Local Environmental Quality Evaluation System Based on Fuzzy Analytical Hierarchical Process

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Abstract: - In this study, the Fuzzy Analytic Hierarchy Process (FAHP) analysis technique is applied to the Local Environmental Quality (LEQ) management strategy for the community.The results show that the factors of resource recycling and utilization are the most important influences on the LEQ management strategy of the community. The global weight of the spare resource and utilize is 0.1664, and it is the most important factor in the sub-factor of the steps. In a community sustainable management strategy assessment, the global weights of the spare resource and utilization, impetus the community zero waste, the community installation, and space activation, in pollution prevention of the community, and recycling, reusing, and the installation of polluting factories are the important sub-factors in the LEQ assessment, and would affect the sustainable management strategy assessments, the analysis of the global weights are at 0.17~0.09.

In the aspect of evaluations on bases, Guannan Village has the lowest degree of achievement in sustainable development of LEQ (24.87%). Compared with the other three villages, it's more critical to effectively control the establishment of polluting factories. Also, the equipment for handling pollutants released by factories must be enhanced. And the education on recycling must be carried out.

Key-Words: - Multi-criteria decision making; Local Environmental Quality; AHP; Fuzzy set theory; FAHP.

1 Introduction

43% of the population on earth is living in metropolises (cities). The percentage is expected to go over 60% in 2030. The increasing number of people in metropolises causes complex changes in the development system of urban and rural communities. Related researches also expect that the current community development strategies, which are very loose, would seriously threaten the natural ecosystem and local cultures (such as hillside, rice paddy, and Hakka cultures) of neighborhoods [1][2][3]. Sustainable development is rooted in local-based communities, with advantages in flexibility. The differences between communities are in environment issues, natural and human resources, economic and social stratums, geology, terrain, and weather conditions [4][5][6]. Because of the heterogeneity, if sustainable development is promoted on the level of globe or nation, the issues would be complicated. In other words, it's impossible to find a single method which is suitable for all. Reviewing the documentation related to sustainable development or eco-development, it is found that their focuses are mostly on the national level, or the construction of sustainable indicator system for regions and big cities. It hasn't been carried out on the local level. In Taiwan, sustainable indicator systems for nation or big cities can hardly be used in villages, towns, or even communities on the local level. It can be supported by the fact that the community promoters who were very enthusiastic in the beginning have become confused and the promotion has been delayed. Therefore, the problem of sustainable local development should be discussed from the local aspect. Methods considered from the communities' points of views can allow proper community strategies made according to the opportunities and limitations of different regions. Currently, the promotion of community development in Taiwan is on the national level with programs such as "National Sustainable Development Indicators" or the neighborhood communities promoted by villages, towns, and cities. The management strategies in these promotions are far from enough. Due to the reasons mentioned above which have influenced the community development strategies in villages and towns, sustainable community developments have been promoted separately and piecemeal, thus resources have been wasted. Many studies attempt to develop the analysis methods of LEQ; the results of which would be a source of information for the government to make a decision. Therefore, the baseline of information is provided to examine and improve LEQ in communities. The development of

the indicators was supported by Local Agenda 21 to the LEQ community strategies assessment [7]. Community quality is a very complex concept, and involves the physical environment that provides opportunities for human life to meet their needs and desires [8], In addition, human waste of energy would cause an urban heat island effect and environmental quality to be negative [9][10]. Therefore, the human behavior, such as increased air pollution would influence LEQ, and cause air, water, and soil pollution, thus, the use of natural resources must be decreased [11].

On the other hand, many influential experts, scholars, environmentalists, economists, and politicians care about the problem and the impact of heavy industrial development in the area. They also care about the rapid development of information technology and knowledge-based industries in the western world, because it would influence the Local Environmental Quality (LEQ) [12].

Xiong Ying et al. used AHP and GIS methods to assess the synthetic evaluation of eco-environmental quality [13], the evaluation of regional environment quality is popularly applied, both inside and outside [14].In the application of environmental fields, a lot of experts applied AHP and fuzzy mathematics to offer a compatibility evaluation model of the vital process of compatibility with the environment [15][16]. Actually, the FAHP method is a more integrated application, which breaks down a complex problem into a simple hierarchical decision-making procession, and can be incorporated with fuzzy logic to suggest the relative strength of the factors in the corresponding criteria, thereby, enabling the construction of a fuzzy judgment matrix to facilitate decision-making [17]. In this study, the FAHP analysis technique has been applied to the LEQ management strategy in the community. The goals of this research are as shown below [1]:

1. Use FAHP to study the three levels of hierarchical indicators, considered as strategy, by investigating the community of Miaoli city [2].
2. Use FAHP to analyze benchmarks by questionnaire survey of experts that would promote community sustainable development [3].

2 Review of previous studies

2.1 The definition and aspect of sustainable communities

The construction of a community should follow the basic principle of the health and comfort of human lives, and pursue the co-existence with the environment according to the principle. In the past, humans had put their emphasis on social and economic systems, with the development conception based on people. This means people cared more about their lives and the convenience of their lives, ignoring the harm done to the environment, which had caused a lot of damage to ecology. Gradually the nature has started to lose its balance. To solve this problem, it must begin with communities, because community is the basic unit of human life. And residents of communities have the right to act on their own to guide the development of their communities. From there to villages and towns, eventually the environmental problems will be solved. Therefore, the key to transform Taiwan into a "Green Silicon Island" in the future is to overcome the crises of the environment step by step based on communities, and bring the concept of sustainable ecology to people.

Sustainability has been playing an important role in culture since a long time ago. For example, in the 19th century, the Germans had used the concept of sustainability in production. The first record of the definition of sustainability in written form is from the Canada Conservation Committee in 1915, which is "Every generation has the right to use natural resources. However, they must follow the principle of not damaging those natural resources". In other words, "sustainable communities" means to use the resources available to meet the current demands, and at the same time guarantee that proper resources will be left to future generations. While pursuing better life quality for all the residents, the nature must be kept to function, in order to reduce waste, prevent pollution, improve efficiency, and open up more resources to activate local economics. A sustainable community is like a life system, in which humans, nature, and economic elements depend on each other and gain power from each other. The decisions are made from citizens' rich lives and the information shared by members of the community.

Beatley believed that the ultimate concern of sustainable development is to ensure humans' basic needs and the health of the earth on which their lives depend. He proposed the following principles for sustainable communities [18]:

1. To reduce the degree of the exposure of personnel and property in natural disasters. A sustainable community is a community which can resist disasters.
2. To understand the basic limitations on ecology, and to protect and improve the soundness of the ecosystem.

3. To build up a tighter relationship with natural environment, in order to have better understanding of it.
4. To reduce the consumption of land and resources.
5. To understand the relationships between the targets of the society, economics, and environment.
6. To support composite and integrated strategies.
7. To create a new moral attitude.
8. To pursue the fair distribution of resources, opportunities, environmental risks.

When the belief of "sustainable development" has been spread out all over the world, how to reach sustainability in every area became an issue. Terms like "Eco-nation", "Eco-city", "Eco-community", "Eco-village" and "Green City" have emerged one by one. The reason behind this phenomenon is that humans finally understood that they can not live without natural environment, and they've been living in an environment which is being destroyed little by little. Among them, "sustainable community" is the one being paid most attention to, because its development ideal came from the natural circulation, and it fits the current development of community systems. "Sustainable community" is also called "eco-community" [19]. A community constructed based on the ideal of sustainable development should possess the features of residents being their own masters and the concept of ecology being introduced to the living environment, with purpose of protecting the nature while living in it, to reach the goal of the co-existence of humans and the nature. It is also mentioned in another scholar's study that an eco-community is "minimum resource input and minimum waste output" and "the design of spending the least resources on earth to create a community environment with least waste". Also it should be a community which meets the standard of "ecology, energy saving, waste reduction, and health" [20]. According to these ideals, it can be found that to create a sustainable community is to reach the goals planned earlier, while residents' demands can be met, and the natural eco-environment is not harmed. The goals are listed below [21]:

1. To build a safe and healthy community with local features.
2. To implement community self governance through residents' participation.
3. To use community resources (including substantial environmental resources, cultural heritage, and economic resources) sustainablly.
4. To sustainablly develop the variety (including the variety of life forms and cultures) of the community.
5. To implement the 3R policy of "reduce, reuse, and recycle".
6. To carry out the ideal of "green consumption".

