Systems Engineering Application to Community Innovative Diagnosis System Development

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Abstract

The community building is a comprehensive transformation process and the long-term project for the local community's cultural form, the landscape environment and the life quality. The purpose of community building is to arouse the cooperation consciousness, participation in mutual resolve the society problems for the civil organization. At present, the Taiwan government supports and strengthens the welfares and service functions of the community through this process. Although the appraisal mechanism has the advantage to select a good community, but it also creates problems such as the difference between the appraisal items and community actual results, and individual standards for appraisal reviewers. Other problem such as taking strives for the government funds primarily but the community inhabitants as the auxiliary phenomenon has also appeared.

The present study applies an innovation concept in the community building process through the systematic innovation think, methodology and process which combines system engineering technique and information technology to construct a community innovation service platform in order to provide an innovation service environment for the diagnosis and dialogue communication of the community.

The present study explores community research papers including community definitions, category and measurement index. It then designs a community innovative index questionnaire. With the help of the result of this questionnaire, statistics analysis, and AHP, this study reveals the community innovative index and the weight factors. The study also gives quantify diagnose results and with the application of system engineering technique and process to construct this e-platform from the diagnose model.

Key Words：Systems Engineering, Community Building, Community Appraisal Mechanism,

Introduction

1.1 Background

Community is a basic unit in nowadays society. People formulate different types of communities by living together in their ways of life. For most of the people living in a community, it is not just a way living together but also is a way to improve their living quality. Whichever types of community, people expect to have a good quality of life with respect to their living environment. This introduces recognition among people of having a "good" community. As far as a good community and environment, how good is really good for a community is worth to investigate. What kind of conditions is essential for a good community is another problem worth to examine. For a good community, it all comes from the consciousness of people. This consciousness can be accepted from a grace environment quality, abundant culture contents, an innovated management of place, a passion for localized service and above of all, the high degree of recognition rational concept. These are all the essence characteristics for people to living together and to improve their living quality. Chaskin(2001) mentioned that a good community is a way for community to cultivate self-resolve capability during the process to promote community. This self-resolve capability can be considered as community innovative capability.

As above-mentioned, the purpose of community building is to stimulate the cooperation consciousness and participation in a process to resolve the society's problems for the community residents. By using the appraisal mechanism, the community can be evaluated their own community building capability while facing problems and realizing execution short comings. The purpose of community building appraisal mechanism is for the selection of a good community. At present, the government supports and strengthens the welfares and service functions of the community through this selection process. Although the official appraisal mechanism held by the local government has the advantage to select a good community, but it also creates problems such as the difference between the appraisal items and community actual results, and individual standards for appraisal reviewers. Other problem such as taking strives for the government funds primarily but ignoring the community residents actual needs have also appeared. Also, this kind of appraisal mechanism is also lacking of qualitative and quantitative characteristics.

In order to diagnose community innovative capabilities, present study uses the method developed from the systems engineering application to enterprise innovative diagnosis development results developed by Hsu et al.(2007). This method uses systems engineering combined with IT technology to construct an enterprise innovative diagnosis platform

specialized for manufacture industry. Qualitative and quantitative results have been obtained to describe the enterprise innovation problems which contained with the environment of multi-objectives, measureless, ambiguous, and acknowledge behaviour confusing characteristics. The present study will utilize and extend the above-mentioned method to apply to the innovative concepts of community building. It is expected that the present study can alleviate community living quality, discover and improve community's problems, and increase innovation capability. As the result of present study, this paper is the first time to apply the structured systems engineering application model on more complex community service. This research shall shed the light on the application of systems engineering on sociology related soft systems as proposed by Checkland (1998).

1.2 Definition of Community Building

Community has been defined as a group of people living in a geographic region, sharing common relations, social interactions and service systems by Hsu (1980). This can be further explained for the community residents as containing the following characteristics, (1)living in vicinity and visiting frequently, (2)sharing some common interests, (3)a need to support each other, (3)be able to provide some service, (4)facing some common problems, (5)producing some common needs.

