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INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION journal homepage : www.joiv.org/index.php/joiv INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION The Implementation of SAW and BORDA Method to Determine the Eligibility of Students' Final Project Topic Dwiny Meidelfia*, Yulherniwatia, Fanni Sukmaa, Dikky Chandrab, Anna Hendri Soleliza Jonesc a Department of Information Technology, Politeknik Negeri Padang, Limau Manis, Padang, 25164, Indonesia b Department of Electronics Engineering, Politeknik Negeri Padang, Limau Manis, Padang, 25164, Indonesia c Department of Information of Technology, Universitas Ahmad Dahlan, Yogyakarta, Indonesia Corresponding author: *dwinymeidelfi@pnp.ac.id Abstract— The fourth-year students of Bachelor of Applied Studies (BAS) Software Engineering Technology Department of Information Technology (IT) Politeknik Negeri Padang (PNP) are required to work on the Final Project Proposal to the Coordinator, to deliver to the expertise group team to assess the eligibility of the topic. The expertise teams consist of the same skill family. The assessment criteria include originality, novelty, target and topic contribution, methodology, and similarity. Therefore, a system to support group decisions is highly needed to get eligibility for the topic. In a pandemic like today, indoor gatherings are severely restricted. The work from home policy also limits the movement of the team to gather together so that the expert team who would judge cannot conduct a meeting to determine the feasibility of the final project topic optimally. The existence of a subjective assessment of a particular topic requires discussion from the team. The simple Additive Weighting (SAW) method was used to rank the final project proposal, and BORDA method was used to Accumulate the assessment score of the expert team. The research revealed the recommendation on students' final topics. Testing is done by testing the sensitivity of the criteria used in a decision maker's preference. The final result of this research is a recommendation of a final project that is feasible to be implemented by students and recommendation for sensitive assessment criteria. From the ten topics of the final project that were assessed, seven topics could be accepted. The sensitivity test results showed that the weight with criterion 1 and criterion 4 significantly affect the assessment

results. Keywords— SAW; BORDA; final project; software engineering technology; Politeknik Negeri Padang. Manuscript received 18 Nov. 2020; revised 11 Jan. 2021; accepted 5 Mar. 2021. Date of publication 30 Jun. 2021. International Journal on Informatics Visualization is licensed under a Creative Commons Attribution-Share Alike 4.0 International License. I. INTRODUCTION Bachelor of Applied Studies in Software Engineering Technology is one of the Department of Information Technology (IT) in Politeknik Negeri Padang (PNP) study programs. The IT-PNP study program grouped the lecturer into three areas of expertise to decide the lecturers' expertise: networking, programming, and IT support. Every lecturer was grouped into certain expertise. These lecturers are responsible for guiding the students' final project proposals. As stated in the academic regulation of PNP [1], bachelor of applied studies students is responsible for writing a final project as the graduation requirements. The stages of proposal writing for Bachelor of Applied Studies on Software Engineering Technology began with topic submission from the students to the coordinators. These topics are delivered to the