To summarize the above descriptions, it can be found that, the relationship between sustainable development and sustainable community and its value are in the possibility of connecting to the world with the thoughts of sustainable construction. And the power can be generated from local, in order to further bring the thoughts of sustainable development into local. The operating thoughts came from "sustainable development" and "global thoughts, local actions" [22]. To discuss this from another angle, "sustain" means to keep a status, to maintain, and to continue an action. Based on this definition, a sustainable community means a community which becomes more sustainable from unsustainable with a dynamic development process [23][24]. In other words, it means to construct a community by the principles of sustainable development. Through our hard work, the environments we live in will forge ahead toward sustainability. We must find a place for sustainable construction, through which we can make efforts in environment, society, and economics to reach soundness and balance, helping the community moving toward the goal of sustainable development, and further helping the earth moving toward the goal of sustainable development.

As for the aspects it is concerned with, some research indicated that sustainable development include four aspects, which are ecology, production, life, and system. In the production aspect, the goal is the improvement of production efficiency; in the aspect of life, it's the promotion of life quality with health care, community security, and humanistic education; in the aspect of ecology, "conservation of eco-environment" is the goal for environmental landscape and environmental ecology. These are used as evaluation indexes for communities. This is exactly the concept of carrying out the sustainable development in certain area or community. From this kind of context thinking, the aspects considered for choose evaluation variables in this study will be more diversified, as shown in figure 1 [25].

2.2 Sustainable Development of Local Environmental Quality

In the current society, environmental problems follow humans' economic activities. Especially the

environmental pollution caused by enterprises and the public can endanger people's health and reduce environmental quality, leading to the loss of the society. Some of the environmental changes haven't caused serious social loss right away, but these factors will bring major obstructions to human life [7]. Generally, environmental problems can be categorized into two types: one is the direct harm in health caused by public hygiene problems directly. The other is the deterioration problem of comfort caused by environmental quality. The loss caused by these problems and the related reasons differ. Different methods and means should be adopted in environmental policies [26]. It can be concluded that improving local environmental quality can also improve the comfort of environmental quality, providing local residents a comfortable environment to live in. From the documentations, it can be found that living environmental quality can be generalized into three aspects, including improving community environmental quality, promoting community sustainable construction, and creating a humane and safe living space for the community. To improve community environmental quality means to improve convenience of spatial arrangement, service standard of public facilities, communication service system, public equipment service system, and facilities for villages/towns. To promote community sustainable construction includes issues such as landscaping, greening, public nuisance, pollution, and community management. To create a humane and safe living space for the community includes issues such as the arrangement reasonability of constructions, and preparedness against natural calamities. There are a total of 10 evaluation factors, and evaluation items were developed from each factor [27]. According to the research of environmental quality index construction in Taiwan by Yu (1997), there are many complex factors which may influence the environmental quality in Taiwan, the major ones include [28]: (1) the recycling and reuse of the energy and resources. The efficiency of this would influence the consumption condition of each resource and the amount of waste and pollution produced. Therefore under the premise of sustainable development of the environmental quality in Taiwan, the recycling and reuse of resources is an evaluation factor which can not be ignored. (2) Open space is used in Hsie's (2006) study as evaluation index. The comfort of living space is also an important factor which affects people's living environmental quality. Therefore, efficient planning and designing of living space relays on the perfection of the management's plans [29]. In Yu's study, under the premise of sustainable development of local environmental quality, people's living space, residence style, and facilities factors can be categorized into internal space and external space. To make efficient plans and management of each leisure and public facilities in a community, people's living space and the variety of residence styles must be taken into account, so that the facilities and space in the community can be activated. (3) According to Yu (1997) study, environmental pollution has become more and more serious with the development of industry. Factories produce pollutants in the air, water, and waste. These pollutants eventually will pollute the soil, on which our existence depend, leading to the extinction of the human race. Thus, under the premise of sustainable development of local environmental quality, the effective management evaluation factor of environmental pollution is the effective management of the set up of polluting factories, and the pollution of air, water, waste, and soil [28].

Induced from the above description, it can be found that the planning, designing, management, and improvement of environmental quality for sustainable development will reduce the loading of environmental pollution and promote the sustainable development of environmental quality.

3 FAHP & LEQ factors

3.1 Analytic hierarchy process (AHP)

The AHP was developed in the 1970s by Saaty [30]. AHP is an impersonal, systematic, and scientific analysis method, which not only solves complicated decision-making problems, but can also be used to solve problems under uncertain and unclear situations. AHP uses a Normal Scale to perform pairwise comparisons of the factors. Generally, AHP can use Saaty's five-part method to calculate complicated problems and pairwise comparisons, the five parts of the method are: (1 = equal importance; 3 = little importance; 5 = common importance; 7 = certain importance; 9 = absolute importance) [31]. Analytic Hierarchical Process (AHP) was developed by Saaty. It's mainly applied in decision making when the condition is uncertain and there are several evaluation principles available [31]. The purpose of AHP is to systemize complex and unstructured problems by decomposing them from high levels to low levels, step by step, and through quantified judgment, simplifying and improving the previous decision making process which depended on instinct, in order to obtain the weights of each plan to provide

sufficient information for decision makers to choose a proper plan. The plans with higher weights are more likely to be chosen for their priorities are higher. This way the risk of making wrong decisions can be lowered [13]. In the research by Prasanta Kumar Dey, three factors, including environment, economics, and society, were used in the AHP analysis. AHP can be used to build a model for decision making due to the following reasons [32]:

1. All the subjective and objective factors will be used to guide the choice of analysis target in this model.
2. Whether to adopt an evaluation factor or not depends on the weight of it, in order to create the best decision model of target planning.
3. Some subjective factors can reflect the objectivity of other factors.
4. AHP can consider each factor, subjective or objective, with flexibility, and make it easy to understand.
5. After professionals' and scholars' opinions are consistent, weights will be given to all the factors, and decisions will be made, so that decision makers can create a model to manage decisions with a reasonable foundation.

3.2 Fuzzy set theory

Fuzzy Set Theory was proposed by Zadeh in 1965 [33]. He put emphasis on humans' thoughts, inference, and cognitions of surroundings. Its concepts are quite vague. He also believed that many traditional precise quantitative methods can no longer solve complex problems with people being the center. Therefore, the logic concept from Fuzzy is used to descript the things in our daily lives, to improve the shortcomings of using the Boolean logic to describe things in the traditional set theory. In the fuzzy theory, the concept of membership function is used to describe the solutions to uncertain problems related to degrees, which is like the adjectives in humans' natural language, ambiguity encountered in daily lives, or vagueness. The fuzzy set theory could solve unclear, uncertain, and imprecise situations and problems, the fuzzy set theory can be used as a modeling tool for uncertain and complex systems that are difficult to accurately define.

3.2.1 Fuzzy set and membership function

There are many ways to represent a fuzzy set. A common way to show its definition is:

$$A=\{(X, MA(X)) \mid X \in U\} \quad (1)$$

A collection of objects and (universe of discourse) U has a fuzzy set, where A describes a membership function, μA, with values in intervals (0, 1):μA and U(0, 1). Therefore, A can be represented as A ={μA (u)/u; where u∈U}. The degree that u belongs to A is the membership function μA(u)[34].

3.2.2 Fuzzy number

The definition of fuzzy numbers by Klir & Yuan is that [35]: if A is a fuzzy number, then A is a convex set and a fuzzy set which follows normal distribution. Its membership function μA(χ) is a continuous function which maps real numbers to the range [0,1]. And there exists at least one real number χ0 which satisfies μA(χ) = 1. Figure 2 is a triangular fuzzy number.

