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A Rule Based SWOT Analysis Application: A Case Study for Indonesian Higher Education Institution

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Abstract

Learning the current condition of strength, weakness, opportunities, and threat (SWOT) can help a study program in a university in making a decision. For the middle term, it can also help in building strategic planning. However, conducting SWOT analysis is usually an expensive and time consuming activity. We have been doing a research to provide a software application that may facilitate study program stakeholders to conduct SWOT analysis more quickly and easily. The application is web-based providing question-answer system that allow users reveal facts and conditions of their study program. The system adopts assessment criteria of standard accreditation system for Indonesian higher education institution. The system implements sentiment analysis approach to help classification process in constructing SWOT matrix. The research shows that the application has a potential to help study program stakeholders to conduct SWOT analysis. The output of the application is considered reliable with approximately 80% of SWOT mapping is accepted by an expert.

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1. Introduction

SWOT analysis was first introduced by Albert Humphrey during the period of 1960 to 1970 when he led a project at Stanford University to develop methods to help companies in the United States in planning changes ¹. In that study the term SWOT which stands for Strength, Weakness, Opportunities, and Threat first appeared. SWOT analysis is an attempt to reveal the strengths and the weaknesses of an organization, to analyze opportunities for improvement, and to see possible external obstacles that need anticipations. SWOT analysis is widely used for strategic planning of long-term and short-term development on an organization. The main purpose of strategic

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planning is to maintain the balance of the organization to any changes in the environment and to maintain the stability of the organization to be able to survive all over the time². However, conducting SWOT analysis is usually an expensive and time consuming activity³.

At the beginning of its development, SWOT analysis is widely used to plan the development of companies and industries in the United States. Later on, SWOT analysis was adopted by organizations in other fields. In a study, van Wijngaarden et al. attempted to modify the method of SWOT analysis to develop a strategic planning of healthcare organizations in the Europe⁴. Another study employed SWOT analysis to plan the significant changes at the University of Warwick⁵. Since 2009, Indonesian Higher Education National Accreditation Board (BAN-PT: Badan Akreditasi Nasional Perguruan Tinggi) has also encouraged the use of SWOT analysis as a common practice in doing self-evaluation for both study programs and universities/institutes. It can be inferred, therefore, that the SWOT analysis can be an excellent tool for designing a strategic planning for educational organizations.

SWOT analysis consists of 8 steps⁶. The steps are collecting information (particularly through interviews), mapping each condition into strength, weakness, opportunity or threats, deciding weights of SWOT statement, deciding rates, calculating scores, evaluating quadrant position, deciding strategies, and presenting the result. In the traditional technique, all of these steps are usually conducted by brainstorming and group discussions. Hence, traditional process consumes a lot of time and involves many resources, including board of executives. There is a need to reduce time in doing SWOT analysis. Therefore, it is important to automate the SWOT analysis process to make the process is faster and easier especially during data analysis. Techniques of decision support system may be applied which includes determining the weight (level of importance) of each factors. Traditional technique usually ignores the different weighting among factors which causes deficiency on the results of the SWOT analysis at the evaluation stage⁷. There are already a lot of studies that explored the possibility to automate the SWOT analysis in various domains, such as small and medium enterprise⁸, forestry⁹, and electronic industry¹⁰. However, we have not found one in the field of higher education institution.

Previous paragraphs suggest the importance of employing SWOT analysis to create strategic planning for educational organization and the significance of automating the process in the data analysis phase. This writing describes an attempt to create computer application to help higher education institution in doing SWOT analysis. Our application is language dependent because we use forms of natural language processing, such as sentiment analysis. Hence, the study is limited to cases in Indonesia. The rest of the paper describes related works, research methodology, validation and discussion, and conclusion.

2. Related Works

The study adopts Indonesian Higher Education Accreditation System to build a series of questions and obtain the SWOT matrix. Some rule based method and weighting process was implemented to construct the SWOT matrix based on the user's answer. We have explored previous studies that discussed about several SWOT analysis approach. As far as we know, efforts to build a SWOT analysis system in the education domain has not been carried out. This study seems to be the first attempt in automating the SWOT analysis process, especially in the Indonesian educational environment. Furthermore, we have not been able to discover researches that utilize natural language processing and sentiment analysis for the purpose of SWOT analysis.