Community classification is based upon various indexes such as social relationship, geographic area, major production methods/functions, or the combination of above-mentioned index. These indexes can not be covered all of the community types but can be considered as the references of community in a society. There are two major types of community into two types consisting rural type and municipal type. For rural type, this is a major type of community around the world. It is outnumbered and spread vast area as compared to municipal type of community. The municipal type is more important and the number will be increased in the municipalized area for more rapid developed economy states or countries around the world.

Taiwan government has also made the community classification by the resident's ratio of their profession. It further divides into four types, which is including the municipal type, rural type, mixed type and mountaineer type. Present study examined all the community types and made classification based upon residential style. The classification can be summarised as following:

1. Building type:

This type of community is located in the municipal area. Over 60% of residents are living in buildings or apartments over five stories high.

2. Village type:

Over 60% of residents are living in the village of mountain and rural area.

3. Settlement type:

Over 60% of residents are living in an area centred by a street, a town or village,

covering some tens or hundreds of families. Most of the housing type is characterized by their complete house.

4. Agriculture, forestry, and fishery functional type:

This type of residential area is mainly formed by the resident group's special function of production, such as agriculture, forestry, and fishery.

The concept of community building originates from Japan. Furukawa Machi in Kansei area of Japan has created a benchmark case for the community building by Nishimura(1997). Starting from cleaning a river downtown dating back in 1960s and later combining the wooden architecture work has made this small town famous for its tourism. As pointed out by Taiwan government, five major elements are contained in the management of community building, including consciousness, culture, industry, geographic location, space and scenery view. Community building means the local residents can actively conceptualize and design in their own willingness by using local resources and culture characteristics. Throughout this process the traditional culture can be preserved and be exalted. It can also cultivate the voluntary and autonomy discipline for the local residents. Taiwan Government encourages its local governments to develop the community building as a tool to cohere the community people in order to obtaining a better life. Sung(2006) also proposed that the community building can be the ingredients to support local people to act as an organic whole with the generated identity. It is suggested that the government should provide appropriate skills and financial supports to the residents based on the results obtained from the communication platform between community and local government.

1.3 Innovation Service

The topic of innovation has been conceptualized and studied broadly in many perspectives. These studies are including strategic innovation, organizational innovation, technology/know-how innovation product/systems innovation, process innovation, and other related topics by Afuah(1998). Among these researches, the innovative service is defined as the execution and management capability for the novelty of service process, the technology needed for service participants, and with service physical equipment and environment change by Prahalad and Hamel(1990). Although most of the researches have been focused on the breakthrough or improvement of technology, but there have been little researches in innovation from the enterprise systems view and their results were also confined to certain industries. As the community can be considered as an enterprise in a broader aspect, the innovative community can be regarded as the application of latest knowledge, technology, and process to community in order to provide or improve products and service for their residents. In order to provide a competitive product or service, the use of community innovative diagnosis system is a necessity. Unfortunately, the researches involved with this topic are relatively less. In addition to this shortage of research results, these studies also could not provide a total solution for the community. Therefore, it is worthwhile to study an

innovative diagnosis system and to supplement the community innovation theory and its contents from this perspective.

The present study applies an innovation concept in the community building process through system thinking, systems engineering platform and process, Delphi method, and analytic hierarchy process(AHP) combining with web-based IT technology are used to formulate a community innovative diagnosis system platform in order to provide an innovation service environment for the diagnosis and dialogue communication of the community. AHP or Delphi method is used on current research for their role in complex sociology related decision making. This innovative approach is based on the combination of systems engineering and sociology science in order to help the community to diagnose themselves in the field of innovative service for community building and to provide consulting service for their community life.

Systems Platform

A systems platform describes some sort of hardware architecture or software framework that allows software to run in systems and helps integration of people, process and data. Hsuan (2002) introduced the common technology platform architecture to Taiwan research institutions and industries. This architecture was applied to the Knowledge Intensive Service Industry Pilot Program (KISIPP) supported by Ministry of Economy Affair and was first published by authors in English in 2005. This KISIPP system platform was developed with the use of system engineering for the application to service industry development strategy and mechanism formation. The platform contains three different types of core functions including knowledge management, collaborative design and business integration. These core functions can relate to the platform contents, which can provide the program management function, database and on-line process management respectively. The concept of using systems engineering methodology to build up the knowledge management platform for this program is the major outcome of the authors' paper. This concept has also been verified through the use of a few projects, such as the Fresh-Food Logistics Service System project with RFID technology in KISIPP program as shown in Chin et al.(2009).

