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Support System In Determining Final Evaluation Supervisor And Examiner With Best Worst Method

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ABSTRACT

Final evaluation is a scientific work that is a requirement for students of the Politeknik Negeri Pontianak (Polnep) Business Administration Major to obtain an academic degree. As the person in charge of a final evaluation, supervisors and examiners have an important role in ensuring students are able to create a qualified final evaluation. Therefore, the diversity of titles and fields of final evaluation proposed by students needs to be combined with lecturers who have synchronized scientific disciplines and experiences. The manual determination of supervisors and examiners has the opportunity to be affiliated with subjective factors. The support system, which can essentially be used as a guide, explanation and reinforcement of a decision, has the opportunity to eliminate subjective factors that arise during decision making. The design of the support system was carried out based on five criteria that were calculated with a multi-criteria decision-making method, namely the Best Worst Method (BWM). Based on the results of system testing with 40 lecturer data and 231 student final evaluation proposal data, the support system could recommend supervisors and examiners that were in accordance with the student's proposed final evaluation field.

1. Introduction

Digitalization and automation are becoming a world development trend, especially in the field of information and communication technology. Not only structured problems that are touched by digitization and automation, semi-structured and unstructured problems have begun to be touched with various mathematical theories and methods in order to achieve digitization and automation.

One of the semi-structured problems faced by the Polnep Business Administration Major is the determination of final evaluation supervisors and examiners. The current method of determining supervisors and examiners is more likely to be based on the habits, experience and personal knowledge of the lecturer that assigned as the coordinator of the Final Evaluation. If there is improvement in the capability of a lecturer, whether it was done independently or financed by an institution, will be missed by Final Evaluation coordinator due to the non-disclosure of these data. Whereas collecting data and information from various sources will assist someone in making decisions [1]. As a result, students have the opportunity to obtain supervisors and examiners whose capabilities do not match the proposed title.

For rendering the precise determination of final evaluation supervisors and examiners, and eliminating subjective factors from within the final evaluation coordinator, a system that works based on mathematical theory or methods is needed to produce calculations that can be a guide, explanation and reinforcement of a decision. The theory or mathematical method uses a number of criterias as parameters, assigns weight to the criteria and calculates the result of the criteria weighting as a source of decision making.

Determining the weight of a criteria is one of the key problems that arise during multi-criteria analysis. The objectivity of criteria weighting will greatly affect the results of the decision-making process. Likewise with the important issue of selecting an uncomplicated mathematical method in decision-making process [2].

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In a similar research, namely the determination of the thesis supervisor [3], the WP method was used to weight the criteria of topic suitability, availability of assistance schedules, ability to train, ability to communicate in foreign languages, assisting by providing references, attention, consequences, length of assistance, teamwork, and ease of scoring. Another use of the WP method that was combined with a comparison algorithm between student final evaluation titles and lecturer research titles, namely the Winnowing algorithm [4], calculated the criteria of research titles that had been carried out by lecturers, lecturer's functional groups, majors, guidance quota, functional positions and workload as weighting parameters.

In addition to the use of the Weighted Product (WP) method as a mathematical method in a decision support system, the use of fuzzy logic methods, AHP methods and the combination of fuzzy logic with AHP are methods that are often used to support multi-criteria problem solving, especially the determination of supervisors. This can be seen in the research on the determination of the thesis/dissertation supervisor, which uses a combination of fuzzy logic with AHP [5]. The relevance of the lecturer's research area, track record of publications, obtaining research grants and collaboration records were used as criteria for determining supervisors.

Research that uses the AHP method singly [6], [7], criteria for education level, educational background, status of lecturers in employment, suitability of lecturer's expertise, mentoring experience, functional positions and research fields were the benchmarks for ranking supervisors. While in research that uses the fuzzy logic method [8], the results of supervisor determination using the criteria of the lecturer's expertise, the student's Grade Point Average (GPA), lecturer's supervision burden, the average duration of time for students to complete their final evaluation and the average score of the supervised student's final evaluation, showed a conformity rate of 87% with the determination of the supervisor manually.

