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PAKAR-UKM - EXPERT SYSTEM FOR SMES USING DYNAMIC KNOWLEDGE BASE

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ABSTRACT

The rapid developments in the field of Information and Communication Technology (ICT) opens wide opportunities for Small Medium Enterprises (SMEs) in Indonesia to be able improving its performance in producing, marketing and even to conduct business planning by analyzing patterns of every days business transactions. Additionally, ICT costs in Indonesia are getting cheaper, and the changes of SMEs activist perception that ICT can be improve the performance of their business had increase the value of their confidence towards more intensive the adoption of ICT in their works. However, the adoption of ICT process is still experiencing obstacles such as a lack of expertise and skill in producing or managing advanced technology in line with business needs. One solution is the assistance offered by the ICT practicing, to get a optimal solution, So the ICT is not only used for business operational purposes only, but furthermore can be used as business Intelligence function for SME business development planning. This study was a meta-analysis of the behavior patterns the adoption of ICT by SMEs in Indonesia from individual studies that have been done before. Based-on that study, we designing a business intelligence system that best suits to the characteristics of SMEs business behavior were found. In general, the expert system can be use as the most suitable method for SMEs in Indonesia, and in this study, we have accomplished developing a prototype of expert system with a dynamic knowledge based using data mining by doing a classification and web crawling to generate high quality results to accommodate decision making for small and medium enterprises.

Keywords: expert system, SMEs, data mining.

INTRODUCTION

Small and Medium Enterprises (SMEs) in Indonesia is one of pillars Indonesian economy which must be protected and maintained the sustainability. From surveys conducted by Center Statistic Bureau of Republic Indonesia - BPS (Biro Pusat Statistik) and Kementerian Koperasi dan UKM (Ministry Cooperation and SMEs of Republic Indonesia), from year to year SMEs have proved very helpful to absorb labour, and have a high contribution to increase the value of exports and Gross Domestic Product (GDP) [1], [11]. Although the role of SMEs is very strategic, but the stright business competition in Indonesia, especially against the big companies and other modern competitors, it have put SMEs in a disadvantageous position. In Indonesia, the majority of SMEs doing business with traditional ways, including in the production, marketing and planning. So, the rapid development of information and communication technology (ICT), it should have present an enormous opportunity to improve the quality of business SMEs.

However, there are still barriers the use of ICT for SMEs. According to research conducted by [6], there are a several factors that inhibit the level of use of ICT by SMEs. These factors include:

1. Non-compliance of business processes.
2. Limitations in terms of managerial knowledge and skill to use of ICT.
3. The cost of development and maintenance of electronic systems.
4. The problem of computer network infrastructures and communications.
5. Issue of trust and security of the use of ICT.
6. Legal uncertainty Issues relating to the use of ICT in business.
7. The challenges associated with the adoption of electronic business processes.

Indirectly, the OECD research report indicates that, although ICT is not the only solution to improving the business performance, the use of ICT to strengthen business strategies have a positive influence to contribute to the improvement of the performance of the company, for example, it can increased market share, increase product diversity, product customization, or can give a better response to consumer demand.

At this research, we describe a steps that needed to be taken in ICT adoption by SMEs in Indonesia, starting from the analysis of the utilization of ICT that have been implemented by the SMEs in Indonesia, classifying proper intelligent technologies used by SMEs to support their business, not merely to support the business operations, but also to run the business intelligence process. At the end, we try to build a prototype intelligent web-based application that can helps SMEs activists to make business decisions and maintain their business.

RESEARCH METHOD

The research methods used in this study are:

1. Descriptive meta-analysis of previous research publications. The method meta-analysis implemented by analysis the results of research publications collection, in order to integrate these findings and get clear patterns of ICT adoption by SMEs in Indonesia. We use a descriptive analysis to determine the characteristics of a variety of research consisting of:
(a) Aspects the use of ICT by SMEs, which include the types of ICT adopted by the SMEs in Indonesia. The method of analysis used to model the adoption of ICT by end users, and to make a models of the relationship of ICT to the performance of SMEs.
(b) Aspects the study of intelligent systems, which include the type and method of use of a smart system that can easily adopted by SMEs.

