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Fuzzy Logic based Decision Support Model for Determining the Subject of Online Course Materials

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Abstract. This research started by the very urgent condition of future knowledge. Since the Corona Virus Disease-19 pandemic, the world economy has started to plummet and affected many adults to lose their jobs. Also, numerous new habits called "new normal" have been created since the pandemic. In 2020, the number of unemployed people increased significantly. This reason makes people strive to improve their ability to meet job requirements by taking online courses. The way people choose what topics to follow and what materials the service providers will offer academically discussed in this study. The novelty of this research is to obtain a decision support model (DSM) using fuzzy logic method for determining online courses. The fuzzy logic process started by determining the decision parameters, and then the main process performed (i.e. fuzzification, fuzzy inference process, and defuzzification). The crisp output value is used as the final decision (decision value). In the constructed model, there are two groups of parameters; company profits which consist of 5 parameters and user benefits which consist of 9 parameters. Finally, the created model evaluated technically, and the final decision is useful for practical and theoretical implications such as users in choosing online courses and for the decision unit maker of companies in determining online course materials.

Keywords: decision support model, fuzzy logic, online course.

1. Introduction

This research started from problems related to learning effectiveness during the Covid-19 pandemic. Based on (Dhawan, 2020), the only way out is to learn by giving distance because of physical distancing rules. To increase the effectiveness of distance learning, online learning is the best solution to be applied to technological sophistication. Online learning is also supported by the increasing desire of the community to improve abilities with specific goals for users (Jalil, M and Kasnelly, 2020). As (Wang, 2020) said, distance learning brings a feature called online courses. Online learning opportunities generally have many options available, but the Covid-19 pandemic crisis has caused online learning to thrive as most academic institutions have switched to this model. Online learning, remote work, and electronic collaboration are essential for today's daily life (Favale et al., 2020).

There is a big question about how to determine course material so that course providers and people who take online courses feel profit. There are so many materials to choose; this will also be selected according to the wishes of each individual. How to determine the course material will be answered by decision support model (DSM) to determine the subject of the online course material. This study performed to construct a DSM with the parameters obtained through the results of the literature of previous research studies, observations and interviews which later be tested with the help of a computer. The model obtained was tested using the basis and rules of fuzzy logic in order to have proper validation and verification.

Based on (Utama, 2017), DSM aims to support all stages of decision making, from identifying problems, selecting data, and choosing an approach that will be used in the decision-making process, to evaluating choices. Decision-making in education management is critical because systematic and evidence-based education management is an information and technology-focused approach. Knowledge management is meant by continuous and integrated reusing and evaluation of experience, knowledge, and assets to achieve competitive advantage by improving the quality of knowledge (Dixit, 2021). The value of this study is finding an innovation as a novelty in the decision support model for determining online course material. This model using Fuzzy Logic method that is scientific and never learned before. Previous research that ever learned about online course and decision support model will be explained on the literature study section. The decision model is expected to be used by companies engaged in the business providing online course services, online course users for choosing the material and researchers in further research.

2. Theoretical View

2.1. Online course

Based on (Singh and Thurman, 2019), online learning is defined as a learning experience in an synchronous environment using different devices with internet access. Online learning is the future. Online learning can help providing inclusive education even in times of crisis (Dhawan, 2020). The increasing market demand for online learning needs opens high opportunities for technology-based startups to bring technology disruption to the education sector. Due to the Covid-19 pandemic, users of all ages and from anywhere can access the materials provided and benefit from the flexibility of time and location (Reformat and Boechler, 2013). Determining the course material online has its framework and system and must be supported by adequate technology. Course material is determined by syllabus management, learning needs, and objectives. The material is also a selection of material recommendations from experts with evaluation before and after the material is given.

2.2. Decision support model (DSM)

Decision support was first introduced in the early 1970s by Michael S. Scott Morton with the term management decision system (Sprague, 2013). The DSM is designed to support all stages of decision making, from identifying problems, selecting relevant data, determining the approach used in the decision-making process, to evaluating choices. Therefore, the fundamental components that must exist in the decision-making model are the database model, the management model, and the dialogue model (Dridzel and Flynn, 2011). For this reason, in determining the decision model, computational assistance is used using one of the methods in computer intelligence, namely Fuzzy Logic.

2.3. Fuzzy logic

Based on (Utama, 2021), fuzzy itself means bias. Fuzzy logic is a method to allow computers to have a better understanding of parameter descriptions. Thus, the parameter value is not an exact absolute value, but the parameter value can be understood as a bias value. Jan Lukasiewicz first introduced it in the 1920s as probability theory. This probability logic extends the range of truth values for all real numbers in the interval between 0 and 1. Max Black further investigated it in the 1930s in his research on the vagueness of an exercise in logical analysis. In 1965, professor of the department of electrical engineering at the University of California at Berkeley, Lotfi Zadeh, rediscovered, identified, explored, promoted, and expanded the workspace of probability theory into systems of formal mathematical logic and new concepts for applying natural language terms to his research, namely 'Fuzzy Sets.' This new logic is called fuzzy logic, a mathematical calculation method with uncertainty values (Utama et al., 2020). Fuzzy logic has a membership function in the range 0 (zero) to 1 (one), in contrast to discrete, which only has two values, namely 1 (one) and 0 (zero). Fuzzy logic allows reasoning with uncertain facts to infer new realities with more certainty regarding each point (Budiharto, 2016). Through real problems, a definite value can be obtained (called absolute input), which must then

be converted into a biased value through a fuzzification process. Then with the defuzzification process, a definite value is obtained (called absolute output). To carry out the fuzzification process, several things are needed. The first is the language variable representation. For example, the temperature can be described as cold, warm, and hot. Second, a membership function must be formed to carry out the fuzzification process. Then the defuzzification process is carried out. Finally, the absolute output value will be generated using this defuzzification process. This means that an absolute value in the form of absolute input through the process of fuzzification and defuzzification, which is part of the fuzzy logic stage, is used as the main method of decision support modeling itself will produce another absolute value in the form of absolute output depending on the membership function design used.

3. Related Works

3.1. Literature study

Literature studies are the results of reviews from national and international scientific journals that previous researchers have studied. Based on (Utama, 2021), the basic process in determining the decision support model is the determination of parameters, to later investigate the value of the decision value before entering the process of determining the basis in computational calculations using fuzzy logic. Selecting the online course material itself has parameters that are used as the basis for the formation of the model; for that, an observation process is used such as interviews, surveys, and literature studies before determining the selected parameters so that they can be investigated more deeply and further.