A number of mathematical method implementations in supporting the resolution of multi-criteria problems, especially the determination of supervisors showed more objective results than the manual selection of supervisors. However, along with the continuous development of mathematical methods, a number of new mathematical methods were published which emphasized their superiority compared to previous mathematical methods. One of the theories or mathematical methods that confirmed it is the Best Worst Method (BWM). BWM displayed a better consistency ratio than AHP and other evaluation criteria [9].

Research on selecting the best smartphone to support academic activities is one of the studies that uses BWM. As a mathematical method that is also used to support solving multi-criteria problems, BWM was used to calculate the optimal weight of smartphone criteria, namely price, camera, battery, chipset, screen size, RAM, ROM and screen resolution. The results showed that the BWM method can be used as a decision-making method for similar problems and other problems [10], such as risk management [11] and innovation management [12]. Based on a number of researches that have the same topic, fuzzy AHP, WP method, fuzzy logic, AHP or BWM, can be used to support multi criteria decision making problems. The purpose of this research was to design a decision support system using one of the latest multi criteria decision making methods, namely BWM in determining the final evaluation supervisor and examiner for the Polnep Business Administration Major's students.

Decision Support System, An organization has various types of decisions that must be conducted, namely decisions for structured to unstructured problems. Decisions for structured problems often occur and usually relate to what the problem is. Decisions for structured problems are good candidates for automation and do not usually use a decision support system to build them. Decision support systems work very well for semi-structured problems. Semi-structured problems already have a number of factors that are needed in solving them, but human and other external experiences may still influence the solution [13], [14].

Pada umumnya terdapat 2 model dalam kontruksi pengambilan keputusan yaitu phase model dan stream model. In general, there are 2 models in the construction of decision making, namely the phase model and the stream model. The phase model distinguishes a number of stages in decision making, such as policy formation, policy adoption and policy implementation. While the stream model describes decision making as a combination of problems, solutions, and implementation that run simultaneously [15]. The decision-making process as described by Herbert Simon, has three phases, namely the understanding phase, the design phase and the selection phase. In the understanding phase, the decision maker collects facts, assumptions and ideas. In the design phase, method that uses data begin to be designed. The method deals with techniques, formulas, models and other tools that systematically reduce alternatives to a controllable number. In the selection phase, the decision maker makes a selection based on the results of the design phase [16].

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2. Research Method

The research was conducted at Polnep Business Administration Major with the following systematics

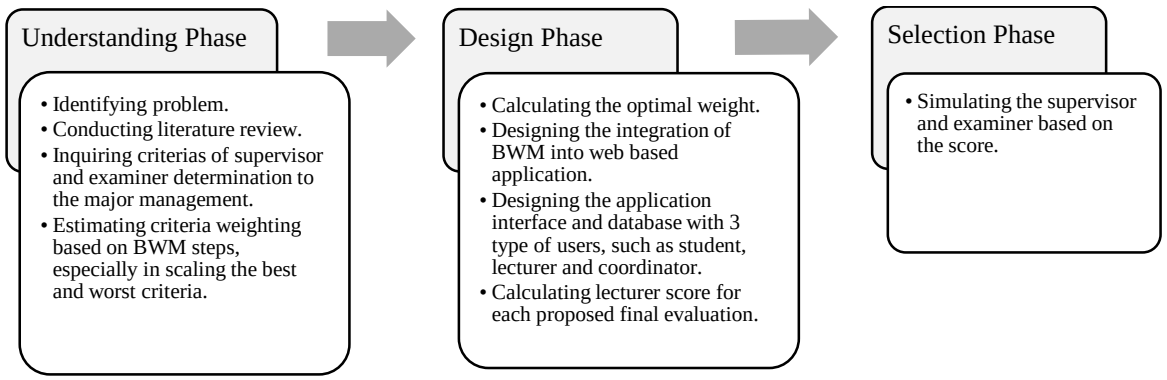

Figure 1. Research Flow

2.1 Understanding Phase

In this phase, researchers identified problems that often occured when determining final evaluation supervisors and examiners. Based on this identification, a decision support system was needed to be a guide, explanation and reinforcement for the final evaluation coordinator in determining supervisors and examiners. The researchers determined the Best Worst Method (BWM) as the multi criteria based problem solving method. Although it was dominated by the Analytical Hierarchy Process (AHP) method for similar problems. This selection was based on research by Rezaei (2015) which confirmed that BWM displayed a better consistency ratio than AHP and other evaluation criteria. BWM also had less comparison data and produced reliable calculations along with better comparison consistency. The next activity from this phase was asking and discussing with the major management about the criteria (weight included) that would be used in determining the final evaluation supervisor and examiners.