As stated by Chen(2008), to have a sustainable competitive advantage requires integrating knowledge management and innovation into innovation process to increase innovation capacity for achieving successful innovation. Investment in the development of new knowledge may drive enterprise into a fruitful market if the search for innovation gains positive influence on knowledge management. The influence of knowledge management on innovation and competitiveness can be illustrated be a conceptual model. This model shows that innovation and competitiveness can be a function of knowledge management. The result of increasing competitiveness may come from the combination efforts of innovation,

information and communication technology (ICT) and knowledge management.

Wang and Peng(2006) also proposed the concept of service industry systems platform for the application of Technology and Research Center Program supported by Ministry of Education. This platform can be applied in the fulfillment of the needs of industry and community through the integration of system innovation, systems engineering, information technology, environmental management, knowledge service and community building as shown in Figure 1. The integration of systems engineering and sociology science is the main characteristic of this platform. The cross interaction and integration of two different unrelated and odd to each other fields shed a new light on the application of systems engineering.

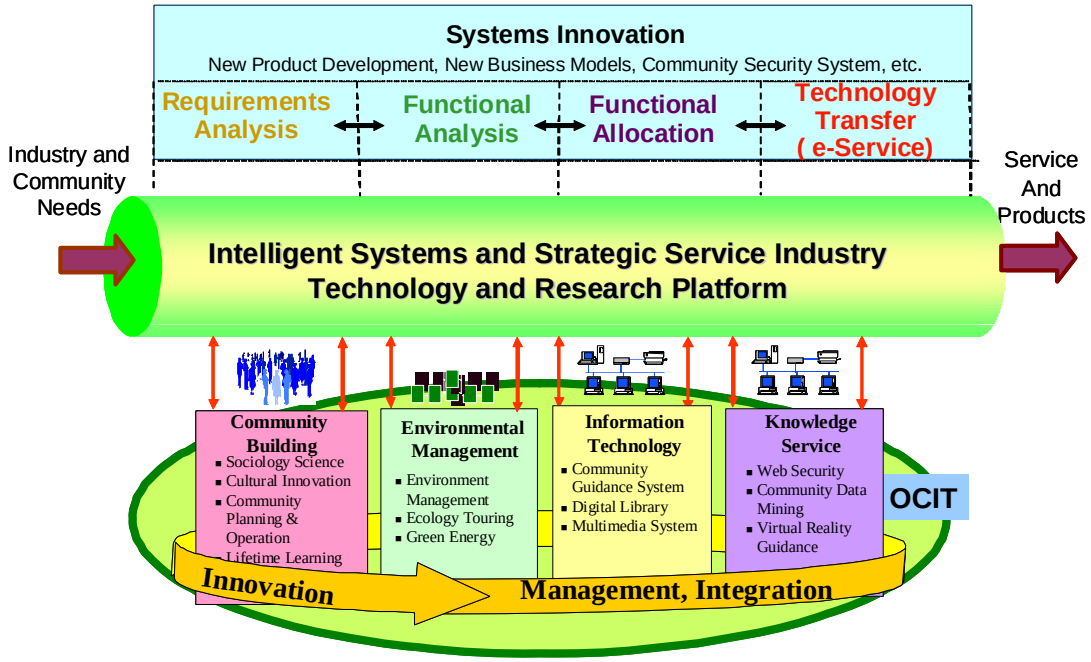

Figure 1. Intelligent systems and strategic service industry technology and research platform.