Membership function:

$$\mu_A(x)\begin{cases}\dfrac{x-c}{a-c} & c \le x \le a, \\ \dfrac{x-b}{a-b} & a \le x \le b, \\ 0 & Otherwise \end{cases} \qquad 0 \le c \le a \le b \quad (2)$$

3.2.3 The calculation of fuzzy numbers

The calculation of fuzzy numbers can be done according to the extension principle of triangular fuzzy numbers. If there are two triangular fuzzy numbers A = (a_1, b_1, c_1) and B = (a_2, b_2, c_2), the basic calculation principles are listed below:

1. Addition：$A \oplus B = (a_1 + a_2, b_1 + b_2, c_1 + c_2)$
2. Subtraction：$A \Theta B = (a_1 - c_2, b_1 - b_2, c_1 - a_2)$
3. Multiplication：$A \times B = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2)$
4. Division：$A \div B = (a_1 / c_2, b_1 / b_2, c_1 / a_2)$

3.2.4 Defuzzification

Defuzzification means to transform a fuzzy set into a specific value. Among many defuzzification methods, center of gravity method is the simplest one which doesn't require decision maker's personal preference. The principle of the center of gravity method proposed in documentation is to calculate the center of gravity of a triangle. In other words, the center value of a fuzzy set is used to present the whole set. The calculation method is listed below: If $\tilde{A}ij=(L_{ij},M_{ij},R_{ij})$ is a triangular fuzzy number, its fuzzy weight DF_{ij} is [36]:

$$DF_{ij} = \frac{(R_{ij} - L_{ij}) + (M_{ij} - L_{ij})}{3} + L_{ij} \quad (3)$$

3.3 Consistency test of the hierarchical structure

Through the AHP method proposed by Satty, the result obtained from data analysis is in fact a calculation process of FAHP. In other words, the value calculated from AHP is the mij in FAHP. Therefore, if the CI of mij meets the requirement of the consistency test (CI<0.1), it can be inferred that the result calculated by FAHP is consistent [37].

3.3.1 Consistency Index (C.I.)

Consistency index (CI): The formula is listed below. Where n is the number of hierarchical factors and λmax is the eigenvalue of the comparison matrix created by evaluator. Random index (RI): The value can be obtained from table 1.

$$C.I. = \frac{\lambda_{man} - n}{n-1} \tag{4}$$

3.3.2 Consistency ration (CR)

Consistency ration (CR): The formula is listed below. If C.R. $\leqq$ 0.1, it means when the decision maker creates a comparison matrix, the degree of deviation for the judgment of each factor weight is acceptable, meaning it' s consistent.

$$C.R. = \frac{C.I.}{R.I.} \tag{5}$$

3.4 The factors of LEQ

As mentioned in Agenda 21, to achieve the implementation of sustainability in the environmental quality inside communities, the important factor is the management of the recycling and reuse of resources, the style and features of a community and facilities, and the degree of environmental pollution [38]. Maclaren (1996) suggested that in the process of creating indexes for sustainability, six evaluation bases must be taken into account, including domain basis, target basis, department basis, topic basis, causal structure, and overall basis [39]. Therefore, this study referenced the documentations mentioned above and the opinions from experts, to select evaluation factors of the sustainable community decision management in local environmental quality (LEQ). The hierarchical structure of the decision management model is shown in figure 3.

3.4.1 Resource recycling and utilization

Local environment is a man-made space, on which people's lives depend. It's a substantial space which was not formed naturally. The execution of the environment regulatory policy shall improve "local environmental quality", how good the "local environmental quality" is depends on the conditions of air, water, and waste. Generally, it means the prevention of pollution. Under the premise of maintaining local environmental quality, it is necessary to efficiently implement the recycling and reuse of resources and reduce the loading on environment created by all kinds of pollution. To efficiently implement the recycling management, it requires everyone's participation, in order to efficaciously control the pollution of waste, keep the environment clean, and insure the health of people [29]. If it is not done right, the maintainability of sustainable development would also be effected [25]. The report of sustainable community development by Woodrow W. Clark II discussed the influences of the management of renewable energy and resources on the sustainable development of communities. If there is no management system of renewable energy and resources, the energy and resources which can be reused would become waste and disposed. The usability of land would be reduced and there would be more pollution [40]. The study by Ivan Vera and Lucille used the management of waste as one of the indexes for sustainable development, to evaluate the sustainability of natural resource management [41]. Besides, Gerhardus Schultink indicated that the influence of environmental pollution on sustainable development is of full scale. The maintainability of sustainable development can also be affected by the management of resources, disposal of waste, and quality of management [42]. Thus, in this study, for the resource recycling and utilization to improve "local environmental quality", five indexes were used, including pollution prevention of the community, resources spare and utilization, recycle and reuse, development renewable sources of energy.

3.4.2 Community style, feature and installation

People live in groups. Community is the basic unit of living. The demands in life drive the development of that region. Therefore, environmental quality is closely linked to us human beings. Basically, environmental quality is the accumulated record left after development. Before going into discussion on how accumulated influence is formed, the background of the occurrence of this influence, which is also the content of development structure, should be understood clearly first, in order to confirm the subjects being influenced. The substantial space structure of a place means all kinds of visible facilities. Therefore, all kinds of buildings

and facilities are included in the range of substantial development [43]. It includes aspects such as the space needed for all kinds of human activities, the type of residence and its usage condition, historical culture, and public facility management and planning. Gerhardus Schultink also indicated in his study that the design and management of space of a place would influence the maintainability of sustainable development [42]. Woodrow W. Clark II pointed out that, because the design and management of buildings could influence the consumption of energy and resources, if materials with weaker influence on environment can be used, and greening planning and management can be carried out efficiently in designing buildings, then the influence of buildings on environmental energy and resources can be reduced [40]. Thus, in this study, for the community style, feature and installation to improve "local environmental quality", four indexes were used, including each person's living space and area, housing style and multiplicity, construct the community style and features, community installation and space activation.

3.4.3 The extent of the environment pollution

C. Mondini and P. Sequi proposed that soil is the basic substance needed for human beings to live. The quality of organic matters in soil or the degree of pollution can influence the environmental quality and the sustainable development of the society of human beings [44]. Generally, factories produce polluting substances such as waste water, waste gas, and waste, which would influence the ecology of our environment. In order to carry out pollution prevention efficiently, it is necessary to efficiently control those polluting factories and to prevent the pollution in soil. Therefore, in this study, for the extent of the environment pollution to improve "local environmental quality", two indexes were used, including installation of pollution factories, soil resource pollution.

4 Methodology

In this study, the FAHP analysis technique is applied to the LEQ management strategy in the Case of the community of Miaoli. Therefore, FAHP is not only developed to solve complicated decision-making problems, but can also accurately solve uncertain and unclear problems [34].

The proposed FAHP model is used to analysis the LEQ situation in the case of the community of Miaoli. acorrding to the figure 4 of this study is composed of the following [45]:

1. Identify the factors and sub-factors to be used in the model.
2. Structure the AHP model based on the goal, factors, and sub-factors. Then, list the AHP model structure goal of the first level, factors of the second level, and the sub-factors of the third level.
3. Use fuzzy theory to create a FAHP questionnaire. Then, invite six experts and scholars examine the FAHP questionnaire.
4. Calculate different FAHP questionnaire questions and determine different opinions of six experts and scholars on the relative importance of fuzzy numbers and relative membership functions of the fuzzy judgment matrix and weight vector.
5. Calculate the local weights of the factors and sub-factors using pairwise comparison. Finally, show the global weight of these different sub-factors.
6. LEQ evaluation principles were made for the field study. Four villages in Gongguan Township, Miaoli County were selected for case simulation (figure 5). The feasibility of the LEQ decision model was evaluated by the degrees of achievements of the sustainable indexes for these four villages (as shown in table 2).

5 Field survey

The purpose of field survey is, through case study, to review the feasibility of the LEQ decision making structure for sustainable community, and at the same time, to understand current communties' substantial conditions of LEQ for sustainable communities, and to provide suggestions for future improvement.

5.1 Choice of base

The choice of base for field survey depends on the research purpose of this study, the definition of sustainable communities' LEQ, research duration, man power, and material resources. Considering all these, the principles for choosing base in this study is listed below:

1. Clustered community is the first choice, in order to avoid the piecemeal community development research in the current studies. The community should evolve with time, and can be "renewed" by experts, economic decision makers, and residents.

2. Setting up sustainable community indexes corresponding the definition of LEQ in this study, including indexes for the recycling and reuse of resources, the style and features of a community and facilities, and the degree of environmental pollution.
3. Evaluating the feasibility of these indexes by field survey.

Following the principles above, bases were selected from the Golden Town Community. The Golden Town Community was established in 2003, including Guannan, Fuji, Fuxing, and Shiqiang. After performing evaluations on these four villages, suggestions for improvement were made.