2. Design of the prototype system, includes:
(a) Design of expert system, which consists of determining the knowledge base, the inference engine manufacture and design of the user interface.
(b) Decision support system design, which consists of keyword classification and methods of web crawlers.

DESCRIPTIVE META-ANALYSIS METHOD

a) Analysis aspects the use of ICT by SMEs

The goal of this section is to determine the characteristics of the use of ICT that include:
(a) Types of ICT services used by SMEs in helping business activities and decision-making.
(b) The effect of the use of ICT and the Internet by SMEs in Indonesia.
(c) Research area covering Jakarta, West Java, Central Java, Yogyakarta and Lampung.

The usage of Information Technology (IT) by SMEs in Indonesia, is more to operational (such as administration, accounting, human resources, advertising, production, inventory, internet), as from the research study in [2] and [3] in western Java, study by [1] and [5] in central Java, analysis study by [12] and [13] in big cities such as Jakarta, Bogor, Depok, Tangerang, and Bekasi. It also has been found several research studies that using information technology as decision support system for advertising strategy, as what has been done by [14] in Lampung region. However all of those studies are still in the form of concept and not yet become a tool of decision support system that can be used by small and medium enterprises directly.
The observation result can be seen in Table-1.

Table-1. The use of ICT by SMEs in Indonesia.

No	Publication	ICT Service type	The influence of ICT	Areas of Research
1	Ahmad Budi Setiawan, 2007 [1]	Administration, accounting, human resources, marketing, production, inventory, internet	not specified	Central Java
2	Arief Rahmana, 2012 [3]	Administration, accounting, marketing, production	Data input, production support, , business strategy	West Java
3	Victorianus Aries Siswanto, 2009 [15]	Administration, accounting, marketing	not specified	Central Java
4	Arief Rahmana, 2009 [2]	Administration, accounting, marketing, production	business strategy	West Java
5	Toto S etc, 2008 [13]	Administration, internet	Marketing support	Jakarta, Bogor, Depok, Tangerang, Bekasi (Jabodetabek)
6	Fathul Wahid dan Lizda Iswari, 2007 [5]	Administration, accounting, marketing, production	business strategy	Yogyakarta
7	Teddy Oswari etc, 2008 [12]	Administration, accounting	Data input, kebutuhan	Jabodetabek
8	Wheny Khristianto, 2012 [14]	Administration, accounting	business strategy	Lampung, Sumatera

b) Analysis Aspects the study of intelligent systems

The implementation of ICT in area SMEs become establishment to support a business plan. One of integrated system can be found at application produced by Deputy Ministry of Resource Assessment for SMEs Businesses at 2008 [4]. This application can be used directly for decision making of investment development, which taking account of production, advertisement, and accounting aspect to measure the feasibility of their business, it is also used to find opportunity and to detect business obstacles around SMEs works area.

Another study which performed by [10] tries to combine expert system as knowledge source which can measures businesses aspects, and the processing of these

knowledge that can provide business advices which can be followed by the enterprise directly and can be accessed broadly because it is based on interactive web. Knowledge of expert system as input in this system become the key of output accuracy which is the business advices given [9]. However, to widen more the knowledge still need addition of function to be able to search automatically knowledge from the internet web that relevant with the users needs.

DESIGN OF PROTOTYPE SYSTEM

i. Expert System

In general, expert system is a system that trying to adopt human knowledge to a computer system, so the computer can solve the problems like that made by experts. In the area of SMEs, one of interesting research using expert system to benchmarking of SMEs business performance can be found in [7]. A survey in our research was intended to get an actual and accurate knowledge base to be used as a source of "Expertise" for the interactive web based application (see Figure-1).

