ENERGY CROP KNOWLEDGE MANAGEMENT
USING FUZZY LOGIC

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ENERGY CROP KNOWLEDGE MANAGEMENT USING FUZZY LOGIC

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ABSTRACT

This paper proposes a group evaluation structure model in the knowledge management tools for the candidate site of rice straw power plants. The algorithm finds the appropriate knowledge management evaluation (KME) using a fuzzy set theory. The candidate site evaluation is a significant factor in the decision to invest that often involves much information. This information is vague, uncertain and imprecise which leads to the difficult decision-making. Thus the KME is used to decide and evaluate the appropriate candidate sites for power plants. The KME in this research was divided variables into eight modules including capital management, operational management, cost management, material quantity, functionality management, demand-supply KME, and output, respectively. Some modules received the data from the ArcGIS and evaluate the degree of knowledge management capability (KMC) of an organization using a fuzzy linguistic approach. The result of KMC in using the fuzzy system has the advantage of reducing information distortion and to solving the subjective information by a group of evaluators.

KEY WORDS: KNOWLEDGE MANAGEMENT EVALUATION/ FUZZY SET
THEORY/ FUZZY LINGUISTIC APPROACH AND KNOWLEDGE
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110 pages

การจัดการความรู้พืชพลังงานโดยใช้ฟัซซีลอจิก

ENERGY CROP KNOWLEDGE MANAGEMENT USING FUZZY SYSTEM

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บทคัดย่อ

บทความนี้นำเสนอโครงสร้างการประเมินแบบกลุ่มในการจัดการความรู้สำหรับการจัดหาความเหมาะสมพื้นที่ตั้งโรงงานไฟฟ้าโดยการนำพลังงานชีวมวลจากฟางข้าวมาเป็นเชื้อเพลิงสำหรับผลิตไฟฟ้าโดยอัลกอลิทึมจะทำการประเมินความเหมาะสมของการจัดการความรู้เกี่ยวกับสถานที่ตั้งของโรงไฟฟ้าโดยใช้ระบบฟัซซีการปราะเมินสถานที่ตั้งของโรงไฟฟ้ามีความสำคัญอย่างมากในการตัดสินใจลงทุนสร้างโรงงานไฟฟ้าซึ่งเกี่ยวข้องกับการวิเคราะห์ข้อมูลจำนวนมากในกลุ่มข้อมูลนี้มีความคลุมเครือไม่แน่นอนและไม่อาจตัดสินใจได้โดยเด็ดขาดจึงนำไปสู่ความยุ่งยากในการตัดสินใจดังนั้นระบบการจัดการความรู้จึงช่วยในการตัดสินใจและประเมินสถานที่ตั้งที่เหมาะสมของโรงไฟฟ้าระบบการประเมินการจัดการความรู้ในงานวิจัยนี้จะถูกจัดแบ่งออกเป็น 5 โมดูลประกอบด้วยการบริหารต้นทุน, วัสดุ, การนำไปใช้, อุปสงค์-อุปานและการประเมินการจัดการความรู้ตามลำดับข้อมูลบางโมดูลจะรับข้อมูลจากระบบสารสนเทศภูมิศาสตร์และทำการประเมินดีกรีขององค์ประกอบโดยใช้วิธีภาษาศาสตร์แบบฟัซซีผลลัพธ์ของระบบมีข้อดีคือลดความผิดเพี้ยนของข้อมูลและแก้ปัญหาอัตวิสัยโดยเป็นการประเมินข้อมูลต่างๆจากกลุ่มตัวแปร

คำสำคัญ: ระบบการประเมินการจัดการความรู้/ ระบบฟัซซี

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CHAPTER 1
INTRODUCTION

1.1 Statement of Problem

Thailand needs to survey new energy resource in order to replace with Petroleum energy which is rarely consumed now. Alternative Energy is another resource which will be replaced with fossil fuel. It is divided into 2 categories; Non-Renewable Energy is a kind of alternative energy which could be completely consumed i.e. coal, natural gas, oil shale, etc. And Renewable Energy is a kind of alternative energy which could be renewed i.e. sunlight, wind, water, etc. The most famous energy now is biomass which is produced as the Alternative Energy and decrease fuel import from oversea. It is the benefit Agriculture.

Energy crops are the part of plant which can make a fuel. This is the energy from plants as clean energy. The current emerging all the time. Or run over biomass energy. To replace the use of renewable energy. The use of alternative fuels, biomass fuels petroleum has been developed in many European countries such as India and Europe is known about environmental protection. Petroleum buyers do not just pay for fuel only. But will have to pay very high tax of environment. It has contributed to environmental damage caused by the use of petroleum the greenhouse gas emissions and the associated resource is not difficult to emerging away. When petroleum fuels more expensive to the development of renewable energy are cost-effective easy.

The materials are used to extract to biomass called types of energy crops, such as olive, peanut, corn, tallow, safflower and soybean etc. The crops are planted which appropriate in local will be surveyed about soils, terrain and climate. As well as the distance between each power crops. This will be a shipping cost to manufacture.

This research is a presentation of knowledge management in the search for candidate sites for rice straw power plants. The research was developed and designed to help analyze the various complexities of data and problems such as the search for

candidate sites for power plants which need to be located be near rice fields and communities in order to reduce costs for the transportation of rice straw and electrical supply. Furthermore, the candidate sites need to be within close proximity to roads for transportation convenience. Citation from geographical analysis is required to acquire the most suitable candidate site in each province. Then an evaluation system using various factors such as land price, quantity of raw materials and demand for electricity is employed. Once this data is analyzed, it will affect investment also be suitable for use in analyzing risks or projections for the future.

1.2 Objectives

1) To collect the knowledge type data of energy crop, and located area of energy crop.

2) To apply the knowledge management with GIS.

3) Use of the fuzzy system as a tool for energy crop analysis and appropriated position of plant.

4) Use the knowledge information to help decision making for planning and investing.

1.3 Scope of Work

1) To study about the energy crops.

2) Use the knowledge management with fuzzy system to evaluate the plant location.

1.4 Expected Result

1) The knowledge of appropriated information for energy crop, located area of energy crop.

2) The knowledge of fuzzy system application.

3) The fuzzy knowledge management prototype system for planning and decision making to invest the rice straw power plants.

CHAPTER 2
LITERATURE REVIEW

2.1 Fuzzy Logic

Logic started as the study of language in arguments and persuasion, and it may be used to judge the correctness of a chain of reasoning, in a mathematical proof for example. In two-valued logic a proposition is either true or false, but not both. So, The "truth" or "falsity" which is assigned to a statement is its truth-value.[3] In fuzzy logic a proposition may be true or false or have an intermediate truth-value, such as maybe true. It may be convenient to restrict the possible truth values to a discrete domain, say $\{0, 0.5, 1\}$ for false.

2.1.1 Fuzzy Set

The classical set A defined on the algebra is a collection of objects. Under this definition, each element x in the universal is either in the set or not.

Therefore, the membership $\mu A(Xi)$ is 1 for those elements in the set ($x \ \varepsilon \ A$) and 0 for those out of the set ($x \ \text{not} \ \varepsilon \ A$)

However, a fuzzy set is defined as a collection of nation:

$$A = \frac{\mu A(xi)}{xi} \quad i = 1, 2 \ldots N$$

Where $\mu A(Xi)$ is the membership function that maps x to the fuzzy domain [0, 1] and N is the number of elements in the set. The value indicates the degree of the elements belong to the fuzzy set. Larger values denote higher degrees of the memberships.

The generalized fuzzy set is defined similarly except that the fuzzy domain is [-1,1] comparing [0,1] in general fuzzy domain.

2.1.2 Universe

Elements of a fuzzy set are taken from a universe of discourse, or universe for short. The universe contains all elements that can come into consideration. Even the universe depends on the context.

2.1.3 Membership function

Every element in the universe of discourse is a member of the fuzzy set to some grade, maybe even zero. The set of elements that have a non-zero membership is called the support of fuzzy set [4]. The function that ties a number to each element X of the universe is called the membership function $\mu(X)$

$$S(x_l, x_r, x) = \begin{cases} 0 & , x < x_l \\ \frac{1}{2} + \frac{1}{2}\cos\left(\frac{x - x_r}{x_r - x_l}\pi\right) & , x_l \leq x \leq x_r \\ 1 & , x > x_r \end{cases}$$

Where x_γ is the left breakpoint, and x_r is the right breakpoint. The z-curve is just a reflection,

$$Z(x_l, x_r, x) = \begin{cases} 1 & , x < x_l \\ \frac{1}{2} + \frac{1}{2}\cos\left(\frac{x - x_r}{x_r - x_l}\pi\right) & , x_l \leq x \leq x_r \\ 0 & , x > x_r \end{cases}$$

Then the π-curve can be implemented as a combination of the s-curve and such that the peak is flat over the interval [x2, x3],

$$\pi(x1, x2, x3, x4, x) = \min(s(x1, x2, x), z(x3, x4, x))$$

2.2 Knowledge Management

Knowledge management is an instrument used in the management of knowledge in various tasks aimed at achieving work goals, the development of

personnel and corporate development in becoming organizations of learning. Therefore, knowledge management is not a goal in and of itself, but goals of work teams and organizations are the key conditions. Knowledge can be divided into two categories, namely, explicit knowledge (knowledge in the form of documents or academics in work manuals), and tacit knowledge (knowledge concealed in people such as experiences accumulated in evaluation for candidate sites for rice straw power plants involving multiple elements with a great deal of complexity requiring the expertise of evaluators. Tacit knowledge and explicit knowledge in the form of technical information require learning and draw upon knowledge to solve work problems aimed at achieving work objectives. The method for assessing the Fuzzy System has knowledge management methods for both explicit knowledge and tacit knowledge concealed within experts. However, [5] categorized knowledge management criteria into three aspects, namely, system cost, functionality and seller. Cost is a key factor directly affecting the system provider together with product procurement, intellectual property and training costs. Functionality is a component of various functions, including the management of documents, cooperation in the creation of knowledge organizations and sharing, communication, and continuous measurement of work capacity together with safety. The seller of the system is another key property in software procurement aimed at achieving success for system usage goals, credibility, training services, consultation for maintenance support, upgrades and integration of systems, all of which are requiring consideration.

Knowledge management is not so much a new practice as it is an integrating practice. It offers a framework for balancing the myriad of technologies and approaches that provide value, tying them together into a seamless whole. It helps analysts and designers better address the interests of stakeholders across interrelated knowledge flows and, by doing so, better enables individuals, systems and organizations to exhibit truly intelligent behavior in multiple contexts.

The classification framework presented in this paper can be used in several ways:

- to organize and classify knowledge management methods, practices and technologies by relating them to distinct phases of the targeted knowledge flows

● to examine knowledge flows for understand the interactions and dependencies among pieces of information, communicators and their associated behaviors.

2.2.1 The General Knowledge Model

Knowledge flows comprise the set of processes, events and activities through which data, information, knowledge and meta-knowledge are transformed from one state to another. To simplify the analysis of knowledge flows, the framework described in this paper is based primarily on the General Knowledge Model.[10-11]. The model organizes knowledge flows into four primary activity areas: knowledge creation, retention, transfer and utilization.

(1)   Knowledge Creation

This comprises activities associated with the entry of new knowledge into the system, and includes knowledge development, discovery and capture.

(2)   Knowledge Retention

This includes all activities that preserve knowledge and allow it to remain in the system once introduced. It also includes those activities that maintain the viability of knowledge within the system.

(3)   Knowledge Transfer

This refers to activities associated with the flow of knowledge from one party to another. This includes communication, translation, conversion, filtering and rendering.

(4)   Knowledge Utilization

This includes the activities and events connected with the application of knowledge to business processes.

2.2.2 Knowledge Artifacts

Artifacts come in a variety of forms, including documents, files, papers, conversations, pictures, thoughts, software, databases, e-mail messages, data sets, winks and nods, and whatever else can be used to represent meaning and understanding. Said another way: knowledge artifacts flow among and form the linkages between the activities and events that comprise knowledge flows.

(1) Explicit Knowledge Artifacts

These are knowledge artifacts that have been articulated in such a way that they can be directly and completely transferred from one person to another. This normally means that they have been codified so it is possible to touch, see, hear, feel and manipulate them (e.g. books, reports, data files, newsreels, audio cassettes and other physical forms).

(2) Implicit Knowledge Artifacts

These are knowledge artifacts whose meaning are not explicitly captured, but can be inferred; in effect, the codification process is incomplete. Explicit artifacts can be interpreted totally on their content. Interpreters of implicit artifacts must rely on previously retained knowledge.

For example, the knowledge that a given phrase is a book title tends to be implicit. Rarely is there anything that specifically tells someone that they are reading a book title, as might be the case in an SGML or XML system when <BookTitle> tags explicitly communicate semantic meaning. In most cases, the reader infers the meaning of the words from their position (on the cover of a book), formatting (big, bold and centered) and content (lacking formal subject and predicate).

2.3 Geographic Information System (GIS)

2.3.1 Definition of GIS

Geographic information systems have emerged in the last decade as an essential tool for urban and resource planning and management. Their capacity to store, retrieve, analyze, model and map large areas with huge volumes of spatial data has led to an extraordinary proliferation of applications. Geographic information systems are now used for land use planning, utilities management, ecosystems modeling, landscape assessment and planning, transportation and infrastructure planning, market analysis, visual impact analysis, facilities management, tax assessment, real estate analysis and many other applications.[15]

Functions of GIS include: data entry, data display, data management, information retrieval and analysis.
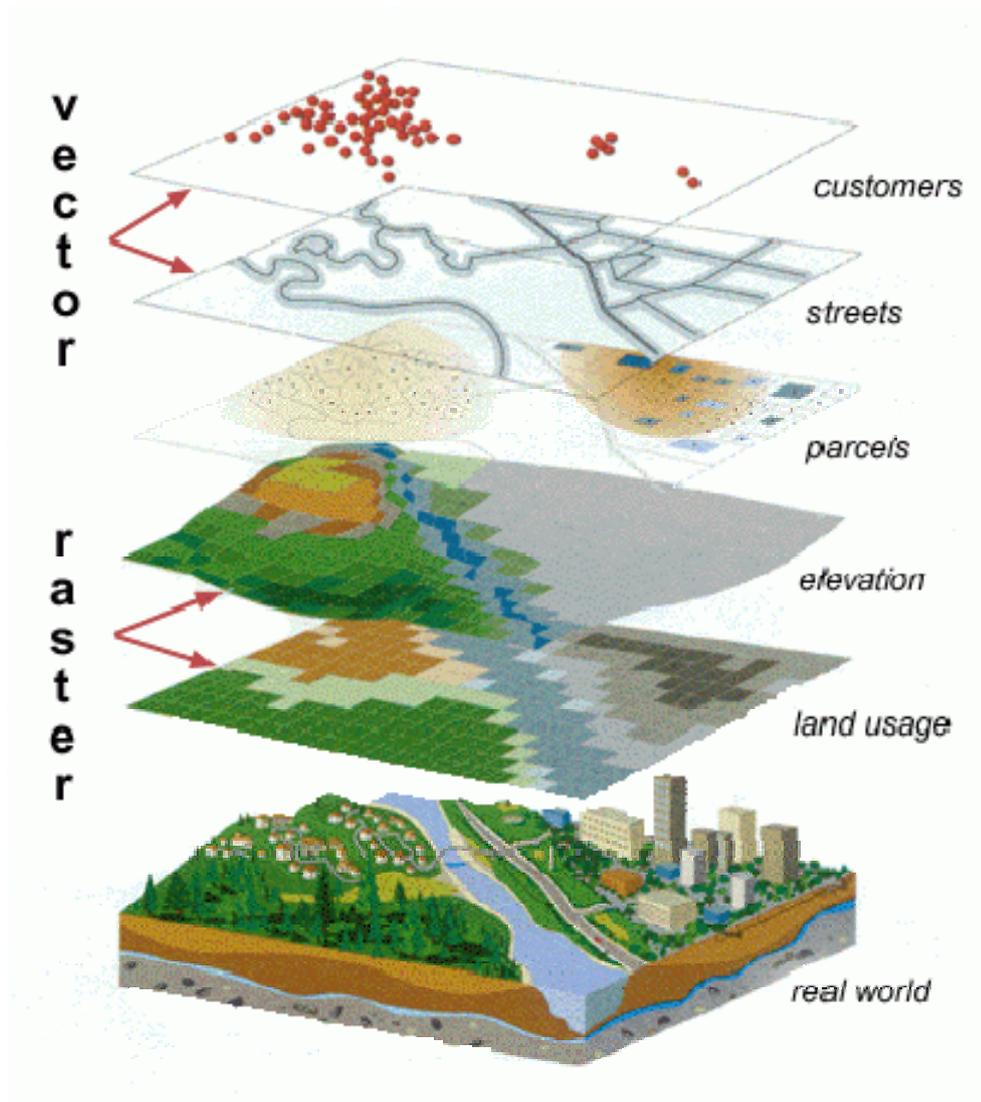
Figure 2.1 The concept of layers

2.3.2 GIS applications

Mapping locations: GIS can be used to map locations. GIS allows the creation of maps through automated mapping, data capture, and surveying analysis tools. [16]

Mapping quantities: People map quantities, like where the most and least are, to find places that meet their criteria and take action, or to see the relationships

between places. This gives an additional level of information beyond simply mapping the locations of features.

Mapping densities: While you can see concentrations by simply mapping the locations of features, in areas with many features it may be difficult to see which areas have a higher concentration than others. A density map lets you measure the number of features using a uniform areal unit, such as acres or square miles, so you can clearly see the distribution.

Finding distances: GIS can be used to find out what's occurring within a set distance of a feature.

Mapping and monitoring change: GIS can be used to map the change in an area to anticipate future conditions, decide on a course of action, or to evaluate the results of an action or policy.

2.3.3 Vector representation of data

In the vector based model, geospatial data is represented in the form of co-ordinates. In vector data, the basic units of spatial information are points, lines (arcs) and polygons. Each of these units is composed simply as a series of one or more co-ordinate points, for example, a line is a collection of related points, and a polygon is a collection of related lines.[17]

- Co-ordinate: Pairs of numbers expressing horizontal distances along orthogonal axes, or triplets of numbers measuring horizontal and vertical distances, or n-numbers along n-axes expressing a precise location in n-dimensional space. Co-ordinates generally represent locations on the earth's surface relative to other locations.

- Point: A zero-dimensional abstraction of an object represented by a single X, Y co-ordinate. A point normally represents a geographic feature too small to be displayed as a line or area; for example, the location of a building location on a small-scale map, or the location of a service covers on a medium scale map.

- Line: A set of ordered co-ordinates that represent the shape of geographic features too narrow to be displayed as an area at the given scale (contours, street centerlines, or streams), or linear features with no area (county boundary lines). A line is synonymous with an arc.

- Arc: An ARC/INFO term that is used synonymously with line.

- Polygon: A feature used to represent areas [17]. A polygon is defined by the lines that make up its boundary and a point inside its boundary for identification. Polygons have attributes that describe the geographic feature they represent.
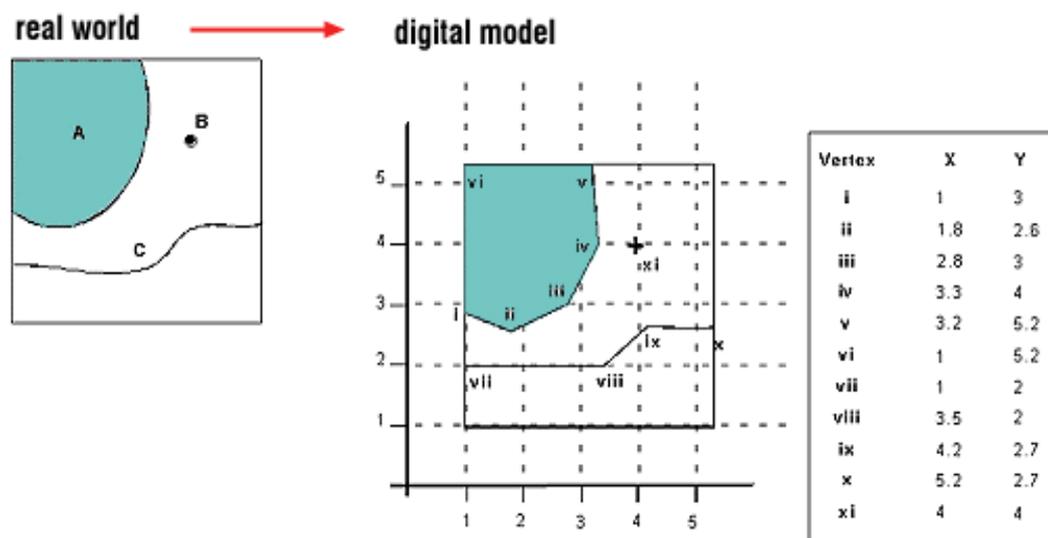
Figure 2.2 GIS Vector of data

2.4 Energy crops

2.4.1 The world's energy supply – A future challenge

Currently some 80% of the world's overall energy supply of about 400 EJ per year is derived from fossil fuels. Nevertheless roughly 10–15% of this demand is covered by biomass resources, making biomass by far the most important renewable energy source used to date. On average, in the industrialized countries biomass contributes by some 3–13% to the total energy supplies, but in developing countries this proportion is much higher. In quite a number of countries biomass covers even over 50 to 90% of the total energy demand. Biomass combustion is responsible for over 90% of the current production of secondary energy carriers from biomass [2]. Liquid biofuels cover only a small part and the most used are ethanol and biodiesel.