5.2 Current conditions of the bases

5.2.1 Guannan Village

Guannan used to be a typical agricultural village. Gradually it was transformed to develop more diversified and delicate industries. In the recently years, the tourism industry seems to be the one with most potential. Residents, businesses include traditional artistry, pottery, bamboo weaving, guesthouse, garden landscape, floriculture, and tourist farm. All these have added colorful features to the local industries

5.2.2 Fuxing Village

In the early days, the main industry was agriculture. After the efforts by the community residents, all kinds of programs and activities have been developed, such as: training for community tour guides, "appointment with forest cities" program, environmental protection volunteer team (keeping the roads in the community clean), seminars for transformation of industries with local colors, visiting trips to communities in other counties/cities, the plan to recreate the lives with countryside water channels, etc.

5.2.3 Fuji Village

The main industry is agriculture. Most farmlands are rice fields and jujube fields. Jujubes are also used as dietary materials by Fuji Village, and restaurants with features have been developed. This is the main economic source of Fuji village.

5.2.4 Shiqiang Village

There are three treasures in Shiquiang village: jujubes, sweet potatoes, and water channels. The main industry is agriculture. Most farmlands are rice fields and jujube fields.

5.3 Survey results

5.3.1 Guannan Village

The research range of this base is about 11,192 m^2, and the area for survey evaluation is 5,596 m^2. The plants in this area are mainly shade trees and bonsais placed in stores, outside doors of residences, on balconies, and on windowsills. Most of the trees are deciduous trees. In the research base, the crops in residents' own vegetable gardens/farms are mostly natural and original. Rice fields and jujube fields occupy 45% of area of this base. Overall, this place is still lack of greening. Shade trees include royal palms, golden showers, green maples, and camphor trees. They all grow very well. The survey had recorded the environment greening conditions of the parking lots, roads, buildings, plazas, and sidewalks of Guannan Village. The green-covered area is 1,007 m^2, which is about 18% of the total area. The current condition of Guannan Village is shown in figure 6.

In the city planning, this area was marked off as agricultural area and residential area. But small factories can still be found by Datong Road. Most of the buildings contain 3 or 4 floors of residential-commercial and residential-industrial use. There are also many old brick or wood-frame farmhouses. Generally, most of the building materials are RC and bricks. The tops of buildings are mostly iron sheets. The detailed survey results are listed in table 3.

5.3.2 Fuxing Village

The research range of this base is about 31,600 m^2, and the area for survey evaluation is 10,533 m^2. This area is in the south of Guannan Village. It's the only innocent place left. There is a high-quality and safe water channel in the village for irrigation. The vegetation engineering is more complete. The government has spent NT$3,000,000 on the renovation of this place by eco-technology. Most of the crops are rice, jujubes, and sweet potatoes. Shade trees are mainly green maples and camphor trees, which grow very well. The survey had recorded the environment greening conditions of the parking lots, roads, buildings, plazas, and sidewalks of Fuxing Village. The green-covered area is about 2,317 m^2, which is about 22% of the total area. The current condition of Fuxing Village is shown in

figure 7. The detailed survey results are listed in table 3.

5.3.3 Fuji Village

The research range of this base is about 20,322 m^2, and the area for survey evaluation is 6,774 m^2. This area is in the south-east of Fuxing Village. The main road is Guanzhong road. The plants in the area are mainly the plants in the small gardens before the residential and residential-commercial buildings. Most of them have been grown naturally with a variety of breeds. Rice fields and jujube fields occupy more than 50% of area of this base. The building materials are mostly RC. There is a ceramics museum in this village. The main road is Guanzhong road, with rather heavier traffic. Shade trees are mainly green maples and camphor trees, which grow very well. The survey had recorded the environment greening conditions of the parking lots, roads, buildings, plazas, and sidewalks of Fuji Village. The green-covered area is 948 m^2, which is about 14% of the total area. The current condition of Fuji Village is shown in figure 8. The detailed survey results are listed in table 3.

5.3.4 Shiqiang Village

The research range of this base is about 30,240 m^2, and the area for survey evaluation is 15,120 m^2. This area is in the south-west of Fuji Village. The main road is Guanzhong road. The plants in the area are mainly the plants in the small gardens before the residential and residential-commercial buildings. Most of them have been grown naturally with a variety of breeds. Rice fields and jujube fields occupy more than 55% of area of this base. The building materials are mostly RC. There is a ceramics museum in this village. The main road is Guanzhong road, with rather heavier traffic. Shade trees are mainly green maples and camphor trees, which grow very well. The survey had recorded the environment greening conditions of the parking lots, roads, buildings, plazas, and sidewalks of Shiqiang Village. The green-covered area is about 3,780 m^2, which is about 25% of the total area. The current condition of Shiqiang Village is shown in figure 9. The detailed survey results are listed in table 3.

6 Result and discussion

6.1 FAHP weight analysis

In the results, the three factors are the FAHP structure, shown in figure 3. This research is with the fuzzy theory of the trigonometry. In addition, in the initial of the questionnaire, we asked each expert and scholar to choose an importance value, for the fuzzy maximum value, median value, and minimum value, separately. Then, calculate each of experts and scholars fuzzy values of different importance intensities, separately.

According to the researcher's experience in the past, using arithmetic means to integrate the expert opinions into a consistency index (C.I.), and consistency ratio (C.R.), of the highest values, would result in inconsistencies. However, using geometric means to calculate the results would provide consistency. It can be found from table 4 that the consistency index and consistency ratio of each index are both less than 0.1. The test criterion is the CI of pair-wise comparison matrix < 0.1 and the CR of it <0.1. Therefore the overall hierarchical structure's CI and CR values are acceptable. Therefore, the research integrated experts and scholars opinions with a geometric mean method to integrate consistent opinions, and then, the FAHP could calculate each factor and sub-factor weight value. The results are shown, as below.

In this result, the influences of the factors on LEQ management strategies of a community are showed in Table 5. The local weight of resource recycling and utilization is 0.5239, and is higher than the local weights of community style, features, and installation (local weight: 0.3154). In addition, the local weight of the community style, features, and installation is higher than the local weight of the extent of the environmental pollution (local weight: 0.1607). Therefore, the factors of resource recycling and utilization are the most important influences on LEQ management strategies of a community, without a complete resource recycling and utilization management system to influence the overall ecology, all living organisms could become extinct.

In Table 5, the sub-factors of resource recycling and utilization are calculated. The local weight of the resources spare and utilization is 0.3177, and the local weight is higher than the local weight of the impetus of the community zero waste (local weight: 0.2566), the local weight of the pollution prevention of the community (local weight: 0.2308), the local weight of recycle and reuse (local weight: 0.1949), and the local weight of the development of renewable sources of energy (local weight: 0.0908). Therefore, the resources spare and utilization are very important sub-factors in resource recycling and utilization.

In Table 5, the community style, features, and installation are the next important factors, the sub-

factors of the community style, feature, and installation are calculated. The local weight of the community installation and space activation is 0.4029, and the local weight is higher than the local weight of the housing style and multiplicity (local weight: 0.2177), the local weight of the construct the community style and features (local weight: 0.2068), and the local weight of the each person's living space and area (local weight: 0.1726). The results show that the sub-factors of community installation and space activation are very important in the factors of community style, features, and installation.

Table 5 shows that the extent of environmental pollution is the third most important factor of these factors, the sub-factors of the extent of the environment pollution are calculated. The local weight of the installation of pollution factories is 0.5654, and the local weight is higher than the local weight of soil resource pollution (local weight: 0.4346). Therefore, the sub-factor of the installation of pollution factories is a very important sub-factor in the factors of the extent of the environmental pollution.

The global weights of the all sub-factors in the FAHP structure are shown in Table 6, the global weight of resources spare and utilization is 0.1664, and is the most important factor in the sub-factors of this step. Following this are the global weights of the impetus of community zero waste, community installations, space activation, pollution prevention in the community, recycling and reusing, and the installation of pollution factories are 0.1344, 0.1271, 0.1209, 0.1021, and 0.0909, respectively. In community sustainable management strategy assessment, the global weights of the resources spare and utilization, impetus the community zero waste, community installations and space activation, pollution prevention by the community, recycling and reusing, and the installation of pollution factories do not directly affect human life and health. Nevertheless, they are the important sub-factors in the LEQ assessment, and will affect sustainable management strategy assessment. Therefore, the analysis of the global weights are 0.17~0.09.

In addition, the global weights of soil resource pollution, the housing styles and multiplicity, which construct the community style and features, each person's living space and area, renewable development of sources of energy are 0.0699, 0.0687, 0.0652, 0.0544, and 0.0476, respectively. The global weights of soil resource pollution, housing styles and multiplicity, construct community style and features, every person's living space and area, and development of renewable sources of energy are 0.07~0.05. Even though these sub-factors are very low, they affect the whole assessment of the LEQ.