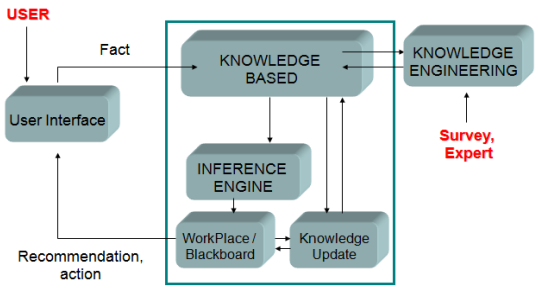

Figure-1. Expert System Architecture.

Inference Engine is a computer program that acts as the brain of the expert system, formulate a methodology for reasoning about information in the knowledge base and in the workplace, and to formulate conclusions based on the available knowledge base. The category type of Small Medium Enterprises (SMEs) may have a number of the same manifestations, so in this case every manifestation is grouped by the type of SMEs, and expert system will use the amount of the value of the findings from each of these manifestations to deduce the type of SMEs which one the most possible fit with the SMEs Employers situation.

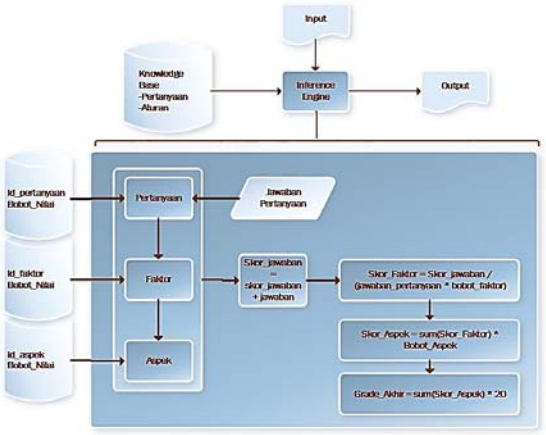

Figure-2. Inference Engine Design.

Inference engine will work while receiving instruction from the user in such of answers from the questions that are displayed in the user interface and the user clicks the submit button. The first process is taking all variables or aspect of the Table as variable. For each variable taken their factors, where for each factor the question and the answer are taken again by the user (range 1-5). If there is a question that is not answered by the user, the value of the question to be considered zero. Score for each factor are calculated by summing all score questions. Then, the summary result is divided by jumlah_pertanyaan is on these factors and multiplied by the weighting factor. The Algorithm can be seen in Figure-2.

To calculate score for each variable or aspect by summing all score factor. Then multiplied by the weighting variable. With this variables score, can be calculated the final score value namely grade rating, which is calculated by multiplying all the score variables with 20.

ii. Decision Support System Design

Development is performed with the addition of knowledge base searching function automatically towards web sites that are related with the small and medium enterprise centers and data banks from related government agencies which fit the given keywords output as solution from the system therefore enrich the results of the expert system. In this research we use Naive Bayes Classifier (NBC) method using data from the output of the expert system. Evaluation process using black box method looking at the matching of the keywords with the web sites which generated directly.

Classification process resulting one of keywords which is subset, element from "class" attributes, result of data testing towards codebook generated by data training in data classification process from the expert system. For example, environment risk attribute has key points of high, medium, and low. The last keyword inserted to the web crawling process contain of series of key points, attributes, and classes from one unit of testing result towards user's data profile.

The next process is web crawling which function is to look for information from the web sites related to the given keywords. Web crawling alone is one of the process of data mining to perform classification in the process of text identification using HTTP access. The result of web crawling will become information such as enterprise categorization, related hyperlinks, and smart information. The design can be seen in Figure-3.

Figure-3. General Overview of Decision Support System.

iii. Classification Design

In training process from Figure-4, the data used are from the expert system data warehouse. Data profiles from each user accounts are highly varied. Therefore, we can't directly use the data for training. Poor data, usually has tendency of losing some of the values from its records, data redundancy, or data outliers, which causing abnormal data. Cleaning is expected to be performed such as adding lost data values or erasing some of the data.