Ethanol is produced from sugar- or starch crops, while biodiesel is derived from vegetable oils or animal fats. Currently biogas plays a smaller, but steadily growing role. Traditionally applied for sewage sludge treatment and stabilization purposes, energy recovery from biogas was a welcome by-product. However, biogas has become a well-established energy resource, especially through the use of renewable biomass i.e. "energy crops". Since about 1950, biogas production from manure and or energy crops, continued to develop as an important new farm enterprise.

2.4.2 Crop Factors

The type of crop grown is a decisive variable in predicting environmental impacts from energy crop production; crops have different effects on erosion, water availability and quality, wildlife habitat, and air quality. For example, growing corn is likely to cause more soil erosion and use more fertilizers than growing short rotation poplar. However, because trees use more water than herbaceous crops, they may reduce stream flow. Wildlife will differentiate among crop types; for example, tree crops can provide habitat for forest bird species. Perennial grasses enhance soil carbon more than do annual crops. Tree crops release more hydrocarbons into the air than do herbaceous crops

How the crop is managed also is important Inter planting a cover crop between trees early in short-rotation woody crop production is likely to reduce erosion compared with leaving the soil bare. The types and amounts of pesticides and fertilizers applied and the timing of applications will affect water quality. Harvesting trees during the winter reduces the loss of nutrients from the site because the leaves are not removed [1]. Burning crop residues in the field, as is done with sugarcane, can harm air quality locally and regionally.

Figure 2.3 Rice straw drying after threshing

Figure 2.4 Energy crops

2.4.3 Site factor

The physical characteristics of the soil will severely affect the production of energy crops, and so it is possible that they will grow up by type of soil, climate and topography can influence. Erosion and runoff [12], the type of soil, it will affect the

demand for the use of fertilizers and pesticides and fertilizer rate filter groundwater. Add organic matter content, soil retention of pesticides and nutrients. The climate is warm and pesticides break down rapidly.

The previous use of the land is an especially important consideration when developing policies to promote or discourage energy crops. The difference between the environmental effects of the former land use and of the energy crop determines the environmental value of the energy crop. For example, growing switch grass rather than soybeans (Glycine max) has many environmental advantages. Compared with soybeans, switch grass will increase soil carbon, reduce erosion, improve water quality, and provide better animal habitat. Thus, a policy that encouraged the production of switch grass on former soybean land would have environmental benefits, but a policy that encouraged conversion of forests to switch grass would be environmentally damaging. Valuable forest habitat would be lost and water quality would likely be degraded.

Figure 2.5 Biomass resources

Finally, the location of the energy crops in relation to other land uses will strongly influence water quality and wildlife impacts. Perennial energy crops such as trees or grasses that receive low levels of fertilizers or pesticides can serve as filters if planted along streams. These crops can absorb nutrients coming from more heavily fertilized conventional crops upslope and can catch sediment as it moves downslope. Both actions can improve local water quality. If streamside planting is extensive and nonpoint-source pollution from agriculture is a regional problem, perennial energy crops could improve regional water quality [9]. Planting energy crops on a small amount of land adjacent to streams could have a much larger influence on water quality than planting two or three times as much land upslope.

If planted in a landscape dominated by annual crops, energy crops may enhance regional and local wildlife. In particular, woody energy crops add structural diversity to agricultural landscapes, which should enhance biodiversity on a regional scale. Measurements of abundance, type, and number of bird species have shown that woody crops can serve some of the habitat functions of natural. However, woody energy crops are not a substitute for natural forests. Producing energy crops can harm wildlife if the crops displace a food source in the original land use. For example, birds migrating from Canada to Mexico and South America use the corn left in the fields of the Midwestern U.S. If switch grass displaced large areas of corn in this region, this food source would disappear, with no obvious replacement.

2.4.4 The result of the study of each type of biomass

2.4.4.1 Rice Straw

Rice straw as a biomass crop in paddy crop harvested in a total volume 2552/2553, the three regions surveyed, the total volume was 10,727,682.14 tons/year, equivalent to crude oil of 3,140.37 ktoe/year, equivalent to energy of 7,348,462,267.52 KWh/year, equivalent to the power 874.82 MW (20% of operating the plant, effective 350 days/year) [13], a compilation of the survey and analysis of fuel use and other benefits that. Applications representing 10 percent of the total volume or average.

Therefore, 1,086,774.12 9,640,908.02 tons/year, a potential oil 2,822.23 ktoe/year, equivalent to the energy. 6,604,021,992.72KWh / year, equal to

786.19 MW of electricity in the province. Of grain left in the province, the potential energy is equivalent to Figure 2.6
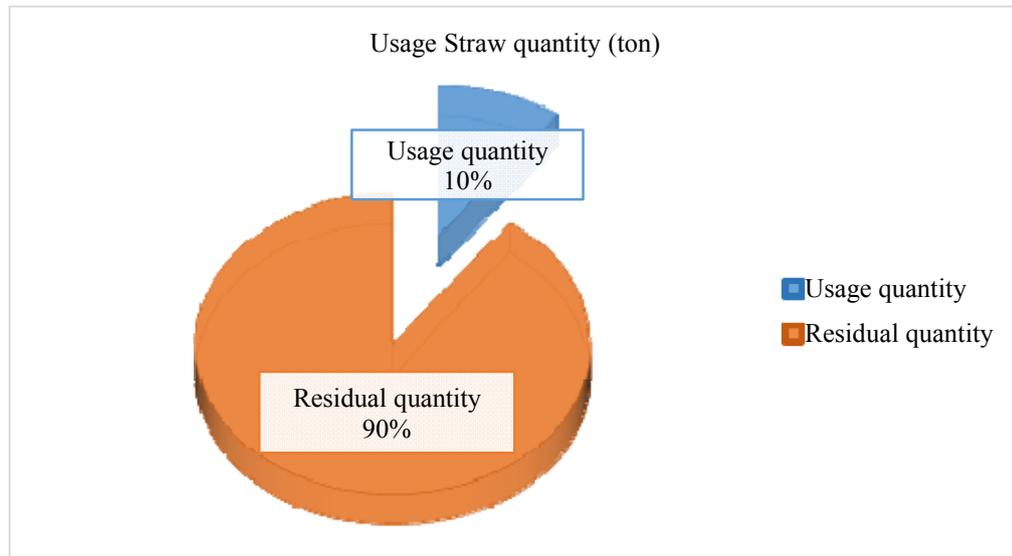
Figure 2.6 The amount of utilization of rice straw

        2.4.4.2 Rice Husk

        Rice Husk is the biomass at the rice mill, community rice mill and steamed rice mill. In crop year 2552/2553 in the three regions surveyed, the total amount of rice husk was 4,597,578.06 tons/year, equivalent to crude oil potential 1,475.77 ktoe/year, equivalent to electrical energy potential 3,453,291,965.83 kW-h/year, equivalent to the electrical power 411.11 MW (plant efficiency is 20% up 350 days/year), from the compilation of surveys and analysis of its use as fuel and other benefits, including, [14]

        1) Produce heat for the mill, approximately 15 percent of the volume equivalent to the amount of 689,636.71 tons/year

        2) Produce thermal energy for use in brick, about 5.5 percent of the volume as the amount of 252,866.79 tons/year

        3) Produce thermal energy for industrial use in cement, about 6.5 percent of the volume as the amount of 298,842.57 tons/year

        4) Electric power generation and combined heat and power plant, about 35 percent of the volume. As the amount of 1,609,152.32 tons/year

5) Produce thermal energy for use in other industries, about 15 percent of the volume. As the amount of 689,636.71 tons.

6) Used in agriculture and livestock such as chicken farms, duck farms, about 6.5 percent of the volume. As the amount of 298,842.57 tons.

7) Proportional to the rice husk use, as mentioned above, the total amount of rice husk that has been used was 3,680,679.20 tons, representing 80.1 percent of the amount of the rice husk.

The remaining rice husks were 916,898.86 tons, representing 20 percent of the amount of rice husks , equivalent to 294.31 ktoe of crude oil or comparable energy, equivalent to 688,692,925.19 kW-h of electric power potential, equivalent to installed power 81.99 MW (plant efficiency is 20% up 350 days/year) in each province. With the remaining rice husk, potential energy shown as Figure 2.7 and Figure 2.8
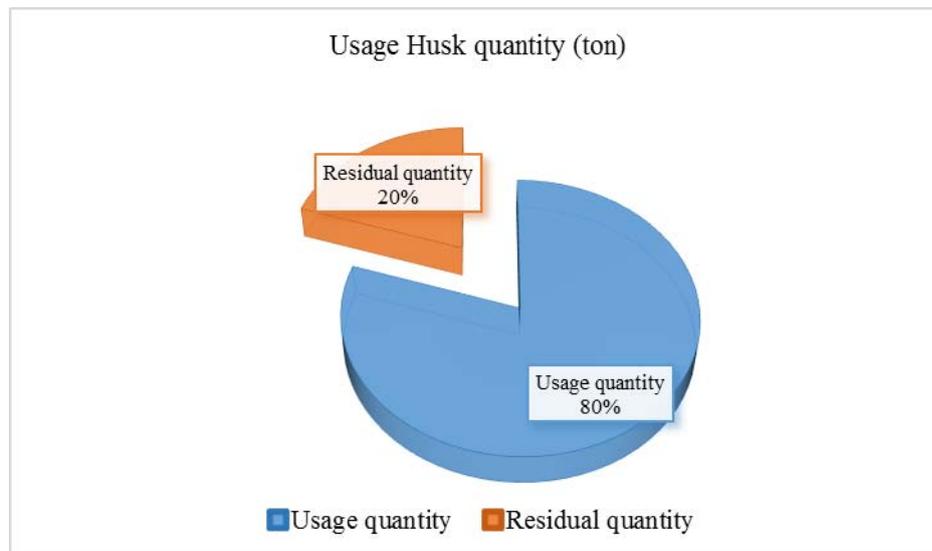
Figure 2.7 The amount of utilization of rice husk
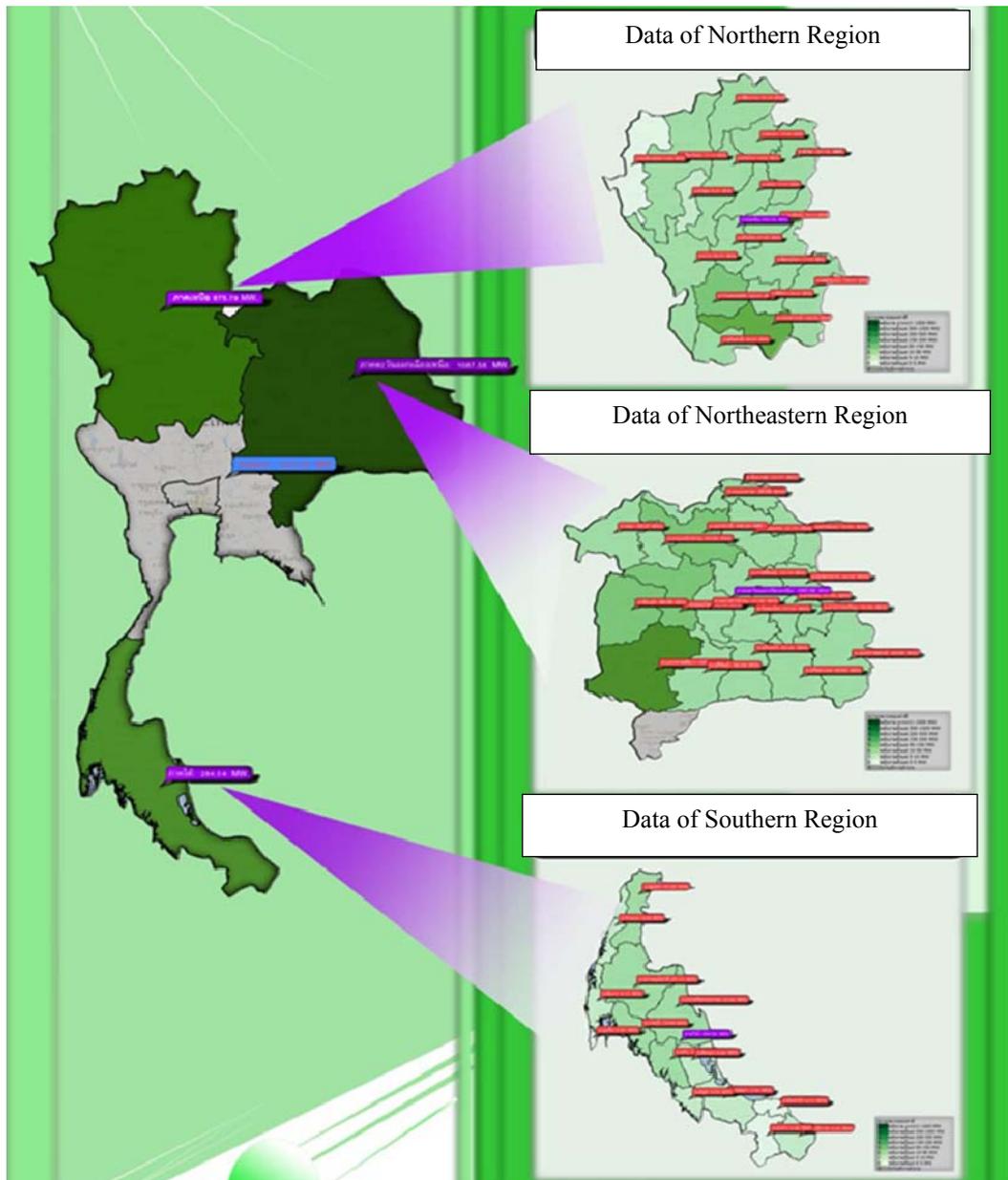
Figure 2.8 Map showing biomass potential in Thai regions in 2010

as shown in www.dede.go.th

Biomass Potential in Thailand 2010
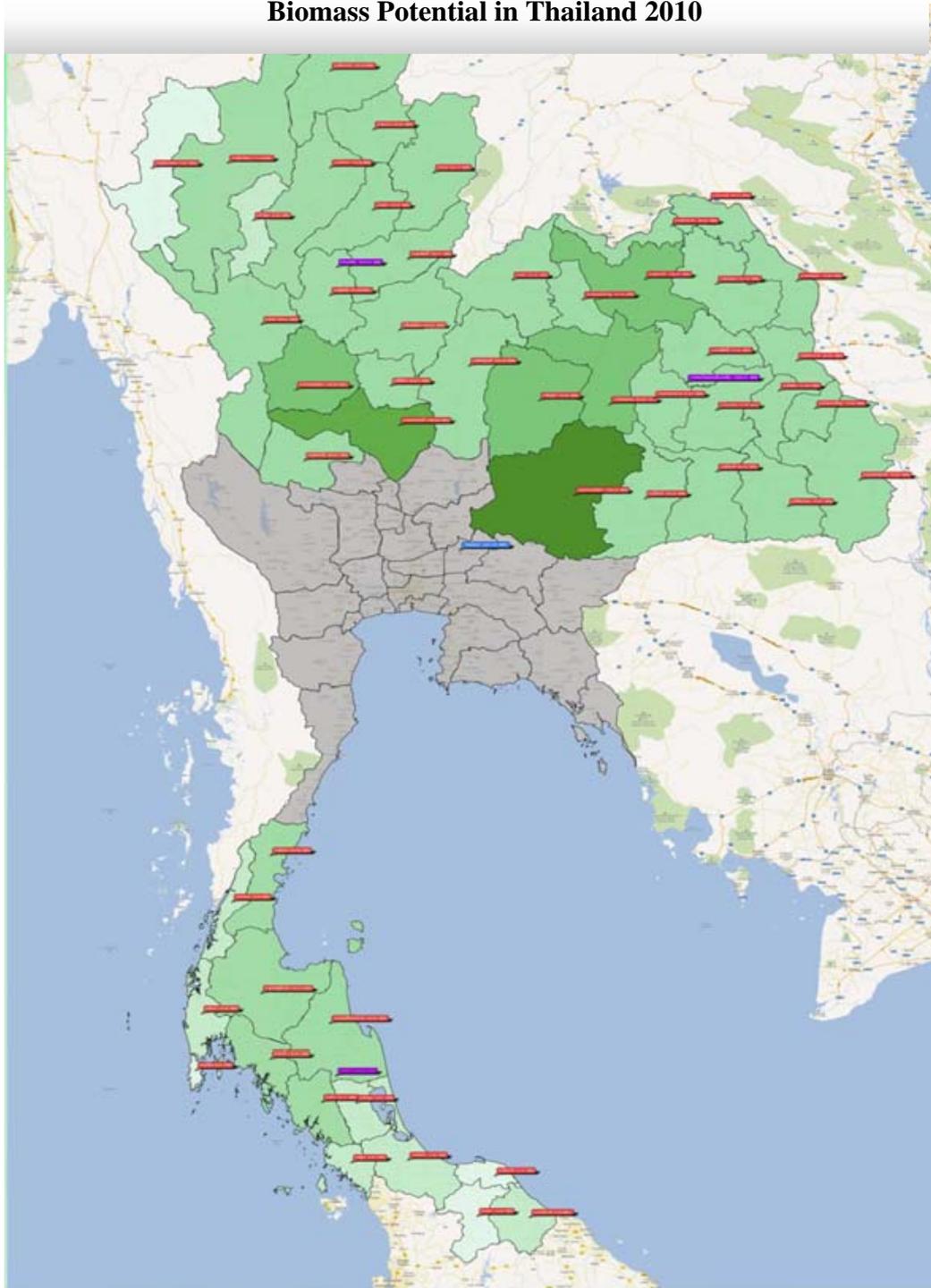
Figure 2.9 Map showing biomass potential in Thai province in 2010
as shown in www.dede.go.th

2.4.5 Biomass Energy

Biomass is composed of materials derived from living or natural organic materials that can be transformed into energy. Biomass includes agricultural waste products such as rice straw, rice husks, corn cobs and cassava roots. At present, factories are seeking ways to reduce production costs by using biomass as alternative energy or by processing it for distribution.

2.4.5.1 Biomass Potential

According to data on agricultural products residual biomass. (The amount of biomass - biomass to be utilized), which has the potential to be used as fuel for energy production is summarized in Table.2.1

2.4.5.2 Effects of Biomass Composition on Energy Production

Biomass is a fancy name for material from plants and animals. Some kinds of biomass can be burned to produce energy. One common example is wood. Biomass contains stored energy. That's because plants absorb energy from the sun through the process of photosynthesis. When biomass is burned, this stored energy is released as heat.

Burning biomass releases carbon dioxide. However, plants also take carbon dioxide out of the atmosphere and use it to grow their leaves, flowers, branches, and stems. That same carbon dioxide is returned to the air when the plants are burned. Many different kinds of biomass, such as wood chips, corn, and some types of garbage, are used to produce electricity. Some types of biomass can be converted into liquid fuels called biofuels that can power cars, trucks, and tractors. Leftover food products like vegetable oils and animal fats can create biodiesel, while corn, sugarcane, and other plants can be fermented to produce ethanol.