6.2 Evaluations on bases

Summarizing the evaluation results above, tables 7~10 show the class-transformed values of evaluation factor scores for bases multiplied by the factor weights, as described below:

1. The degree of achievement for each evaluation item is divided into different classes according to its score.
   A. Two classes: 0 point for the first class and 1 point for the second.
   B. Three classes: Calculating the overall average of that region for class demarcation.
   C. Four classes: Calculating the overall average of that region for class demarcation.
2. Multiply the transformed value of each evaluation item by the weight of the third-level factor to obtain the degree of achievement of the third-level factors.
3. Sum up the degree of achievement of the third-level factors from the 2nd step by group, then multiply it by the corresponding second-level factor weight, to obtain the degree of achievement of the second-level factors. And so forth, the degree of achievement of the first-level and final target level will be obtained.

6.2.1 The evaluation result of the third-level factors

Tables 7~10 show the class-transformed values of evaluation factor scores for bases multiplied by the factor weights, as described below:

6.2.1.1 Evaluation factors of the resource recycling and utilization

From table 7, it can be found that the first ground is composed of five evaluation factors of the resource recycling and utilization: impetus of the community zero waste, pollution prevention of the community, resources spare and utilization, recycle and reuse, development renewable sources of energy.

1. Impetus of the community zero waste

Among the four villages, Guannan, Fuji, Fuxing, and Shiqiang, for the degree of achievement in promotion of zero waste in the community, Guannan Village is the village with the best efficiency. The reason is that the concept of trash reduction has been put into practice in Guannan Village. There are recycling stations in the

community, that's why the evaluation score is high. The second place is Fuxing Village, while there are no such trash reduction related activities in Fuji Village and Shiqiang Village, which scored low.

2. Pollution prevention of the community

Among the four villages, Guannan, Fuji, Fuxing, and Shiqiang, for the degree of achievement in prevention of community pollution, all of them have scored at least 83% of the ideal value. The reason is the enhanced guidance in the aspects of handling and preservation for prevention of pollution, pollution pleading, and the handling of pollution pleading. Also, a community covenant has been legislated to promote a living eco-environment without pollution and to provide residents a common consciousness to improve the prevention of pollution in the community. The degrees of achievement for Guannan, Fuji, Fuxing, and Shiqiang are all 23.08%.

3. Resources spare and utilization & recycle and reuse

In the aspect of energy saving, recycling & reuse, none of the four villages has done well. The residents in these areas have no concepts of recycling and social ethic in environment protection. And there is no propaganda of these concepts in the cleaning team of the community. Therefore, mistakes have been left uncorrected. It has to be improved. Also, residents of the community litter, which leads to the pollution of environment. Thus both the degree of achievement and the ideal value are low.

4. Development renewable sources of energy

In the aspect of development of renewable energy, all the villages except Guannan Village have the degree of achievement of 9.08%. Because there is a water channel going through Fuji, Fuxing, and Shiqiang, and the government has provide subvention to promote the preservation of ecology of the water channel and the applications of renewable energy. The water from the water channel is used to generate electric power for the sprinkler system to reduce the consumption of energy. In Guannan Village, there is no obvious reuse of renewable energy or resources to develop renewable energy. Therefore both the degree of achievement and the ideal value are low.

6.2.1.2 Evaluation factors of Community style, feature and installation

From table 8, it can be found that the first ground is composed of four evaluation factors of the evaluation factors of Community style, feature and installation: each person's living space and area, housing style and multiplicity, construct the community style and features, community installation and space activation.

1. Each person's living space and area

For the four villages, Guannan, Fuji, Fuxing, and Shiqiang, the square measures of living space per person are 2.66 m^2, 12.99 m^2, 14.69 m^2, and 15.38 m^2, respectively. The evaluation method is to calculate the average density of population according to the data from the administrative office of the town, as the basis of demarcation. From the data, the average density of population (square measure per person) is 9.33 m^2, which is used for the 2-class demarcation.

2. Housing style and multiplicity

For the variety of residence type, in this study, demarcation is done according to the materials used: RC, brick, and wood. The three classes are: first class – 1 material; second class – 2~3 materials; third-class: more than 3 materials. From the data, it can be found that the houses in Fuji and Fuxing are with a larger variety of buildings, which are made of RC, brick, and wood. The buildings in Shiqiang are mainly RC or brick buildings, while those in Guannan are mostly made of RC. The degrees of achievement of Guannan, Fuxing, Fuji, and Shiqiang are 5.44%, 8.71%, 8.71%, and 7.62%, respectively.

3. Construct the community style and features

For construction of community style & features, demarcation is done according to the construction ratio and the Local Unique Construction Regulations. One unique construction gets 1 point. The total is 6 points. There are 3 classes with difference of 1 point. According to the results, in Guannan Village, there is only one unique construction, while there is none in Fuji Village. Therefore they are in class 1. There are Guandi Temple and Shimu Shrine in Shiqiang Village, which belongs to class 2. in Fuxing Village, there are Blue Collar Art Hall, a granary, Chuanlong Water Channel, and Fuxing Ceramics Factory. It's in class 3.The degrees of achievement of Guannan, Fuxing, Fuji, and Shiqiang are 5.17%, 8.27%, 5.17%, and 7.24%, respectively.

4. Community installation and space activation

The community facilities & space activation depend on the income of the community which is related to the implementation of plans and construction work. Therefore, for community

facilities & space activation, demarcation is done according to the average outgoings the government has spent on the communities. There are 2 classes. Class 1 contains communities with income less than NT$220,000 and class 2 is over NT$220,000. All the villages except Guannan have incomes over NT$220,000. The degrees of achievement of Guannan, Fuxing, Fuji, and Shiqiang in community facilities & space activation depend are 0.00%, 40.29%, 40.29%, and 40.29%, respectively.

6.2.1.3 Evaluation factors of the extent of the environment pollution

From table 9, the third group of the extent of the environment pollution includes the installation of pollution factories and the soil resource pollution.

1. Installation of pollution factories

The set up of polluting factories is demarcated according to the number of polluting factories into 3 classes: first class – with more than 3 polluting factories; second class – 2~3 polluting factories; third class – 0 or 1 polluting factory. The data show that there are more than 3 polluting factories in Guannan, and more than 2 in Fuxing, while the other 2 villages have 1 or less polluting factory. The degrees of the set up of polluting factories of Guannan, Fuxing, Fuji, and Shiqiang in community facilities & space activation depend are 14.13%, 22.61%, 22.61%, and 22.61%, respectively.

2. Soil resource pollution

The pollution of soil resources is demarcated according to the usage of insecticide. By the area of farmland with the usage of insecticide, the classifications are: first class – Over 60% of the farmland with the usage of insecticide; second class – 40~60%; third class – 20~40%. The data show that there are 65% and 63% areas in Shiqiang and Fuji are farmland. Therefore they are of the first class. Fuxing are in the second class with 48% and Guannan in the third class with 25%. The above values are multiplied by the factor weights and the degrees of the pollution of soil resources of Guannan, Fuxing, Fuji, and Shiqiang in community facilities & space activation depend are 7.24%, 14.49%, 21.73%, and 21.73%, respectively.

6.2.2 Integrated analysis on evaluation results

6.2.2.1 Second level

Three evaluation factors, including the resource recycling and utilization, community style, feature and installation, the extent of the environment pollution, are used in this study as the LEQ sustainable development second-level evaluation indexes. Table 10 shows that, in the aspect of the development of renewable energy, all the villages, except Guannan Villiage, have reached the degree of 9.08%. There is a water channel passing through Fuxing, Fuji, and Shiqiang, and the government has helped with the promotion of the ecology preservation and renewable energy applications, for example, the water from the water channel is used to generate electric power for the sprinkler system to reduce the consumption of energy. In Guannan Village, there is no obvious reuse of renewable energy or resources to develop renewable energy. Therefore both the degree of achievement and the ideal value are low. In the aspect of the evaluation of the degree of achievement in the recycling and reuse of resources, Fuxing, Fuji, and Shiqiang have done better. The degrees of the achievements in recycling and reuse of resources of Guannan, Fuxing, Fuji, and Shiqiang are 17.47%, 21.55%, 20.21%, and 20.21%, respectively.