expertise teams to determine eligibility. The assessment criteria to determine eligibility include originality, novelty, target and topic contribution, methodology, and similarity. Each lecturer of the expertise area would assess the eligibility. These assessments were accumulated to decide on the final project topic's recommendation on the Bachelor of Applied Studies Software Engineering Technology. To determine the eligibility, Simple Additive Weighting (SAW) method was used to get the rank of the proposed topics. The recommendations were accumulated through BORDA analysis. SAW is one of the methods used in Multiple Criteria Decision Making (MCDM) that is widely used to get a decision on the most appropriate alternative and other alternatives based on certain criteria [2], [3]. Meanwhile, BORDA is one of the voting methods used to decide on a single winner or multiple winners. To decide the winner, BORDA analysis determines certain points for each alternative. The winner was further decided based on the accumulation scores of each alternative [4]–[6]. 144JOIV : Int. J. Inform. Visualization, 5(2) - June 2021 144-149 II. MATERIAL AND METHOD This research aims to determine the eligibility of the final

project topic Bachelor of Applied Studies on Software Engineering Technology students by implementing the SAW and BORDA method. Some research on SAW method implementation has been conducted for several years. Here is some research on the performance of the SAW method [7] to determine the supervisor and the examiner for students' final projects. In this research, the decision of the supervisor and examiner was selected based on certain criteria through the implementation of the SAW method. Another research was also conducted through the performance of the SAW method [8]. This research was focused on designing the supporting decision-making system application to determine the students' final project supervisors. This research findings revealed that the system could recommend the list of the supervisors as a recommendation to the users based on the accumulation of SW analysis. The system is also supported with the chosen picture for selecting the supervisor. The implementation of SAW and BORDA analysis were also used in Tirtana's research [9]. This research focused on a decision-making support system to determine the AGC award winner. The implementation of the SAW method was used to support individual decisions, while the BORDA method was used to support group decisions. The research conducted by Satriani et al [10] also implemented the SAW and BORDA method to determine the zakat recipient of the educational program. The assessment criteria include (dependents of family, income, files, previous year distribution status, and other status findings). The SAW analysis was implemented to get a decision and get the alternative rank affected by the importance weighting values in every decision. Meanwhile, BORDA analysis was used to get a single decision based on the alternative rank on individual decisions. The results of BORDA analysis were the recommendation of the zakat recipient lists as recommended by the system. The system has been validated through functional testing on BAZNAS staff, and the results showed similar data as proposed on the design and could show the transparency of zakat recipient. Meanwhile, the interface testing to society showed a percentage of 87%. Sari et al. [11] compared SAW BORDA analysis and TOPSIS BORDA analysis to determine the zakat recipient on Educational program. The findings revealed that both SAW BORDA analysis and BORDA