Types of biomass, each with different advantages and disadvantages, depending on many factors such as the distribution of biomass resources, due to geographical conditions and differing climates of various areas resulting in vastly different production results. Local supply may be insufficient and require supply procurement from other sources which results in additional transportation costs. If the size of each type of biomass is too large, it is not suitable for direct use as energy because a longer period of time is required for combustion. If the moisture levels of some types of biomass are too high, e.g., cassava fiber, and

brewer's yeast, which contain up to 80-90% moisture, the moisture has to be removed before combustion, etc.

Table 2.1 Biomass compositions

type of biomass	amount of biomass	biomass to be utilized	residual Potential	Moisture	Low Heating Value	Crude oil Potential	Electrical energy potential	Electrical Power-plant potential
	(ton/year)	(ton/year)	(ton/year)	(%)	(MJ/kg)	(ktoe)	(kW-h)	(MW)
Rice Straw	10,727,682.00	1,086,774.00	9,640,908.00	10.00	12.33	2,822.23	6,604,021,992.00	786.19
Rice Husk	4,597,578.00	3,680,679.00	916,898.00	12.00	13.52	294.31	688,692,925.00	81.99
Cane leaves and tops	7,810,955.00	815,995.00	6,994,959.00	9.20	15.48	2,570.80	6,015,665,267.00	716.15
Bagasse	7,644,639.00	7,644,639.76	7,701.29	50.73	7.37	1.35	3,153,251.00	0.38
Leaves and stalks of corn	32,693.27	163,466.00	3,105,861.00	40.00	9.83	724.85	1,696,145,259.00	201.92
Corn cobs	956,876.34	788,822.00	168,054.30	42.00	9.62	38.38	89,815,689.00	10.69
Cassava roots	4,171,526.00	-	4,171,526.00	59.40	5.49	543.72	12,723,155.30	151.47
Palm trunk	1,441,884.00	-	1,441,884.00	48.40	7.54	255.76	598,471,791.00	71.25
Palm leaves and branches	10,529,274.00	326,451.00	10,202,823.00	78.00	1.76	422.48	988,609,367.00	117.69
Palm empty fruit bunch	2,389,622.00	1,417,539.00	972,083.18	58.60	7.24	164.04	383,851,487.00	45.70
Palm fiber	1,418,838.00	1,418,838.00	-	38.50	11.40	-	-	-
Palm shell	298,702.82	298,702.00	-	12.00	16.90	-	-	-
root, stump and rubber tree branches	808,025.00	70,383.00	737,641.50	55.00	6.57	115.06	269,239,147.00	32.05
branches	1,939,260.00	1,939,260.00	-	55.00	6.57	-	-	-
rubber wood Slab rubber wood	1,939,260.00	1,939,260.00	-	55.00	6.57	-	-	-
Rubber wood ship and sawdust	484,815.00	484,815.00	-	55.00	6.57	-	-	-
Leaves and stems of soybean	205,600.00	10,280.00	195,320.00	10.93	16.23	75.26	176,113,558.00	20.97
Leaves and stems of mung bean	110,838.00	5,541.00	105,296.00	10.93	16.23	40.57	94,942,486.00	11.30
Leaves and stems of peanut bean	48,074.00	2,403.00	45,670.00	10.93	16.23	17.60	41,179,737.00	4.90
Total Potential						8,083.00	18,922,217,491.00	2,252.65

2.4.5.3 Energy Production from Biomass

Energy production from biomass can be divided into the following two categories: [7-8]

1) Direct combustion, a process where biomass is transformed into heat energy where the acquired heat levels are dependent on the type and category of biomass. The acquired heat energy is used to boil water in boilers to transform water into steam for use in efficient electricity production and without effects on the environment. Materials suitable to this method include various agricultural biomass materials.

2) The use of heating chemicals to induce gasification, an incomplete combustion used to acquire carbon Monoxide (CO) and Hydrogen (H) for use with gas turbines in the production of electricity.

2.5 Centroid Theory in the Selection of Candidate Sites

In determining the centroid position C_x, C_y of a geometric shape, if the area of that position has gaps or empty space, the empty space is to be calculated as accompanying areas with results shown in negative values based on a non - self-intersecting close polygon, which has n positions and begins at the center of x and y in the sub areas of each shape in order to locate the centroid of the combined area. The initial values are set as follows: $(x_0, y_0), (x_1, y_1), \dots, (c_x, c_y) \ (x_{n-1}, y_{n-1})$.

The values can be calculated from the equation as follows: [6]

$$C_x = \frac{1}{6A} \sum_{i=0}^{n-1} (x_i + x_{i+1})(x_i y_{i+1} - x_{i+1} y_i) \tag{1}$$

$$C_y = \frac{1}{6A} \sum_{i=0}^{n-1} (y_i + y_{i+1})(x_i y_{i+1} - x_{i+1} y_i) \tag{2}$$

Assigned A is a polygon signed area then are the position on the top and calculation in (3)

$$A = \frac{1}{2}\sum_{i=0}^{n-1}(x_i y_{i+1} - x_{i+1} y_i)$$ (3)

After the position is obtained from the use of the centroid theory, the position is marked on a map where the position for each area has to be related to the other control variables, namely, the area amount of rice straw and as close to a road as possible. Conditions can be set in the information technology program (ArcGIS). Data will be obtained as shown in Figure 2.8, a display of the centroid position and rice areas in Pichit.
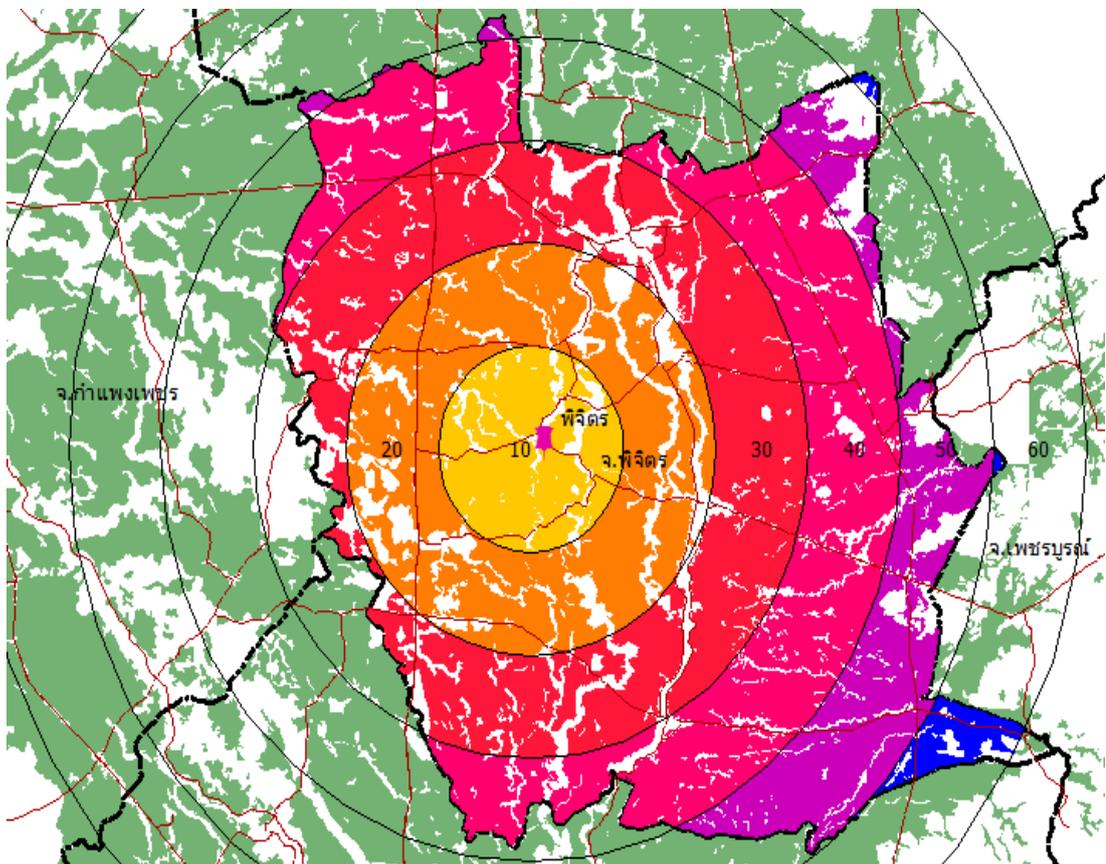
Figure 2.10 Suitable area for the establishment of a plant at Pichit, through the use of centroid theory.

2.6 Related research

Research: S. Maria Wenisch, G.V. Uma and A. Ramachandran [13], have studied a fuzzy inference system for an integrated knowledge management system from India. That proposed for an integrated and holistic approach to knowledge management system for natural resource management needs to take local indigenous knowledge as one of its components for achieving sustainability. The system of indigenous or local ecological knowledge on natural resource is fuzzy. The integration of such fuzzy knowledge requires a methodology for converting fuzzy data into crisp data for a quantitative analysis. The process of arriving at a conclusion from indigenous knowledge fuzzy data is done using a set of fuzzy inference rules. This work shows that fuzzy inference system is an efficient method to demonstrate defuzzification of the local ecological knowledge using fuzzy inference process. The paper builds a fuzzy inference system from the fuzzy indigenous knowledge system on soil. The inference rules are framed from the fuzzy indigenous knowledge on soil as IF...THEN structures. FIS tool in Matlab is used for building a mamdani fuzzy inference system using the inferences. The relationships between various factors influencing the suitability of soil for crops are produced as the output of the suitability fuzzy inference system.

The results have the two inputs, type and structure membership functions have been built. A range from 0 to 1 has been assigned for the types 'black' and 'red'. Structure has three membership functions such as loose, sandy, sticky or hard. Similarly the membership functions for outputs such as suitability coffee, suitability paddy, paddy rice taste, erodability, and fertilizer requirement are also plotted. The appendix presents the membership functions for the inputs and outputs, the two dimensional plots that show the relationships between type and suitability for coffee, type and suitability for paddy, type and paddy rice taste, type and fertilizer utilization, and type and erodability. Similarly the relationships between structure and suitability for coffee, structure and suitability for paddy, structure and paddy rice taste, structure and fertilizer utilization, and structure and erodability are plotted. It is feasible to analyze how the type or structures have effects on these suitability conditions. Analysis combining type and structure with various suitability requirements results in

surface plots. For example type and structure combined with suitability for coffee crop is represented in a surface plot.

Research: Ferdinand Murni H and Rahmat Budiar [10], to have studied a decision support in enterprises business process. The prior methods have been developed based on multiple-criteria. However, these methods are still lack capable to deal with the human judgment, uncertainty and different purchasing policy in every enterprise. That paper proposed fuzzy inference system (FIS) approach to solve the problem in evaluating knowledge management tools. Our aim is to produce useful decision model such as capable to be applied in many different environments of enterprise, reduce time-consuming calculations and be able to handle multiple conflicting criteria. We believe that the system shown can deal with the problem faced by enterprise in knowledge management tools evaluation before implementing the KMS. The test for the fuzzy logic program based on the four screens created in the user interface as discussed in section IV is done through simulation. The input of this simulation attempts to deal with the different value according to a particular enterprise circumstance that might happen in actual practice. The results that have been obtained in this simulation of each main parameter are presented in linguistic and numerical formats. Many different inputs can be given to test the model. In this paper, only 9 typical examples are represented for each fuzzy module. For instance, the user evaluates vendor characteristic factor by push vendor button in main screen, then the vendor sub screen will be appear. The user input the information about the vendor characteristic respective to the FIS by moving the slider of vendor sub factor. Case 8 which the inputs are given as Reputation is Good (88.5), Implementation Partner is Poor (26.7), KM Consulting Services is Best (96.7), Training Provided is High (83.6), Maintenance is Good (77.8), Upgrades is Easy (14.4), Integration is Good (87.6), so that the interface display the result of Vendor Characteristics are "Best". Otherwise, by the similar simulation as in case 1 the result for case 9 is obtained which is the result of situation, the result of vendor characteristic obtained from the nine test run are shown in Table 1. The testing process is also same for the two other factors before accomplishing all evaluation of the KMT, that gives the result of KMT evaluation is Very Good from input values: Costs – Low (31), Functionality – High (75), Vendor – Best (94.8) the result is Poor. Even though what is representing in this paper is just

provide the recommendation to assist any user in evaluating KMT by using FIS and not absolute the correct one. From the result, it can be seen that the FIS for KMT evaluation work properly to suggest the suitable results in any purchasing policy by the parameter that interrelated each factor to the enterprise.

Table 2.2 Result for vendor characteristic simulation

No.	Input							Output
	R	**IP**	**CS**	**TP**	**M**	**U**	**I**	**Vendor Characteristics**
1	Poor	Good	Poor	Low	Poor	Difficult	Average	Poorest
	(7.8)	(87)	(4.1)	(11)	(6.4)	(88.9)	(8.3)	(16.4)
2	Poor	Average	Poor	Low	Average	Difficult	Average	Very Poor
	(12.2)	(68.4)	(7.2)	(13.2)	(31.7)	(86)	(41.6)	(12.5)
3	Average	Good	Average	Low	Poor	Difficult	Poor	Moderatly Poor
	(38.9)	(78.9)	(42.3)	(10.6)	(17.6)	(97.3)	(26.2)	(39.7)
4	Average	Poor	Average	Low	Average	Easy	Average	Average
	(50.2)	(19.6)	(47.2)	(29.8)	(72.5)	(39.7)	(56.7)	(51.6)
5	Average	Poor	Average	High	Average	Easy	Average	Moderatly Good
	(38.8)	(11.3)	(31.2)	(87.6)	(68.5)	(26.8)	(58.4)	(68.7)
6	Good	Average	Good	High	Average	Easy	Good	Very Good
	(91)	(45.3)	(85.7)	(56.3)	(47.5)	(28.9)	(78.6)	(88)
7	Good	Average	Average	High	Average	Difficult	Good	Good
	(92.4)	(52.3)	(47.4)	(56.4)	(47.3)	(67.4)	(74.3)	(77.3)
8	Very Good	Poor	Good	High	Good	Easy	Good	Best
	(88.5)	(26.7)	(96.7)	(83.6)	(77.8)	(14.4)	(87.6)	(94.8)
9	Poor	Average	Average	High	Poor	Easy	Average	Poor
	(11.7)	(60.4)	(21.3)	(52.5)	(40.4)	(24.4)	(27.1)	(23.7)

CHAPTER 3
RESEARCH METHODOLOGY

The research distinguished three sections study and explore factor of energy crop, prepare to knowledge management and prediction information of energy crop using by fuzzy logic to display in form graphs and information. The procedure of the research is shown in Figure 3.1
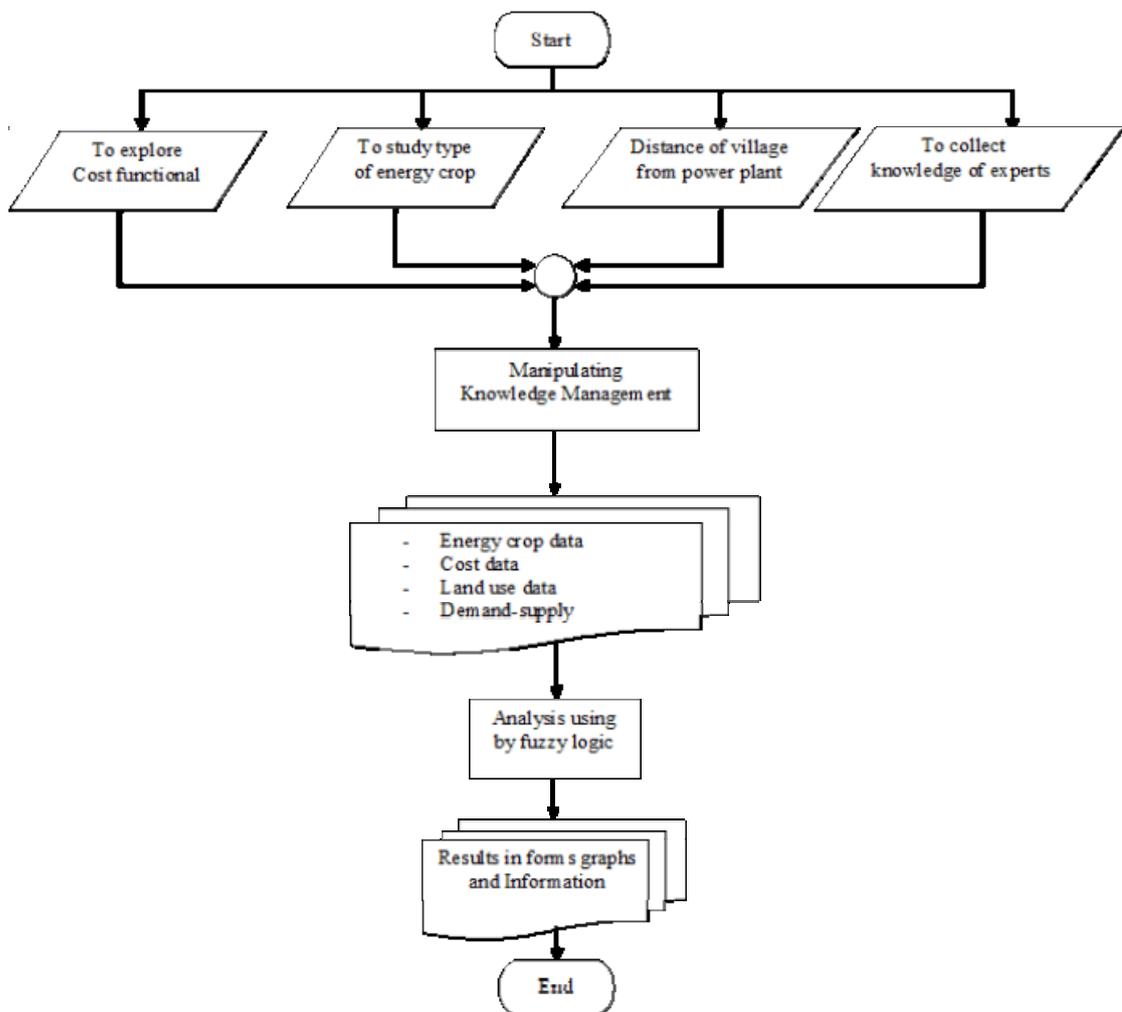
Figure 3.1 The procedure of the research

3.1 To study factor of energy crop

It is very important to first determine the concentration of the source, in this case the energy crops. In doing do, soil samples from active mining in the study area will be collected.

