization,” or “Magnetization  $M$ ,” not just “ $M$ .” Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write “Magnetization (A/m)” or “Magnetization ( $\text{A} \cdot \text{m}^{-1}$ ),” not just “A/m.” Do not label axes with a ratio of quantities and units. For example, write “Temperature (K),” not “Temperature/K.”

Multipliers can be especially confusing. Write “Magnetization (kA/m)” or “Magnetization ( $10^3 \text{ A/m}$ ).” Do not write “Magnetization ( $\text{A/m}$ )  $\times 1000$ ” because the reader would not know whether the top axis label in Fig. 1 meant 16000 A/m or 0.016 A/m. Figure labels should be legible, approximately 8 to 12 point type.

TABLE I: THE ARRANGEMENT OF CHANNELS

| Channels          | Group 1   | Group 2   | ... | Group $c$   |
|-------------------|-----------|-----------|-----|-------------|
| Main channel      | Channel 1 | Channel 2 | ... | Channel $c$ |
| Assistant channel | Channel 2 | Channel 3 | ... | Channel 1   |

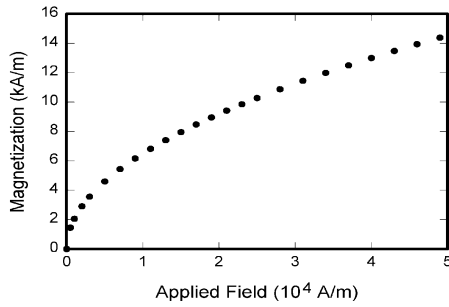


Fig. 1. Magnetization as a function of applied field.

## B. References

Number citations consecutively in square brackets [1]. The sentence punctuation follows the brackets [2]. Multiple references [2], [3] are each numbered with separate brackets [1]–[3]. When citing a section in a book, please give the relevant page numbers [2]. In sentences, refer simply to the reference number, as in [3]. Do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] shows ... .” Number footnotes separately in superscripts (Insert | Footnote).<sup>1</sup> Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes (see Table I).

Please note that the references at the end of this document are in the preferred referencing style. Give all authors’ names; do not use “*et al.*” unless there are six authors or more. Use a space after authors’ initials. Papers that have not been published should be cited as “unpublished” [4]. Papers that have been submitted for publication should be cited as “submitted for publication” [5]. Papers that have been accepted for publication, but not yet specified for an issue

should be cited as “to be published” [6]. Please give affiliations and addresses for private communications [7].

Capitalize only the first word in a paper title, except for proper nouns and element symbols. For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [8].

## C. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have already been defined in the abstract. Abbreviations such as SI, ac, and dc do not have to be defined. Abbreviations that incorporate periods should not have spaces: write “C.N.R.S.,” not “C. N. R. S.” Do not use abbreviations in the title unless they are unavoidable (for example, “JOURNAL OF ADVANCES IN COMPUTER NETWORKS” in the title of this article).

## D. Equations

Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). First use the equation editor to create the equation. Then select the “Equation” markup style. Press the tab key and write the equation number in parentheses. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Use parentheses to avoid ambiguities in denominators. Punctuate equations when they are part of a sentence, as in

$$\int_0^{r_2} F(r, \varphi) dr d\varphi = [\sigma r_2 / (2\mu_0)] \cdot \int_0^\infty \exp(-\lambda |z_j - z_i|) \lambda^{-1} J_1(\lambda r_2) J_0(\lambda r_i) d\lambda. \quad (1)$$

Be sure that the symbols in your equation have been defined before the equation appears or immediately following. Italicize symbols ( $T$  might refer to temperature, but  $T$  is the unit tesla). Refer to “(1),” not “Eq. (1)” or “equation (1),” except at the beginning of a sentence: “Equation (1) is ... .”

## E. Other Recommendations

Use one space after periods and colons. Hyphenate complex modifiers: “zero-field-cooled magnetization.” Avoid dangling participles, such as, “Using (1), the potential was calculated.” [It is not clear who or what used (1).] Write instead, “The potential was calculated by using (1),” or “Using (1), we calculated the potential.”