Lin (2007) applied this concept in the radio frequency identification (RFID) innovative service systems platform through the use of systems engineering and web-based platform technology with consultation from Chin. This platform is including an automatic search engine module, modulated tool knowledge database, and customer-interactive communication interfaces. The RFID innovative services systems development platform can be applied in RFID related component suppliers, systems provider, systems integrator, software provider and other users to assist in solving each individual needs, different applications, and different properties of customized problems. Under Chin's advisory, Chang (2007) also uses systems engineering and information technology to construct a web-based advanced vehicle innovative service platform. It is this platform serving as the collaboration platform among industry, universities, and research institutes for Taiwan's vehicle industries. In order to explain systems engineering how to satisfy the different

users' requirements, a web-based consulting service function module is added to the advanced vehicle innovative service platform.

For further study the integration effect on innovation and systems engineering, Hsu et al.(2007) introduces decision making tools to combine with the systems platform. This leads to an enterprise innovative diagnosis system platform that combines with qualitative and quantitative research methods to clarify enterprises innovation contents and to identity measurement model. It is useful to apply in enterprise innovation resources planning. This platform is able to measure industry and community readiness of innovation by itself accordingly. The decision making tools are including statistics analysis, data mining and analytic hierarchy process methodologies. It will provide knowledge intensive and innovative service industry further added value in their operation.

During the community building appraisal process, the databank was not easy to obtain due to those community organizers reluctantly releasing the community data. Facing with this difficulty, the study turned to establish the appraisal indexes in the first part of work. The platform used in community building also apply the concept of a web-based advanced vehicle innovative service platform to include further service such as C to B e-commerce. This type of C to B e-commerce is quite popular among communities, especially among high-density-building type community within the metropolitan area. The appraisal indexes use Delphi method for questionnaire, and then adopt statistics analysis for further analytic hierarchy process analysis. The priority weight is selected from the calculation result of Expert Choice software. The community innovative service platform is constructed by the addition of these indexes with priority weight. The systems engineering process including requirement analysis and functional analysis is used for this platform to serve the needs of community building stakeholders.

Data Analysis

The present study separates community data analysis framework into four stages as shown in figure 2. The first stage can be expressed as community innovation service index construction stage. The appraisal index has been design from all sorts of community type. It is then to find out our key indexes by questionnaire and sorting out useful information by factor analysis. The second stage is community innovation service index weight construction stage. The result of factor analysis from the first stage was then input into second stage with the use AHP questionnaire. The index weight has been calculated with the use of Expert Choice. Systems engineering process that includes system requirement analysis, functional analysis, functional allocation, and design synthesis is responsible for the construction of community innovative service platform in the stage 3. Finally, to establishing community service diagnosis physical platform is a main theme in stage 4. The

framework for community aspect of data analysis can be expressed as following.