3.1.1 GIS Model – ArcGIS

ArcGIS is designed to meet the needs of the widely available. Elements of the ArcGIS Desktop GIS include

- ArcView

- ArcEditor

- ArcInofo

Choosing to use the software either is up to the needs of organizations that will choose to use the appropriate ArcView can just browse the information is managed under the ArcSDE but ArcEditer with ArcInfo only. Can refine the information obtained under the ArcSDE software, a Client / Server is to manage the spatial database is characterized DBMS (Database Management Systems)
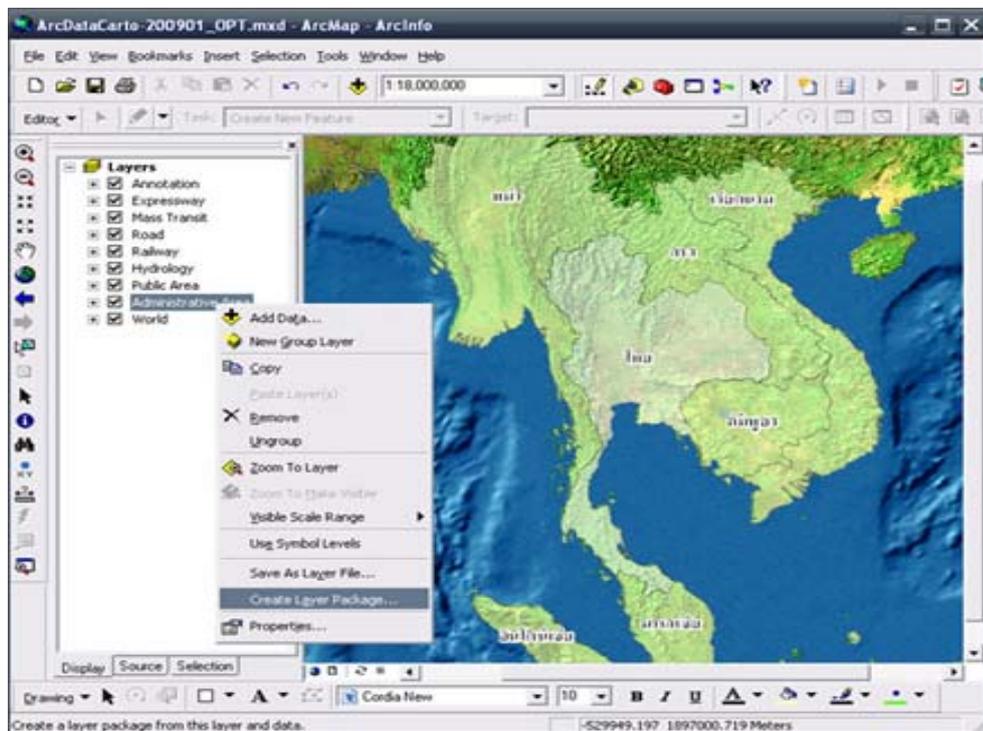
Figure 3.2 Arc Map
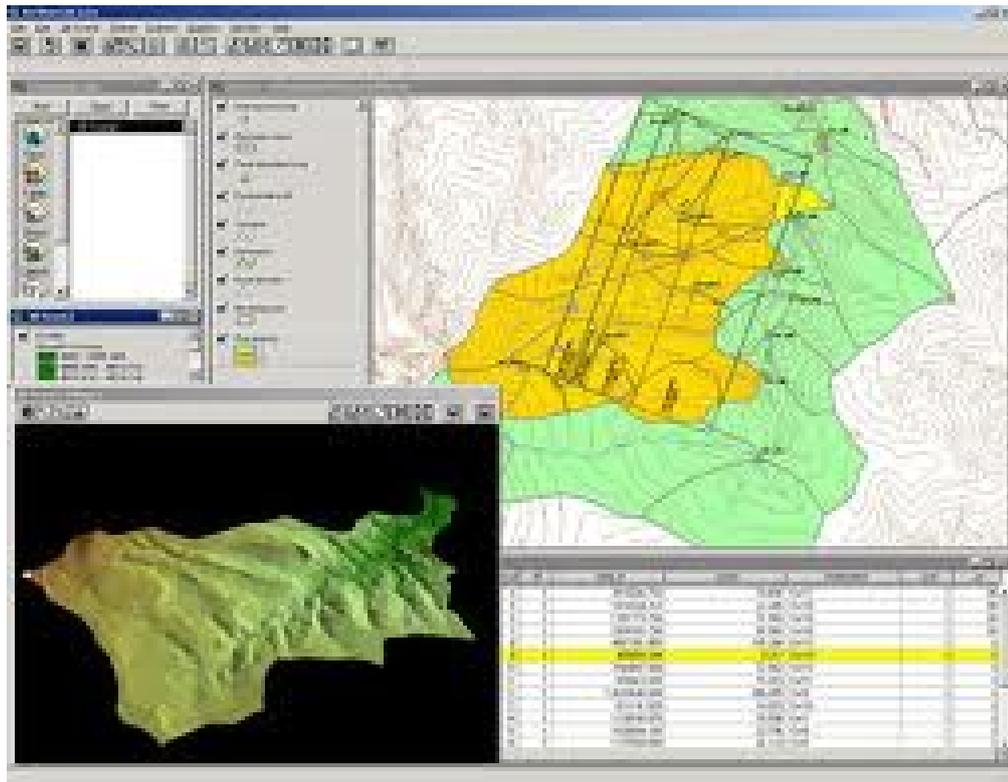
Figure 3.3 Arc view

In Figure 3.2 – 3.3 can use ArcMap, and ArcToolbox applications to search, browse a map to analyze possible.

3.1.2 Expert system

It is a collection of knowledge from experts about energy crops. The access information from knowledge and technical from the experts. Then be collected as information for decision support.

3.2 Manipulating Knowledge management

The study found that the program is appropriate for adoption is MATLAB because of convenience and ease of use. To be used for work related to the prediction can run MATLAB Fuzzy logic toolbox library, which is a set of tools MATLAB program was created for its use. Allows users the convenience of use.

3.3 Analysis using by Fuzzy Logic

These extend the above-mentioned fuzzy logics by adding universal and existential quantifiers in a manner similar to the way that predicate logic is created from propositional logic. The semantics of the universal (resp. existential) quantifier in t-norm fuzzy logics is the infimum (resp. supremum) of the truth degrees of the instances of the quantified sub formula.

3.3.1 Fuzzy System

Fuzzy logic is the use of relative reasoning, which is different from the use of absolute reasoning of traditional logic with the characteristics of true-false and yes-no answers. Fuzzy logic can adapt the decisions of experts about complex problems. The present study employs fuzzy evaluation in improving knowledge management systems in the selection of candidate sites for rice straw power plants. Fuzzy is used because Fuzzy logic employs Fuzzy truth values in specifying the membership of a fuzzy set, which is different from the probability of randomization. The definition of Fuzzy Set is explained by set X to not be an empty set where Fuzzy Set A can display specific characteristics from membership functions.

$$\mu_{\underline{A}}(x) : X \to [0,1] \tag{4}$$

Then $\mu_{\underline{A}}(x)$ is a membership of X in fuzzy set $\underline{A}$ for every fuzzy set can be written in (5)

$$\underline{A} = \{(x, \mu_{\underline{A}}(x)) | x \in X\} \tag{5}$$

Then $\underline{A}$ is fuzzy set

x is a set membership

$\mu_{\underline{A}}(x)$ is a membership function

3.3.2 Fuzzy System Basic Structure

The basic structure of the Fuzzy evaluation [7-9] is composed of four key elements as shown in Figure 3.4
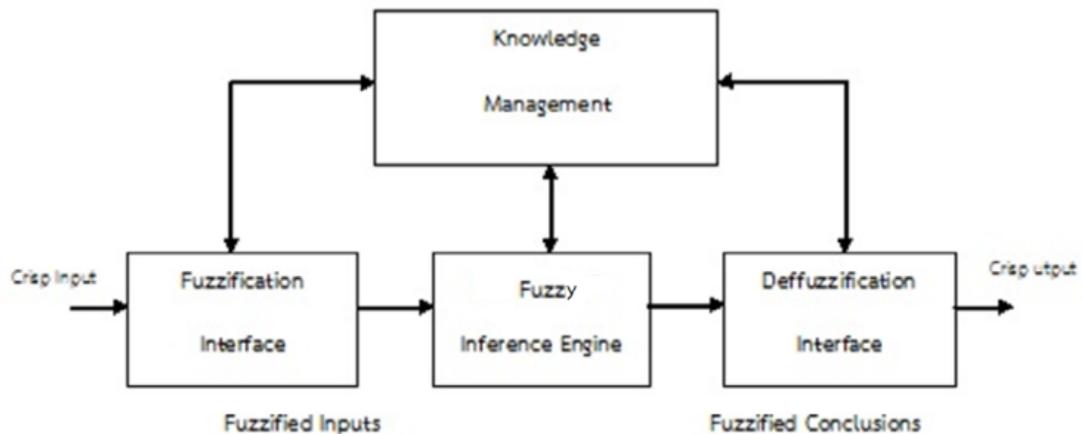
Figure 3.4 The basic structure of the Fuzzy evaluation

For Fuzzification, or the Fuzzy sets called linguistic variables, the knowledge base is an element that stores control data comprising two parts, namely, rule base and database. Rule base is an element for setting control methods acquired from experts in the form of linguistic rule data sets. The database is the preparation of essential elements to be used in setting the control rules and Fuzzy logic data management. The inference engine is an element for testing facts and rules for use in the interpretation of reasons similar to the mechanism for the control of knowledge in problem-solving in addition to setting interpretation methods for finding answers. Defuzzification is the transformation of data in the form of Fuzzy as a summary or system control values.

3.3.3 Fuzzy Inference System

In this research, the researcher has developed a knowledge management system in searching for candidate sites for rice straw power plants. Fuzzy evaluation was employed and the evaluation was divided into eight modules as shown Figure 3.5
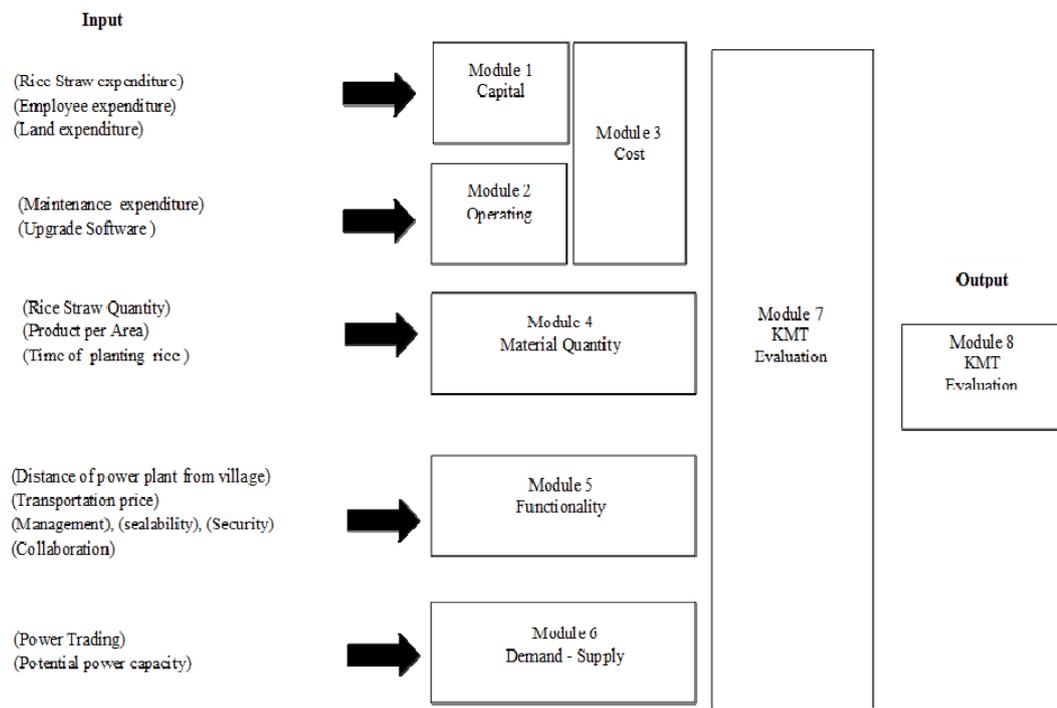
Figure 3.5 Fuzzy Modules

Figure 3.5, forming fuzzy modules: In the search for candidate sites for rice straw power plants through knowledge management comprises of 8 sub modules:

The database was made by the expertise of specialists in investment evaluation together with the geographical and environmental data acquired from the ArcGIS program composed of modules to manage assets, operations, costs, materials, power plant management, supply and demand, knowledge management evaluation and output.

Setting functions for members: All member functions for the input and output values in each Fuzzy module of the KME system use the triangle function as shown in Figure:

- Cost modules in Figure 3.7

- Materials quantity module in Figure 3.8

- Functional module in Figure 3.9

- Demand-supply module in Figure 3.10

- KMT Evaluate Module in Figure 3.11
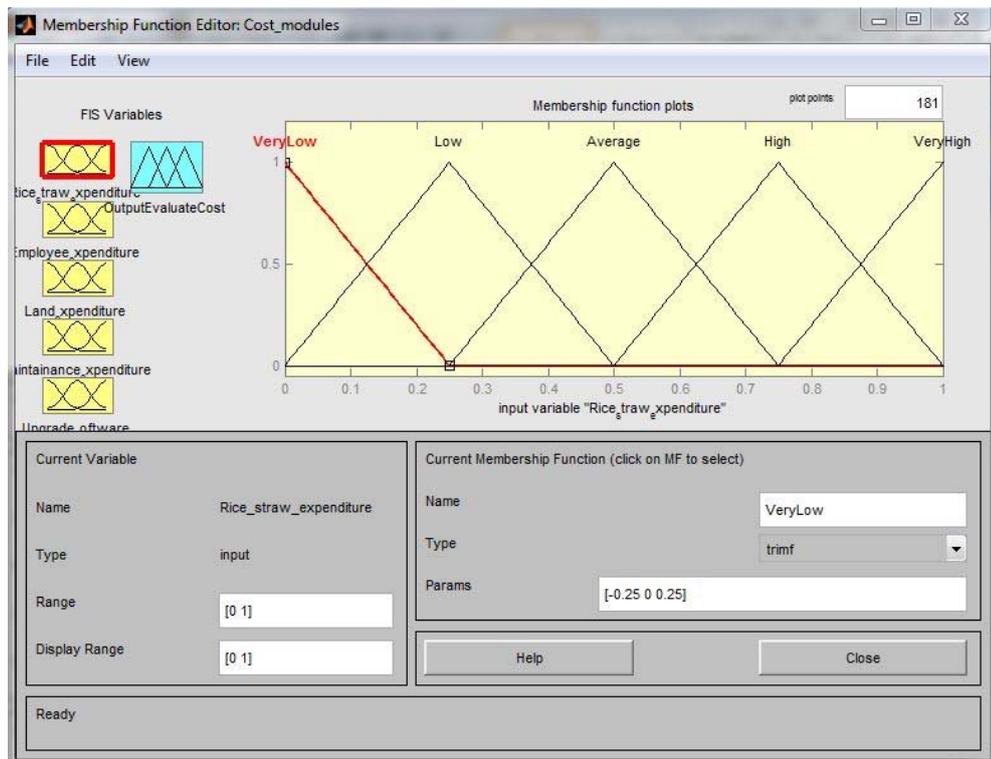
Figure 3.6 Member functions of cost modules
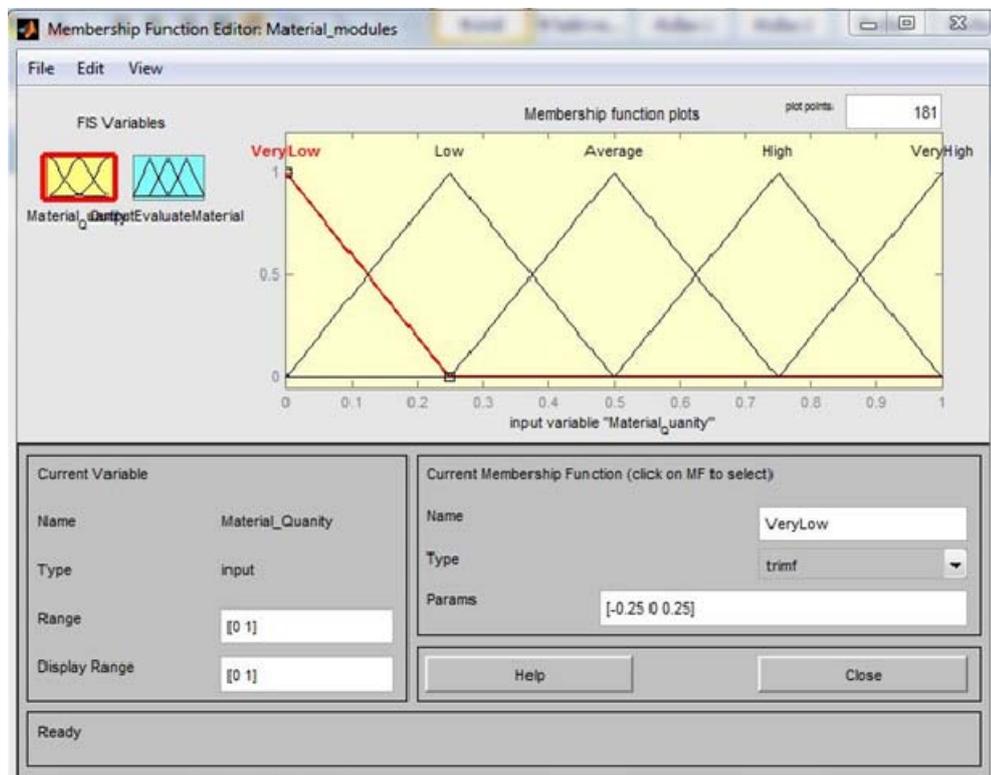
Figure 3.7 Member functions of material modules
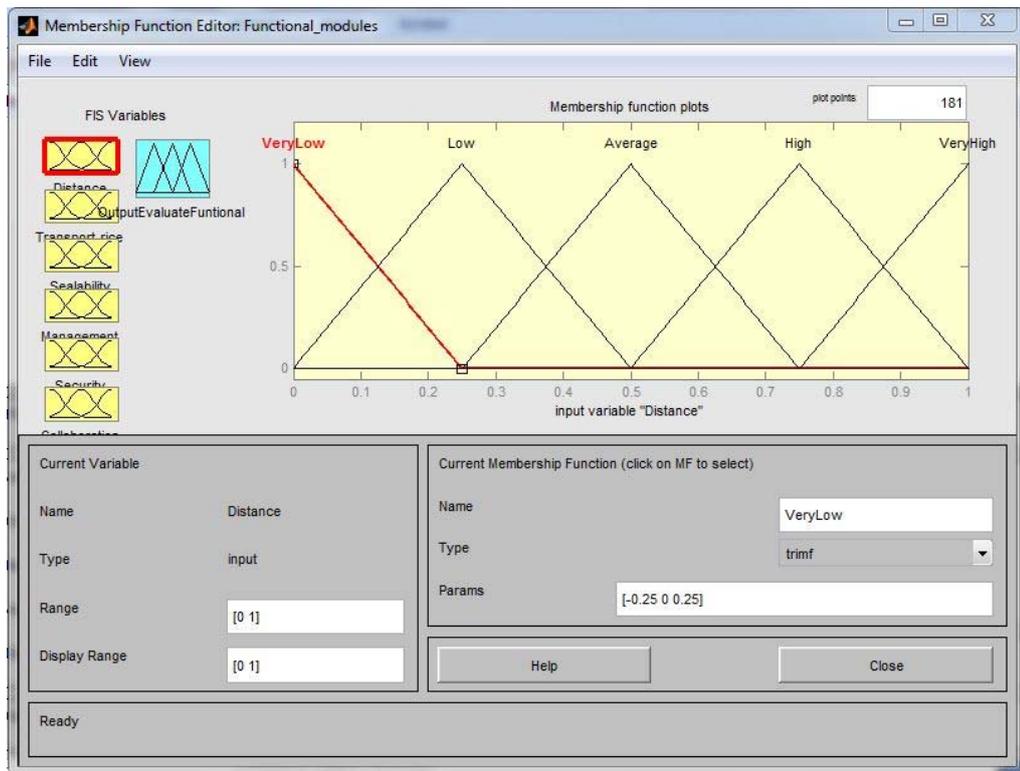
Figure 3.8 Member functions of functional modules
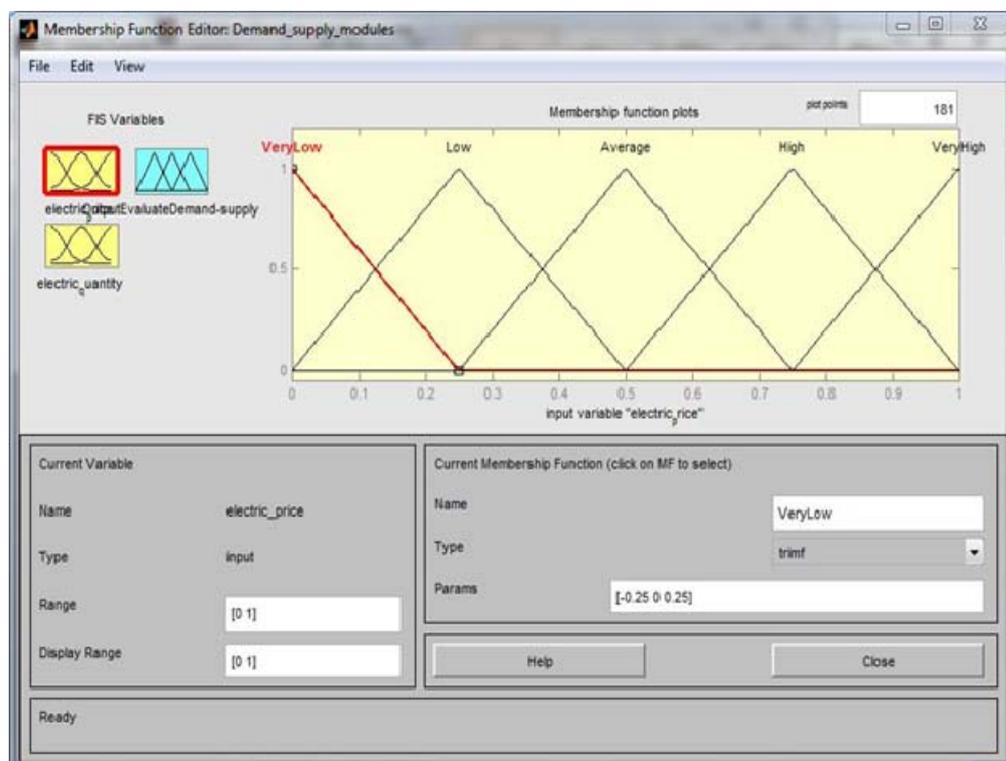
Figure 3.9 Member functions of demand-supply modules
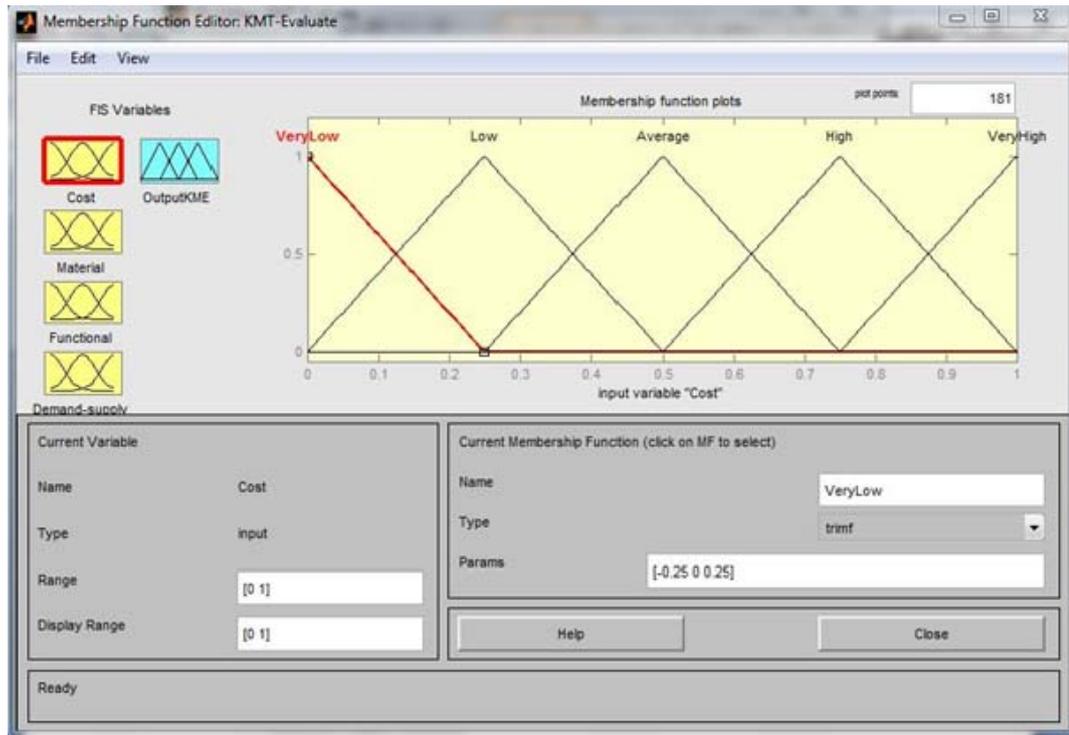
Figure 3.10 Member functions of KMT evaluate modules