After the data are clean, the next process is transformation. This is related with providing data for training process, which has to take account of the needs from the method. The method used here is Naive Bayesian which tend to sensitive with the data type. Data type that is used has to be the same across the data which is polynomial. Series data have to be discretized, for example, income data can be converted to range data such as $0 to $500, $501 to $1500, and more than $1500. In this way Naive Bayesian will be able to perform classification optimally.

Naive Bayes Classifier (NBC) is a simple probability classifier using Bayes Theorem with high and naive independent assumption. The advantage of using NBS is the method only need small number of training data to determine the parameter estimation that is needed by the classification process. [8].

According to the nature of the probabilistic model, Naive Bayes Classifier can be trained efficiently in the supervised learning condition. In many practical applications, parameter estimation for Naive Bayes is using maximum likelihood method. In abstract, probabilistic model for classifier is a conditional model:

$$P(C, F_1, F_2, \ldots F_n) \quad (1)$$

In the C dependent class with the low number of results or classes, conditional towards several feature variables F1 to Fn. Problem to be faced is when the number of features are large or when those features handle values in large numbers, so that impossible to base the model with probabilistic Table.

Figure-4. Process of Classification Training from Grouping and Suitability.

Naive Bayes Classifier can be combined with the probabilistic model decision rule. One of the general rule is to take the most possible hypothesis, this is called maximum a posteriori or MAP decision rule. This is can be defined as:

$$\text{Classify } (f_1,..f_n)=\text{argmax}C\ P(C=c) \prod P(fF_1=f_1|C=c) \quad (2)$$

The output from this training module is a data dictionary or code book which is classified. Each line of data has different characteristics, and has best practice pointing the data class in each of the lines. For example from the number of users' data profile have characteristics of: capital = $15000/day; expenses = $10000/day; income = $5000/day; number of employees = 100. In best practice, with this characteristic belong to the "developing or intermediate" category. Best practice will resulting model or rule, which is used as testing reference for new data, or from the training data itself.

iv. Web Crawling Design

In web crawling module, the first process is searching each keywords generated by classification module from the small and medium enterprise centers websites, according to url link defined before, see Figure-5. Next is matching each found content, to make sure sentence/words found from the searching process match with what we intended to. This matching process using two functions of indexer and anchor. The result is url link directed to the paragraph or sentences from the websites.

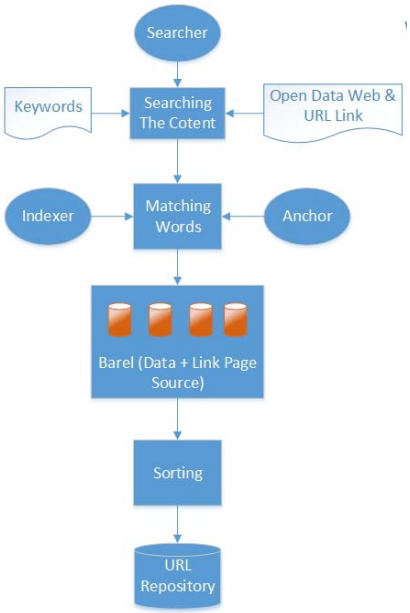

Figure-5. Process of Web Crawling from Small and Medium Enterprise Centers Websites.

Even though the results are only url links, the keywords and paragraph/sentences that are successfully matched are saved in the data barrel. This data barrel will be sorted to determine the rank of web content related to the processed keywords. Next only the URL links that are saved in the repository along with the Meta data extracted from the keywords and the content.