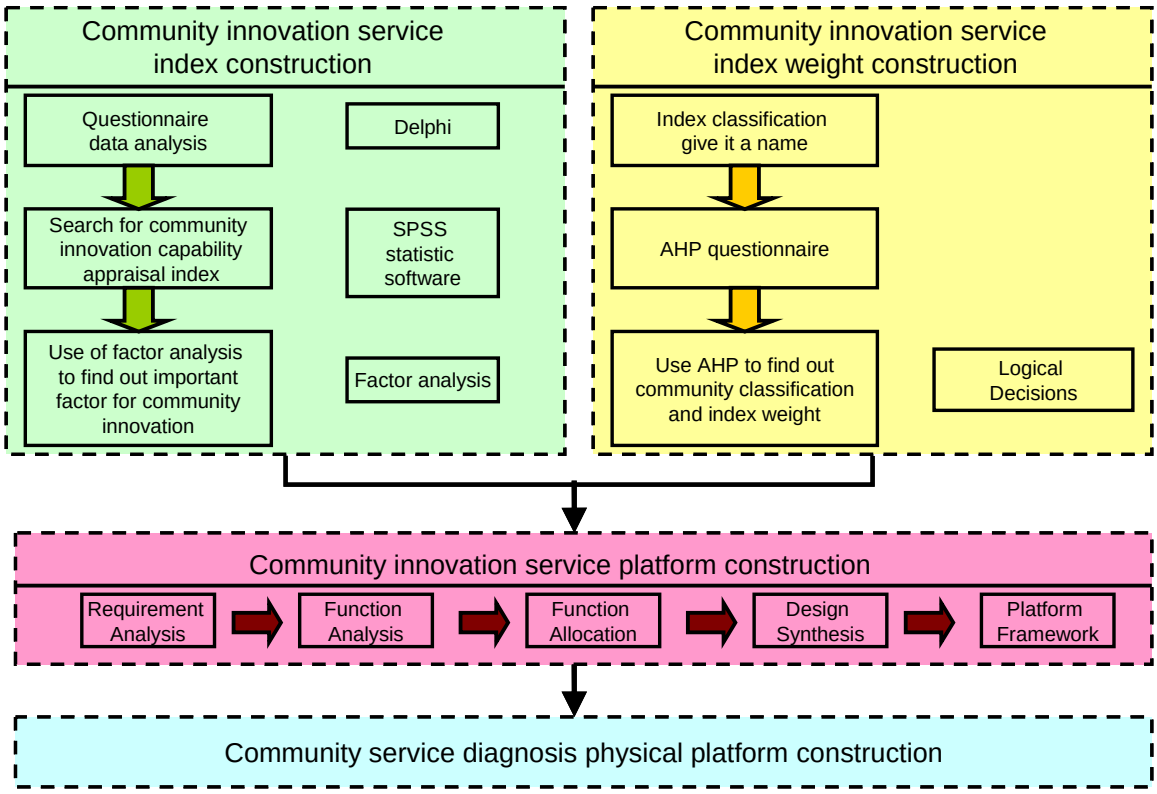

Figure 2. Data Analysis Framework for Community

Reliability analysis is for the stability or consistency measurement of historical data results as pointed out by Wu and Lin(2001). This study has adopted Cronbach's α coefficient as the reliability judgment index. Cronbach's α can be defined as [1] where *n* is the number of items, Sx^2 is the variance of the observed total test scores, and $Si^2$is the variance of component *i*. Generally, if the coefficient α is within 0.5 to 0.6 can be accepted, and if α is within 0.7 to 0.9 can be treated as highly reliable. These industry data measurement results can be illustrated in Table 1.

$$\alpha = \frac{n}{n-1}\left(1 - \frac{\sum S_i^2}{S_x^2}\right) \quad [1]$$

These community data measurement results can be illustrated in Table 1.

Table 1: Variables' Reliability in Community Aspect

measurement variables	community innovative service diagnosis factors
Item numbers measured	21
Cronbach'α	0.836

In order to investigate key indexes for successful community innovative service, present study has used a report issued by Ministry of Interior (2006) and other reference relating community building to set up the innovation service index framework and appraisal factors as in Table 2. The first tier is innovation service index framework and with the second tier as the community type. The third tier is the appraisal factors. After constructing the innovation service index framework, the Delphi method applied in the process of screening out key factors that has its influence on community type. The consistence of key factors can be found with the application of coefficient of variance eventually.

Table 2: Community Innovation Service Appraisal Indexes

Community Type	Appraisal Factors
1. Building type 2. Village type 3. Settlement type 4. Agriculture, forestry, and fishery functional type	1. Entrance Security 2. Community Consciousness 3. Medical Service 4. Hardware Equipment 5. Environment Maintenance 6. Environment Building 7. Community Autonomy 8. Community Welfare 9. Fund Resource 10. Promoting Local Art and Culture 11. Information Management Capability 12. Volunteer Service 13. Combination of Sociology and Industry 14. Community Organization Operation 15. Public Recreation Facility 16. Information Service 17. Caring Points 18. Security Maintenance 19. Fire Safety 20. Residents Involvement 21. Community Activity

The present study has asked a group of community experts to form a Delphi panel to conduct the questionnaire. In order to make judgment of experts' consensus, Chang et al.(2002) has suggested to use coefficient of variance to measure each individual difference. The coefficient of variance (CV) is defined as [2]. The experts' consensus degree is higher if the CV value is smaller. Experts agree consistently when $CV \leq 0.3$, $0.3 \leq CV \leq 0.5$ means expert's opinions are within acceptable range, $CV \geq 0.5$ means there will need explanation.