3.3.4 Fuzzy Rules

The rules of Fuzzy have structures in characteristics of if-then clauses. These Fuzzy rules are created through the experiences and expertise of specialists in investment evaluation with geographical and environmental data on sites. The ArcGIS program was used to create Fuzzy rules as shown in the following examples:

1) Cost modules

• If (Rice straw expenditure is Very Low) and (Employee expenditure is Very Low) and (Land expenditure is Very Low) and (Maintenance expenditure is Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Very Good) (1)

• If (Rice straw expenditure is Low) and (Employee expenditure is Very Low) and (Land expenditure is Very Low) and (Maintenance expenditure is Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Very Good) (1)

• If (Rice straw expenditure is Average) and (Employee expenditure is Very Low) and (Land expenditure is Very Low) and (Maintenance expenditure is

Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Good) (1)

- If (Rice straw expenditure is High) and (Employee expenditure is Very Low) and (Land expenditure is Very Low) and (Maintenance expenditure is Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Good) (1)

- If (Rice straw expenditure is Very High) and (Employee expenditure is Very Low) and (Land expenditure is Very Low) and (Maintenance expenditure is Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Average) (1)

- If (Rice straw expenditure is Very Low) and (Employee expenditure is Low) and (Land expenditure is Very Low) and (Maintenance expenditure is Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Very Good) (1)

- If (Rice straw expenditure is Very Low) and (Employee expenditure is Average) and (Land expenditure is Very Low) and (Maintenance expenditure is Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Very Good) (1)

- If (Rice straw expenditure is Very Low) and (Employee expenditure is High) and (Land expenditure is Very Low) and (Maintenance expenditure is Very Low) and (Upgrade software is Very Low) then (Output Evaluate Cost is Good) (1)

- ……..
- ……..
- ……..
- ... (172)…
- ……..

- If (Rice straw expenditure is Very High) and (Employee expenditure is Very High) and (Land expenditure is Very High) and (Maintenance expenditure is Very High) and (Upgrade software is Very High) then (Output Evaluate Cost is Very Poor) (1) , Example in Figure 3.11
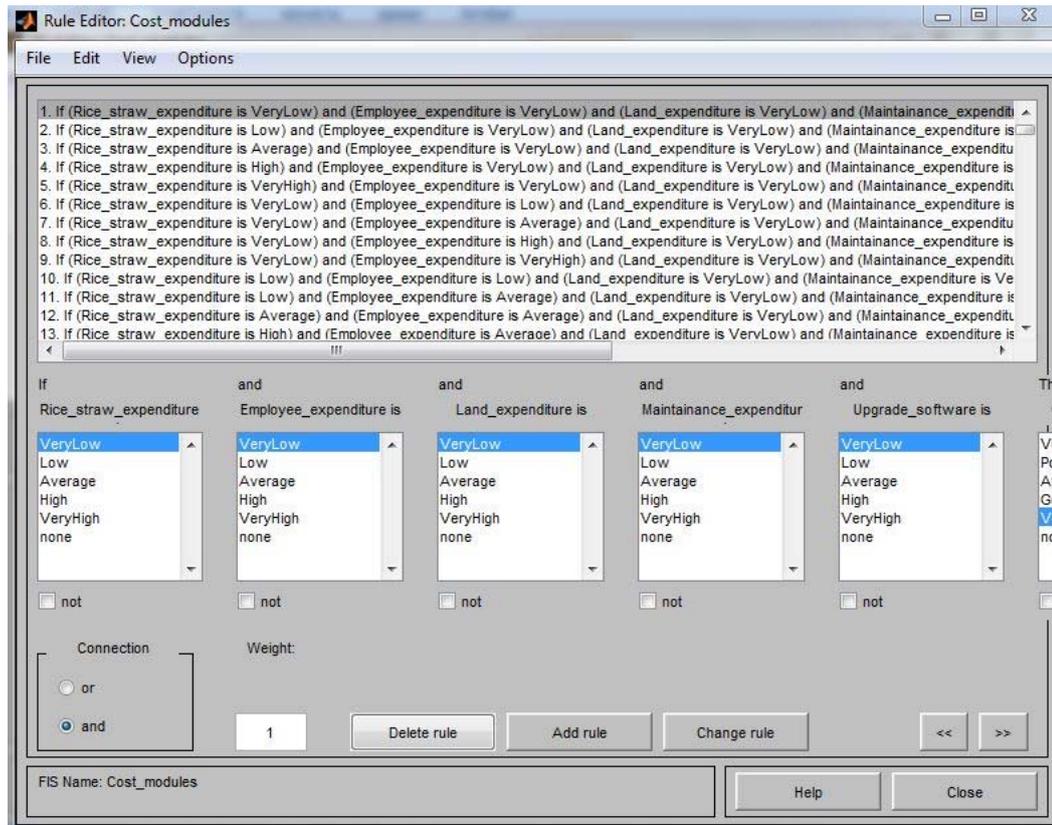
Figure 3.11 Rules of Cost module

2) Material Quantity Modules

• If (Material Quantity is Very Low) then (Output Evaluate Material is Very Poor)

• If (Material Quantity is Low) then (Output Evaluate Material is Poor)

• If (Material Quantity is Average) then (Output Evaluate Material is Average)

• If (Material Quantity is High) then (Output Evaluate Material is Good)

• If (Material Quantity is Very High) then (Output Evaluate Material is Very Good) , Example in Figure 3.12
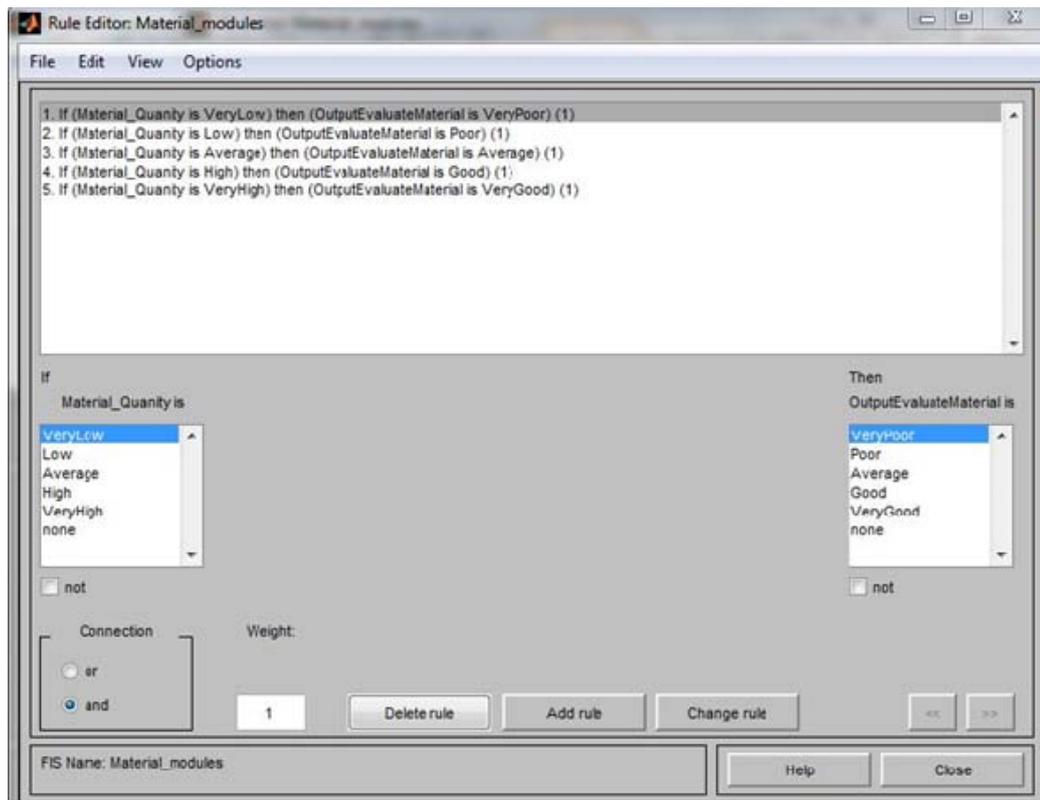
Figure 3.12 Rules of Material module

3) Functional Modules

- If (electric price is Very Low) and (electric quantity is Very Low) then (Output Evaluate Demand-supply is Very Poor) (1)

- If (electric price is Very Low) and (electric quantity is Low) then (Output Evaluate Demand-supply is Very Poor) (1)

- If (electric price is Very Low) and (electric quantity is Average) then (Output Evaluate Demand-supply is Poor) (1)

- If (electric price is Very Low) and (electric quantity is High) then (Output Evaluate Demand-supply is Poor) (1)

- If (electric price is Very Low) and (electric _quantity is Very High) then (Output Evaluate Demand-supply is Average) (1)

- If (electric price is Low) and (electric quantity is Very Low) then (Output Evaluate Demand-supply is Very Poor) (1)

- If (electric price is Low) and (electric quantity is Low) then (Output Evaluate Demand-supply is Poor) (1)

- If (electric price is Low) and (electric quantity is Average) then (Output Evaluate Demand-supply is Poor) (1)

- If (electric price is Low) and (electric quantity is High) then (Output Evaluate Demand-supply is Average) (1)

- …

- … (24)...

- If (electric price is Very High) and (electric quantity is Very High) then (Output Evaluate Demand-supply is Very Good) (1)

Figure 3.13 Rules of Functional module

4) Demand-supply Modules

- If (electric price is Very Low) and (electric quantity is Very Low) then (Output Evaluate Demand-supply is Very Poor) (1)

- If (electric price is Very Low) and (electric quantity is Low) then (Output Evaluate Demand-supply is Very Poor) (1)

- If (electric price is Very Low) and (electric quantity is Average) then (Output Evaluate Demand-supply is Poor) (1)

- If (electric price is Very Low) and (electric quantity is High) then (Output Evaluate Demand-supply is Poor) (1)

- …

- ..(24)...

- If (electric price is Very High) and (electric quantity is Very High) then (Output Evaluate Demand-supply is Very Good) (1)
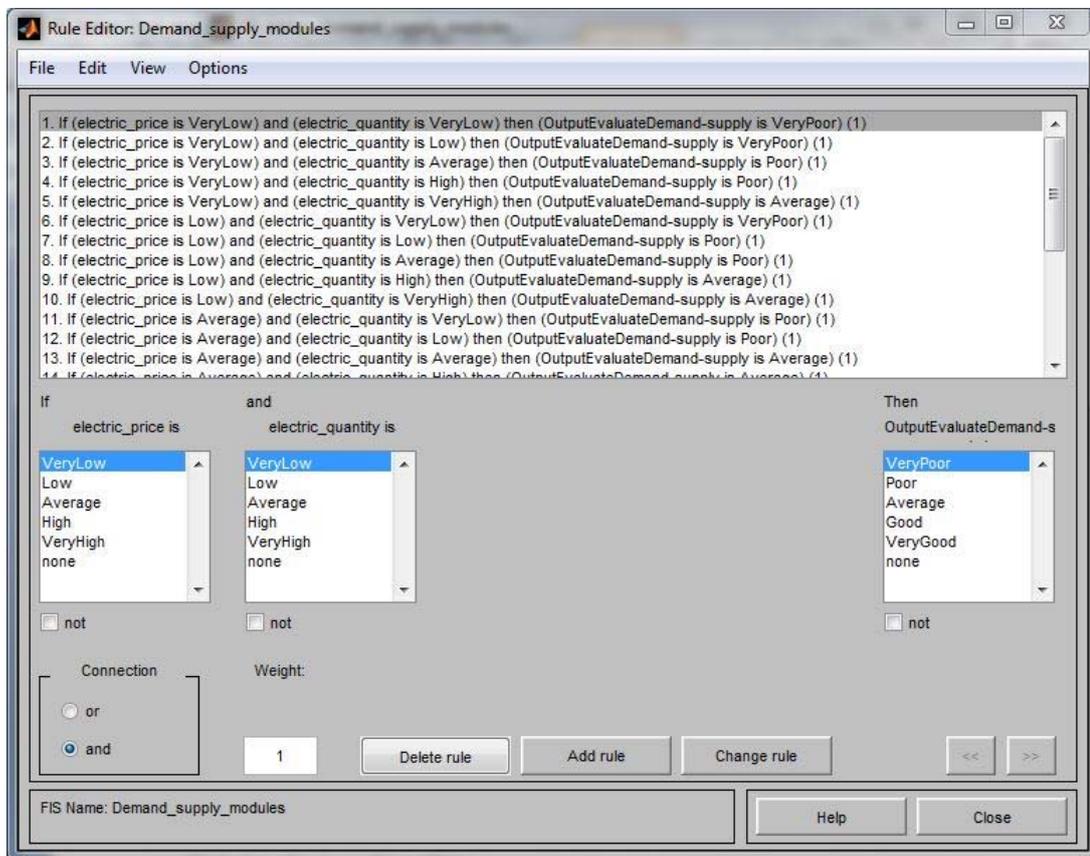
Figure 3.14 Rules of Demand-supply module

5) KMT Evaluate Modules

- If (Cost is Low) and (Material is Very Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Very Poor) (1)

- If (Cost is Average) and (Material is Very Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Very Poor) (1)

- If (Cost is High) and (Material is Very Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Very Poor) (1)

- If (Cost is Very High) and (Material is Very Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Very Poor) (1)

- If (Cost is Very Low) and (Material is Very Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Very Poor) (1)

- If (Cost is Very Low) and (Material is Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Very Poor) (1)

- If (Cost is Low) and (Material is Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Poor) (1)

- If (Cost is Average) and (Material is Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Poor) (1)

- If (Cost is High) and (Material is Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Poor) (1)

- If (Cost is Very High) and (Material is Low) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Poor) (1)

- If (Cost is Very Low) and (Material is Average) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Very Poor) (1)

- If (Cost is Low) and (Material is Average) and (Functional is Very Low) and (Demand-supply is Very Low) then (Output KME is Poor) (1)

- …

- …

- …

- … (100)…

- If (Cost is Very High) and (Material is Very High) and (Functional is Very High) and (Demand-supply is Very High) then (Output KME is Very Good) (1)
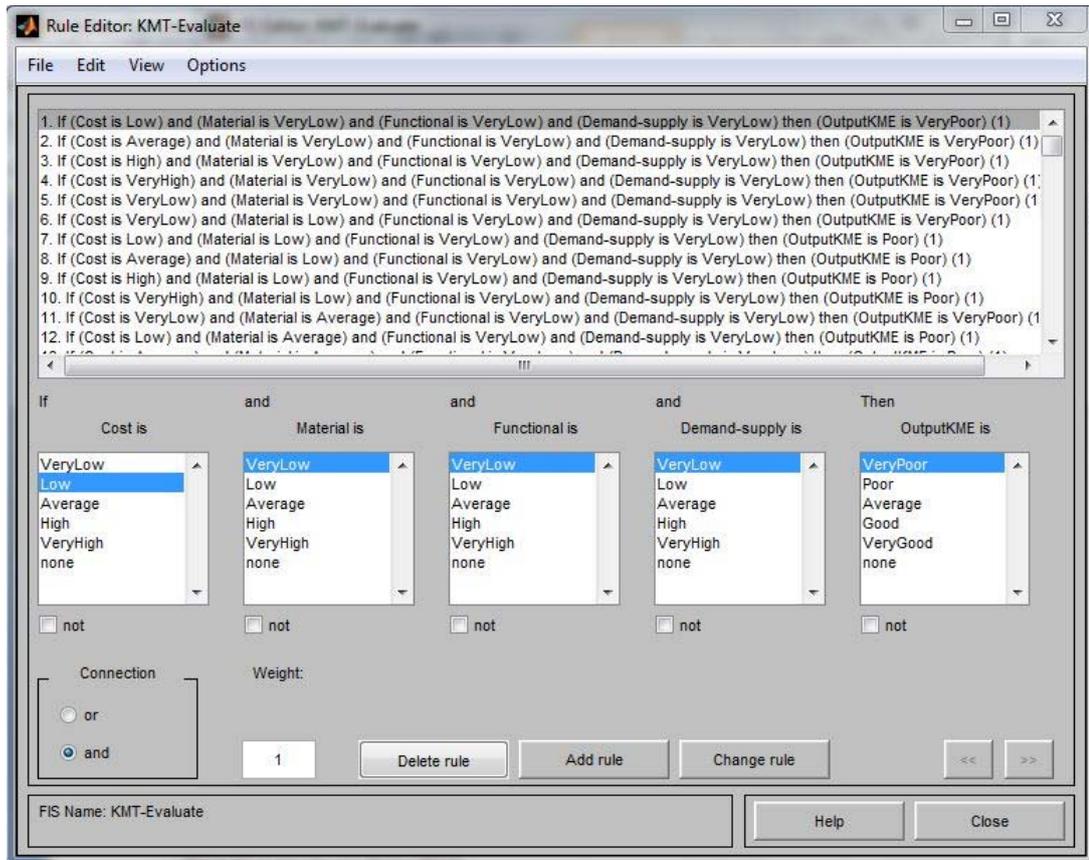
Figure 3.15 Rules of KMT Evaluate module

3.4 Measurement

Data is a quantitative Legacy will be a detailed description of the soil local look kind. Suitable for growing crops what kinds of energy. Viewing distance between the cultivated areas with the plant.