Previous research using fuzzy ever learned by (Wang, Zhu and Li, 2013), they analyzed the classification of supply chain risk (SCR) and put forward its index systems on the basis of its many results. As the final, they specified numerical example to analyze the model, the results indicate that the method is not only accommodates the existing fuzzy decision-making methods, but also successfully incorporates the decision preference into the optimization process

Still related with fuzzy on the previous work, wang Also (Gao, Qian and Gu, 2017) used fuzzy clustering for their research. The urban clustering method based on gray theory and fuzzy clustering for urban green transformation proposed in this paper overcomes the problem that the time and comprehensive evaluation of traditional green transitional cities cannot be balanced and achieves the purpose of comprehensive analysis of the city according to multiple indicators at multiple time points

This research begins with observations of online course services widely available in the media and the internet. Next, the researchers went directly to see the existing course materials and spread them on different platforms, and then continued with discussions in the form of interviews with experts. Through interviews and

observations, a very close relationship was obtained between the organizing company and the course service provider, course user, or so-called learner (student). So that the research study is continued with a literature study. Several studies have been conducted by previous researchers related to online learning. This research is closely related to the performance of learning users (students), the benefits of service providers (companies), and learning management. Research that refers to student performance with the help of machine learning has been conducted by (Dixit, 2021) and (Utama and Kurniawan, 2021). Based on (Dixit, 2021), research in detecting student performance. This research begins by completing the data in the form of a dataset of test results with a parameter-based algorithm. The results of this study showed that the student datasets produced different qualities. This causes shortcomings in this study, namely the scope of the analysis to determine absolute assumptions that still have to be eliminated again.

However, it can be concluded that the system to support better student performance can be based on experts' suggestions and students' ability through study habits. The same research on student performance was carried out by (Utama and Kurniawan, 2021). Based on fuzzy logic and the end result was to get decision support model of students' academic performance. This study succeeded in finding seventeen parameters in this case, namely gender, area of origin, number of siblings, family status, parental education, family income, motivation, mileage, type of transportation, scholarship organization, social media, entertainment, and index value. academic. Nevertheless, this research still hopes for future research contributions in the form of using Fuzzy Clustering Means for decision support model in academic performance. Research related to student performance in learning was also investigated by (Vinoth, Ummageshwari and Unnimaya, 2017) using an intelligence approach to predict student performance and habits. This research is based on a dataset with parameters such as attendance, assignment scores, academic index scores, test scores and final exam scores. The results of the research are beneficial for teachers to develop the teaching and learning process and improve efficiency. Conversely, it is hoped that predictions with classification data will increase the accuracy value and expand the scope of the research.

Some studies are directly related to online learning through a review of research related to student performance. For example, an analysis that still uses the Fuzzy method of online learning technology has been carried out by (Reformat and Boechler, 2013). This research started with the need for online learning design. The solutions given in this research are fuzziness and semantic web. This research achieved a framework for use in the next multidisciplinary field. However, this study does not present a detailed enough dataset, so the level of accuracy is still not absolute. Research conducted by (Dhawan, 2020), shows that online learning has become a very urgent mandatory requirement and has been successfully anticipated. Through SWOC-based research (strengths, weaknesses, opportunities, challenges), it was

found that distance learning increases opportunities for technology-based startups engaged in education but still poses threats in every opportunity. For this reason, quality control management and periodic improvements can help to increase the level of success of online learning. Research by (Anderson and Haddad, 2019) uses a dataset of students who participate in online learning to obtain a direct and indirect comparison of learning. This study aims to validate the value of data reliability through the value of Chronbach's Alpha. According to (Van Rooij and Zirkle, 2016), research related to the development of online courses obtained seven dimensions that impact the success of online learning: access to receive materials, learning and technology experiences, study habits and abilities, individual goals, lifestyle influences, and personality traits. In addition, five categories also influence online courses to be very impactful: human factors, material quality factors, the technology used, evaluation, and multimedia usability. Research on course material has been investigated by (Khan et al., 2017). The background of the problem is that there are still many institutions that face difficulties in integrating the material directly into a course. This research results from a literature review where it is concluded that the consistency of the system of a course must be adjusted to the student's perspective to receive the material.

Related research is growing, (Cherney, Fetherston and Johnsen, 2018) concluded that student involvement in online learning significantly impact on the quality of learning success. Therefore, it can be concluded involvement with systematic material design affects their learning success in online courses. Research that strengthens the reason that student involvement in the form of student attendance in online learning has also been studied by (Yang et al., 2016). This study looks for reliability values through 5 main parameters: attendance, gender, age, education level, and learning experience. The analysis was carried out using the Chronbach Alpha test and regression and obtained significant results that have a correlation and influence on learning outcomes objectively and subjectively. The drawback in this research is the lack of expert opinion, so advice and input from experts is needed in this study. Regarding the online course service provider company which is quite fast, it was also investigated by (Wang, 2020) and by using the managerial profit analysis method, it was found that the main source of profit from the company was through course fees obtained through the facilities provided by the company to students.

Through the results of a literature study, it is briefly obtained that decision support model has been used in the method to examine the object of research and in each study has parameters that can later be used as a reference in answering the research objectives and the formation of the final model as a basis for supporting decisions. Previous research that was also related to online courses in determining the material was also motivated by many parameters such as class performance and students as class users, company benefits in return for providing online course services with materials offered to users, user goals in choosing a course material and learning

facilities that are in accordance with the wishes and expectations, the content of the material offered and the presence of users with the facilities obtained.

3.2. Study limitation

This research also limited to parameters and the model used in the model making for determining online course. The parameters are grouped by company parameter that consists of 5 parameters and user benefit that consists of 9 parameters. After the decision parameters are determined, this study will look for decision value as the basis for calculating fuzzy logic in the calculation and computation process. In finding the decision, there are rules as the fuzzy rule base for getting the crisp output.

This research is expected to be able to make optimal strategic decisions. This research can contribute to providing a reference for computing models for determining online course materials for online course service providers and of course becoming a reference for future researchers who want to investigate further about DSM and fuzzy logic in determining online course materials.