$$CV = \frac{\sigma}{\mu} \qquad [2]$$

The factor analysis has adopted principal component method to abstract relative factors with the help of varimax method suggested by Wu and Lin(2001). In selection standard for factors, there are four criteria; first of all, the eigenvalue has to be greater than 1, second, the absolute value of factor loading has to be greater than 0.6 after varimax transformation, third, each two loading factors are greater than 0.3, and finally, the correlate coefficient for item to total are obviously greater than 0.5 distingusihly. After adapting principal of Kaiser, this study selected eigenvalue greater than 1 and reached 6 factor facets with their factor loading absolute value all exceeding 0.6 for the building type community. These 6 factor facets have selected their own factors but community expert has suggested medical service and fund resource can be rearranged and combined into other five facets. Building type community innovation service facets and indexes are illustrated in figure 3.

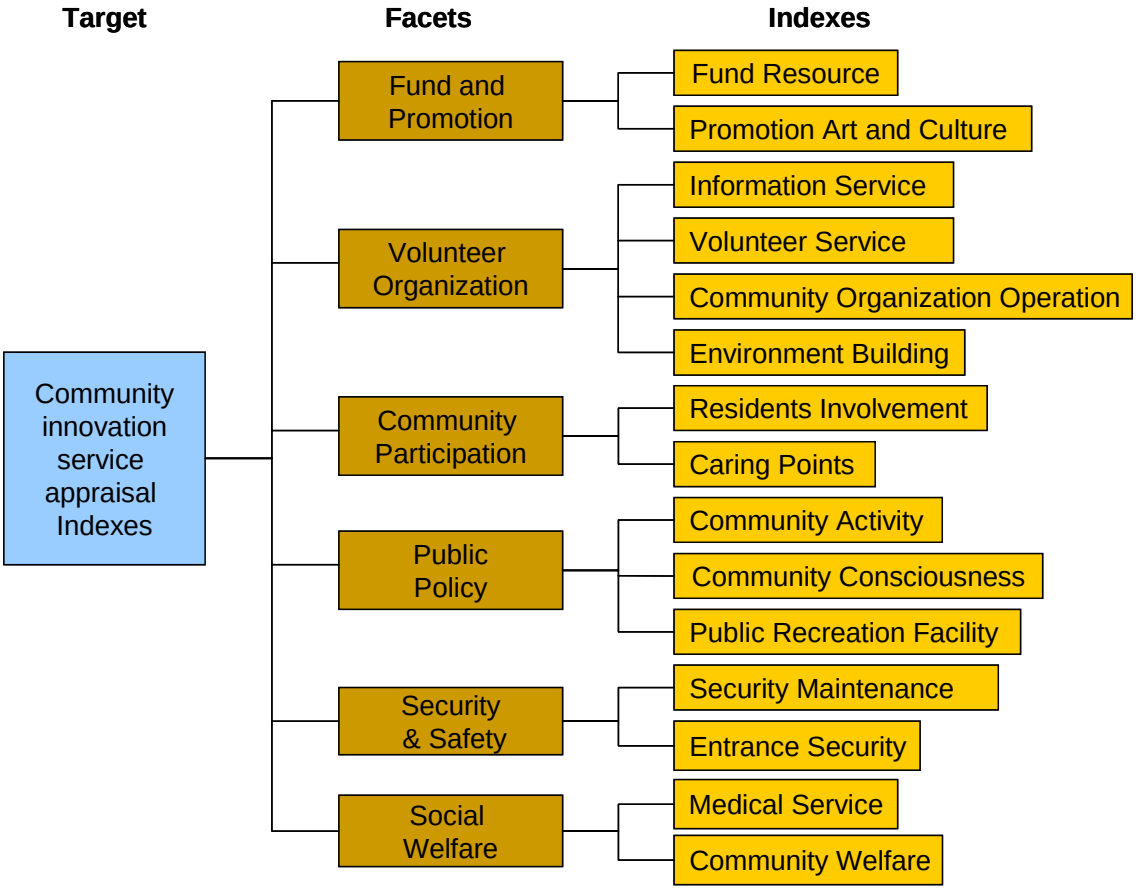

Figure 3. Building type community's innovation service facets and indexes

Analytic hierarchy process (AHP) can transform problem into hierarchy and structure form. It then separates the system influence factors into several different groups. Each group can separate further into the corresponding sub-groups. Saaty(1980) suggested the hierarchy numbers are limited to seven to nine tiers and factors number for each tier can not exceed seven. The present study uses Expert Choice 2000 AHP software to estimate weight ratio for each facets. Taking building type community as an example, the security & safety

index is 35.2% and the social welfare index is 23.4% implies the innovation service for building type community focus on these two items. Those community experts also indicate residents in building type community like to have this kind of tangible service.