3.5 Documentation

Finally, the study research of result will be analyzed, concluded and present with recommendation for the future research related. Research documentation is made and inspected.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 The result of fuzzy system

Fuzzy rules and the database of the aforementioned knowledge management system will have input in the knowledge management system composed of rice straw prices, labor costs, land prices, maintenance, software development and plant management as well as the supply and demands of the power plant. The knowledge management system evaluated the results as shown in the evaluation example.

The Fuzzy deduction of this test employed triangular Fuzzy sets composed of five sets. The evaluation example shown in Table 1 will be categorized as very poor, poor, average, good and very good, while the cost set in Table 2 will be very low, low, average, good and very good, respectively.

Table 4.1 The cost evaluating a power plant

Province	Input				Output Evaluaton
	Costs	Material Qurantity	Functionality	Demand - Supply	
North					
CHIANG RAI	Average	Very Low	Low	Low	Poor
PHAYAO	High	Very Low	Low	Low	Poor
LAMPANG	Average	Very Low	Low	Average	Poor
LAMPHUN	Average	Very Low	Low	Low	Poor
CHIANG MAI	Very High	Very Low	Low	Very High	Poor
MAE HONG SON	Average	Very Low	Low	Very Low	Poor
PHRAE	High	Very Low	Low	Low	Poor
NAN	High	Very Low	Low	Low	Poor
UTTARADIT	Average	Low	Average	Average	Average

Table 4.1 The cost evaluating a power plant (Cont.)

Province	Input				Output Evaluaton
	Costs	Material Qurantity	Functionality	Demand - Supply	
Middle					
SUKHOTHAI	Average	Low	High	High	Average
KAMPHAENG PHET	Average	High	High	High	Good
PHITSANULOK	Average	High	High	High	Good
PHICHIT	Low	Very High	High	High	Very Good
NAKHON SAWAN	Low	Very High	Average	High	Good
UTHAI THANI	Average	Low	Average	Average	Average
PHETCHABUN	Average	Very Low	Average	Average	Average
SAMUT PRAKAN	Average	Very Low	Low	High	Poor
SAMUT SAKHON	Average	Very Low	Low	High	Poor
NAKHON PATHOM	Average	Average	Average	High	Average
SARABURI	Average	Low	Average	Average	Average
LOP BURI	Average	Average	Average	Average	Average
SING BURI	Average	Average	Average	Average	Average
CHAINAT	Average	High	High	High	Good
SUPHAN BURI	High	Very High	Low	Very High	Good
ANG THONG	Average	Average	Average	Low	Average
PHRA NAKHON SI AYUTTHAYA	High	High	Average	Very High	Good
NONTHABURI	Very High	Very Low	Low	Very High	Poor
BANGKOK	Very High	Very Low	Low	Very High	Poor
PATHUM THANI	High	Low	Low	Very High	Average
NAKHON NAYOK	Average	Very Low	Average	Average	Average
RATCHABURI	Average	Low	Average	Average	Average
SAMUT SONGKHRAM	Average	Very Low	Low	Average	Poor
PHETCHABURI	Average	Low	Low	High	Poor
PRACHUAP KHIRI KHAN	Average	Very Low	Low	Average	Poor

Table 4.1 The cost evaluating a power plant (Cont.)

Province	Input				Output Evaluaton
	Costs	Material Qurantity	Functionality	Demand - Supply	
North-East					
LOEI	High	Very Low	Low	Average	Poor
NONG BUA LAM PHU	Average	Very Low	Low	Average	Poor
UDON THANI	High	Very Low	Low	High	Poor
NONG KHAI	Average	Very Low	Low	Average	Poor
SAKON NAKHON	Average	Very Low	Low	Average	Poor
NAKHON PHANOM	Average	Very Low	Low	Average	Poor
MUKDAHAN	Average	Low	Average	Average	Average
YASOTHON	Average	Very Low	Low	Low	Poor
AMNAT CHAROEN	High	Very Low	Low	Low	Poor
UBON RATCHATHANI	Very High	Very Low	Low	High	Poor
SI SA KET	Average	Low	Average	Average	Average
SURIN	Average	Low	Average	Average	Average
MAHA SARAKHAM	Average	Average	Average	Low	Average
ROI ET	Average	Average	Average	Low	Average
KALASIN	Average	Low	Low	Low	Poor
KHON KAEN	High	Very Low	Low	Very High	Poor
NAKHON RATCHASIMA	High	Very Low	Low	Very High	Poor
CHAIYAPHUM	High	Very Low	Low	Average	Poor
East					
KANCHANABURI	Average	Low	Low	Average	Poor
PRACHIN BURI	High	Very Low	Low	Low	Poor
CHACHOENGSAO	High	Average	Low	Low	Poor
SA KAEO	High	Very Low	Low	Low	Poor
TRAT	High	Very Low	Low	Low	Poor
RAYONG	High	Very Low	Low	Average	Poor
CHON BURI	High	Very Low	Low	Very High	Poor

Table 4. 1 The cost evaluating a power plant (Cont.)

Province	Input				Output Evaluaton
	Costs	Material Qurantity	Functionality	Demand - Supply	
South					
CHUMPHON	Average	Very Low	Low	Average	Very Poor
SURAT THANI	Average	Very Low	Low	High	Very Poor
TRANG	Average	Very Low	Low	Average	Very Poor
NAKHON SI THAMMARAT	Average	Very Low	Low	High	Very Poor
PHATTHALUNG	Average	Very Low	Low	Average	Very Poor
SONGKHLA	High	Very Low	Low	Very High	Very Poor
SATUN	Average	Very Low	Low	Low	Very Poor
PATTANI	High	Very Low	Low	Low	Very Poor
YALA	High	Very Low	Low	Low	Very Poor
NARATHIWAT	High	Very Low	Low	Low	Very Poor

Figure 4.1 The result of fuzzy system: Cost Module

The result of cost module in fuzzy system represent the example Pichit model. From the Figure 4.1 the output of it is 0.68 that is a Good in fuzzy sets.

Table 4.2 The Material quantity of KME

Province	Quantity	Output Evaluaton
	Rice Straw	
Northern		
CHIANG RAI	Very Low	Very Poor
PHAYAO	Very Low	Very Poor
LAMPANG	Very Low	Very Poor
LAMPHUN	Very Low	Very Poor
CHIANG MAI	Very Low	Very Poor
MAE HONG SON	Very Low	Very Poor
PHRAE	Very Low	Very Poor
NAN	Very Low	Very Poor
UTTARADIT	Low	Poor
Middle		
SUKHOTHAI	Low	Poor
KAMPHAENG PHET	High	Good
PHITSANULOK	High	Good
PHICHIT	Very High	Very High
NAKHON SAWAN	Very High	Very High
UTHAI THANI	Low	Poor
PHETCHABUN	Very Low	Very Poor
SAMUT PRAKAN	Very Low	Very Poor
SAMUT SAKHON	Very Low	Very Poor
NAKHON PATHOM	Average	Average
SARABURI	Low	Poor
LOP BURI	Average	Average
SING BURI	Average	Average
CHAINAT	High	Good
SUPHAN BURI	Very High	Very Good
ANG THONG	Average	Average
PHRA NAKHON SI AYUTTHAYA	High	Good
NONTHABURI	Very Low	Very Poor
BANGKOK	Very Low	Very Poor
PATHUM THANI	Low	Poor
NAKHON NAYOK	Very Low	Very Poor
RATCHABURI	Low	Poor
SAMUT SONGKHRAM	Very Low	Very Poor
PHETCHABURI	Low	Poor
PRACHUAP KHIRI KHAN	Very Low	Very Poor

Table 4.2 The Material quantity of KME (Cont.)

Province	Quantity	Output Evaluaton
	Rice Straw	
North - Eastern		
LOEI	Very Low	Very Poor
NONG BUA LAM PHU	Very Low	Very Poor
UDON THANI	Very Low	Very Poor
NONG KHAI	Very Low	Very Poor
SAKON NAKHON	Very Low	Very Poor
NAKHON PHANOM	Very Low	Very Poor
MUKDAHAN	Low	Poor
YASOTHON	Very Low	Very Poor
AMNAT CHAROEN	Very Low	Very Poor
UBON RATCHATHANI	Very Low	Very Poor
SI SA KET	Low	Poor
SURIN	Low	Poor
BURIRAM	Low	Poor
MAHA SARAKHAM	Average	Average
ROI ET	Average	Average
KALASIN	Low	Poor
KHON KAEN	Very Low	Very Poor
NAKHON RATCHASIMA	Very Low	Very Poor
CHAIYAPHUM	Very Low	Very Poor
Eastern		
KANCHANABURI	Low	Poor
PRACHIN BURI	Very Low	Very Poor
CHACHOENGSAO	Average	Average
SA KAEO	Very Low	Very Poor
TRAT	Very Low	Very Poor
RAYONG	Very Low	Very Poor
CHON BURI	Very Low	Very Poor
Southern		
CHUMPHON	Very Low	Very Poor
SURAT THANI	Very Low	Very Poor
TRANG	Very Low	Very Poor
NAKHON SI THAMMARAT	Very Low	Very Poor
PHATTHALUNG	Very Low	Very Poor
SONGKHLA	Very Low	Very Poor
SATUN	Very Low	Very Poor
PATTANI	Very Low	Very Poor
YALA	Very Low	Very Poor
NARATHIWAT	Very Low	Very Poor

Figure 4.2 The result of fuzzy system: Material Quantity Module

The result of material quantity module in fuzzy system represents the example Buriram model. From the Figure 4.2 the output of it is 0.339 that is a Poor in fuzzy sets.

Table 4.3 The functional of KME

Province	Functional					Output Evaluaton
	Distance of power plant&village	Transportation	Management	Sealability	Collaboration	
Northern						
CHIANG RAI	High	Very Low	Low	Low	Low	Poor
PHAYAO	High	Very Low	Low	Low	Low	Poor
LAMPANG	High	Low	Average	Low	Average	Poor
LAMPHUN	High	Low	Low	Low	Low	Poor
CHIANG MAI	Average	High	High	High	High	Poor
MAE HONG SON	Low	Low	Low	Low	Low	Poor
PHRAE	Average	Low	Low	Low	Low	Poor
NAN	Average	Low	Low	Low	Low	Poor
UTTARADIT	Average	Average	Average	Average	Average	Average

Table 4.3 The functional of KME (Cont.)

Province	Functional					Output Evaluaton
	Distance of power plant&village	Transportation	Management	Sealability	Collaboration	
Middle						
SUKHOTHAI	Average	Average	Average	Average	Average	Good
KAMPHAENG PHET	Average	Low	Low	Average	Average	Good
PHITSANULOK	Low	Average	Average	Average	Average	Good
PHICHIT	Low	Low	Average	Average	Average	Good
NAKHON SAWAN	Low	Average	Average	Average	Average	Average
UTHAI THANI	Low	Average	Average	Low	Average	Average
PHETCHABUN	Average	Average	Average	Low	Average	Average
SAMUT PRAKAN	Very High	High	High	Low	Average	Poor
SAMUT SAKHON	Very High	High	High	Low	Average	Average
NAKHON PATHOM	High	High	High	Average	Average	Average
SARABURI	Average	Average	Average	Average	Average	Average
LOP BURI	Average	Average	Average	Average	Average	Average
SING BURI	Average	Average	Average	Average	Average	Average
CHAINAT	Low	Low	Average	Average	Average	Good
SUPHAN BURI	Low	High	High	Average	High	Poor
ANG THONG	Average	Low	Average	Average	Average	Average
PHRA NAKHON SI AYUTTHAYA	Low	High	High	Average	Average	Average
NONTHABURI	Very High	Very High	Very High	Very Low	High	Poor
BANGKOK	Very High	Very High	Very High	Very Low	High	Poor
PATHUM THANI	Very High	Very High	Very High	Very Low	High	Poor
NAKHON NAYOK	Average	Average	Average	Average	Average	Average
RATCHABURI	Average	Average	Average	Low	Average	Average
SAMUT SONGKHRAM	Very High	Average	Average	Low	Average	Poor
PHETCHABURI	High	Average	Average	Low	Average	Poor
PRACHUAP KHIRI KHAN	Very High	Average	Average	Low	Average	Poor
North-Eastern						
LOEI	High	Average	Average	Low	Average	Poor
NONG BUA LAM PHU	High	Low	Average	Low	Average	Poor
UDON THANI	Average	High	High	Average	Average	Poor
NONG KHAI	Average	Average	Low	Low	Average	Poor
SAKON NAKHON	High	Low	Average	Average	Average	Poor
NAKHON PHANOM	Average	Average	Average	Average	Average	Poor
MUKDAHAN	High	Low	Low	Average	Average	Average
YASOTHON	Average	Low	Low	Low	Average	Poor
AMNAT CHAROEN	Average	Low	Low	Low	Average	Poor
UBON RATCHATHANI	High	High	High	Low	Average	Poor
SI SA KET	Average	Average	Average	Low	Average	Average
SURIN	Average	Low	Average	Average	Average	Average
BURIRAM	High	High	Average	Average	Average	Poor
MAHA SARAKHAM	High	High	Average	Average	Average	Average
ROI ET	High	Average	Average	Average	Average	Average
KALASIN	Average	Low	Low	Low	Average	Poor
KHON KAEN	High	High	High	Low	Average	Poor
NAKHON RATCHASIMA	High	High	High	Low	Average	Poor
CHAIYAPHUM	High	Low	Average	Low	Average	Poor

Table 4.3 The functional of KME (Cont.)

Province	Functional					Output Evaluaton
	Distance of power plant&village	Transportation	Management	Sealability	Collaboration	
North-Eastern						
LOEI	High	Average	Average	Low	Average	Poor
NONG BUA LAM PHU	High	Low	Average	Low	Average	Poor
UDON THANI	Average	High	High	Average	Average	Poor
NONG KHAI	Average	Average	Low	Low	Average	Poor
SAKON NAKHON	High	Low	Average	Average	Average	Poor
NAKHON PHANOM	Average	Average	Average	Average	Average	Poor
MUKDAHAN	High	Low	Low	Average	Average	Average
YASOTHON	Average	Low	Low	Low	Average	Poor
AMNAT CHAROEN	Average	Low	Low	Low	Average	Poor
UBON RATCHATHANI	High	High	High	Low	Average	Poor
SI SA KET	Average	Average	Average	Low	Average	Average
SURIN	Average	Low	Average	Average	Average	Average
BURIRAM	High	High	Average	Average	Average	Poor
MAHA SARAKHAM	High	High	Average	Average	Average	Average
ROI ET	High	Average	Average	Average	Average	Average
KALASIN	Average	Low	Low	Low	Average	Poor
KHON KAEN	High	High	High	Low	Average	Poor
NAKHON RATCHASIMA	High	High	High	Low	Average	Poor
CHAIYAPHUM	High	Low	Average	Low	Average	Poor
Eastern						
KANCHANABURI	High	Average	Average	Low	Average	Poor
PRACHIN BURI	High	Average	Average	Low	Average	Poor
CHACHOENGSAO	High	Average	Average	Low	Average	Poor
SA KAEO	High	Average	Average	Low	Average	Poor
TRAT	High	Average	Average	Low	Average	Poor
RAYONG	High	Average	Average	Low	Average	Poor
CHON BURI	High	Average	Average	Low	Average	Poor
Southern						
CHUMPHON	Very High	Average	High	Very low	Average	Poor
SURAT THANI	Very High	Average	High	Very low	Average	Poor
TRANG	Very High	Average	High	Very low	Average	Poor
NAKHON SI THAMMARAT	Very High	Average	High	Very low	Average	Poor
PHATTHALUNG	Very High	Average	High	Very low	Average	Poor
SONGKHLA	Very High	High	High	Very low	Average	Poor
SATUN	Very High	Average	High	Very low	Average	Poor
PATTANI	Very High	Low	High	Very low	Average	Poor
YALA	Very High	Low	High	Very low	Average	Poor
NARATHIWAT	Very High	Low	High	Very low	Average	Poor
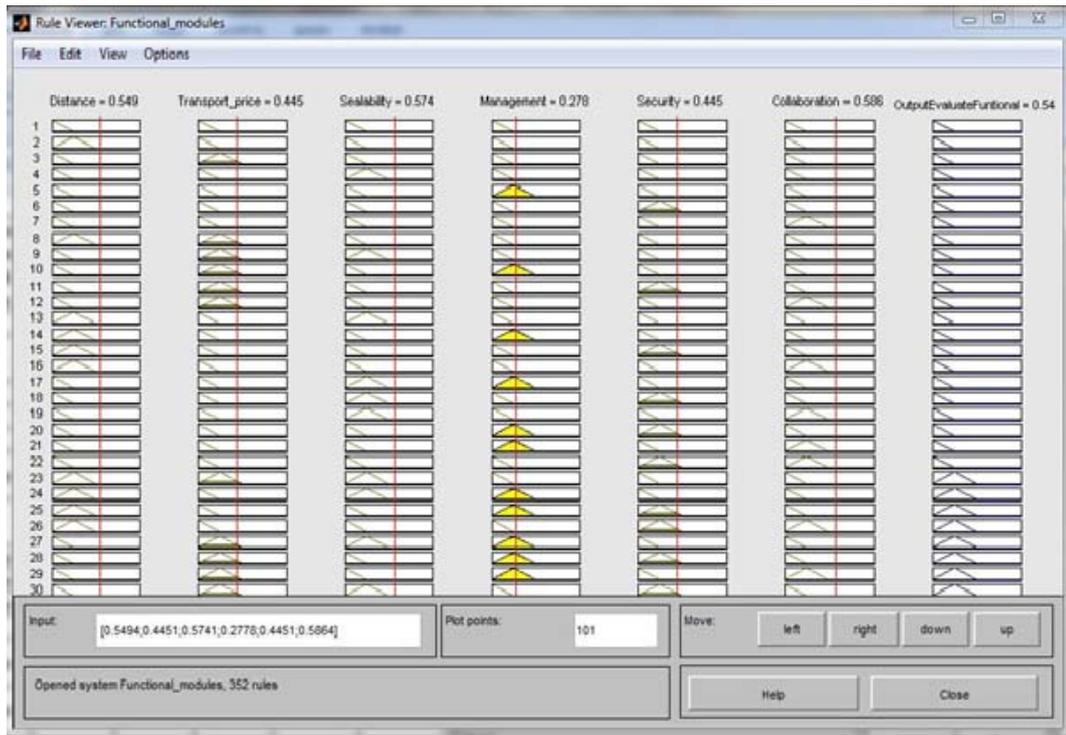
Figure 4.3 The result of fuzzy system: Functional Module

The result of functional module in fuzzy system represents that model of the example, Phetchabun model. From the Figure 4.3 the output of it is 0.54 that is a Average in fuzzy sets.

Table 4.4 The demand-supply of KME

Province	Demand - Supply		Output Evaluation
	Demand	Price	
Northern			
CHIANG RAI	Low	Low	Poor
PHAYAO	Low	Low	Poor
LAMPANG	Average	Average	Average
LAMPHUN	Low	Low	Poor
CHIANG MAI	Very High	Very High	Very Good
MAE HONG SON	Very Low	Very Low	Very Poor
PHRAE	Low	Low	Poor
NAN	Low	Low	Poor
UTTARADIT	Average	Average	Average

Table 4.4 The demand-supply of KME (Cont.)

Province	Demand - Supply		Output Evaluation
	Demand	**Price**	
Middle			
SUKHOTHAI	High	High	Good
KAMPHAENG PHET	High	High	Good
PHITSANULOK	High	High	Good
PHICHIT	High	High	Good
NAKHON SAWAN	High	High	Good
UTHAI THANI	Average	Average	Average
PHETCHABUN	Average	Average	Average
SAMUT PRAKAN	High	High	Good
SAMUT SAKHON	High	High	Good
NAKHON PATHOM	High	High	Good
SARABURI	Average	Average	Average
LOP BURI	Average	Average	Average
SING BURI	Average	Average	Average
CHAINAT	High	High	Good
SUPHAN BURI	Very High	Very High	Very Good
RA NAKHON SI AYUTTHA	Very High	Very High	Very Good
NONTHABURI	Very High	Very High	Very Good
BANGKOK	Very High	Very High	Very Good
PATHUM THANI	Very High	Very High	Very Good
NAKHON NAYOK	Average	Average	Average
RATCHABURI	Average	Average	Average
SAMUT SONGKHRAM	Average	Average	Average
PHETCHABURI	High	High	Good
PRACHUAP KHIRI KHAN	Average	Average	Average
Eastern			
KANCHANABURI	Average	Average	Average
PRACHIN BURI	Low	Low	Poor
CHACHOENGSAO	Low	Low	Poor
SA KAEO	Low	Low	Poor
TRAT	Low	Low	Poor
RAYONG	Average	Average	Average
CHON BURI	Very High	Very High	Very Good

Table 4.4 The demand-supply of KME (Cont.)