Use a zero before decimal points: “0.25,” not “.25.” Use “ $\text{cm}^3$ ,” not “cc.” Indicate sample dimensions as “ $0.1 \text{ cm} \times 0.2 \text{ cm}$ ,” not “ $0.1 \times 0.2 \text{ cm}^2$ .” The abbreviation for “seconds” is “s,” not “sec.” Do not mix complete spellings and abbreviations of units: use “ $\text{Wb/m}^2$ ” or “webers per square meter,” not “webers/ $\text{m}^2$ .” When expressing a range of values, write “7 to 9” or “7–9,” not “7~9.”

A parenthetical statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.) In American English, periods and commas are within quotation marks, like “this period.” Other punctuation is “outside”! Avoid contractions; for example, write “do not” instead of “don’t.” The serial comma is preferred: “A, B, and C” instead of “A, B and C.”

<sup>1</sup>It is recommended that footnotes be avoided (except for the unnumbered footnote with the receipt date on the first page). Instead, try to integrate the footnote information into the text.

If you wish, you may write in the first person singular or plural and use the active voice (“I observed that ...” or “We observed that ...” instead of “It was observed that ...”). Remember to check spelling. If your native language is not English, please get a native English-speaking colleague to proofread your paper.

## VI. SOME COMMON MISTAKES

The word “data” is plural, not singular. The subscript for the permeability of vacuum  $\mu_0$  is zero, not a lowercase letter “o.” The term for residual magnetization is “remanence”; the adjective is “remanent”; do not write “remnance” or “remnant.” Use the word “micrometer” instead of “micron.” A graph within a graph is an “inset,” not an “insert.” The word “alternatively” is preferred to the word “alternately” (unless you really mean something that alternates). Use the word “whereas” instead of “while” (unless you are referring to simultaneous events). Do not use the word “essentially” to mean “approximately” or “effectively.” Do not use the word “issue” as a euphemism for “problem.” When compositions are not specified, separate chemical symbols by en-dashes; for example, “NiMn” indicates the intermetallic compound  $\text{Ni}_{0.5}\text{Mn}_{0.5}$  whereas “Ni–Mn” indicates an alloy of some composition  $\text{Ni}_x\text{Mn}_{1-x}$ .

Be aware of the different meanings of the homophones “affect” (usually a verb) and “effect” (usually a noun), “complement” and “compliment,” “discreet” and “discrete,” “principal” (e.g., “principal investigator”) and “principle” (e.g., “principle of measurement”). Do not confuse “imply” and “infer.”

Prefixes such as “non,” “sub,” “micro,” “multi,” and “ultra” are not independent words; they should be joined to the words they modify, usually without a hyphen. There is no period after the “et” in the Latin abbreviation “*et al.*” (it is also italicized). The abbreviation “i.e.,” means “that is,” and the abbreviation “e.g.,” means “for example” (these abbreviations are not italicized).

An excellent style manual and source of information for science writers is [9].

## VII. EDITORIAL POLICY

The submitting author is responsible for obtaining agreement of all coauthors and any consent required from sponsors before submitting a paper. It is the obligation of the authors to cite relevant prior work.

Authors of rejected papers may revise and resubmit them to the journal again.

## VIII. PUBLICATION PRINCIPLES

The contents of the journal are peer-reviewed and archival. The journal *Journal of Advances in Computer Networks* publishes scholarly articles of archival value as well as tutorial expositions and critical reviews of classical subjects and topics of current interest.

Authors should consider the following points:

- 1) Technical papers submitted for publication must advance the state of knowledge and must cite relevant

prior work.

- 2) The length of a submitted paper should be commensurate with the importance, or appropriate to the complexity, of the work. For example, an obvious extension of previously published work might not be appropriate for publication or might be adequately treated in just a few pages.
- 3) Authors must convince both peer reviewers and the editors of the scientific and technical merit of a paper; the standards of proof are higher when extraordinary or unexpected results are reported.
- 4) Because replication is required for scientific progress, papers submitted for publication must provide sufficient information to allow readers to perform similar experiments or calculations and use the reported results. Although not everything need be disclosed, a paper must contain new, useable, and fully described information. For example, a specimen's chemical composition need not be reported if the main purpose of a paper is to introduce a new measurement technique. Authors should expect to be challenged by reviewers if the results are not supported by adequate data and critical details.