Web-based Platform

Community innovative service diagnosis platform uses system development process as the platform operation process. It starts with community innovation needs and then can choose community type and key index. The community can use this platform to measure its innovation capability. This diagnosis result also gives suggestions and improvement opinions. The platform contains several different discussion modules to serve the needs of community organization workers for online discussions and exchange opinions. The community innovative service diagnosis platform framework is shown as figure 4.

The community innovative service diagnosis platform is formulated by systems engineering process from requirement analysis, functional analysis, and functional allocation and then synthesis into an optimum platform. This platform has five main modules to provide integral service except Portal module. These modules are including friendly Websites Link Module, Information Window module, Achievement Data module, Innovation Service Diagnosis module, and Discussion module. Portal module is where the users enter this website. The innovation service diagnosis module can provide self-diagnosis for innovative service and appraisal functions. It can also choose innovative service for present community as compared to other registered community records for self-diagnosis. The achievement data module can display all the other community achievement data published by government for reference. The information window module is responsible for latest community activities, knowledge and experience sharing. The discussion module can provide online discussion service for all the community stakeholders. All these modules provide useful functions for community residents and its organization works. They can even exchange opinions and community building experience. The community can use this portal for self-diagnosis its own innovation service capability. The platform can provide suggestions and improvement opinions, even with strategy for improvements. The website can also provide latest community activities information, achievement information, and C to B e-commerce for daily commodity. In addition to above-mentioned, residents can also use the friendly websites link to connect community development associations and community school for training and exercise they choose. The community innovative service platform framework is shown in figure 5.