Province	Demand - Supply		Output Evaluation
	Demand	**Price**	
North - Eastern			
LOEI	Average	Average	Average
NONG BUA LAM PHU	Average	Average	Average
UDON THANI	High	High	Good
NONG KHAI	Average	Average	Average
SAKON NAKHON	Average	Average	Average
NAKHON PHANOM	Average	Average	Average
MUKDAHAN	Average	Average	Average
YASOTHON	Low	Low	Poor
AMNAT CHAROEN	Low	Low	Poor
UBON RATCHATHANI	High	High	Good
SI SA KET	Average	Average	Average
SURIN	Average	Average	Average
BURIRAM	High	High	Good
MAHA SARAKHAM	Low	Low	Poor
KALASIN	Low	Low	Poor
KHON KAEN	Very High	Very High	Very Good
NAKHON RATCHASIMA	Very High	Very High	Very Good
CHAIYAPHUM	Average	Average	Average
Southern			
CHUMPHON	Average	Average	Average
SURAT THANI	High	High	Good
TRANG	Average	Average	Average
NAKHON SI THAMMARAT	High	High	Good
PHATTHALUNG	Average	Average	Average
SONGKHLA	Very High	Very High	Very Good
SATUN	Low	Low	Poor
PATTANI	Low	Low	Poor
YALA	Low	Low	Poor
NARATHIWAT	Low	Low	Poor
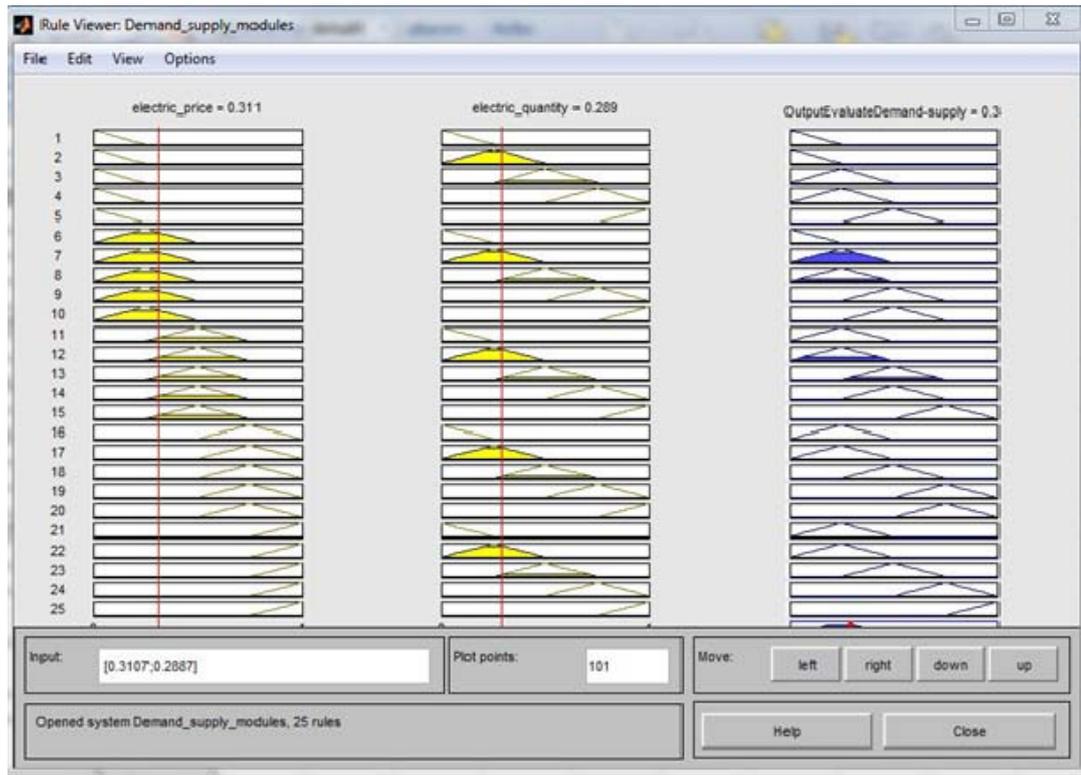
Figure 4.4 The result of fuzzy system: Demand-supply Module

The result of demand-supply module in fuzzy system represents the example Lumphun model. From the Figure 4.4 the output of it is 0.3 that is a Poor in fuzzy sets.

Table 4.5 The result of KMT evaluate: input and output

Province	Input				Output Evaluation
	Costs	Material Qurantity	Functionality	Demand - Supply	
North					
CHIANG RAI	Average	Very Low	Low	Low	Poor
PHAYAO	High	Very Low	Low	Low	Poor
LAMPANG	Average	Very Low	Low	Average	Poor
LAMPHUN	Average	Very Low	Low	Low	Poor
CHIANG MAI	Very High	Very Low	Low	Very High	Poor
MAE HONG SON	Average	Very Low	Low	Very Low	Poor
PHRAE	High	Very Low	Low	Low	Poor
UTTARADIT	Average	Low	Average	Average	Average

Table 4.5 The result of KMT evaluate: input and output (cont.)

Province	Input				Output Evaluation
	Costs	Material Qurantity	Functionality	Demand - Supply	
Middle					
SUKHOTHAI	Average	Low	High	High	Average
KAMPHAENG PHET	Average	High	High	High	Good
PHITSANULOK	Average	High	High	High	Good
PHICHIT	Low	Very High	High	High	Very Good
NAKHON SAWAN	Low	Very High	Average	High	Good
UTHAI THANI	Average	Low	Average	Average	Average
PHETCHABUN	Average	Very Low	Average	Average	Average
SAMUT PRAKAN	Average	Very Low	Low	High	Poor
SAMUT SAKHON	Average	Very Low	Low	High	Poor
NAKHON PATHOM	Average	Average	Average	High	Average
SARABURI	Average	Low	Average	Average	Average
LOP BURI	Average	Average	Average	Average	Average
SING BURI	Average	Average	Average	Average	Average
CHAINAT	Average	High	High	High	Good
SUPHAN BURI	High	Very High	Low	Very High	Good
ANG THONG	Average	Average	Average	Low	Average
PHRA NAKHON SI AYUTTHAYA	High	High	Average	Very High	Good
NONTHABURI	Very High	Very Low	Low	Very High	Poor
BANGKOK	Very High	Very Low	Low	Very High	Poor
PATHUM THANI	High	Low	Low	Very High	Average
NAKHON NAYOK	Average	Very Low	Average	Average	Average
RATCHABURI	Average	Low	Average	Average	Average
SAMUT SONGKHRAM	Average	Very Low	Low	Average	Poor
PHETCHABURI	Average	Low	Low	High	Poor
PRACHUAP KHIRI KHAN	Average	Very Low	Low	Average	Poor
Eastern					
KANCHANABURI	Average	Low	Low	Average	Poor
PRACHIN BURI	High	Very Low	Low	Low	Poor
CHACHOENGSAO	High	Average	Low	Low	Poor
SA KAEO	High	Very Low	Low	Low	Poor
TRAT	High	Very Low	Low	Low	Poor
RAYONG	High	Very Low	Low	Average	Poor
CHON BURI	High	Very Low	Low	Very High	Poor

Table 4.5 The result of KMT evaluate: input and output (cont.)

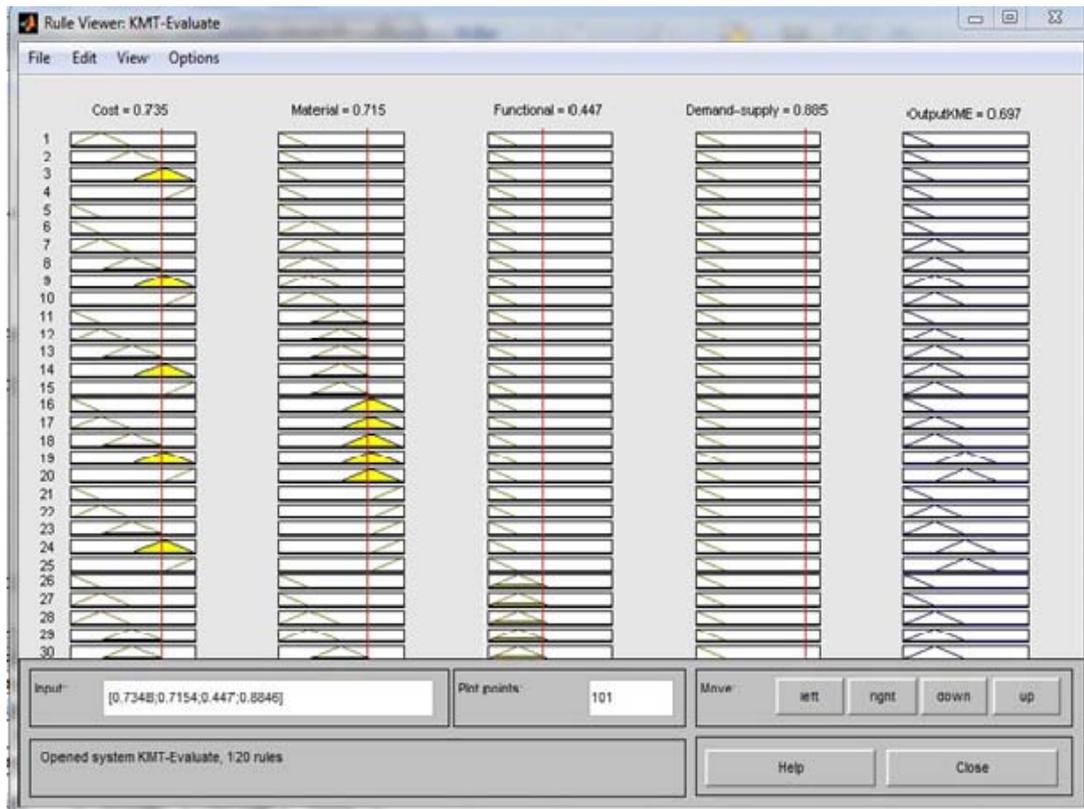| Province	Input				Output Evaluation
	Costs	Material Qurantity	Functionality	Demand - Supply	
North-East					
LOEI	High	Very Low	Low	Average	Poor
UDON THANI	High	Very Low	Low	High	Poor
NONG KHAI	Average	Very Low	Low	Average	Poor
SAKON NAKHON	Average	Very Low	Low	Average	Poor
NAKHON PHANOM	Average	Very Low	Low	Average	Poor
MUKDAHAN	Average	Low	Average	Average	Average
YASOTHON	Average	Very Low	Low	Low	Poor
AMNAT CHAROEN	High	Very Low	Low	Low	Poor
UBON RATCHATHANI	Very High	Very Low	Low	High	Poor
SI SA KET	Average	Low	Average	Average	Average
SURIN	Average	Low	Average	Average	Average
BURIRAM	Average	Low	Low	High	Average
MAHA SARAKHAM	Average	Average	Average	Low	Average
ROI ET	Average	Average	Average	Low	Average
KALASIN	Average	Low	Low	Low	Poor
KHON KAEN	High	Very Low	Low	Very High	Poor
NAKHON RATCHASIMA	High	Very Low	Low	Very High	Poor
CHAIYAPHUM	High	Very Low	Low	Average	Poor
Southern					
CHUMPHON	Average	Very Low	Low	Average	Very Poor
SURAT THANI	Average	Very Low	Low	High	Very Poor
NAKHON SI THAMMARAT	Average	Very Low	Low	High	Very Poor
PHATTHALUNG	Average	Very Low	Low	Average	Very Poor
SONGKHLA	High	Very Low	Low	Very High	Very Poor
SATUN	Average	Very Low	Low	Low	Very Poor
PATTANI	High	Very Low	Low	Low	Very Poor
YALA	High	Very Low	Low	Low	Very Poor
NARATHIWAT	High	Very Low	Low	Low	Very Poor

Figure 4.5 The result of fuzzy system: KMT evaluation Module

The result of material quantity module in fuzzy system represents the example PhraNakhon Si Ayutthaya model. From the Figure 4.5 the output of it is 0.697 that is a Good in fuzzy sets.

Table 4.1 shows the cost evaluating a power plant in which PhraNakhon Sri Ayutthaya and Phi chit were found to be provinces suitable for investments, while Phetchabun was found unsuitable because the evaluation results were low. According to the test results, it is evident that the data aiding in decision making is very complex, with many layers which makes it difficult to be adapted for the formation of mathematical models to accompany decision-making. However, the evaluation of the knowledge management system through Fuzzy deduction can aid the decision-making process of investors.

4.2 The result of candidate sites by fuzzy system

The result of best candidate sites is five provinces in the middle of Thailand. The top five are Phichit, Nakhon Sawan, Chainat, Phitsanulok and Kamphaengphet. They are representing in the Table 4.6 and Figure 4.6

Figure 4.6 The result of candidate site by fuzzy system

Table 4.6 Top five of the best candidate in Thailand

Province	Input				Output Evaluaton
	Costs	Material Qurantity	Functionality	Demand -Supply	
PHICHIT	Low	Very High	High	High	Very Good
NAKHON SAWAN	Low	Very High	Average	High	Good
CHAINAT	Average	High	High	High	Good
PHITSANULOK	Average	High	High	High	Good
KAMPHAENG PHET	Average	High	High	High	Good

From the Table 4.6, Phichit has a very high of the material and the cost of all production is low then Phichit is the best province for locating the rice straw power plant in Thailand.

CHAPTER 5
CONCLUSION

This article presents research about knowledge management in the search for candidate sites for the establishment of power plants in various regions of Thailand. The research is divided into two parts. The first part involved data collection on rice planting areas and roads aimed at finding candidate sites in Thailand by using the centroid theory to specify the areas. The second part involved the evaluation of various data and factors with the Fuzzy system through the division of modules as shown in Figure 4. After the test was deducted with the Fuzzy system, the following could be summarized:

1)   Knowledge management (KM) is essential for use in answering the questions of investors about whether or not they will be successful. Knowledge management (KM) is required to evaluate decisions.

2)   Knowledge management (KM) can evaluate items with complexities, conflicts or incomplete data.

3)   According to this research, the adaptation of Mamdani's fuzzy is essential in helping the system make decisions intelligently. This system is capable of solving problems with ambiguity and uncertainty in decision-making, thereby making the use of the fuzzy system effective in knowledge management.

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APPENDICES

APPENDIX A
EXPERIMENTAL OUTPUT

1. Cost modules output

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Name='Cost_modules'

Type='mamdani'

Version=2.0

NumInputs=5

NumOutputs=1

NumRules=177

AndMethod='min'

OrMethod='max'

ImpMethod='min'

AggMethod='max'

DefuzzMethod='centroid'

[Input1]

Name='Rice_straw_expenditure'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input2]

Name='Employee_expenditure'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input3]

Name='Land_expenditure'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input4]

Name='Maintainance_expenditure'

Range=[0 1]

NumMFs=5

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MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input5]

Name='Upgrade_software'

Range=[0 1]

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MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

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2. Material modules output

[System]

Name='Material_modules'

Type='mamdani'

Version=2.0

NumInputs=1

NumOutputs=1

NumRules=5

AndMethod='min'

OrMethod='max'

ImpMethod='min'

AggMethod='max'

DefuzzMethod='centroid'

[Input1]

Name='Material_Quanity'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Output1]

Name='OutputEvaluateMaterial'

Range=[0 1]

NumMFs=5

MF1='VeryPoor':'trimf',[-0.25 0 0.25]

MF2='Poor':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='Good':'trimf',[0.5 0.75 1]

MF5='VeryGood':'trimf',[0.75 1 1.25]

[Rules]

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3. Functional modules output

[System]

Name='Functional_modules'

Type='mamdani'

Version=2.0

NumInputs=6

NumOutputs=1

NumRules=352

AndMethod='min'

OrMethod='max'

ImpMethod='min'

AggMethod='max'

DefuzzMethod='centroid'

[Input1]

Name='Distance'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

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[Input2]

Name='Transport_price'

Range=[0 1]

NumMFs=5

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[Input3]

Name='Sealability'

Range=[0 1]

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MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input4]

Name='Management'

Range=[0 1]

NumMFs=5

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[Input5]

Name='Security'

Range=[0 1]

NumMFs=5

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Range=[0 1]

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MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Output1]

Name='OutputEvaluateFuntional'

Range=[0 1]

NumMFs=5

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MF2='Poor':'trimf',[0 0.25 0.5]

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4. Demand supply modules output

[System]

Name='KMT-Evaluate'

Type='mamdani'

Version=2.0

NumInputs=4

NumOutputs=1

NumRules=120

AndMethod='min'

OrMethod='max'

ImpMethod='min'

AggMethod='max'

DefuzzMethod='centroid'

[Input1]

Name='Cost'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input2]

Name='Material'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input3]

Name='Functional'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input4]

Name='Demand-supply'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Output1]

Name='OutputKME'

Range=[0 1]

NumMFs=5

MF1='VeryPoor':'trimf',[-0.25 0 0.25]

MF2='Poor':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='Good':'trimf',[0.5 0.75 1]

MF5='VeryGood':'trimf',[0.75 1 1.25]

[Rules]

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5. KME Evaluating output

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Name='KMT-Evaluate'

Type='mamdani'

Version=2.0

NumInputs=4

NumOutputs=1

NumRules=120

AndMethod='min'

OrMethod='max'

ImpMethod='min'

AggMethod='max'

DefuzzMethod='centroid'

[Input1]

Name='Cost'

Range=[0 1]

NumMFs=5

MF1='VeryLow':'trimf',[-0.25 0 0.25]

MF2='Low':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='High':'trimf',[0.5 0.75 1]

MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input2]

Name='Material'

Range=[0 1]

NumMFs=5
MF1='VeryLow':'trimf',[-0.25 0 0.25]
MF2='Low':'trimf',[0 0.25 0.5]
MF3='Average':'trimf',[0.25 0.5 0.75]
MF4='High':'trimf',[0.5 0.75 1]
MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Input3]
Name='Functional'
Range=[0 1]
NumMFs=5
MF1='VeryLow':'trimf',[-0.25 0 0.25]
MF2='Low':'trimf',[0 0.25 0.5]
MF3='Average':'trimf',[0.25 0.5 0.75]
MF4='High':'trimf',[0.5 0.75 1]
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[Input4]
Name='Demand-supply'
Range=[0 1]
NumMFs=5
MF1='VeryLow':'trimf',[-0.25 0 0.25]
MF2='Low':'trimf',[0 0.25 0.5]
MF3='Average':'trimf',[0.25 0.5 0.75]
MF4='High':'trimf',[0.5 0.75 1]
MF5='VeryHigh':'trimf',[0.75 1 1.25]

[Output1]
Name='OutputKME'
Range=[0 1]
NumMFs=5
MF1='VeryPoor':'trimf',[-0.25 0 0.25]

MF2='Poor':'trimf',[0 0.25 0.5]

MF3='Average':'trimf',[0.25 0.5 0.75]

MF4='Good':'trimf',[0.5 0.75 1]

MF5='VeryGood':'trimf',[0.75 1 1.25]

[Rules]

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APPENDIX B

KNOWLEDGE MANAGEMENT TOOLS IN THE CANDIDATE SITE OF RICE STRAW POWER PLANT USING FUZZY SYSTEM

S. Chanamate[a,e1], P. Pisit[b,e2]

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Mahidol University, Nakornpatthom, 73170, Thailand

[b]Department of Computer Engineering, Faculty of Engineering,

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Abstract

This paper proposes a group evaluation structure model in the knowledge management tools for the candidate site of rice straw power plants. The algorithm finds the appropriate knowledge management evaluation (KME) using a fuzzy set theory. The candidate site evaluation is a significant factor in the decision to invest that often involves much information. This information is vague, uncertain and imprecise which leads to the difficult decision-making. Thus the KME is used to decide and evaluate the appropriate candidate sites for power plants. The KME in this research was divided into eight modules including capital management, operational management, cost management, material quantity, functionality management, demand-supply KME, and output, respectively. Some modules received the data from the ArcGIS and evaluate the degree of knowledge management capability (KMC) of an organization using a fuzzy linguistic approach. The result of KMC in using the fuzzy system has the advantage of reducing information distortion and to solving the subjective information by a group of evaluators.