analysis were biased to support the decision to decide the zakat recipient on the Educational program. Syaukani and Hartati [12] focused on designing a group decision support system. It explored the development of a supporting system on group decisions to diagnose Pneumonia patients. The system was designed to help the medical personnel diagnose pneumonia patients and to reduce the level of delay in handling the pneumonia students, and as well as to minimize any error in administering antibiotics to pneumonia patients. It was defined that a decision-maker is a process or a selection activity among several alternatives to get single or multiple purposes [13]. Generally, decision-making is a selection activity from several activities that were chosen through a certain mechanism to get the most excellent decision[14]–[16]. Simple Additive Weighting (SAW) is one of the methods that is mostly used in multiple criteria decision making (MCDM)[17]. SAW consists of attribute assessments for every alternative and it is represented in a decision assessment matric [18], [19]. The matrix was used to determine the whole criteria and scoring from each alternative. The SAW method required normalization matric decision (X) to compare with the existing alternative

ranks. = h (1) = h (2) If the attribute is positive, the attribute is categorized into beneficial, while the attribute is categorically cost if the attribute is negative. In further, the highest value of alternative was determined as the best alternative. The analyst structure of the SAW method for N alternative and attribute M could be formulated as follows: = ∑ (3) for i = 1, 2, ..., N notes Si the accumulation of total value from alternative -i rij a normalization of alternative rating eo-I for criteria j rij = xij / (maxi xij) for benefit attributive and rij = (1 / xij) / (maxi (1/xij)) for cost criteria that represented an element of normalized Matric R xij is the element of a matrix decision A, that represented the original value from j criteria to i-alternative wj the value of j criteria N the accumulation of alternatives W the accumulation of criteria SAW method is to accumulate the values on each alternative and compare the values among each alternative [20]. SAW method required a normalization matric to a certain scale that compared with the existing alternative values. Figure 1 shows the stages

of decision-making through the SAW method. 11Group Decision Support System is a Computer-Based system that supports involving groups for common goals [9]. The methods involved in group decisions (for MCDM in particular) would meet the challenges when the decisionmaker gives the preference individually. Generally, two stages should be implemented in group decisions: stimulating decision-maker preference and group aggregation on each given preference. The stages of problem-solving through the implementation of Borda analysis are explained as follows [21]: · The determination of the highest rating value in an alternative sequence is valued m, in which m is the accumulation of alternatives minus 1. The second highest position is valued m-1, and the series up to the last order is valued 0. · The value is 1used as a multiplier of sounds derived from the position concerned. · Based on BORDA'S functional, statistical analysis of its alternative, the highest selection is the most likely alternative selected by the respondent. Generally, the design of the system architecture can be seen in Figure 1. The stages began with inserting the data of each criterion in each alternative and weight on its criteria. Then, a 145 decision matrix was created as well as a weighted criteria revision. The