In the aspect of the achievement in community style, feature and installation, in Fuxing Village, because the living space per person is rather large, and there are unique constructions such as Blue Collar Art Hall, a granary, Chuanlong Water Channel, and Fuxing Ceramics Factory, the degree of achievement is high, 23.51%. As for Shiqiang Village, there are Guandi Temple and Shimu Shrine, the degree of achievement is also high, 22.84%, which is only second to Fuxing Village. Due to not having enough unique construction, the degree of achievement, 22.53%, is lower than Shiqiang. According to the data, in Guannan Village, the community income if low, population is high, area is small. The living space per person is only 2.66 m^2, which is in the first class, and is lower than the average density of population of 9.33 m^2. Compared with the density of population of 9.33 m^2 (square measure per person): Fuxing, Fuji, and Shiqiang have similar average area measures and populations. The space for recreation and the green are broad. Relatively, the living space per person, which is in the second class, is higher than the average density of population of 9.33 m^2. The constructions in Guannan Villages are all made of RC, which means the variety is low. And there is only one unique construction in the village – the Lotus Lily House. Therefore, its degree of achievement in community style, feature and installation, which is 3.35%, is the lowest.

In the aspect of the degree of achievement in the

extent of the environment pollution, because of the differences of the set up of polluting factories and the pollution of soil resources among Guannan, Fuxing, Fuji, and Shiqiang, the extent of the environment pollution are also different. The result shows that the degrees of the achievements in the extent of the environment pollution of Guannan, Fuxing, Fuji, and Shiqiang are 3.44%, 5.96%, 7.13%, and 7.13%, respectively.

6.2.2.2 Target level

The first level in this study is the target level of LEQ. The final result in table 10 shows that the degree of achievement in sustainable development of LEQ for Fuxing Village is 52.32%, followed by Shiqiang Village (51.45%) and Fuji Village (51.13%). Guannan Village has the lowest degree of achievement in sustainable development of LEQ (24.87%). Guannan Village's area measure is rather small while the population is high. And there are many polluting factories in the village. Compared with the other three villages, the residents in Guannan Village didn't do well in recycling, and that leads to the low degree of achievement in sustainable development of LEQ.

7 Conclusion and propose

The factor of resource recycling and utilization are the most important influences on LEQ management strategies of a community. The global weight of the resources spare and utilization is 0.1664, and it is the most important factor in the sub-factors. In community sustainable management strategy assessment, the global weights of the resources spare and utilization n, impetus of community zero waste, community installations and space activation, pollution prevention of the community, recycling and reusing, and the installation of pollution factories do not directly affect human life and health, however, they are important sub-factors in the LEQ assessment, and will affect the sustainable management strategy assessment. Therefore, the analysis of the global weights are 0.17~0.09. Finally, the global weights of soil resource pollution, housing style and multiplicity, construct the community style and features, each person's living space and area, and development of renewable sources of energy are 0.07~0.05. Although these sub-factors are very low they would still affect the whole assessment of the LEQ. In the aspect of evaluations on bases, the degree of achievement in sustainable development of LEQ for Fuxing Village is 52.32%, followed by Shiqiang Village (51.45%) and Fuji Village (51.13%). Guannan Village has the lowest degree of achievement in sustainable development of LEQ (24.87%). The main reason is that the residents in Fuxing Village have done well in recycling and put a lot of efforts in the improvement of the style and features of a community and facilities. But Fuxing's prevention of pollution still needs more attention. As for Shiqiang and Fuji, they are similar in population, area measure, building type, lifestyle, and residents' consciousness. Therefore, the degrees of achievement in sustainable development of LEQ for these two villages are not much different. Guannan Village's area measure is rather small while the population is high. And there are many polluting factories in the village. Compared with the other three villages, the residents in Guannan Village didn't do well in recycling, and that leads to the low degree of achievement in sustainable development of LEQ.

And the suggestions are: in the aspect of the sustainable development of LEQ, Guannan, Fuji, and Shiqiang need to improve their recycling and put emphasis on the style and features of a community and facilities. With education, promotion, and encouragement, the residents of these three villages can handle the waste in their villages better. There are no activities related to energy saving and recycling in all four villages, to improve the sustainable development of LEQ in recycling and reuse of resources. Guannan's area measure is small but the population is high, therefore the space needs to be activated and used properly. Fuxing and Guannan haven't done well in the prevention of environment pollution, it needs to be improved. Guannan Village's area measure is rather small while the population is high. And there are many polluting factories in the village. Compared with the other three villages, it's more critical to effectively control the establishment of polluting factories. Also, the equipment for handling pollutants released by factories must be enhanced. And the education on recycling must be carried out.

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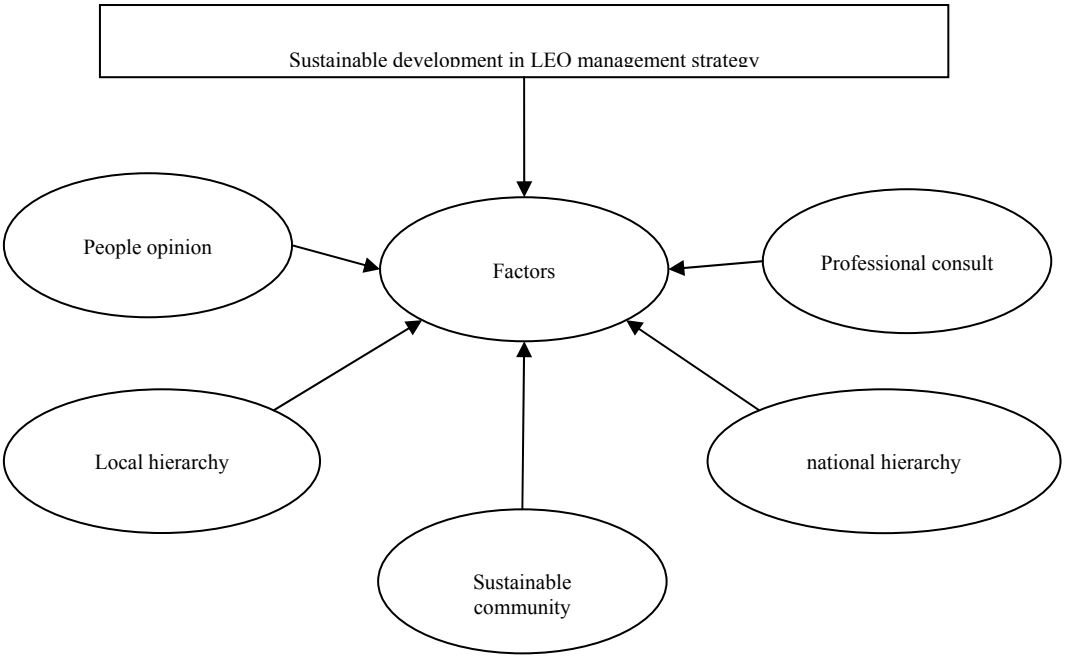