Keywords: Knowledge management evaluation, Fuzzy set theory, Fuzzy linguistic approach and Knowledge management capability

1. Introduction

This research is a presentation of knowledge management in the search for candidate sites for rice straw power plants. The research was developed and designed to help analyze the various complexities of data and problems such as the search for candidate sites for power plants which need to be located be near rice fields and communities in order to reduce costs for the transportation of rice straw and electrical supply. Furthermore, the candidate sites need to be within close proximity to roads for transportation convenience. Citation from geographical analysis is required to acquire the most suitable candidate site in each province. Then an evaluation system using various factors such as land price,

quantity of raw materials and demand for electricity is employed. Once this data is analyzed, it will affect investment also be suitable for use in analyzing risks or projections for the future.
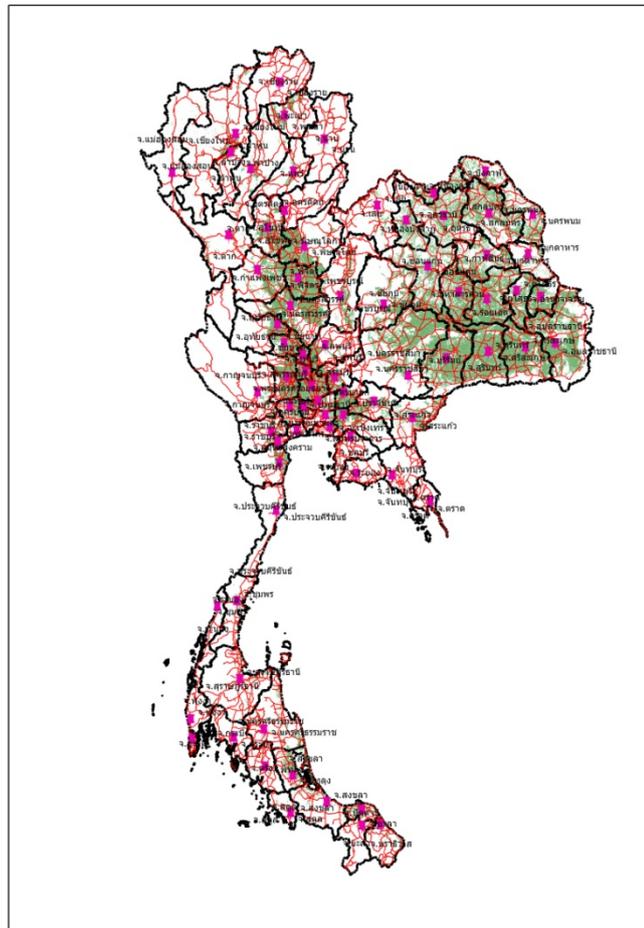

Fig 1. Rice field and Road in Thailand.

2. Theory and Work Principles

2.1 Biomass Energy

Biomass is composed of materials derived from living or natural organic materials that can be transformed into energy. Biomass includes agricultural waste products such as rice straw, rice husks, corn cobs and cassava roots. At present, factories are seeking ways to reduce production costs by using biomass as alternative energy or by processing it for distribution.

2.1.1 Biomass Potential

According to data on agricultural products from 2006-2007, the amount of rice production for the entire country was 29 million tons. When the data is calculated in biomass, it can be sorted into two

categories, namely, rice husks with a biomass value of 0.23 in which 6.87 million tons are available for use when the remainder is calculated, and the amount of heat energy comparable to crude oil is calculated at 2,533 Ktoe and the wattage was 2.5 MW. The remainder is rice straw with a biomass value of 1.19, 35.58 million tons available for use when the remainder is calculated. The amount of heat energy comparable to crude oil is calculated at 13,064 Ktoe, and the wattage was 152.3 MW. [1-3] as shown in Table 1

Table 1. Biomass compositions

Type	Production (Ton)	Biomass	Biomass Generated (Ton)	Total Biomass (ตัน)	Energy content (MJ/kg)	ENERGY(GJ)	equivalents of oil (Ktoe)	Potential power capacit (MW)
Sugar cane	73,501,000	Bagasse	0.30	22,050,300	16.21	357,435,363	8,461	97.20
		Top &Trashier	0.24	17,640,240	16.24	289,652,741	6,857	79.00
Paddy	29,900,000	Paddy husk	0.23	6,877,000	15.56	107,006,120	2,533	2.50
		Straw	1.19	35,581,000	15.51	551,810,992	13,064	152.30
MAIZE	4,249,000	Corn cob	0.19	807,310	16.63	13,425,565	318	3.70
Oil palm	9,264,000	Empty Bunches	0.23	2,130,720	19.41	37,221,547	881	10.20
		Fiber	0.15	1,389,600	19.94	27,708,624	656	7.50
		Shell	0.06	555,840	21.13	11,744,899	278	3.10
		Frond	0.27	2,501,280	17.87	446,997,873	1,058	0.50
CASSAVA	25,155,000	Stalk	0.12	301,860	13.38	4,038,887	96	1.00
		ROOT	0.10	251,550	10.61	2,668,945	63	0.60
PARA RUBBER	3,166,000	SAW DUST	0.03	940,980	16.65	1,581,417	37	0.30
		Wood chip	0.10	316,600	16.85	5,334,710	126	1.30
Eucalyptus	6,800,000	FUEL WOOD	0.20	1,360,000	16.85	22,916,000	542	6.20
		Bark	0.10	680,000	17.3	11,764,000	278	3.10
wood residues	6,000,000	FROND AND LEAVES	0.10	600,000	16.85	10,110,000	239	2.60
	158,035,000			98,118,970		1,499,168,000	35,488	363.40

2.1.2 Effects of Biomass Composition on Energy Production

Each type of biomass has different advantages and disadvantages, depending on multiple factors such as the distribution of biomass sources due to geographical conditions and differing climates of various areas resulting in vastly different production results. Local supply may be insufficient and require supply procurement from other sources which results in additional transportation costs. If the size of each type of biomass is too large, it is not suitable for direct use as energy because a longer period of time is required for combustion. If the moisture levels of some types of biomass are too high, e.g., cassava fiber, and brewer's yeast, which contain up to 80-90% moisture, the moisture has to be removed before combustion, etc.

2.1.3 Energy Production from Biomass

Energy production from biomass can be divided into the following two categories: 1) Direct combustion, a process where biomass is transformed into heat energy where the acquired heat levels are dependent on the type and category of biomass. The acquired heat energy is used to boil water in boilers to transform water into steam for use in efficient electricity production and without effects on the

environment. Materials suitable to this method include various agricultural biomass materials. 2) The use of heating chemicals to induce gasification, an incomplete combustion used to acquire carbon Monoxide (CO) and Hydrogen (H) for use with gas turbines in the production of electricity.

2.2 Centroid Theory in the Selection of Candidate Sites

In determining the centroid position (C_x, C_y) of a geometric shape, if the area of that position has gaps or empty space, the empty space is to be calculated as accompanying areas with results shown in negative values based on a non- self- intersecting close polygon, which has n positions and begins at the center of x and y in the sub areas of each shape in order to locate the centroid of the combined area. The initial values are set as follows: $(x_0, y_0), (x_1, y_1), \ldots, (x_{n-1}, y_{n-1})$. The values can be calculated from the equation as follows: [4]

$$C_x = \frac{1}{} \sum_{i=0}^{n-1} (x_i + x_{i+1})(x_i \tag{1}$$

$$C_y = \frac{1}{6A} \sum_{i=0}^{n-1} (y_i + y_{i+1})(x_i y \tag{2}$$

Assigned A is a polygon signed area then (x_i, y_i) are the position on the top and calculation in (3*)*

$$A = \frac{1}{2} \sum_{i=0}^{n-1} (x_i y_{i+1} - x_{i+1} y_i) \tag{3}$$

After the position is obtained from the use of the centroid theory, the position is marked on a map where the position for each area has to be related to the other control variables, namely, the area amount of rice straw and as close to a road as possible. Conditions can be set in the information technology program (ArcGIS). Data will be obtained as shown in Figure 2, a display of the centroid position and rice areas in Pichit.
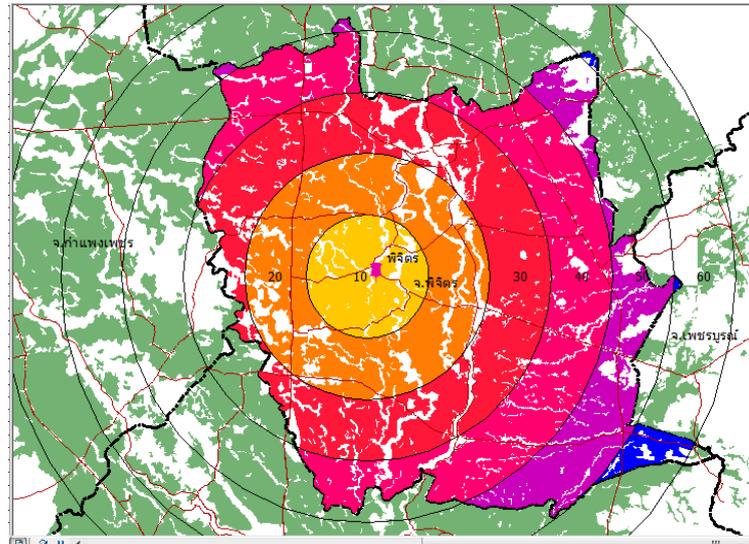
Fig 2: Suitable area for the establishment of a plant at Pichit through the use of centroid theory.

2.3 Knowledge Management (KM)

Knowledge management is an instrument used in the management of knowledge in various tasks aimed at achieving work goals, the development of personnel and corporate development in becoming organizations of learning. Therefore, knowledge management is not a goal in and of itself, but goals of work teams and organizations are the key conditions. Knowledge can be divided into two categories, namely, explicit knowledge (knowledge in the form of documents or academics in work manuals), and tacit knowledge (knowledge concealed in people such as experiences accumulated in evaluation for candidate sites for rice straw power plants involving multiple elements with a great deal of complexity requiring the expertise of evaluators. Tacit knowledge and explicit knowledge in the form of technical information require learning and draw upon knowledge to solve work problems aimed at achieving work objectives. The method for assessing the Fuzzy System has knowledge management methods for both explicit knowledge and tacit knowledge concealed within experts. However, E.W.T Ngai and E.W.C Chan [5] categorized knowledge management criteria into three aspects, namely, system cost, functionality and seller. Cost is a key factor directly affecting the system provider together with product procurement, intellectual property and training costs. Functionality is a component of various functions, including the management of documents, cooperation in the creation of knowledge organizations and sharing, communication, and continuous measurement of work capacity together with safety. The seller of the system is another key property in software procurement [6] aimed at achieving success for system usage goals, credibility, training services, consultation for maintenance support, upgrades and integration of systems, all of which are requiring consideration.

2.4 Fuzzy Systems

Fuzzy logic is the use of relative reasoning, which is different from the use of absolute reasoning of traditional logic with the characteristics of true-false and yes-no answers. Fuzzy logic can adapt the decisions of experts about complex problems. The present study employs fuzzy evaluation in improving knowledge management systems in the selection of candidate sites for rice straw power plants. Fuzzy is used because Fuzzy logic employs Fuzzy truth values in specifying the membership of a fuzzy set, which is different from the probability of randomization. The definition of Fuzzy Set is explained by set X to not be an empty set where Fuzzy Set A can display specific characteristics from membership functions.

$$\mu_{\underline{A}}(x): X \rightarrow [0,1] \qquad (4)$$

Then $\mu_{\underline{A}}(x)$ is a membership of X in fuzzy set $\underline{A}$ for every fuzzy set can be written in (5)

$$\underline{A} = \{(x, \mu_{\underline{A}}(x)) \mid x \in X\} \qquad (5)$$

Then $\underline{A}$ is fuzzy set

x is a set membership

$\mu_{\underline{A}}(x)$ is a membership function

2.4.1 Fuzzy System Basic Structure

The basic structure of the Fuzzy evaluation [7-9] is composed of four key elements as shown in Figure 3.
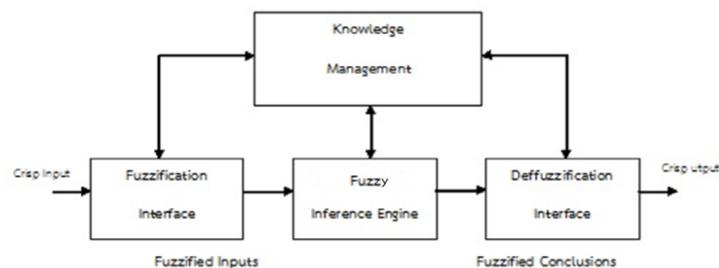

Fig3. The basic structure of the Fuzzy evaluation

For Fuzzification, or the Fuzzy sets called linguistic variables, the knowledge base is an element that stores control data comprising two parts, namely, rule base and database. Rule base is an element for setting control methods acquired from experts in the form of linguistic rule data sets. The database is the preparation of essential elements to be used in setting the control rules and Fuzzy logic data

management. The inference engine is an element for testing facts and rules for use in the interpretation of reasons similar to the mechanism for the control of knowledge in problem-solving in addition to setting interpretation methods for finding answers. Defuzzification is the transformation of data in the form of Fuzzy as a summary or system control values.

2.4.2 Fuzzy Inference System

In this research, the researcher has developed a knowledge management system in searching for candidate sites for rice straw power plants. Fuzzy evaluation was employed and the evaluation was divided into eight modules as shown in Figure 4.
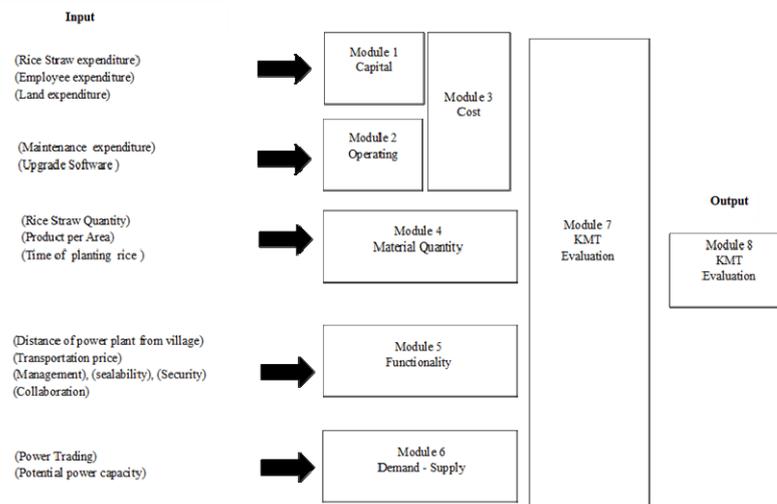

Fig 4. Fuzzy Modules

- Forming fuzzy modules: In the search for candidate sites for rice straw power plants through knowledge management comprises of 8 sub modules, the database was made by the expertise of specialists in investment evaluation together with the geographical and environmental data acquired from
the ArcGIS program composed of modules to manage assets, operations, costs, materials, power plant management, supply and demand, knowledge management evaluation and output.

- Setting functions for members: All member functions for the input and output values in each Fuzzy module of the KME system use the triangle function as shown in Figure 5.
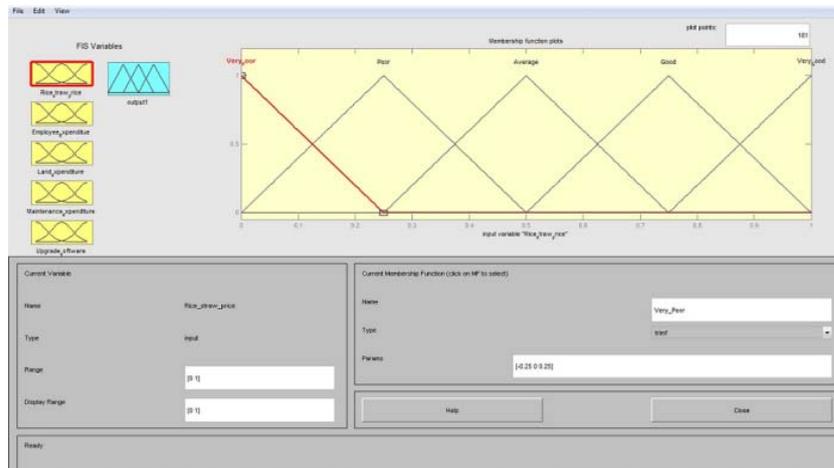
Figure 5. Member functions of KME

2.4.3 Fuzzy Rules

The rules of Fuzzy have structures in characteristics of if-then clauses. These Fuzzy rules are created through the experiences and expertise of specialists in investment evaluation with geographical and environmental data on sites. The ArcGIS program was used to create Fuzzy rules as shown in the following examples:

Cost modules

   - If Rice straw price is Low and Employee price is Average and Land price is law then Costs are Moderately Low

   - If Rice straw price is High and Employee price is Moderately High and Land price is High then Costs are Moderately High

   - If Rice straw price is Very High and Employee price is high and Land price is High then Costs are Very High

Material Quantity Modules

   - If Rice straw quantity is Low then Costs are High

   - If Rice straw quantity is Average then Costs are Average

   - If Rice straw quantity is High then Costs are Low

3. Testing and Outcomes

Fuzzy rules and the database of the aforementioned knowledge management system will have input in the knowledge management system composed of rice straw prices, labor costs, land prices, maintenance, software development and plant management as well as the supply and demands of the

power plant. The knowledge management system evaluated the results as shown in the evaluation example in Table 2.

Table 2. The evaluation example of KME

Province	Input				Output Evaluaton
	Costs	Material Qurantity	Functionality	Demand - Supply	
PHICHIT	Low	Very High	High	High	Very Good
NAKHON SAWAN 60	Low	Very High	Average	High	Good
CHAINAT 18	Average	High	High	High	Good
PHITSANULOK 65	Average	High	High	High	Good
KAMPHAENG PHET 62	Average	High	High	High	Good

The Fuzzy reduction of this test employed triangular Fuzzy sets composed of five sets. The evaluation example shown in Table 2 will be categorized as very poor, poor, average, good and very good, while the cost set in table 3 will be very low, low, average, good and very good, respectively.

Table 3. The cost evaluating a power plant

Province	Costs					Output Evaluation
	Rice Straw	Employee	Land	Maintainace	Software	
SUKHOTHAI	High	Average	Average	Average	Average	Average
KAMPHAENG PHET	Low	Average	Average	Average	Average	Average
PHITSANULOK	Low	Average	Average	Average	Average	Average
PHICHIT	Very Low	Low	Low	Average	Average	Good
NAKHON SAWAN	Very Low	Average	Average	Average	Average	Good

Table 3. Shows the cost evaluating a power plant in which Phra Nakhon Sri Ayutthaya and Phichit were found to be provinces suitable for investments, while Phetchabun was found unsuitable because the evaluation results were low. According to the test results, it is evident that the data aiding in decision making is very complex, with many layers which makes it difficult to be adapted for the formation of mathematical models to accompany decision-making. However, the evaluation of the knowledge management system through Fuzzy deduction can aid the decision-making process of investors

4. Summary and Discussion

This article presents research about knowledge management in the search for candidate sites for the establishment of power plants in various regions of Thailand. The research is divided into two parts. The various data and factors with the Fuzzy system through the division of modules as shown in Figure 4. After the test was deducted with the Fuzzy system, the following could be summarized: first part

involved data collection on rice planting areas and roads aimed at finding candidate sites in Thailand by using the centroid theory to specify the areas. The second part involved the evaluation of

1 .Knowledge management (KM) is essential for use in answering the questions of investors about whether or not they will be successful. Knowledge management (KM) is required to evaluate decisions.

2. Knowledge management (KM) can evaluate items with complexities, conflicts or incomplete data.

3. According to this research, the adaptation of Mamdani's fuzzy is essential in helping the system make decisions intelligently. This system is capable of solving problems with ambiguity and uncertainty in decision-making, thereby making the use of the fuzzy system effective in knowledge management.

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