normalization on the decision matrix was processed. Then the multiplication of decision matrix with certain weighted criteria, so 1the preference of each alternative was found. Start Enter data from each criteria for each alternative criteria weights Create a decision matrix Improved criteria weights Normalization of the decision matrix Multiply the decision matrix by the criteria weight Preference for each alternative Finish Fig. 1 The Stages of decision-making process through SAW method SAW preferences SAW preferences Ranking Ranking Borda Alternative Decisions Lecturer 1 Lecturer 2 Fig. 2 Process Architecture of BORDA Voting After doing the decision-making process shown in Figure 1, Figure 2 shows the preference results of each lecturer as decision-makers combined with the BORDA method. BORDA ranking was 1derived from the highest score based on score [22]. The following is BORDA calculation matrix. (4) III. RESULT AND DISCUSSION A. Calculation Process Using the five criteria below, the study program 2is expected to shorten the students' final project eligibility. These criteria are as follows: C1: originality and novelty

C2: target and topic contribution C3: Methodology C4: similarity There were ten topics used as alternatives in this research. The selection of the best topics through the SAW method was used in this research. The process was begun by reading the attribute value of each criterion for all of the alternatives and each attribute (Table 1). The process was started with constructing a match and a criteria rating table. The value of 146 the match rating is a subjective assessment of a decisionmaker. TABLE I MATCH RATING OF LECTURER 1 Alternative Criteria C1 C2 C3 C4 Topic 1 2 2 3 4 Topic 2 3 4 3 3 Topic 3 3 4 3 3 Topic 4 4 4 3 4 Topic 5 2 2 3 5 Topic 6 3 3 2 3 Topic 7 4 4 4 2 Topic 8 5 4 4 1 Topic 9 5 5 4 1 Topic 10 3 3 3 3 Max 5 5 4 5 Min 2 2 2 1 Next is the process of calculating the normalization matrix (Table 2) on the match rating table to the compared matrix according to formula 1. An attribute would benefit if the higher score gave the bigger opportunity for the selecting alternative to get the highest rank. On the other hand, the attribute is a cost; if the higher value is given to the attribute, the smaller opportunity of the alternative to reach the highest rank. TABLE II NORMALIZATION CALCULATION OF LECTURER 1 Alternative Criteria C1 C2 C3 C4 Topic 1 0.4 0.4 0.75 0.25 Topic 2 0.6 0.8 0.75 0.33 Topic 3 0.6 0.8 0.75 0.33 Topic 4 0.8 0.8 0.75 0.25 Topic 5 0.4 0.4 0.75 0.2 Topic 6 0.6 0.6 0.5 0.33 Topic 7 0.8 0.8 1 0.5 Topic 8 1 0.8 1 1 Topic 9 1 1 1 1 Topic 10 0.6 0.6 0.75 0.33 If Lecturer 1 determine weight preference as W= (5,4,3,5) means as follows: The importance level of criteria 1 is 5, The importance level of criteria 2 is 4, The importance level of criteria 3 is 3, The importance level of criteria 4 is 5. Then, the weight value (W) is multiplied by the normalization calculation table (Table 3) TABLE III MULTIPLICATION OF WEIGHT AND NORMALIZATION CALCULATION OF LECTURER 1 Alternative Criteria Score C1 (5) C2 (4) C3 (3) C4 (5) Topic 1 2 1.6 2.25 1.25 4.60 Topic 2 3 3.2 2.25 1.67 6.78 Topic 3 3 3.2 2.25 1.67 6.78 Topic 4 4 3.2 2.25 1.25 8.20 Topic 5 2 1.6 2.25 1 4.85 Topic 6 3 2.4 1.5 1.67 5.23 Topic 7 4 3.2 3 2.5 7.70 Topic 8 5 3.2 3 5 6.20 Topic 9 5 4 3 5 7.00 Topic 10 3 2.4 2.25 1. 67 5.98 The multiplication calculation of normalized data with weighted value is calculated for each alternative's attributes to get the alternative value. The biggest alternative score means the best alternative. To determine the eligibility of the final