2.2 Designing Phase

The results of understanding phase were followed by calculating the optimal weight of criteria using BWM Solver as the basis of solving mathematical equations. BWM Solver was built with Simplex Linear Programming approach. Next, the researchers designed the optimal weight integration flow of the criteria into the application, grouped the lecturer data on these criteria and determined the maximum and minimum scores for meeting the criteria. In this phase, the interface and database application design were also carried out which included three type of users, such as student, lecturer and final evaluation coordinator. The application features for student and lecturer were used to collect the data that needed to calculate the suitability score of a lecturer's competence against student's proposed final evaluation field.

2.3 Selection Phase

Unlike the application feature for students and lecturers, the coordinator feature had a simulation feature for determining the final evaluation supervisor and examiner. The simulation would calculate the weight of the lecturer's competence by multiplying the optimal weight of the criteria with the initial score of lecturer's competence data. Lecturer with the highest competency weight against student's proposed final evaluation field, will be suggested to the coordinator.

3. Results and Discussion

3.1 Calculation with Best Worst Method

Solving the problem of determining supervisors and examiners was carried out in several stages, starting from determining and weighing criterias, determining scores and ending with determining lecturers based on the highest score or best performance.

1. Criteria Determination and Weighting
   Based on discussions held with the major management, the following criterias had been set as the basis for calculating lecturer scores

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TABLE 1
CRITERIAS

No	Criteria	Symbol
1	educational qualification	K1
2	certificate of expertise	K2
3	mastered research method	K3
4	teaching / practitioner experience	K4
5	homebase	K5

Furthermore, the weighting of the criteria was carried out by following the BWM rules, such as determining the best and worst criteria and giving a preference rating for the best criteria against other criteria (Best to Others) and evaluating the preferences of other criteria against the worst criteria (Others to Worst). The results of determining the best and worst criteria and the weighting of the criterias based on the instruction of the major management were as follows

TABLE 2
CRITERIA WEIGHTING

	K1	K2	K3	K4	K5
Best to Others (K1)	1	2	3	4	8
Others to Worst (K5)	8	6	5	4	1

After criteria weighting, the calculation for the optimal weight of the criteria (w*) was carried out using the BWM converted min max linear model. The following is the result of the calculation

TABLE 3
CRITERIA OPTIMAL WEIGHT

	K1	K2	K3	K4	K5
Optimal Weight (w*)	0,425	0,244	0,163	0,122	0,045

The consistency ratio resulting from the calculation of the criteria optimal weight is 0.06. The consistency ratio got closer to 0, indicating the comparison/weighting of the criteria had been done consistently and would have more reliable effect on each calculation.

2. Scoring
   The meaning of score was the value of competence mastered by a lecturer. The lecturer conducted a self-assessment of the competencies possessed and was entered into the system. The following is a table of scores.

TABLE 4
SCORING

Criteria	Requirement	Reference	Score
educational qualification	appropriate	1 area of competence	100
	inappropriate		0
certificate of expertise	appropriate	>1 area of competence	100
	inappropriate		0
mastered research method	mastered	qualitative quantitative	100
	unmastered		0
teaching / practitioner experience	> 3 years	>1 area of competence	100
	< 3 years	>1 area of competence	50
	0 year		0
Homebase	onsite	AB ABO AN	100
	offsite		0

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Lecturer could enter more than 1 field of competence for certificate of expertise and teaching / practitioner experience. As for the educational qualification criteria, lecturer could only enter 1 field of competence that corresponded to the lecturer's latest educational competence. The more areas of competence that were entered, the wider scope of proposed final evaluation area that could be supervised and examined. Another criterion that used a reference outside the field of competence was the mastered research method and homebase. Lecturer could choose more than 1 research method but could only choose 1 homebase.