4. Research Methods

In a research design, there is a frame of mind to determine how the flow will be carried out so that it becomes research that has a real contribution. An illustration of research framework was figured by Fig. 1. Understanding the case is the basis as well as the root of the determination of the idea of making a DSM. Understanding the case is meant by analyzing the case which is the research object. The issue here does not indicate a big problem but is a sense of anxiety to maximize the potential that can be obtained with the decision model that will later be developed. This research departs from a big question about what happens behind the determination of online course materials that benefit the service providers and users, what underlies users to choose the course, whether there are criteria for material to be launched, and why online courses should be.

Through literature study, observation and interviews, case understanding is expected to produce problem formulations, research objects, summaries of previous research and in-depth understanding of the cases studied. Through the observation of online course sites, it was found that there are very many online course material offerings that can be studied, selected and accessed by users through the payment process.

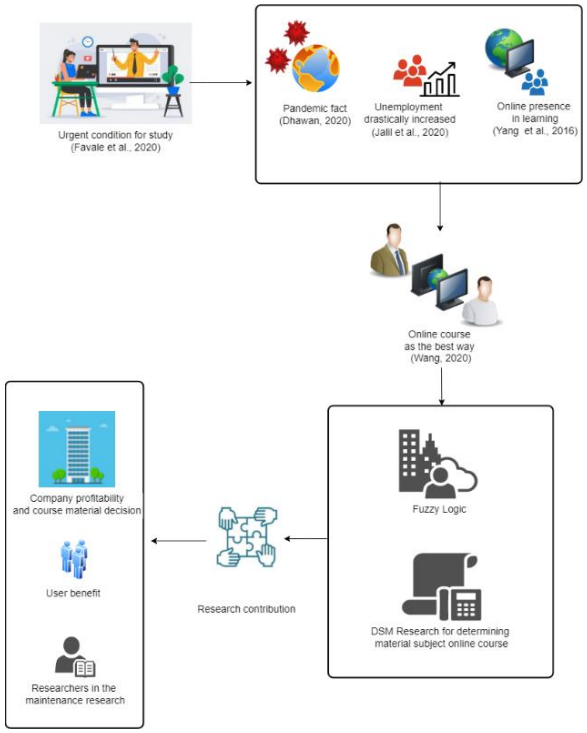


Fig. 1: The research framework.

However, the main reason for choosing a material is a big question, so the research continues by comparing research related to online course materials. There are several variables that determine the material offered, so to ensure the facts, an interview was conducted with a company founder who provides online course services. It turned out that through the results of interviews from the point of view of research, facts and business, there was an interesting case to be investigated so that it could contribute to companies, users and researchers in determining course materials that were of the type of online course. This case can be answered through a decision-making process with computational assistance, namely fuzzy logic to support decisions. The detail flow from the framework in Fig. 1 has clearly detailed by Fig. 2.

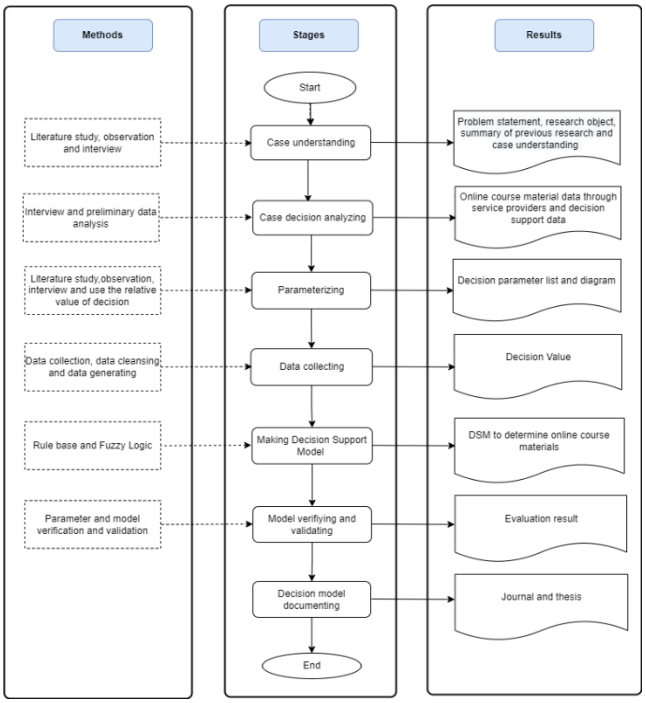


Fig. 2: The Research flowchart.

Fig. 2 shows the started stage until the last stage of this study. The stages are case understanding, case decision analyzing, parameterizing, data collecting, making decision support model, model validating and verification, and ended with documentation.

5. Results

5.1. Selected parameters

The basis of the choice of decision parameters as a step in the formation of the model is the result of a literature study related to research related to distance learning that has been studied by previous researchers. Another process that underlies the chosen decision parameters is also through the results of discussions with the representation of service providers who are considered experts in the form of interviews and observations from online course websites with their respective analyzes. The decision parameters were collected and selected according to research needs related to the business side of the online course service provider, the online course material side and the user side of the online course. Based on Fig. 2, the selected parameters were collected by parameterizing stage through literature study, observation, interview and using the relative value.

Through (Van Rooij and Zirkle, 2016), the appropriate decision parameters for this research are user goals (certificate, experience, and work) and course facilities (personal mentor and type of learning). Through (Yang et al., 2016), the chosen decision parameters are the company's income and expenses that affect business profits, access to material and the ability to understand the material. Through the results of interviews with experts, the decision parameters of user understanding were obtained, the number of website visitors, the number of course users and the presence of course users. Finally, by comparing different online course materials, decision parameters were obtained in the form of course prices and course promotion values. The decision parameters with their sources have been summarized through the Venn diagram in Fig.3.

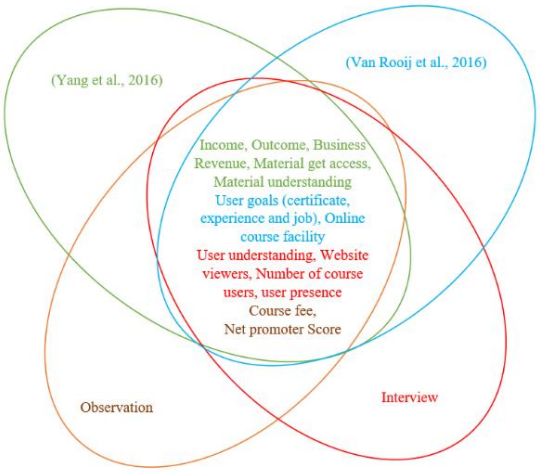


Fig. 3: The venn diagram selection of decision parameters of the constructed DSM.