project topic, the expertise team could decide the selected topics if the value is bigger or similar to 6.50. Table III shows the five topics with the value ≥ 6.50, namely Topic 2, Topic 3, Topic 4, Topic 7, and Topic 9. The calculation is regulated for every lecturer of the expert team. TABLE IV MATCH RATING OF LECTURER 2 Alternative Criteria C1 C2 C3 C4 Topic 1 1 2 4 5 Topic 2 4 4 3 2 Topic 3 4 3 3 2 Topic 4 4 4 3 4 Topic 5 2 3 3 4 Topic 6 3 3 4 1 Topic 7 5 4 4 1 Topic 8 5 4 2 1 Topic 9 5 4 4 1 Topic 10 3 3 4 2 Max 5 4 4 5 Min 1 2 2 1 Next is the process of calculating the normalization matrix on the match rating table for Lecturer 2. TABLE V NORMALIZATION CALCULATION OF LECTURER 2 Alternative Criteria C1 C2 C3 C4 Topic 1 0.2 0.5 1 0.2 Topic 2 0.8 1 0.75 0.5 Topic 3 0.8 0.75 0.75 0.5 Topic 4 0.8 1 0.75 0.25 Topic 5 0.4 0.75 0.75 0.25 Topic 6 0.6 0.75 1 1 Topic 7 1 1 1 1 Topic 8 1 1 0.5 1 Topic 9 1 1 1 1 Topic 10 0.6 0.75 1 0.5 If Lecturer 2 determines weighted preference as W = (5,4,4,5), so the weight value (W) is multiplied by the normalization calculation table (Table 6). TABLE VI MULTIPLICATION OF WEIGHT AND NORMALIZATION CALCULATION OF LECTURER 2 Alternative Criteria Score C1 (5) C2 (4) C3 (4) C4 (5) Topic 1 1 2 4 1 6.00 Topic 2 4 4 3 2.5 8.50 Topic 3 4 3 3 2.5 7.50 Topic 4 4 4 3 1.25 9.75 Topic 5 2 3 3 1.25 6.75 Topic 6 3 3 4 5 5.00 Topic 7 5 4 4 5 8.00 Topic 8 5 4 2 5 6.00 Topic 9 5 4 4 5 8.00 Topic 10 3 3 4 2.5 7.50 147 The alternatives are then shorted from the largest value to the lowest. Thus, the successive alternative is obtained based on Topic 2, Topic 3, Topic 4, Topic 5, Topic 7, Topic 9, and Topic 10. Then, if the ranking results are obtained from each expertise team, the preference value of each expertise was analyzed through the BORDA method to get the best alternative decision method. TABLE VII RESULTS OF BORDA ANALYSIS Alter- native Ranking Ranking Weights 1 2 3 4 5 6 7 8 9 10 Topic 1 0 0 0 0 0 0 0 1 0 1 2 0.02 Topic 2 0 1 0 1 0 0 0 0 0 0 14 0.16 Topic 3 0 0 0 0 2 0 0 0 0 0 10 0.11 Topic 4 2 0 0 0 0 0 0 0 0 0 18 0.20 Topic 5 0 0 0 0 0 0 1 0 1 0 4 0.04 Topic 6 0 0 0 0 0 0 0 1 0 1 2 0.02 Topic 7 0 1 1 0 0 0 0 0 0 0 15 0.17 Topic 8 0 0 0 0 0 1 0 0 1 0 5 0.06 Topic 9 0 0 1 1 0 0 0 0 0 0 13 0.14 Topic 10 0 0 0 0 0 1 1 0 0 0 7 0.08 B. Performance Sensitivity Testing To get the performance of the most sensitive criteria on the preference values as the results of SAW analysis [23], [24]. The additional and the reduction of the weight value was

given sequentially -20%, -10%, 0%, 10%, 20% is the assessment process to test the sensitivity [25]. The results of sensitivity performance testing can be seen in Table VIII to table XI. TABLE VIII THE CALCULATION OF THE SENSITIVITY PERFORMANCE ANALYSIS ON C 1 C1 (-20%) C1 (-10%) C1 (0%) C1 (10%) C1(20%) 4,200 10 4,400 10 4,600 10 4,800 10 5,000 10 6,183 3 6,483 4 6,783 4 7,083 4 7,383 4 6,183 4 6,483 5 6,783 5 7,083 5 7,383 5 7,400 1 7,800 1 8,200 1 8,600 1 9,000 1 4,450 9 4,650 9 4,850 9 5,050 9 5,250 9 4,633 8 4,933 8 5,233 8 5,533 8 5,833 8 6,900 2 7,300 2 7,700 2 8,100 2 8,500 2 5,200 7 5,700 6 6,200 6 6,700 6 7,200 6 6,000 5 6,500 3 7,000 3 7,500 3 8,000 3 5,383 6 5,683 7 5,983 7 6,283 7 6,583 7 TABLE IX THE 1CALCULATION OF THE SENSITIVITY PERFORMANCE ANALYSIS ON C 2 C2 (-20%) C2 (-10%) C2 (0%) C2 (10%) C2(20%) 4,280 10 4,440 10 4,600 10 4,760 10 4,920 10 6,143 4 6,463 4 6,783 4 7,103 4 7,423 4 6,143 5 6,463 5 6,783 5 7,103 5 7,423 5 7,560 1 7,880 1 8,200 1 8,520 1 8,840 1 4,530 9 4,690 9 4,850 9 5,010 9 5,170 9 4,753 8 4,993 8 5,233 8 5,473 8 5,713 8 7,060 2 7,380 2 7,700 2 8,020 2 8,340 2 5,560 6 5,880 6 6,200 6 6,520 6 6,840 6 6,200 3 6,600 3 7,000 