3. Lecturer Determination

   The stages of determining lecturer in accordance with student's proposed final evaluation field were as follows

   a) Based on the results of lecturer competency self assessment, the following matrix contained the lecturer's performance which will be used against student's proposed final evaluation field.

$$P = \begin{array}{c} \\ Lecturer\ 1 \\ Lecturer\ 2 \\ \vdots \\ Lecturer\ 40 \end{array} \begin{array}{c} \begin{array}{ccccc} K1 & K2 & K3 & K4 & K5 \end{array} \\ \begin{pmatrix} 100 & 100 & 0 & 50 & 100 \\ 100 & 0 & 100 & 0 & 100 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 50 & 100 \end{pmatrix} \end{array}$$

   b) Furthermore, the criteria optimal weight (shown on table 3) was used as a multiplier factor.

$$w = \{0{,}425, 0{,}244, 0{,}163, 0{,}122, 0{,}045\}$$

   c) The final score of each lecturer was obtained from the sum of multiplication between each lecturer scores based on criteria with criteria optimal weight.

$$S_i = \sum_{j=1}^{n} w_i P_{ij} \qquad (4)$$

$$S_1 = (100 \times 0{,}425) + (100 \times 0{,}244) + (0 \times 0{,}163) + (50 \times 0{,}122) + (100 \times 0{,}045) = 77{,}5$$

$$S_2 = (100 \times 0{,}425) + (0 \times 0{,}244) + (100 \times 0{,}163) + (0 \times 0{,}122) + (100 \times 0{,}045) = 62{,}8$$

$$\boldsymbol{S_{40} = (0 \times 0{,}425) + (0 \times 0{,}244) + (0 \times 0{,}163) + (50 \times 0{,}122) + (100 \times 0{,}045) = 10{,}1}$$

3.2 Business Process

Broadly speaking, the decision support system business processes were as follows

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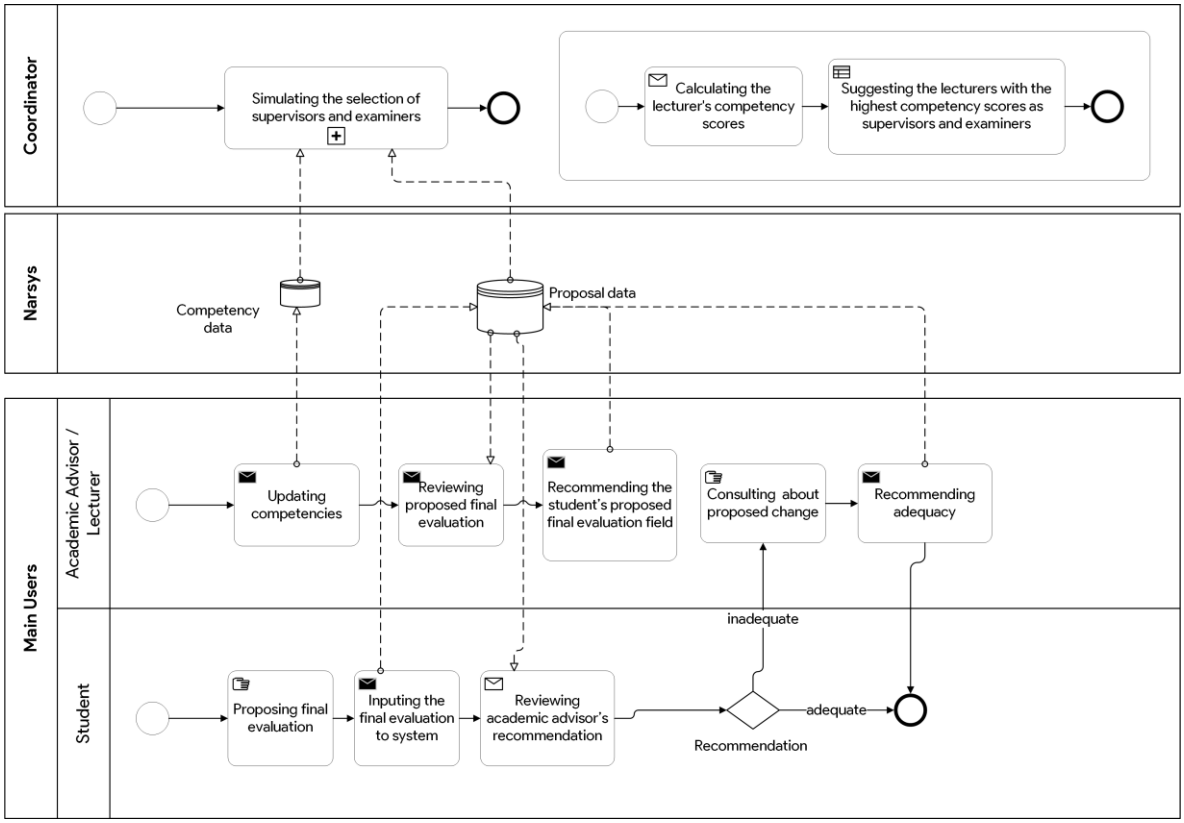