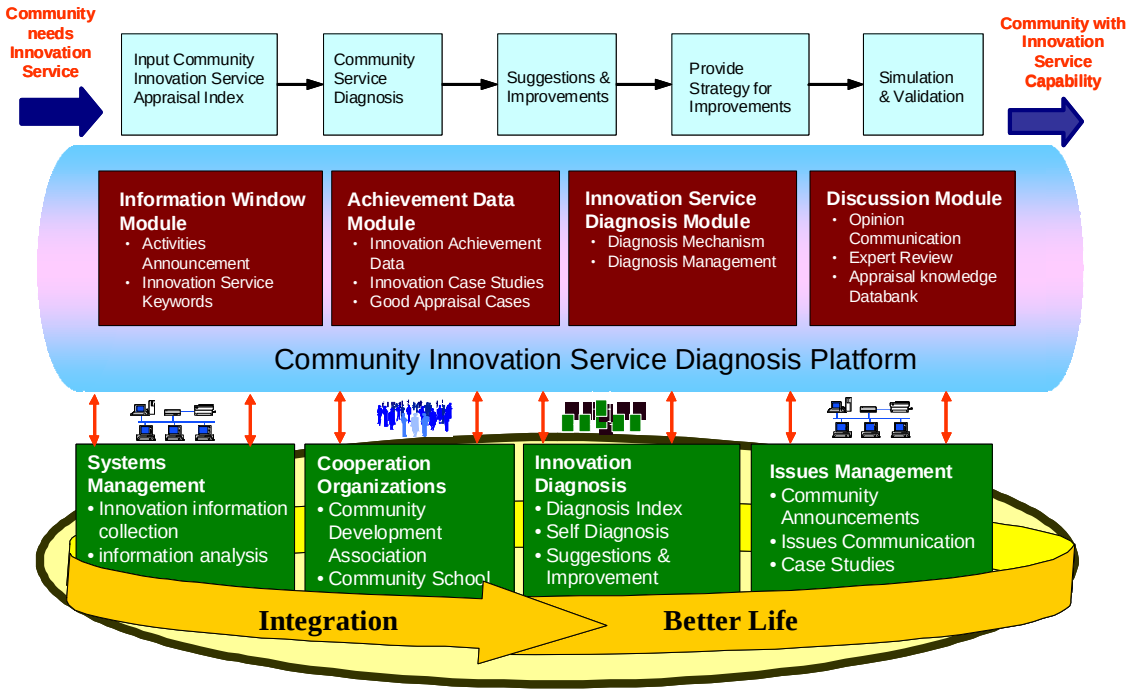

Figure 4. Community innovative service diagnosis platform framework

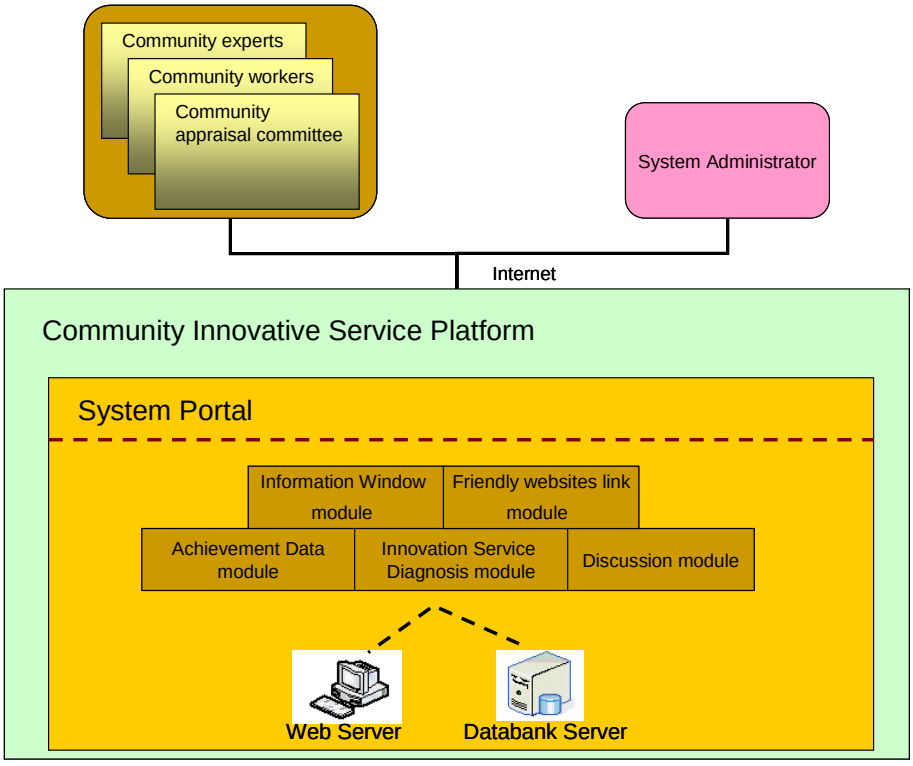

Figure 5. Community innovative service platform framework

Conclusions

The present study applies systems engineering methodology and process, expert's

questionnaires, statistic analysis, AHP and network software tools to construct a community innovation service platform in order to provide an innovation service environment for the diagnosis and dialogue communication of the community. This innovative service diagnosis system platform can satisfy the needs of community. The web-based platform comes from the framework of a service industry systems platform can also demonstrated the fulfillment of community needs. It demonstrates the integration capability of a platform correlating technology and science, and even with process, people and knowledge. With the addition of other information technology, such as web-based and RFID technology, give this kind of platform greater capability to examine the innovation level of a community by itself. The cross interaction and integration of systems engineering and sociology science for an innovative service diagnosis system platform shall shed a new light on the application of systems engineering. The platform can further expanded with respect to resident's new needs in order to provide community all aspects systematic service. The proposed web-based platform by the authors is designed as an open system for inviting more creative thinking to enrich its content. It is certainly leave a plenty room for future development.

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Biography

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David Chin received his doctoral degree in the field of Aeronautical & Astronautical Engineering from Purdue University. He also attended the Advanced Management Program

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