5.2 Parameter grouping

Through the selection of decision parameters, there is a grouping of parameters based on model relations. The decision parameter groups are (AX) which is called company profit and (BX) which is called user benefit. Through the results of literature studies, observations and interviews related to company profits, five decision parameters or sub parameters that make up company profit are selected: business profits (income), net promoter score, number of website visitors, number of course users, and course user attendance. Business profits are obtained by calculating the entry fee minus the exit fee to get the profit per class. The entrance fee requires data in the form of class fees and the number of participants. Meanwhile, outgoing costs need data on the speaker's income and the number of meetings. The net promoter score (NPS) is a calculating tool in the form of a market research matrix, usually in the form of a survey where the results can indicate how much service users recommend the service

or product used to other people who have or have never used the service or product. In this case, NPS refers to how likely it is that respondents who are users of online course classes recommend the services used to others. Of course, the recommendations are expected to mean well and support the company.

The number of website visitors is used to determine whether the course material offered attracts attention. The number of course users is used as a reference for calculating profits and evaluation material for deciding the course material to be made. The presence, of course, users can indicate whether the material provided is appropriate or not properly presented on the condition that they know the learning conditions of the course user. AX Followed by the decision parameter BX. Usability for users as (BX) has nine decision-forming parameters, namely access to materials; the ability to understand the material; facilities received by users are divided into two, namely personal mentors and types of learning; material preferences; online course fees; and user objectives which are divided into three, namely obtaining certificates, increasing experience, and obtaining jobs After parameterization is done, the next stage is data collection. After the two decision parameters are met, the decision value is obtained with the help of relative values and fuzzy logic. The details of parameter abbreviation with its definition and whether the parameters is fuzzy or not were summarized in Table 1.

Table 1: Parameter abbreviation and the definition.

Parameter	Definition	Grouping Area
P1	Business Revenue	AX - Fuzzy
P2	Net Promoter Score	AX - Fuzzy
P3	Website Visitors	AX - Fuzzy
P4	Course User	AX - Fuzzy
P5	Attendance	AX - Fuzzy
P6	Access to material	BX - Fuzzy
P7	Ability to understand	BX - Fuzzy
P8	Personal Mentor	BX - Fuzzy
P9	Type of learning	BX - Fuzzy
P10	Material Preference	BX - Fuzzy
P11	Course Fee	BX - Fuzzy
P12	Get Certificate	BX - Fuzzy
P13	Experience	BX - Fuzzy
P14	Getting Job	BX – Non-Fuzzy

As it is written that data can justify information, so is the case with the decision support model. Therefore, data has an important role in the formation of the model. The data can be collected through secondary company data, web data, and literature studies. The collection will also be needed if the data is untidy and unstructured. This

process can be done through data cleaning, data normalization, and other methods. The method used in this data collection will be related to cleaning data that is randomly scattered through selected sources, which will later be generated so that the value of the decision can be measured.

After the data were collected, Influence diagram is used as a tool to represent in graphical form of a decision model that is used to assist model design, development and understanding of a system. In building the model the author uses influence diagrams to represent the graphical form of the model as shown in Fig. 4.

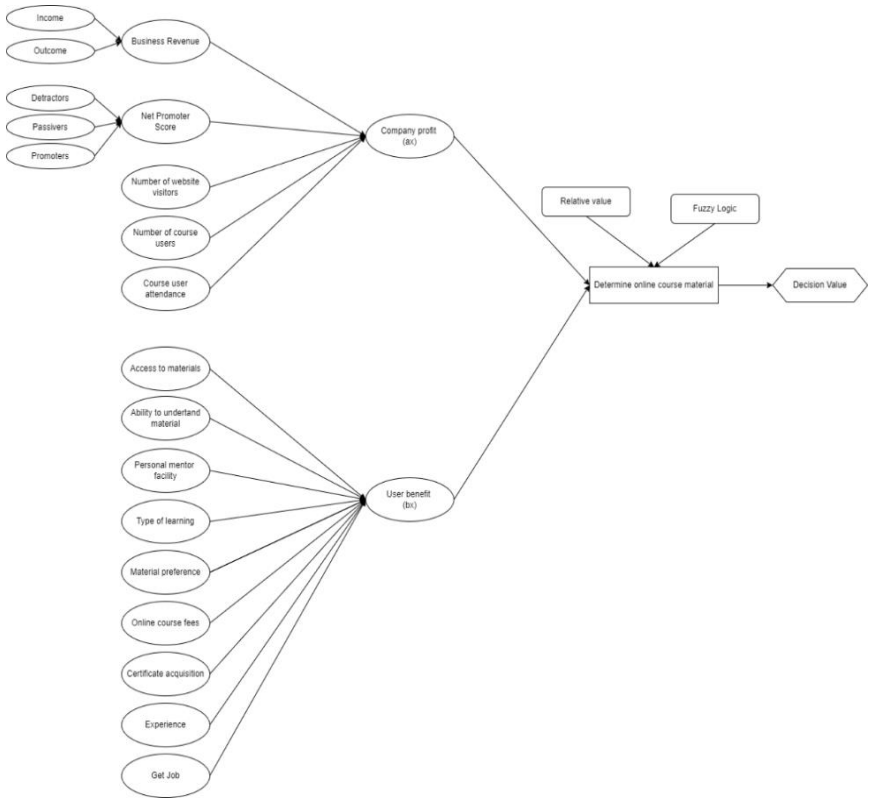


Fig. 4: Influence diagrams for model building of decision support model for determining online course material.

Through Fig. 4, it can be seen that the hexagonal symbol that shows the output of the research is to determine the decision in the form of a decision value. These results are the expected outputs of solving existing problems (decision indicators) from the model. In determining the output results (decision value) it is carried out based on an assessment determined based on the two main parameters that are input to the model.

5.3. Constructed model

The formation of a model with applicable research rules will be followed by the submission of a decision based on the performed model. The proposed model will be checked for verification and validation through a data validation process, parameters both through technology applications and through discussions with experts who can provide decisions that support the model formed. The rule base and fuzzy logic will be used to support the model that was decided and are expected to be able to produce decision suggestions in determining the online course material. The formation of the decision support model uses the generalization of data from excel, and the program will use the Python programming language.