Figure 2. Business Process

First of all, Student consults manually with the academic advisor regarding the title of final evaluation. After consulting, student enters the title of final evaluation which has also been completed with a summary of the proposal into the system. Along with the opening of the final evaluation submission period, academic advisor can update competency data and review proposed final evaluations that have been entered by students. The academic advisor will suggest recommended field that is in accordance with the student's proposed final evaluation. The recommended field refers to the competency field that a lecturer can choose at the time of updating the competency data. Recommended field is the key to determine the supervisors and examiners. Then if the academic advisor gives a recommendation for the inadequacy of the proposed final evaluation, the student must consult about proposed change with the academic advisor to obtain a feasibility recommendation.

After all student's proposed final evaluation have received recommendations for the appropriate fields, the coordinator will simulate the selection of supervisors and examiners by calculating the lecturer's competency scores and suggesting the lecturers with the highest competency scores as supervisors and examiners. The placement of lecturers who are recommended as supervisors or examiners will run automatically based on the student's proposed final evaluation. If there is the same score, the placement will be based on the year the lecturer was accepted as a civil servant. The lecturer placement algorithm has automatically been set in such a way that there is no similarity in the name of the lecturer for each proposal.

3.3 Prototype

The Technology Readiness Level of the proposed research is at the programmatic feasibility level of demonstrated software technology and implementation of laboratory prototypes with full-scale realistic problems. The following are the main features for system users, which are divided into 3 users, such as student, lecturer and coordinator.

1. Student Feature

   The student feature has the main features of title and proposal summary input. The results of the input will be reviewed by the academic advisor.

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Figure 3. Student Feature

2. Lecturer Feature

The lecturer feature has the main features of updating lecturer's competencies and recommending the student's proposed final evaluation field.