## IX. CONCLUSION

A conclusion section is usually required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

## APPENDIX

Appendixes, if needed, appear before the acknowledgment.

## ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments. Avoid expressions such as “One of us (S.B.A.) would like to thank ... .” Instead, write “F. A. Author thanks ... .” **Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page.**

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# Fuzzy Inference System to Predict HE Performance

I N Sutapa, Z J H Tarigan, J Mochtar, and J Rahardjo

**Abstract**—The article discusses a methods to predict Higher Education (HE) performance based on four perspectives of Balanced Scorecards. The relationship model among perspectives to the performance was developed using fuzzy inference system. There are 12 predictors variable are developed as Key Performance Indicator's of BSC. The expert were chosen from qualified national assessor to evaluate the membership function of the predictive variable, and to develop the inference rules from predictor variable to output variable. Based on confirmation and validation model design to the expert, the model can be used to predict the HE's performance.

## I INTRODUCTION

On a tight competition of HE, it needs to develop a well planned actions to win the competition. One of the input needed to create action plan is understanding the future performance of the system. To understand it, HE needs a performance measurement tools which can be used to predict the future performance. There are various methods to predict the performance of the system, one of the methods is expert judgements [1]. Knowledge and experience of the expert can help HE to establish key performance measures that have a significant impact on their performance. Expert judgment also can help HE to evaluate the influence relationship among key performance measurements, and finally to predict future performance [2]. On the other hand, in reality most information and expert knowledge are not expressed in exact data, but in subjective qualitative data [3].

This article discusses HE performance predictions using experience and expert knowledge. The expert was choosen from experienced education managers and qualified education assessors. Based on their experience in managing education and assessing various aspects of education. Furthermore, we translate their expertise in determining key performance measures into variables and fuzzy sets. Then, translate the relationship of influence between measurements in shaping the overall HE performance, using a fuzzy inference system. The resulting model is used to control and predict the performance of HE in the future.

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## II BALANCED SCORECARD AND THE MEASUREMENT

### A. Balanced Scorecards

Balanced Scorecard (BSC) is a tool to structure measures from four perspectives, giving a top management a comprehensive view of the business, short-term and long-term, financial and non-financial, as well as current and

future to formulate vision and strategy. Its focus is on how to link the measures with strategic activities from finance, customer, internal business process and learning and growth perspectives [4]. It is asumed that there is a causal relationship between the four perspectives in translating the company's vision and strategy into action

### B Measurement Framework

In order to translate vision and strategy, objectives and targets are set and the measures and initiatives are designed and aligned by the nominal group techniques. Herein, the designed measures and aligned initiatives interrelate each other in a relation called horizontal linkage. In this paper, we attempt to present a suggestion of a measurement system based on BSC with introducing fuzzy inference [5, 6]. The relations among measures of each perspective consist of as the followings. In order to improve internal process continuously, HE are required to maintenance and improve the learning and growth of human resources and infrastucture. For doing this, HE need to measure lecturers competence, ICT and laboratory capability. The inisiatives to improve lecturers competence are training and expereiening of teaching, researching, and industry services. To improve ICT and Lab capability, HE need to adopt the latest hard and soft technology. The measurement for internal business process to improve student, society, and government satisfaction are improvement for learning process, research, and industry services processes. To do these, the inisiatives of HE i.e. update curricullum follow the market and science and technology development, monitoring and evaluating learning process, research, industry services regularly, and develop collaboration with reputation university and industry to do teaching, research and consulting services. To support HE's financial, customer perspective i.e. student, society, and government's satisfaction must be improved. The initiatives of these measurement are control and monitoring the student saisfaction index, HE accreditation by government, and industry recognition. Finally, the measures for financial perspective are student tuition fee, government funding/grants, and industry funding/grant. The initiatives are increase the size of student, increase the research quality, and improve consultancy services and number of patents for the industry. The following (figure 1) presents the BSC strategy map constructed from the causal relationship of all measures.