Fig. 1 The discuss and consider in the factors face

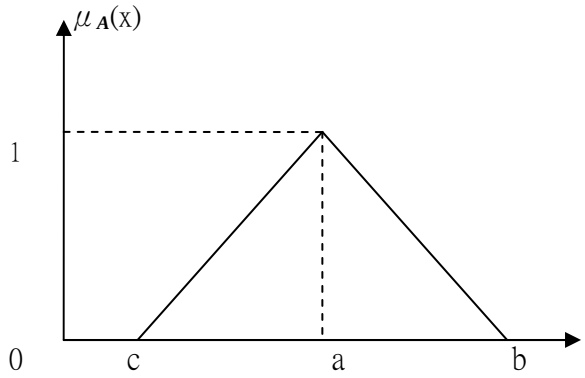

Fig. 2 triangular fuzzy number

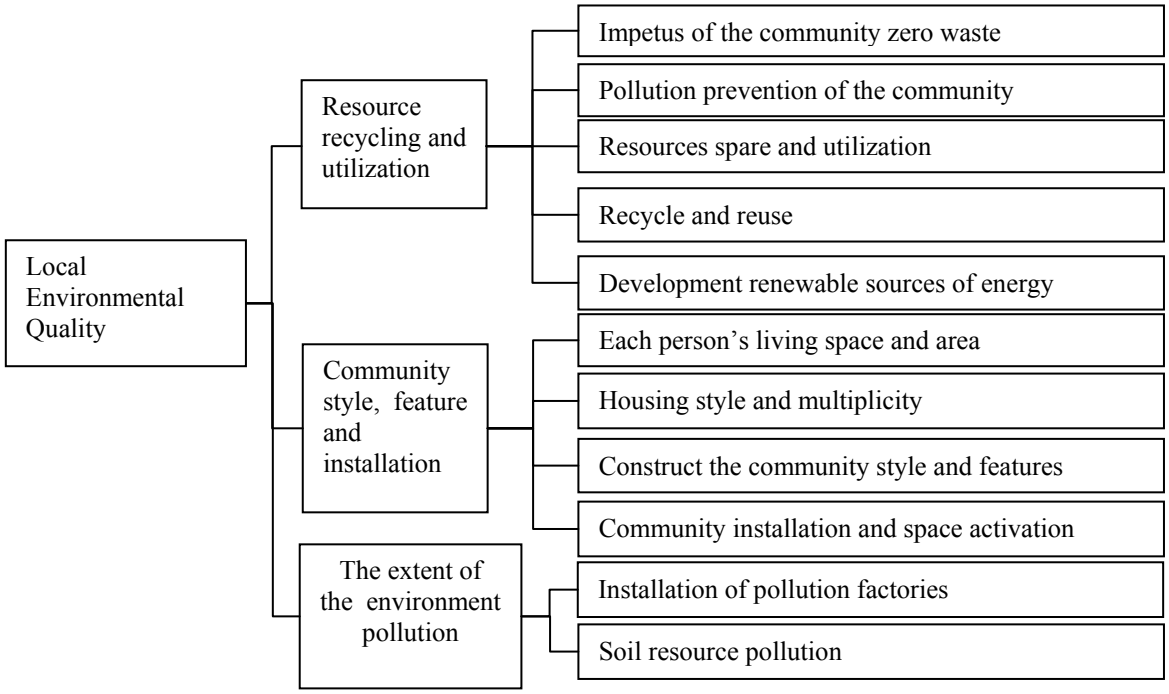

Fig. 3. Hierarchy structure of the fuzzy analytic hierarchy process.

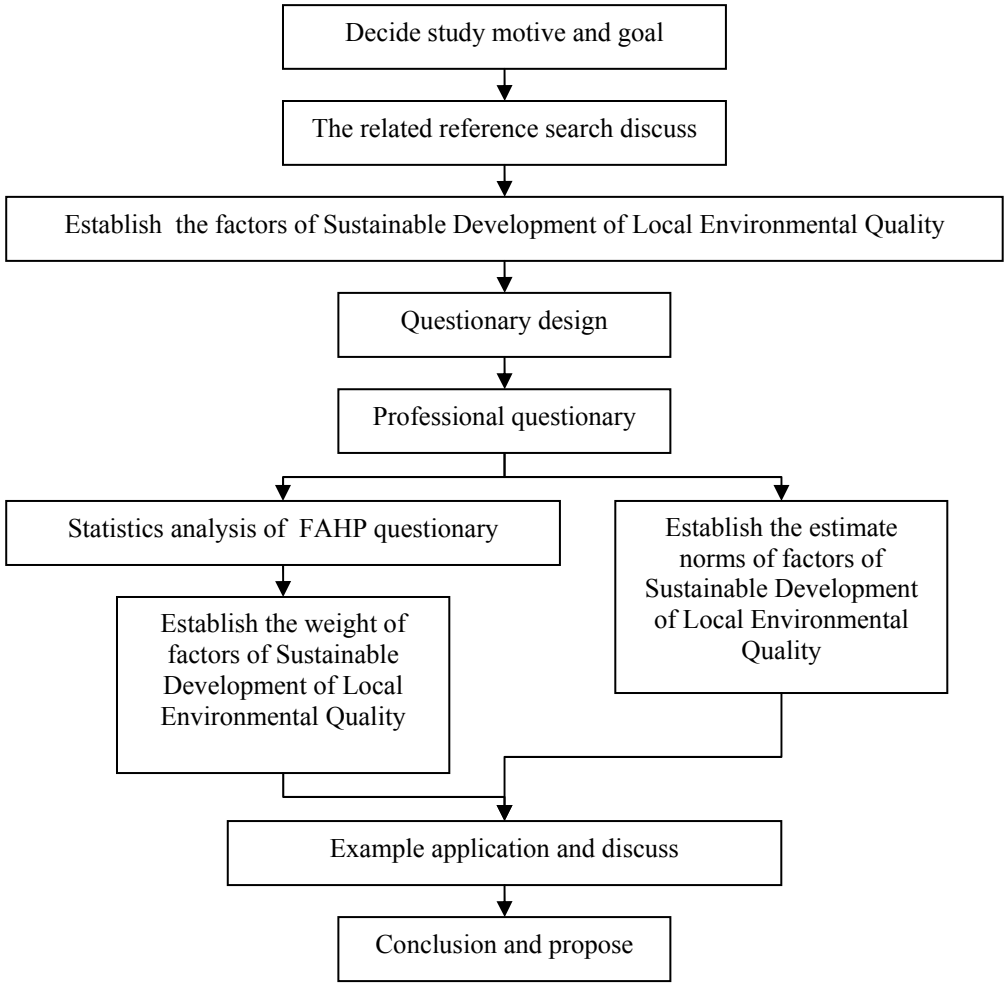

Fig. 4 The flow chart of the study

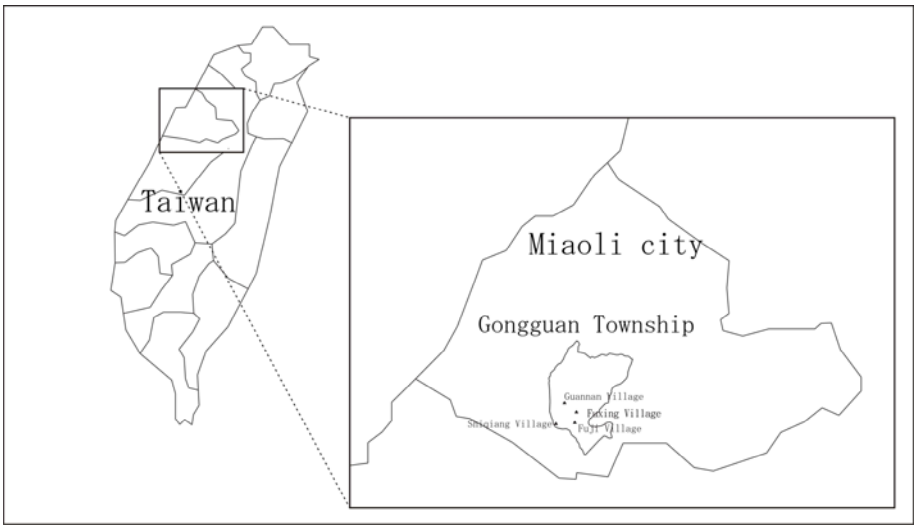

Fig. 5 the situation of four villages in Gongguan Township of Miaoli County

Table 1. Random index (RI)

Index	1	2	3	4	5	6
R.I.	0.00	0.00	0.58	0.90	1.12	1.24
Index	7	8	9	10	11	12
R.I.	1.32	1.41	1.45	1.49	1.51	1. 58

Fig. 6 Guannan village

Fig. 7 Fuxing village

Fig. 8 Fuji village

Fig. 9 Shiqiang village

Table 2. Classification of the degree of achievement in sustainable indexes for the four villages in the Golden Town Community