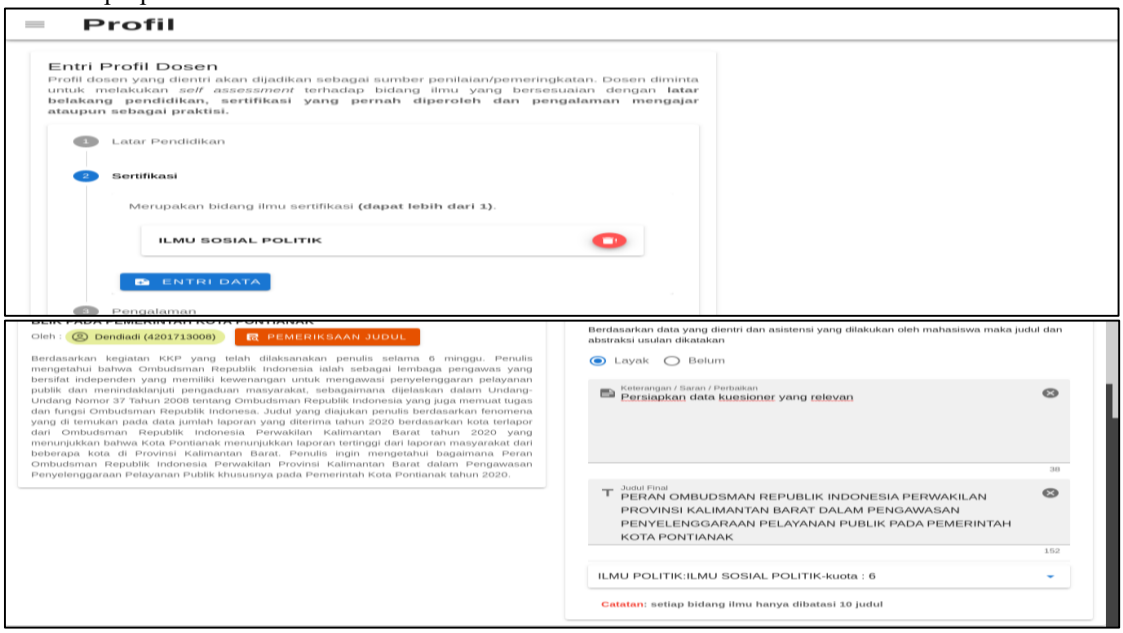

Figure 4. Lecturer Feature

3. Coordinator Feature

The coordinator feature has the main feature of simulating the supervisors and examiners for student's proposed final evaluation.

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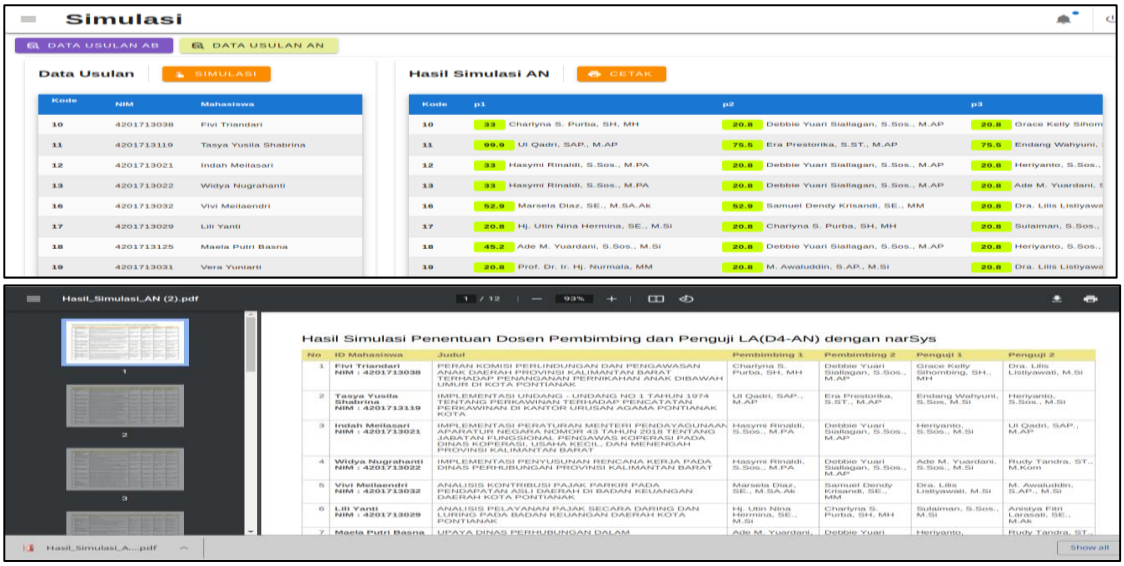

Figure 5. Coordinator Feature

4. Conclusion

The criterias used to determine the final evaluation supervisors and examiners are educational qualification, certificate of expertise, mastered research method, teaching / practitioner experience and homebase. Based on the tests conducted on 40 lecturer data and 231 student final evaluation proposal data, the support system could recommend for supervisors and examiners that were in accordance with the student's proposed final evaluation field. Decision making based on a lecturer's competency score becomes more objective.

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