The results can later be evaluated to get a model that is correct and has a real effect both in the world of education and the business world and can even be developed for further research by the same researcher or different researchers because the decision support model in this study is a real contribution to the development of the academic world. Finally, the validation itself can be applied by comparing the result values of the model formed by mathematical calculations and then checking the model's suitability. Ultimately, it is expected to have a verification value of 1.0. The process flow of the model to be developed can be seen through the activity diagram in Fig. 5.

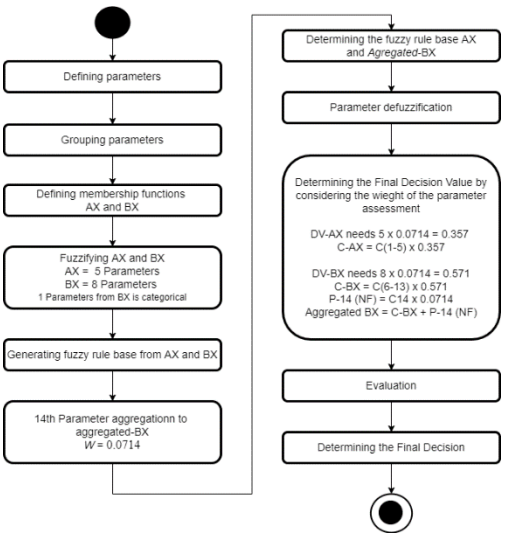


Fig. 5: Activity diagram for the constructed model algorithm.

The process begins by defining the decision parameters to determine the main decision parameters, namely Online Course Materials, which are grouped into two decision parameters: Company Profit (AX) and User Benefit (BX). Next, the decision parameters will be fuzzified with fuzzy inference model by forming a membership function and fuzzy rule base from AX and BX. The 14th parameter part of BX is

absolute and not fuzzified so that it is aggregated by weighting and forms aggregated BX. Then fuzzy rule base from AX and aggregated BX to be fuzzified and continued with the defuzzification process. The final result of the model process flow is a decision in the form of a decision value to choose online course material as a decision supporter.

5.4. Fuzzification

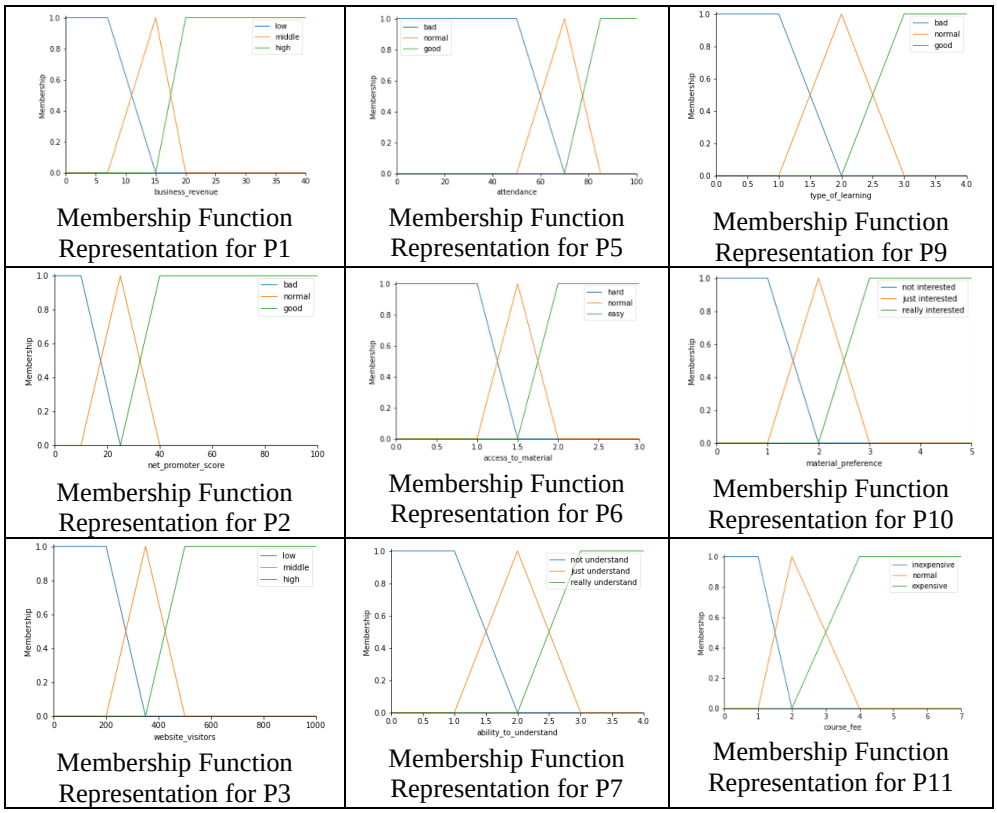
The input parameters are business profit, net promoter score, number of website visitors, number of course users, attendance of course users, access to course materials, ability to understand material, personal mentor, type of learning, material preference, course fee, certificate acquisition, increased experience, and job acquisition. In this study, the value of the business profit parameter has three types of language variables, namely low (L), middle (M) and high (H); with the limit values, respectively, are (0.00, 0.00, 7.00, 15.00), (7.00, 15.00, 20.00) and (15.00, 20.00, 40.00, 40.00). For the NPS parameter value, it has three language variables, namely bad (B), normal (N), good (G); with the limit values, respectively, are (0.00, 0.00, 10.00, 25.00), (10.00, 25.00, 40.00) and (25.00, 40.00, 100.00, 100.00). The parameter value of the number of website visitors has three language variables, namely low (L), middle (M) and high (H); with the limit values, respectively, are (0.00, 0.00, 200.00, 350.00), (200.00, 350.00, 500.00) and (350.00, 500.00, 1000.00, 1000.00).

The parameter value of the number of course users have three language variables, namely low (L), middle (M) and high (H); with the limit values, respectively, are (0.00, 0.00, 10.00, 50.00), (10.00, 50.00, 100.00) and (50.00, 100.00, 200.00, 200.00). The parameter value of the number of course users have three language variables, namely bad (B), normal (N), good (G); with the limit values, respectively, are (0.00, 0.00, 50.00, 70.00), (50.00, 70.00, 85.00) and (70.00, 85.00, 100.00, 100.00). The parameter value of access to material has three language variables, namely hard (H), normal (N) and easy (E); with the limit values, respectively, are (0.00, 0.00, 1.00, 1.50), (1.00, 1.50, 2.00) and (1.50, 2.00, 3.00, 3.00). The parameter value of the ability to understand the material has three language variables, namely not understand (NU), just understand (JU), really understand (RU); with the limit values, respectively, are (0.00, 0.00, 1.00, 2.00), (1.00, 2.00, 3.00) and (2.00, 3.00, 4.00, 4.00).