Houben, et. al is among the first teams that attempted to automate SWOT analysis⁸. They use knowledge-based system where a knowledge engineer interviews a user with questions from the list of the system. The study was an initial attempt and improvements are still needed. Then, Kurtilla et. al. initiate to use decision making technique in building SWOT analysis systems⁹. They use Analytic Hierarchy Process (AHP) to determine the priorities between the SWOT factors. The latest attempt, Yuksel et. al. replace AHP by the ANP (Analytic Network Process) to improve the AHP by taking in to account measurement of dependency between the strategic factors⁷.

Efforts to automate SWOT analysis in bahasa has been rare. Employ short text classification techniques to classify statements in bahasa into SWOT categories have been attempted¹¹. Recently, there has been an attempt to create a SWOT analysis tool for Indonesian small and medium enterprise that uses multiple-choice questions as data collector and employs presumed weight and rating as SWOT classifier¹². The latter study has gone further by trying to generate general strategies as an output.

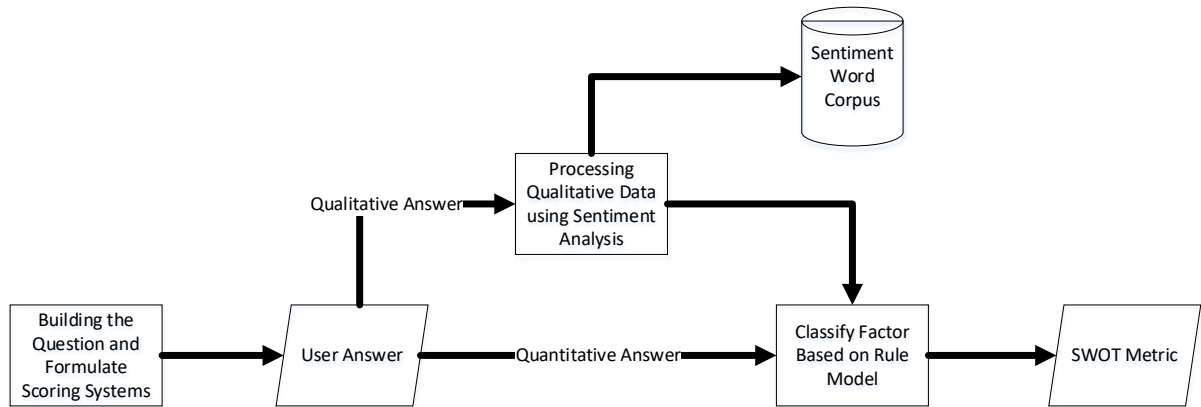


Fig. 1. System Architecture

In helping the analysis process on the user input text, the author also conducted a literature study on the sentiment analysis method especially in Bahasa. Free text data input from a user tends to contain subjectivity. Sentiment analysis aims to estimate whether the data expresses positive or negative opinion¹³. There are two approaches that can be used to determine the level of sentiment, supervised¹⁴ and lexicon-based¹⁵. Supervised method is capable of achieving a good accuracy but it needs data training that is time and labor consuming to build. In addition, this method is topic-dependent where the performance will decrease when it is applied on different topics. So although the lexicon based methods are still not able to achieve good performance, it has an advantage of being topic-independent¹⁶. There are several approaches that already been used to help in determine sentiment level of sentences in Bahasa^{14, 16, 17}. The latter approach will be adopted in this study to classify the sentiment level of sentence.

3. Research Method

In this study, we built a questionnaire-based system in order to automate SWOT analysis process (see Fig. 1). The SWOT matrix is built upon the questionnaire responses of a university stakeholder. Answer to each question may be quantitative or qualitative. Qualitative text answers need text processing in the form of sentiment analysis to help determine whether the response has positive or negative mood.

3.1. Building the Question and Formulate Scoring System

The first step of this study is building the question for the system. Questions are obtained from the Indonesian Higher Education Accreditation System. The accreditation system has several criteria to assess the quality of a study program in higher education level. In total, there are 7 criteria and 100 sub-criteria which has detailed explanation for each criteria. We extract about 70 questions that is classified in to two groups of questions, i.e. external and internal questions. External questions ask about the external factors that may influence the study program sustainability from the both of positive and negative side. While the internal questions ask about the internal factors.

Beside of external and internal grouping, questions is also classified in to two categories, i.e. quantitative questions and qualitative questions. Quantitative questions provide answers that can be immediately classified in to several quality categories. For example, there are several categories that classify the quality of teaching process based on the ratio between the number of students and the number of teachers. For such a case, the quantitative question asks about the number of teacher and students, and then the system calculates the ratio. Therefore, the answer of quantitative question can be used immediately in the next process to classify factor based on rule model. Unlike the quantitative questions, the answer of qualitative questions need to be processed before advancing to the next step. The explanation of the process will be given in the next section.