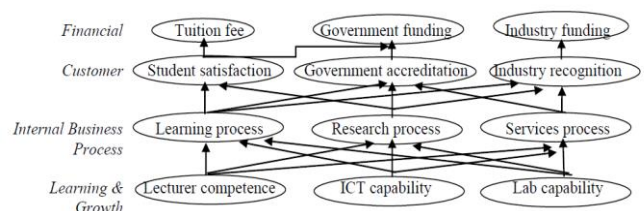


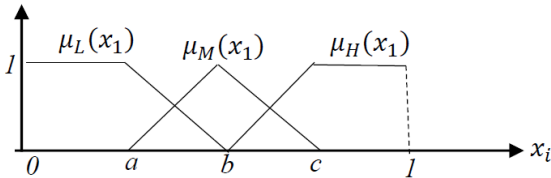
Figure 1. HE's Strategic Map

### III. FUZZY INFERENCE SYSTEM TO PREDICT HE'S PERFORMANCE

Fuzzy inference system (FIS) is the actual process of mapping from a given input to an output using fuzzy logic. In this research, the inputs are measurement of each BSC perspective and the output is HE's performance. In terms of the inference process, there are two main types of FIS, i.e. the Mamdani type [7] and the Sugeno type [8]. In this research, we used Mamdani fuzzy methods as a FIS, this methods is more widely used mostly because of the reasonable results with a relatively simple structure it provides, and the intuitive interpretable nature of the rule base [9, 10]. There are 6 steps for Mamdani FIS model: (1) Determining a set of fuzzy IF-THEN rules, (2) Fuzzifying the inputs using the input membership functions, (3) Combining the fuzzified inputs according to the fuzzy rules to establish a rule strength (Fuzzy Operations), (4) Finding the consequence of the rule by combining the rule strength and the output membership function (implication), (5) Combining the consequences to get an output distribution (aggregation), and (6) Defuzzifying the output distribution (this step is only if a crisp output (class) is needed).

#### A. Membership Functions

Each of BSC perspective measurement is defined as a fuzzy variable, and its value is defined as "Low", "Medium", and "High" fuzzy set. Membership function for each fuzzy set was formulated by four experts. Following are the membership function of "Low", "Medium", and "High" fuzzy set for each measurement after normalized on [0, 1] interval. For HE's performance is used 5 fuzzy sets, i.e. "Very Low", "Low", "Medium", "High", "Very High" fuzzy set, with membership function also formulated by four assessors as expert. Each membership function for "Low" and "High" is approximated by trapezoidal function ( $tz(\cdot, \cdot, \cdot)$ ) and "Medium" fuzzy set is approximated by triangular function ( $ta(\cdot, \cdot, \cdot)$ ).



**Figure 2.** Membership Function of Fuzzy Set "Low", "Medium", and "High"

Where membership function for "Low", "Medium", and "High" are formulated by

$$\begin{aligned} \mu_L(x_i) &= tz(0, 0, a, b) = \begin{cases} 1 & 0 \leq x_i < a \\ \frac{b-x_i}{b-a} & a \leq x_i < b \end{cases} \text{ and} \\ \mu_H(x_i) &= tz(b, c, 1, 1) = \begin{cases} \frac{x_i-b}{c-b} & b \leq x_i < c \\ 1 & c \leq x_i \leq 1 \end{cases} \\ \mu_M(x_i) &= ta(a, b, c) = \begin{cases} \frac{x_i-a}{b-a} & a \leq x_i < b \\ \frac{c-x_i}{c-b} & b \leq x_i < c \end{cases} \end{aligned} \quad (1)$$

Table 1 presents the "Low", "Medium", and "High" fuzzy membership functions for 12 fuzzy variables to measure four BSC perspectives, as well as the fuzzy membership function set for HE's performance. The determination of the values of  $a$ ,  $b$ , and  $c$  of each fuzzy membership function for each fuzzy variable is determined from the average fuzzy membership based on the opinion of all experts. In the table 4, the values  $a$ ,  $b$ , and  $c$  are displayed after normalization in the interval [0, 1].

#### B. Fuzzy Rules and Fuzzy Inference System

Fuzzy rules are core of the fuzzy inference system. Fuzzy inference rules for performance measurement are based on the knowledge and experience of the expert or assessor. We used If-Then type fuzzy rules to converts the fuzzy input to the fuzzy output. From HE's strategic map (figure 1) we derived 1080 rules (presented at table 2), resulted from 24 paths of measurement of learning and growth perspective until financial perspective and finally to the HE's performance, where each path has 45 rules.