Personal mentor parameter values have three language variables, namely bad (B), normal (N), good (G); with the limit values, respectively, are (0.00, 0.00, 1.00, 1.25), (1.25, 1.50, 2.00) and (1.50, 2.00, 3.00, 3.00). The parameter values for this type of learning have three language variables, namely bad (B), normal (N), good (G); with the limit values, respectively, are (0.00, 0.00, 1.00, 2.00), (1.00, 2.00, 3.00) and (2.00, 3.00, 4.00, 4.00). The material preference parameter value has three language variables, namely not interested (NI), just interested (JI) and really interested (RI);

with the limit values, respectively, are (0.00, 0.00, 1.00, 2.00), (1.00, 2.00, 3.00) and (2.00, 3.00, 5.00, 5.00).

The parameter values for online course fees have three language variables, namely inexpensive (I), normal (N), expensive (E); with the limit values, respectively, are (0.00,0.00, 1.00, 2.00), (1.00, 2.00, 4.00) and (2.00, 4.00, 7.00, 7.00). The parameter values for obtaining certificates have three language variables, namely bad (B), normal (N), good (G); with the limit values, respectively, are (0.00, 0.00, 1.00, 1.25), (1.25, 1.50, 2.00) and (1.50, 2.00, 3.00, 3.00). The value of the experience improvement parameter has three language variables, namely bad (B), normal (N), good (G); with the limit values, respectively are (0.00, 0.00, 1.00, 1.25), (1.25, 1.50, 2.00) and (1.50, 2.00, 3.00, 3.00) While the output parameter is the decision whether the material will be published or not. The decision parameter values have two language variables, namely not publish (NP) and publish (P); with the limit values, respectively, are (0.00, 0.00, 25.00, 75.00) and (25.00, 75.00, 100.00, 100.00). All of the input membership function representation were depicted by Fig.6.



Membership Function Representation for P1

Membership Function Representation for P5

Membership Function Representation for P9

Membership Function Representation for P2

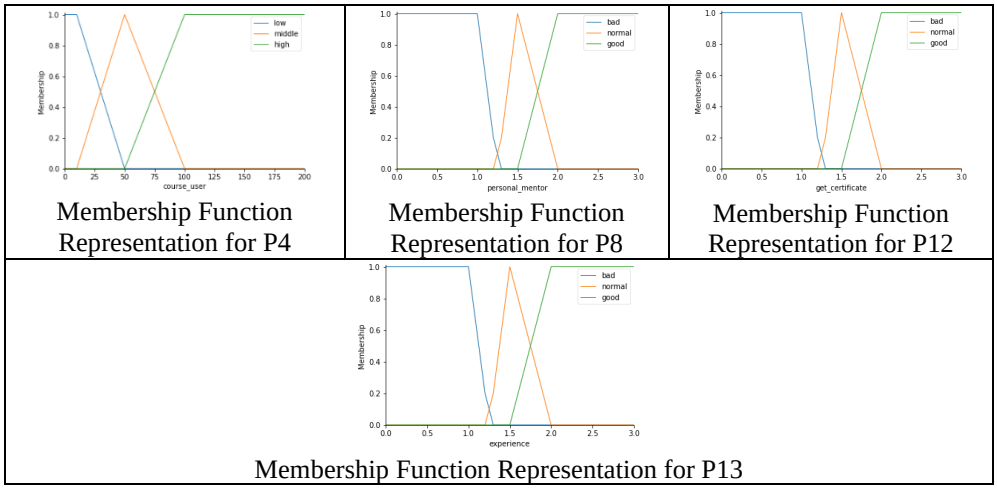
Membership Function Representation for P6

Membership Function Representation for P10

Membership Function Representation for P3

Membership Function Representation for P7

Membership Function Representation for P11

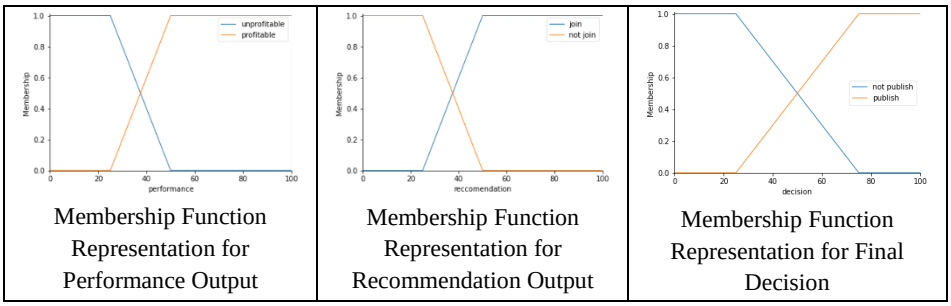


Membership Function Representation for P4 | Membership Function Representation for P8 | Membership Function Representation for P12

Membership Function Representation for P13

Fig. 6: All inputs membership function representation.

However, before entering the final decision, the membership function results from parameter AX (P1 to P5) have an output in the form of a performance decision whether it is profitable (profitable) or not profitable (unprofitable). The membership function results from BX (P6 to P13) have an output in the form of a recommendation to join or not to join. So, the output consists of three; AX (performance), BX (recommendation), and the final decision (published or not published).



Membership Function Representation for Performance Output | Membership Function Representation for Recommendation Output | Membership Function Representation for Final Decision

Fig. 7: All outputs membership function representation.

5.5. Fuzzy rule base

Before described the fuzzy rule base, it is important to considered the rule with the data. In the process of data collection, to obtain correct and convincing data, two types of data were collected in this study, namely primary data and secondary data. In primary data collection, data were obtained through direct studies in the form of interviews with experts in accordance with research cases and online surveys. In this case, the experts in question are experts who understand the online course business as well as managers who compile online course materials and also experts who understand case analysis so that later up-porting models can be developed. Furthermore, for secondary data collection, data and information collection were

obtained through written sources related to research problems and databases from online course service providers that were tailored to their needs to answer research problems and support the achievement of research objectives. Secondary data collection in the form of written sources is carried out through literature research, namely by collecting data from national and international scientific journals, scientific papers and theses by previous researchers. In the making of fuzzy rule base as one of the elements needed to solve problems using the whole fuzzy logic concept.