3 7,400 3 7,800 3 5,503 7 5,743 7 5,983 7 6,223 7 6,463 7 TABLE X THE 1CALCULATION OF THE SENSITIVITY PERFORMANCE ANALYSIS ON C 3 C3 (-20%) C3 (-10%) C3 (0%) C3 (10%) C3(20%) 4,150 10 4,375 10 4,600 10 4,825 10 5,050 10 6,333 4 6,558 4 6,783 4 7,008 4 7,233 4 6,333 5 6,558 5 6,783 5 7,008 5 7,233 5 7,750 1 7,975 1 8,200 1 8,425 1 8,650 1 4,400 9 4,625 9 4,850 9 5,075 9 5,300 9 4,933 8 5,083 8 5,233 8 5,383 8 5,533 8 7,100 2 7,400 2 7,700 2 8,000 2 8,300 2 5,600 6 5,900 6 6,200 6 6,500 6 6,800 6 6,400 3 6,700 3 7,000 3 7,300 3 7,600 3 5,533 7 5,758 7 5,983 7 6,208 7 6,433 7 TABLE XI THE 1CALCULATION OF THE SENSITIVITY PERFORMANCE OF CALCULATION RESULTS ANALYSIS ON C 4 C4 (-20%) C4 (-10%) C4 (0%) C4 (10%) C4(20%) 4,850 10 4,725 10 4,600 10 4,475 10 4,350 10 7,117 5 6,950 4 6,783 4 6,617 3 6,450 3 7,117 6 6,950 5 6,783 5 6,617 4 6,450 4 8,450 1 8,325 1 8,200 1 8,075 1 7,950 1 5,050 9 4,950 9 4,850 9 4,750 9 4,650 9 5,567 8 5,400 8 5,233 8 5,067 8 4,900 8 8,200 2 7,950 2 7,700 2 7,450 2 7,200 2 7,200 4 6,700 6 6,200 6 5,700 7 5,200 7 8,000 3 7,500 3 7,000 3 6,500 5 6,000 5 6,317 7 6,150 7 5,983 7 5,817 6 5,650 6 The sensitivity Performance Testing shows that C 1 and C 4 criteria were sensitive on

ranking results. It is expected to be a suggestion for the teachers to give preference values by adding or reducing the values of each weight. IV. CONCLUSION SAW and BORDA methods could be used to determine the eligibility of students' final topics. The selection of the best alternatives through the implementation of SAW method significantly affects the decision-makers weight value (w). ACKNOWLEDGMENT The authors are grateful to Politeknik Negeri Padang for funding this research under the contract number 287 / PL9.15 / PG / 2020 dated 23 July 2020. REFERENCES [1] Direktur Politeknik Negeri Padang, Peraturan Akademik PNP 2018. 2018. [2] D. Meidelfi, "Penerapan Metode SAW (Simple Additive Weighting) Dalam Pendukung Keputusan Pemilihan Kepala Daerah," SAINSTEK, vol. XII, no. 2, pp. 180–183, 2015. [3] H. Wang, Y. Cai, Q. Tan, and Y. Zeng, "Evaluation of groundwater remediation technologies based on fuzzy multi-criteria decision analysis approaches," Water (Switzerland), 2017, doi: 10.3390/w9060443. [4] K. E. Cheng and F. P. Deek, "Voting methods and information exchange in group support systems," 2006. [5] D. N. Ilham and S. Mulyana, "Sistem Pendukung Keputusan Kelompok Pemilihan Tempat PKL mahasiswa dengan Menggunakan Metode AHP dan Borda," IJCCS (Indonesian J. Comput. Cybern. Syst., 2017, doi: 10.22146/ijccs.16595. 148 [6] P. M. da Rocha, A. P. de Barros, G. B. da Silva, and H. G. Costa, "Analysis of the operational performance of brazilian airport terminals: A multicriteria approach with De Borda-AHP integration," J. Air Transp. Manag., 2016, doi: 10.1016/j.jairtraman.2015.11.003. [7] I. Septiana, M. Irfan, A. R. Atmadja, and B. Subaeki, "Sistem Pendukung Keputusan Penentu Dosen Penguji Dan Pembimbing Tugas Akhir Menggunakan Fuzzy Multiple Attribute Decision Making dengan Simple Additive Weighting (Studi Kasus: Jurusan Teknik Informatika UIN SGD Bandung)," J. Online Inform., 2016, doi: 10.15575/join.v1i1.10. [8] I. Laengge, H. F. Wowor, and M. D. Putro, "Sistem Pendukung Keputusan Dalam Menentukan Dosen Pembimbing Skripsi," J. Tek. Inform., 2016, doi: 10.35793/jti.9.1.2016.13776. [9] A. Tirtana, "Sistem Pendukung Keputusan Kelompok Untuk Menentukan Penerima AGC Award Menggunakan Metode Simple Additive Weighting dan Borda," J. Inform. J. Pengemb. IT, 2019, doi: 10.30591/jpit.v4i1.1062. [10] E. Satriani, Ilhamsyah, and R. Puspita Sari, "Sistem

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