Index	Description	Guannan	Fuxing	Fuji	Shiqiang
Promotion of zero waste in the community	Demarcation by the degree of zero waste promotion First class: No plans at all Second class: With plans Third class: With plans which have been carried out	Third class	Second class	First class	First class
Prevention of community pollution	Demarcation by the degree of the handling of pollution pleading First class: <50% Second class: >50% (Note: Environmental Protection Bureau of Miaoli County)	Second class Complete rate 83%	Second class	Second class	Second class
Energy saving	Demarcation by the usage rate of resources of Gongguan, which is 8.3% First class: <8.3% Second class: >8.3%	First class	First class	First class	First class
Recycling & reuse	Demarcation by the usage rate of resources of Gongguan, which is 8.3% First class: <8.3% Second class: >8.3%	First class	First class	First class	First class
Renewable energy	Demarcation by the cost of renewable energy facilities in the community First class: <NT$600,000 Second class: >NT$600,000 (Note: Interview with the general secretary of the Golden Town Community)	First class	Second class ecology of the water channel revival 3 million dollars	Second class ecology of the water channel revival 3 million dollars	Second class ecology of the water channel revival 3 million dollars
Living space per person (density of population)	Demarcation by the average density of population (square measure per person), which is 9.33m^2 First class: <9.33m^2Second class: >9.33m^2 (Note: Gongguan administrative office)	First class 2.65m^2	Second class 12.99 m^2	Second class 14.69 m^2	Third class 15.3 m^2
Variety of residence type	Demarcation by the number of materials (RC, brick, wood) used First class: 1 Second class: 2~3 Third class: more than 3	First class RC,	Third class RC, brick, wood	Third class RC, brick, wood	Second class RC, brick
Construction of community style & features	Demarcation by the number of unique constructions. One unique construction gets 1 point. The total is 6 points. First class: 1 point Second class: 2 points Third class: 3 points (Miaoli County Government)	First class 1/6 Lotus Lily House	Third class 3/6 Blue Collar Art Hall, a granary, Chuanlong Water Channel, and Fuxing Ceramics Factory	First class 0/6	Second class 0/6 Guandi Temple and Shimu Shrine
Community facilities & space activation	Demarcation by average outgoings the government has spent on the communities First class: < NT$220,000 Second class: > NT$220,000	First class	Second class About NT$800,000	Second class	Second class
The set up of polluting factories	Demarcation by the number of factories First class: more than 3 Second class: 2~3 Third class: 0 or 1	First class	Third class	Third class	Third class
Pollution of soil resources	Demarcation by the usage of insecticide. According the area of farmland with the usage of insecticide. First class: > 60% farmland Second class: 40~60% Third class; > 20~40%	Third class 25%	Second class 48%	First class 45%	First class 65%

Table 3. Comparison table of the villages in the Golden Town Community

Village situation	Guannan	Fuxing	Fuji	Shiqiang
Village area	11,192 m^2	31,600 m^2	20,322 m^2	30,240 m^2
Actual area	5,596 m^2	10,533 m^2	6,774 m^2	15,120 m^2
Population number	4,215	2,432	1,383	1,966
Men and women rate (men/women)	1.014 %	1.175 %	1.181 %	1.257 %
Households	869	487	322	403
Neighborhoods	22	12	11	16
Population grow rete	0.02%	0.031%	-0.003%	-0.001%
Agriculture area	1,932 m^2	3,156 m^2	2,787 m^2	6,969 m^2
Green area rate	1,007 m^2	2,317 m^2	948 m^2	3,480 m^2
Communications	Guanzhong road and Datong road are the main roads. Mostly are small alleys.	Guanzhong road is the main road. Connected to an east-west expressway	Guanzhong road is the main road. Mostly are small alleys to farms and farmhouses	Mostly are small alleys to farms and farmhouses. Only a few of them lead to residences.
Plant types	The plants in this area are mainly shade trees and bonsais with 2~3 different breeds	With a variety of plants.There are at least 5 breeds of plants in this village.	Plants are simple. Mostly are grown in farms. 2~3 breeds.	At least 5 breeds grown in farms.
Commercial activities	Mainly agriculture. There are some stores and shops.	Most farmlands are rice fields and jujube fields. Business men sell their products online. And there are a few restaurants.	Most farmlands are rice fields and jujube fields. Business men sell their products online. And there are a few restaurants.	Most farmlands are rice fields, jujube fields, and sweet potato fields. Mainly agriculture.
square measure of living space per person	About 2.66 m^2	About 12.99 m^2	About 14.69 m^2	About 15.38 m^2

Table 4. Consistency Index and Consistency Ratio

Item	(Consistency Index, CI)	(Consistency Ratio, RI)
Local Environmental Quality	0.0073	0.0081
Resource recycling and utilization	0.0598	0.0664
Community style, feature and installation	0.0143	0.0158
The extent of the environment pollution	0.0000	0.0000

Table 5. Local weights and pairwise comparison matrix of factors

Goal	Factors	Local weights	Important level	Sub-factors	Local weights	Important level
Local Environmental Quality	Resource recycling and utilization	0.5239	1	Impetus of the community zero waste	0.2566	2
				Pollution prevention of the community	0.2308	3
				Resources spare and utilization	0.3177	1
				Recycle and reuse	0.1949	4
				Development renewable sources of energy	0.0908	5
	Community style, feature and installation	0.3154	2	Each person's living space and area	0.1726	4
				Housing style and multiplicity	0.2177	2
				Construct the community style and features	0.2068	3
				Community installation and space activation	0.4029	1
	The extent of the environment pollution	0.1607	3	Installation of pollution factories	0.5654	1
				Soil resource pollution	0.4346	2

Table 6. Computed global weights for sub-factors

Sub-factors	Global weights	Important level
Resources spare and utilization	0.1664	1
Impetus of the community zero waste	0.1344	2
Community installation and space activation	0.1271	3
Pollution prevention of the community	0.1209	4
Recycle and reuse	0.1021	5
Installation of pollution factories	0.0909	6
Soil resource pollution	0.0699	7
Housing style and multiplicity	0.0687	8
Construct the community style and features	0.0652	9
Each person's living space and area	0.0544	10
Development renewable sources of energy	0.0476	11

Table 7. The different village in the reach degree of resource recycling and utilization field

Hierarchy	Item	Local weights	Estimate norm values	Guan-nan village	Fu-xing village	Fu-ji village	Shi-qiang village
Sub-factors	Impetus of the community zero waste	0.2566	0.4000 / 0.3500 / 0.2500	0.1026	0.0898	0.0642	0.0642
	Pollution prevention of the community	0.2308	1.0000 / 0.0000	0.2308	0.2308	0.2308	0.2308
	Resources spare and utilization	0.3177	1.0000 / 0.0000	0.0000	0.0000	0.0000	0.0000
	Recycle and reuse	0.1949	1.0000 / 0.0000	0.0000	0.0000	0.0000	0.0000
	Development renewable sources of energy	0.0908	1.0000 / 0.0000	0.0000	0.0908	0.0908	0.0908
	Subtotal			0.3334	0.4114	0.3857	0.3857
Factors	Resource recycling and utilization	0.5239		0.1747	0.2155	0.2021	0.2021

Table 8. The different village in the reach degree of community style, feature and installation

Hierarchy	Item	Local weights	Estimate norm values	Guan-nan village	Fu-xing village	Fu-ji village	Shi-qiang village
Sub-factors	Each person's living space and area	0.1726	1.0000 0.0000	0.0000	0.1726	0.1726	0.1726
	Housing style and multiplicity	0.2177	0.4000 0.3500 0.2500	0.0544	0.0871	0.0871	0.0762
	Construct the community style and features	0.2068	0.4000 0.3500 0.2500	0.0517	0.0827	0.0517	0.0724
	Community installation and space activation	0.4029	1.0000 0.0000	0.0000	0.4029	0.4029	0.4029
	Subtotal			0.1061	0.7453	0.7143	0.7241
Factors	Community style, feature and installation	0.3154		0.0335	0.2351	0.2253	0.2284

Table 9. The different village in the reach degree of the extent of the environment pollution

Hierarchy	Item	Local weights	Estimate norm values	Guan-nan village	Fu-xing village	Fu-ji village	Shi-qiang village
Sub-factors	Installation of pollution factories	0.5654	0.4000 0.3500 0.2500	0.1413	0.2261	0.2261	0.2261
	Soil resource pollution	0.4346	0.5000 0.3333 0.1667	0.0724	0.1449	0.2173	0.2173
	Subtotal			0.2138	0.3710	0.4435	0.4435
Factors	The extent of the environment pollution	0.1607		0.0344	0.0596	0.0713	0.0713

Table 10. The different village in the reach degree of LEQ

Hierarchy	Item	Local weights	Guan-nan village	Fu-xing village	Fu-ji village	Shi-qiang village
Factors	Resource recycling and utilization	0.5239	0.1747	0.2155	0.2021	0.2021
	Community style, feature and installation	0.3154	0.0335	0.2351	0.2253	0.2284
	The extent of the environment pollution	0.1607	0.0344	0.0596	0.0713	0.0713
	Subtotal		0.2425	0.5102	0.4986	0.5017
Goal	Local Environmental Quality (LEQ)	1.0255	0.2487	0.5232	0.5113	0.5145