Through the linguistic variables of each parameter, fuzzy rule base can be made to produce two possible final decisions, namely whether the course material will be published or not. However, before entering the final decision, fuzzy rule base is divided into 3 major rules, namely AX (P1 to P5), BX (P1 to P13), and AX with aggregated BX. The membership function results from the AX parameters (P1 to P5) have an output in the form of a performance decision whether it is profitable (profitable) or not profitable (unprofitable). Meanwhile, for input the input variable grouped-BX with output join and not join. The BX rule consists nine rules because only P7 and P12 has different rules, but the others have the same value based on survey and it is generalized as the same value. This rule named rule base for recommendation. As the final decision, there are four final rule bases. Rule 1 contains if (AX = Unprofitable) and (Aggregated BX = Not Join) then (Decision = Not Publish). Rule 2 contains if (AX = Unprofitable) and (Aggregated BX = Join) then (Decision = Not Publish). Rule 3 contains if (AX = Profitable) and (Aggregated BX = Not Join) then (Decision = Publish). Rule 4 contains if (AX = Profitable) and (Aggregated BX = Join) then (Decision = Publish).

Table 2: Fuzzy rule base for AX performance (profitable or unprofitable).

Rule 1	IF (P1 = Low) AND (P2 = Bad) AND (P3 = Low) AND (P4 = Low) AND (P5 = Bad) THEN (Performance = Unprofitable)
Rule 2	IF (P1 = Low) AND (P2 = Bad) AND (P3 = Low) AND (P4 = Low) AND (P5 = Normal) THEN (Performance = Unprofitable)
Rule 3	IF (P1 = Low) AND (P2 = Bad) AND (P3 = Low) AND (P4 = Low) AND (P5 = Good) THEN (Performance = Unprofitable)
…	…
Rule 241	IF (P1 = High) AND (P2 = Good) AND (P3 = High) AND (P4 = High) AND (P5 = Good) THEN (Performance = Profitable)
Rule 242	IF (P1 = High) AND (P2 = Good) AND (P3 = High) AND (P4 = High) AND (P5 = Normal) THEN (Performance = Profitable)
Rule 243	IF (P1 = High) AND (P2 = Good) AND (P3 = High) AND (P4 = High) AND (P5 = Bad) THEN (Performance = Profitable)

Through the data, there are expert judgments that have an effect in determining the BAF for BX. Through the results of survey data and data from the company database, it is found that only P7 and P10 has a difference in value. While P6, P8, P9, P11, P12, and P13 have the same value in each material so they are not combined but have a fixed fuzzy value. So, there are 9 BAF for BX.

Table 3: Fuzzy rule base for AX recommendation (join or not join)

Rule 1	(P7 = Not Understand) AND (P10 = Not interested) THEN (Recommendation= Not Join)
Rule 2	(P7 = Not Understand) AND (P10 = Just interested) THEN (Recommendation= Not Join)
Rule 3	(P7 = Not Understand) AND (P10 = Really interested) THEN (Recommendation= Not Join)
Rule 4	(P7 = Just Understand) AND (P10 = Not interested) THEN (Recommendation= Not Join)
Rule 5	(P7 = Just Understand) AND (P10 = Just interested) THEN (Recommendation= Join)
Rule 6	(P7 = Just Understand) AND (P10 = Really interested) THEN (Recommendation= Join)
Rule 7	(P7 = Really Understand) AND (P10 = Not interested) THEN (Recommendation= Not Join)
Rule 8	(P7 = Really Understand) AND (P10 = Just interested) THEN (Recommendation= Join)
Rule 9	(P7 = Really Understand) AND (P10 = Really interested) THEN (Recommendation= Join)

The BX parameters (P6 to P14) will be aggregated using a balancing weight and form a new value called aggregated BX. Because P14 is not fuzzified because it is an absolute value between 1 and 0, so to get a final decision, BX is recalculated using the concept of weighting. A number of fourteen parameters generate initial weight values to obtain the value of aggregated bx. This is also known as following the concept of balancing weight. The weight used in this study is 1/14 = 0.0714. In detail, the aggregated BX value is described by aggregated BX = (0.0714 ×P14) + (8 ×0.0714). The value 0.0714 comes from the result of dividing one by fourteen. P14 has a value between 0 and 1. The number 8 comes from the total BX parameters that can be fuzzified.

Table 4: Fuzzy Rule Base for Final Decision (Published or Unpublished)

Rule 1	IF (AX = Unprofitable) AND (Aggregated BX = Not Join) THEN (Decision = Not Publish)
Rule 2	IF (AX = Unprofitable) AND (Aggregated BX = Join) THEN (Decision = Not Publish)
Rule 3	IF (AX = Profitable) AND (Aggregated BX = Not Join) THEN (Decision = Publish)
Rule 4	IF (AX = Profitable) AND (Aggregated BX = Join) THEN (Decision = Publish)

5.6. Decision value

The decision value (DV) is obtained by comparing all materials that still considered to find the maximum relative value and then this value is paired with the value urgency coefficient to obtain a decision value as the basis for determining the course material to be offered. But, before entering the value of classical method, Table 5 will bring the value using fuzzy logic and based on the weighting rule from Fig. 5.

$$Weighting\ DV(AX) = 5\ x\ 0.0714 = 0.357 \quad (1)$$

$$C(AX) = C(P1, P2, P3, P4, P5)\ x\ Weighting\ DV(AX) \quad (2)$$

$$Weighting\ DV(BX) = 8\ x\ 0.0714 = 0.571 \quad (3)$$

$$C(BX) = C(P6, P7, P8, P9, P10, P11, P12, P13)\ x\ Weighting\ DV(BX) \quad (4)$$

$$P14\ (NF) = C(P14)x\ 0.0714 \quad (5)$$

$$Aggregated\ BX = C(BX) + P14\ (Non\ Fuzzy) \quad 6)$$

$$DV = C(AX) + Aggregated\ BX \quad (7)$$

Table 5: The result of materials decision value based fuzzy logic calculation.