The scoring process is also formulated in this phase. Every extracted question has different score value. We give weight for each question based on its importance level. The weight score is taken from the Indonesian Higher

Education Accreditation System. Similarly, the answer categories is also adopted from the accreditation system. These categories help the SWOT system to assess the answer of a user. The result of this phase is a set of questions and its weight score including answer categories. The next step are building the SWOT analysis system and deploy questions. The user answer on the SWOT system is processed in the next phase.

Beside of the weight for each question, we also define the scoring process for quantitative answer in this phase. The answer of each question will be classified into four classes including very positive (if the score is very good), positive (if the score is good), negative (if the score is poor), and very negative (if the score is very poor). For the qualitative data, the scoring process is included in the next phase, sentiment analysis on qualitative data.

3.2. Sentiment Analysis on Qualitative Answer

A qualitative answer needs to be processed using sentiment analysis before it is classified into SWOT matrix. A qualitative answer is usually in the form of text description. We use dictionary based sentiment analysis to classify the text data into positive or negative response. We calculate the total of sentiment score and classify the sentiment for each data. SentiWordNet¹⁸ is used as a sentiment lexicon to get the sentiment score of each word. SentiWordNet is a sentiment lexicon that use WordNet as its development basis. Therefore we need a method to choose which synset of each word that will be taken because of polysemous issue in the WordNet. In this case, this study implements First Sense and Average Sense to obtain the score of each word. First Sense approach takes the score of the most popular synset of each word, while Average Sense takes the average sentiment score of each word. After obtaining the sentiment score from the SentiWordNet, then the calculation by using the Equation (1) and (2) are implemented.

$$S_{positive} = \sum_{i \in t}^n positive\ score_i \quad (1)$$

$$S_{negative} = \sum_{i \in t}^n negative\ score_i \quad (2)$$

Semantic orientation of each data is calculated using equation (1) and (2). These equations calculate the sum of all negative score and positive score. Thereafter, equation (3) is used to classify the sentiment of each data by comparing the total of negative and positive score.

$$Sentence_{sentiment} \begin{cases} positive\ if\ S_{positive} > S_{negative} \\ neutral\ if\ S_{positive} = S_{negative} \\ negative\ if\ S_{positive} < S_{negative} \end{cases} \quad (3)$$

There are three categories of sentiment including positive (if total of positive score greater than negative score), negative (if total of negative score greater than positive score) and neutral (if the total of negative and positive score are same). After each data has been classified, then these data will be processed in to the next step, classifying the factor based on the rule model.

3.3. Classify the Factor Based on Rule Model

The purpose of this phase is to classify the factors into appropriate SWOT categories including strength, weakness, opportunities, and threat. Both of quantitative and qualitative answer is placed into a SWOT category. The assigning process is based on the score (quantitative data) and sentiment (qualitative data). We build a rule model to classify the factor based on the user answer (see Table 1).

Table 1. Rule Model

		Score	
		Positive	Negative
Factor	Internal	Strength	Weakness
	External	Opportunity	Threat

The rule model in Table 1 is implemented for both quantitative and qualitative data. This rule differentiates the answers based on external (answer from external question) and internal (answer from internal question) classification. After that, we need to classify the answer to positive or negative score. For quantitative data, if the answer has very good or good score then it will be classified to positive score. Meanwhile, if the answer has very poor or poor score then it will be classified to negative score. Then, the score for qualitative data is immediately classified based on its sentiment value. After each answer has been classified to internal or external and positive or negative, then these answers can be immediately classified to SWOT categories. Based on the rule on the Table 1, we can see that the answer is classified to Strength (if it is an internal answer and has positive score), Weakness (if it is an internal answer and has negative score), Opportunities (if it is an external answer and has positive score) and Threat (if it is an external answer and has negative score). The final result of the application is a SWOT matrix. The matrix shows an argument that contains statement of each answer. The statement is built manually based on the answer of each question.