In this fuzzy inference, we used MAX-MIN composition to transform inputs fuzzy to output fuzzy. Aggregation of all fuzzy rules using MIN operator, was obtained a combined fuzzy set with minimal value, which is a combination of all fuzzy sets, results of fuzzy reasoning from each fuzzy rule. Below (figure 3) is the result of a part of aggregation of fuzzy inference, that is calculation result of one reasoning path (45 rules), from variable fuzzy  $x_1$  lecturer competence,  $x_4$  learning process,  $x_7$  student satisfaction, and  $x_{10}$  student tuition fee. For example, IF the lecturer competence is Low (crisp value is 0.6) AND learning process is Low (0.5) AND student satisfaction is Medium (0.7) AND tuition fee is Medium (0.7) THEN HE's performance is approaching Medium (crisp value is 0.414).

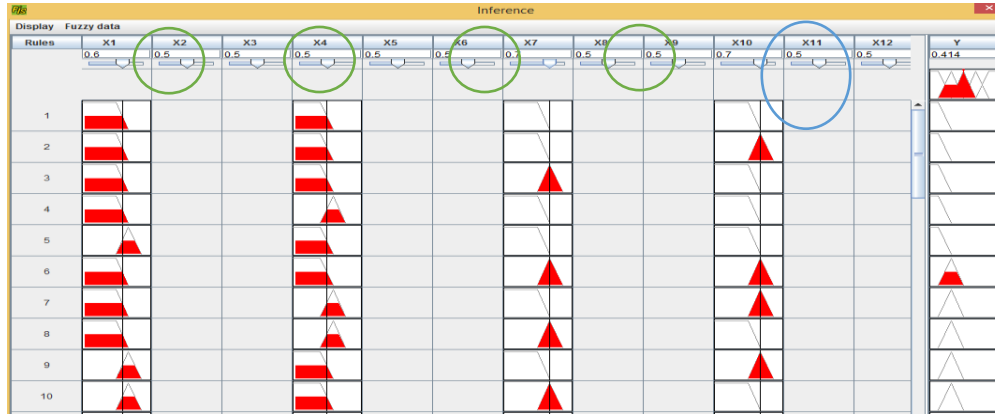
**Table 1.** Membership Function for Fuzzy Set Low, Medium, and High (Normalized)

| Fuzzy Variable                   | Membership Function of Fuzzy Set   |                                  |                                    |
|----------------------------------|------------------------------------|----------------------------------|------------------------------------|
|                                  | Low                                | Medium                           | High                               |
| Lecturer competent ( $X_1$ )     | $\mu_L(x_1) = tz(0, 0, .5, .7)$    | $\mu_M(x_1) = ta(.5, .7, .9)$    | $\mu_H(x_1) = tz(.7, .9, 1, 1)$    |
| ICT capability ( $X_2$ )         | $\mu_L(x_2) = tz(0, 0, .4, .6)$    | $\mu_M(x_2) = ta(.4, .6, .8)$    | $\mu_H(x_2) = tz(.6, .8, 1, 1)$    |
| Lab capability ( $X_3$ )         | $\mu_L(x_3) = tz(0, 0, .3, .5)$    | $\mu_M(x_3) = ta(.3, .5, .7)$    | $\mu_H(x_3) = tz(.5, .7, 1, 1)$    |
| Learning process ( $X_4$ )       | $\mu_L(x_4) = tz(0, 0, .4, .6)$    | $\mu_M(x_4) = ta(.4, .6, .8)$    | $\mu_H(x_4) = tz(.6, .8, 1, 1)$    |
| Research process ( $X_5$ )       | $\mu_L(x_5) = tz(0, 0, .4, .6)$    | $\mu_M(x_5) = ta(.4, .6, .8)$    | $\mu_H(x_5) = tz(.6, .8, 1, 1)$    |
| Services process ( $X_6$ )       | $\mu_L(x_6) = tz(0, 0, .3, .6)$    | $\mu_M(x_6) = ta(.3, .6, .9)$    | $\mu_H(x_6) = tz(.6, .9, 1, 1)$    |
| Student satisfaction ( $X_7$ )   | $\mu_L(x_7) = tz(0, 0, .5, .7)$    | $\mu_M(x_7) = ta(.5, .7, .9)$    | $\mu_H(x_7) = tz(.7, .9, 1, 1)$    |
| Gov. accreditation ( $X_8$ )     | $\mu_L(x_8) = tz(0, 0, .4, .6)$    | $\mu_M(x_8) = ta(.4, .6, .8)$    | $\mu_H(x_8) = tz(.6, .8, 1, 1)$    |
| Industry recognition ( $X_9$ )   | $\mu_L(x_9) = tz(0, 0, .3, .5)$    | $\mu_M(x_9) = ta(.3, .5, .7)$    | $\mu_H(x_9) = tz(.5, .7, 1, 1)$    |
| Student tuition fee ( $X_{10}$ ) | $\mu_L(x_{10}) = tz(0, 0, .5, .7)$ | $\mu_M(x_{10}) = ta(.5, .7, .9)$ | $\mu_H(x_{10}) = tz(.7, .9, 1, 1)$ |
| Gov. funding ( $X_{11}$ )        | $\mu_L(x_{11}) = tz(0, 0, .4, .6)$ | $\mu_M(x_{11}) = ta(.4, .6, .8)$ | $\mu_H(x_{11}) = tz(.6, .8, 1, 1)$ |