Material	Fuzzy Value of AX	CAX	Fuzzy Value of BX	CBX	Aggregated BX	Final DV
Content Writing	66.49	23.73693	68.33	39.01643	40.01643	63.7534
OKR Google	64.54	23.04078	68.33	39.01643	40.01643	63.0572
Copy Writing	66.49	23.73693	68.33	39.01643	40.01643	63.7534
Data Analytics	68.02	24.28314	68.33	39.01643	40.01643	64.2996

Using fuzzy logic, concluded that materials were decided to be publish because based on the rule of performance is profitable and based on the rule of recommendation is join. So based on rule 4 of the final decision rule, the materials should be published.

Previous research stated that the Relative Value (RV) of Decision is divided into two, namely RV-maximum and RV-minimum. Based on this research case, the relative value used is RV-maximum with this below equation. This value used as a comparation for verification as the mathematical method.

$$RVmax = \frac{Value\ current}{Value\ maximum} \quad (8)$$

$$RVmin = \frac{Value\ maximum}{Value\ current} \quad (9)$$

Table 6: The result of materials decision value based realtive value.

No	Parameter	DV Content Writing	DV OKR Google	DV Copy Writing	DV Data Aanalytic
1	Business Revenue	0.23810	0.14075	0.19788	0.22770
2	Net Promoter Score	0.19048	0.19048	0.19048	0.19048
3	Website Visitors	0.05332	0.04102	0.04922	0.03896
4	Course User	0.19048	0.14975	0.10542	0.11980
5	Attendance	0.16563	0.15528	0.16563	0.18634
DV Parameter Company Profit (AX)		**0.8380**	**0.6773**	**0.7086**	**0.7633**
1	Access to material	0.08824	0.08824	0.08824	0.08824
2	Ability to understand	0.08824	0.05882	0.08824	0.11765
3	Personal Mentor	0.08824	0.08824	0.08824	0.08824
4	Type of learning	0.08824	0.08824	0.08824	0.08824
5	Material Preference	0.03529	0.02353	0.02353	0.03529
6	Course Fee	0.08824	0.08824	0.08824	0.08824
7	Get Certificate	0.11765	0.11765	0.11765	0.11765
8	Experience	0.14706	0.14706	0.14706	0.14706
9	Getting Job	0.20588	0.20588	0.20588	0.20588
DV Parameter User Benefit (BX)		**0.9471**	**0.9059**	**0.9353**	**0.9765**

The result of relative value is a decision value that will be the basis for comparison of values between fuzzy logic and the mathematichal (convensional) method. The comparison will be described on the evaluation section.

5.7. Evaluation

Verification is a process to assess the degree of truth of the developed model against the theoretical concepts used and validation is the process of assessing the degree of truth of the data values involved in the model from the actual data values. The decision support model to determine the subject matter of the online course will be obtained after carrying out these six stages and will be written in documented papers and theses. It should also be noted that the model to be obtained should indeed be implemented, but the decision model implementation process can be represented by a verification process so that the research process can be categorized as complete. The verification element contains variables, procedures, and model calculation results which are compared with existing references. The comparison between the model and reference verification elements will give a verification value, if it is apropriate it will be given a value of 1, if it is not suitable it will be given a value of 0. The overall verification value will be calculated how many comparisons are suitable and which are not suitable.

Table 6: Verification.

The Model	Element	Model	References	Verification Value
AX	Variable	5	5	1.00
	Procedure	✓	✓	1.00
	Result	5.00 - 100.00	5.00 - 100.00	1.00
BX	Variable	9	9	1.00
	Procedure	✓	✓	1.00
	Result	5.00 - 100.00	5.00 - 100.00	1.00

The logic procedure or flow used in this study is adjusted to the Decision support model Wheel initiated by (Utama, 2021), where the research process is philosophically iteration because in building the model there are limitations between replicas and reality. The process begins with case analysis, decision solution analysis, parameters needed to support decisions, data collection, model development, and evaluation consisting of model verification and validation. This is already in accordance with the model in this study. So the procedure elements of the AX and BX models are verified with a value of 1.00 because they are the same between the model and the reference.

The formula used is based on fuzzy logic. In fuzzy itself, there are different types of model inference. This study itself used a fuzzy inference model – Mamdani. Through (Utama, 2021) and (Budiharto, 2016), the fuzzy logic process itself begins with determining membership functions, then determining language variables for BAF to later determine as the basis for decisions. The final value of the decision is obtained using the central of gravity formula. The formula, if described, will look like the following equation:

$$Central\ of\ Gravity = \frac{\int \mu_{c\,(x)}.\ x\ dx}{\int \mu_{c\,(x)}\ dx} \tag{10}$$

The formula has been adjusted to the calculation based on the python library when skfuzzy calculations use programming. So that the formula elements of the AX and BX models are verified with a value of 1.00 because they are the same between the models and the references.

For the calculation results, the calculation results are compared between the results using fuzzy logic and mathematic (conventional) calculations using relative values in equation (8). The calculation results through the fuzzy equation are in the same range with maximum relative values ranging from 5.00 to 100.00. So that the calculation elements of the AX and BX models are verified with a value of 1.00 because they are the same between the models and the reference.

Based on Table 6, the verification of this model is 1.00 that means model and references are verified. It also considered the number of the variables, the procedure of getting the parameters, the formulation that compared, the process for getting the final decision and the range of decision value.

6. Conclusion

The process of determining online course material is a process that cannot be completed easily manually. Academically, this process can be solved through the decision support. This research collaborates decision management and fuzzy logic as a knowledge that can be improved all the time. For making a decision, it all started by finding the decision parameter. In this research, concluded that there are 14 parameters that grouped into AX (Company Profit) and BX (User Benefit). Company profit parameter consists of business profits (income), net promoter score, number of website visitors, number of course users, and course user attendance. User benefit parameter consists of access to materials; the ability to understand the material; facilities received by users are divided into two, namely personal mentors and types of learning; material preferences; online course fees; and user objectives which are divided into three, namely obtaining certificates, increasing experience, and job acquisition. Based on each parameter, it has its' own value and using fuzzification and defuzzification. Final decision is whether the material published or not published, and based on the data, if the fuzzy area followed the rules, the company that considered the material should choose what the conclusion get. The conclusion was verified considering the company profit and user benefit. So, the final decision is useful for the user searching for an online course and also useful for the decision unit of an online course company in determining an online material course.

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