4. VERIFICATION, VALIDATION AND DISCUSSION

4.1. Verification

Verification is an activity to ensure that the system has been built in the right way. The objective of verification is to ensure that a system fulfills user requirements. However, it is hard to achieve the ultimate requirement of a SWOT analysis because it produces a matrix containing statements and strategies that are obtained using a comprehensive analysis. Therefore, we define the target is to build a system which is capable of producing a SWOT matrix with reliable statements on the right place, operates easily, captures a higher education accreditation system in Indonesia, and runs on a personal computer. Up to now, the system is able to translate the Accreditation system in Indonesia including the scoring and the assessment system. The system is also able to provide facilities to make it easy to operate. The question-answer system was designed to make it easy to be answered. The system is well implemented and easy to use. Then, absolutely the system can be run on the personal computer. We built web-based system using Django Framework. Lastly, the output of the system can be categorized as a reliable one. The system assesses user answers mostly based on the standard accreditation system assessment so the output is reliable to the extent acceptable by the standard.

4.2. Validation

Validation is a task to ensure that the system give correct and precise output. We face several difficulties in assuring the validity of this system. It is understood that expert system is not completely objective¹⁹. Therefore, the validation process on expert system still have several issues²⁰. For example, when someone goes to two different doctors with the same case. The two doctors can give different diagnosis, advice, and medicine. These differences can be caused by the different level of experience or expertise. Such an issue proves that expert system is not fully objective system while we implement the system based on exact rule. Therefore, we validate the output of this system using expert opinion.

At this stage, we have tested the system by using one case study of higher education study program. The result of the system is asked to an expert about its validity. We define an expert as a person who has experiences in building SWOT analysis manually in the domain of higher education environment. In our case, the expert is also an assessor of the National Accreditation Board with experiences in assessing SWOT matrices of many study programs. The

opinion of the expert regarding to the output validity is quite positive. The system is already capable of producing a comprehensive SWOT matrix that is consistent to its real situation.

However, there are still issues that should be addressed. The expert could hardly remember every detailed items of evaluation criteria in the standard accreditation system. Therefore, his opinion did not completely follow the standard. Another issue is the accuracy of classifying the sentiment of text answers. There is one misclassification on sentiment analysis that results to misplacement of a statement in a incorrect SWOT matrix cell. Approximately 20% of the system output was rejected by the expert. Several rejected outputs seemed to arise from misinterpretation because a clearly external aspect is recommended by the expert as strength.

4.3. Discussion

The application has given output that represents the result of a SWOT analysis. It is able to automate the SWOT analysis process in the domain of higher education. Study program stakeholders in universities can make an analysis of their study program situation more easily. The output of this system can help stakeholders in making a decision considering their surrounding circumstances. It is expected that using the system will reduce the time in performing a SWOT analysis. The system is also able to produce an objective analysis based on real situations. The use of standard accreditation system as a basis rule in building the system is believed to enable it to provide reliable output.

We need to declare that this is a report of an ongoing research. There are still works to do in order to improve the output of the system. Improvement on sentiment analysis method is one of our objective for the further development. Error in classifying sentiment of the answer give a great impact on the SWOT matrix produced. Furthermore, we need to get more opinion from more experts to get a more comprehensive analysis. To the current stage, getting opinion from an expert appears to cause bias on the result.

Experience is the most influencing factor for experts in giving their opinion. There seems to be a need to let the experts remind about details of assessment criteria and scoring of the standard Indonesian Higher Education Accreditation System prior to giving their opinion about the application output. It is because that the accreditation system has so many assessment criteria that experts might not be able to remember them all.

The current research has a limitation in that we use Bahasa Indonesia to map SWOT matrix. Language dependency cannot be eliminated because mapping requires natural language processing, i.e. sentiment analysis. Future research is possible so that the application allows a user to input free text statement. The application has a task to classify the statement into one of the four cells in SWOT matrix. For this to happen, the application needs not only a sentiment analysis to identify the mood of the statement but also a text classifier to identify whether the statement belongs to internal or external factors. Such classifier for Bahasa Indonesia is apparently unavailable but studies to build one have been attempted including by ²¹ and ²².

5. CONCLUSION

SWOT analysis is an essential process in building strategic planning of a study program in higher education institution. Study program stakeholders usually assume that conducting a proper SWOT analysis is an expensive and time consuming activity. This study has attempted to provide a facility for them by building a system that helps constructing a SWOT matrix automatically. The system is able to simplify the SWOT analysis process. The output of the system is potentially reliable based on the expert opinion. However, parts of the system still need to improve. First, more experts are required to get more comprehensive opinion and reduce a biased analysis result. Second, sentiment analysis method need to be modified to get better accuracy in classifying the sentiment of user answer. Nonetheless, this study is a good start in exploring the possibility to build automatic SWOT analysis system in the domain of Higher Education by exploiting several rule based and sentiment analysis method.

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