|                               |                                    |                                  |                                    |
|-------------------------------|------------------------------------|----------------------------------|------------------------------------|
| Industry funding ( $X_{12}$ ) | $\mu_L(x_{12}) = tz(0, 0, .3, .5)$ | $\mu_M(x_{12}) = ta(.3, .5, .7)$ | $\mu_H(x_{12}) = tz(.5, .7, 1, 1)$ |
| HE's Performance (Y)          | Very Low                           | Low                              | High                               |
|                               | $\mu_{VL}(y)$                      | $\mu_L(y)$                       | $\mu_H(y)$                         |
|                               | $= tz(0, 0, .1, .3)$               | $= ta(.1, .3, .5)$               | $= tz(.7, .9, 1, 1)$               |

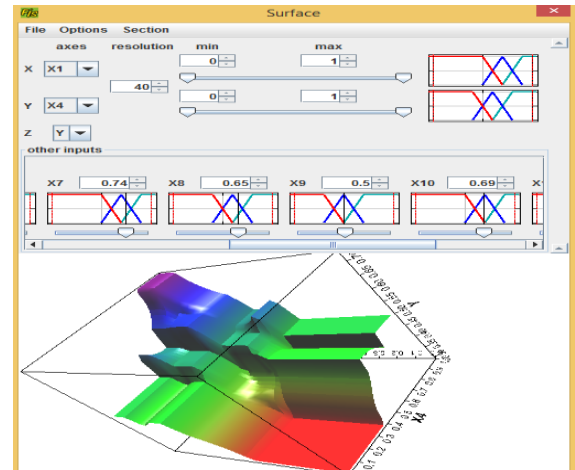
**Table 2.** Fuzzy Inferences

| Rules      | Inference                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------|
| $R_1$      | IF $x_1$ is $\mu_L(x_1)$ AND $x_4$ is $\mu_L(x_4)$ AND $x_7$ is $\mu_L(x_7)$ AND $x_{10}$ is $\mu_L(x_{10})$ THEN $y$ is $\mu_{VL}(y)$ |
| $R_2$      | IF $x_1$ is $\mu_L(x_1)$ AND $x_4$ is $\mu_L(x_4)$ AND $x_7$ is $\mu_L(x_7)$ AND $x_{10}$ is $\mu_M(x_{10})$ THEN $y$ is $\mu_{VL}(y)$ |
| $\vdots$   | $\vdots$                                                                                                                               |
| $R_5$      | IF $x_1$ is $\mu_M(x_1)$ AND $x_4$ is $\mu_L(x_4)$ AND $x_7$ is $\mu_L(x_7)$ AND $x_{10}$ is $\mu_L(x_{10})$ THEN $y$ is $\mu_{VL}(y)$ |
| $R_6$      | IF $x_1$ is $\mu_M(x_1)$ AND $x_4$ is $\mu_M(x_4)$ AND $x_7$ is $\mu_L(x_7)$ AND $x_{10}$ is $\mu_L(x_{10})$ THEN $y$ is $\mu_L(y)$    |
| $R_7$      | IF $x_1$ is $\mu_M(x_1)$ AND $x_4$ is $\mu_L(x_4)$ AND $x_7$ is $\mu_M(x_7)$ AND $x_{10}$ is $\mu_L(x_{10})$ THEN $y$ is $\mu_L(y)$    |
| $\vdots$   | $\vdots$                                                                                                                               |
| $\vdots$   | $\vdots$                                                                                                                               |
| $R_{19}$   | IF $x_1$ is $\mu_M(x_1)$ AND $x_4$ is $\mu_M(x_4)$ AND $x_7$ is $\mu_M(x_7)$ AND $x_{10}$ is $\mu_H(x_{10})$ THEN $y$ is $\mu_M(y)$    |
| $R_{20}$   | IF $x_1$ is $\mu_H(x_1)$ AND $x_4$ is $\mu_H(x_4)$ AND $x_7$ is $\mu_M(x_7)$ AND $x_{10}$ is $\mu_M(x_{10})$ THEN $y$ is $\mu_H(y)$    |