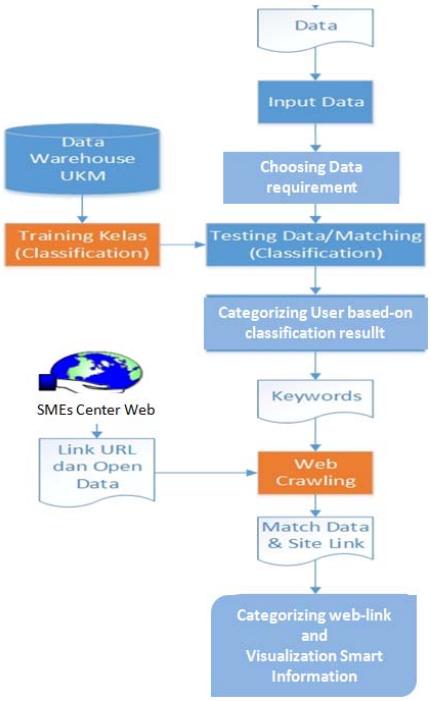

Figure-6. System Integration.

v. System Integration

Each module in this Decision Support System is connected to each other and has connected input and output. The users of this service can be from new registration or old user registered in the system. The input of the data will be checked when needed, even from the new user or old user.

This data profile will be matched with data obtained from the result of training process. The result of this matching are keywords which have been categorized, next step is inserting those keywords to the web crawling process. Web crawling module needs keywords obtained and with url links from the small and medium enterprise centers websites. Then we will obtain the content of data that are fit from the websites like described in Figure-6.

VISUALIZATION

Figure-7. Business Analysis Result on Global Aspect.

The result of expert system is a business score that represent participant's SMEs business which is viewed from their business aspects form their draft or implementation result (See Figure-7). A business score and the global analysis aspect result, and also profile data from users used as input of classification process and web crawling. The classifications results is producing the keywords that will be used by web crawling as a reference scanning data whether in url or data Table from SMEs Organization and Central Bank Indonesia Website. Finally, links the site have been retrieved in accordance with profile and business condition SMEs participant. Links the site is classified become two types of link, i.e. url link that associated with SMEs Business Consultant and another one is some link urls that similar with the kind of participant's SMEs Business, the view is displayed on the Figure-8.

Figure-8. URL Links Website that appears based on keywords for expert system result.

In addition, based on the profile data of the participants of SMES also can be seen the leading commodities that exists around the area of their business. For example in DKI Jakarta, it would appear the leading commodities in Jakarta both sectorial and cross sectorial (see Figure-9). This Data is retrieved directly from the site of SMEs-Central Bank Indonesia automatically using web crawling. The leading commodity Data will greatly assist the participants of SMEs to find the nearest raw material for their business and also to anticipate the external interference on their business.

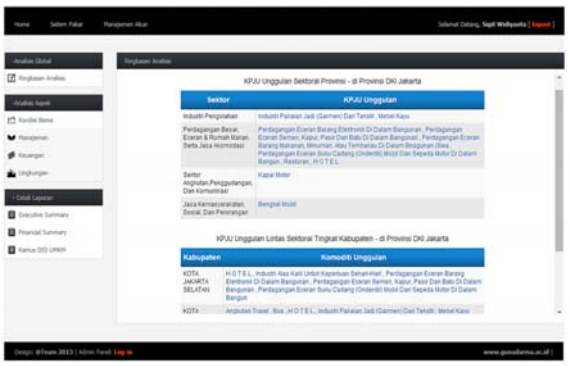

Figure-9. Smart Information of the Leading Commodity in Province.

CONCLUSIONS

In this study we have developed an expert system to measures business feasibility with several main aspects. This web-based expert System for SMEs is a realization of assistance ICT Researcher to support the improvement of SMEs in Indonesia. Beside knowledge base from expert user, we also added expert system knowledge base from gathering data which related to user's business profile and business analysis profile from the web. The usage of Naive Bayes Classifier (NBC) effective to categorize user's business nature or status or attribute in the specific keywords. However, we are still open to other methods such as CART and SVM.

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