| $\vdots$   | $\vdots$                                                                                                                               |
| $R_{45}$   | IF $x_1$ is $\mu_H(x_1)$ AND $x_4$ is $\mu_H(x_4)$ AND $x_7$ is $\mu_H(x_7)$ AND $x_{10}$ is $\mu_H(x_{10})$ THEN $y$ is $\mu_{VH}(y)$ |
| $\vdots$   | $\vdots$                                                                                                                               |
| $R_{1080}$ | IF $x_3$ is $\mu_H(x_3)$ AND $x_6$ is $\mu_H(x_6)$ AND $x_9$ is $\mu_H(x_9)$ AND $x_{12}$ is $\mu_H(x_{12})$ THEN $y$ is $\mu_{VH}(y)$ |

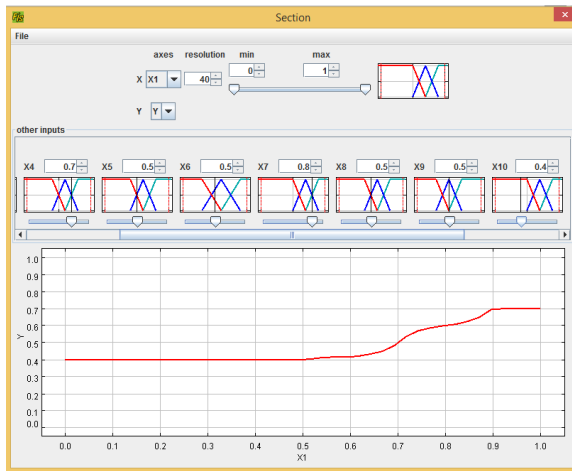


**Figure 3.** Aggregation of all Fuzzy Inference

HE's performance predictions can be observed from 3D visualizations, such as figure 4. If student satisfaction  $x_7$  and student tuition fee  $x_{10}$  are retained in medium positions, then the impact of lecturer competence  $x_1$  and learning process  $x_4$  on HE's performance can be predicted, in the following visual example, increasing on the lecturer competence  $x_1$  and learning process  $x_4$  has effect on increasing of HE's performance. The same observation can also be done on the other variables easily, just replace which variables will be observed and which are retained fixed. Similarly, if we want to observe changes in HE's performance by one predictor variable, by holding three other predictor variables, we can observe in 2D visualization, as seen in figure 5.



**Figure 4.** HE's performance prediction in 3D



**Figure 5.** HE's performance prediction in 2D

Based on confirmation and validation with the leadership of an HE, this model can predict well the performance of HE.

#### IV. CONCLUSION

Fuzzy inference system that has been developed, able to predict HE performance based on value changes on the measurement of 4 BSC perspectives. When detected a decrease in HE performance, it can be done early anticipation to make improvements. The measurement value used as input in this study, can be a qualitative assessment expressed in words, do not have to wait for reports in quantitative data. This system can also be used as a monitoring tool for HE performance, if there are changes in measurement values in some perspectives. This study has limitations, including not considering the weight of each rule and the existence of the path of two-way influence between BSC perspectives. This limitation can be an opportunity for future research. And to be more comprehensive, it can be combined with quantitative measurements.

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