A Tri-indicator Evaluation Method on The Rural Comprehensive Information Service Stations and Its Case Study in Ningbo, China

Zhiwei Yu[a,b], Xingsen Li[a], Fangyao Liu[b]
[a] Ningbo Institute of Technology, Zhejiang University, Ningbo 315100, China
[b] College of Information Science and Technology, University of Nebraska at Omaha, Omaha, NE 68182, USA
nityzw@gmail.com

***Abstract*—This paper presents a tri-indicator evaluation method for the utilization of Rural Comprehensive Information Service Station (RCISS). We developed the relative index of service (γ) to indicate how many times the RCISS was utilized. We used diversity of service (δ) to measure the variety of service and volatility of service (υ) to show the fluctuation of service. The tri-indicator evaluation method is tested by the utilization comparison of RCISS in Ningbo, China. The results show that Yinzhou and Fenghua are in the beginning stages of RCISS utilization; Xiangshan is well entrenched in the utilization of RCISS; Ninghai and Zhenhai have individualized plans for developing their RCISS and the other four sub-areas are making steady progress in utilizing the RCISS.**

***Index Terms*—Rural Comprehensive Information Service Stations (RCISS); evaluation indicator; evaluation method; Ningbo**

I. INTRODUCTION

China's economic growth has been significant for the past 30 years. However, disparities between rural and urban areas have broadened [1]. Rural development is a persistent challenge everywhere, whether in advanced industrial and post-industrial economies or in less developed settings [2]. Recognizing the negative impact of rural–urban diversity on social harmony and China's long-term development, the Chinese government vowed to develop rural areas into the so-called new socialist countryside. For nine consecutive years after 2004, the Chinese government and the State Council issued nine priority policy documents on rural development.

Agriculture informatization plays the key role in the process of achieving agriculture modernization [3] Common wisdom reveals that a modern and adequate information infrastructure can benefit a country's development [4]. The deployment of information and communication technologies in rural areas has long been regarded as a catalyst for rural development [5]-[6].

Informatization is regarded as one of the driving forces behind the Chinese government's new socialist countryside. In only five years, nearly all rural villages have been connected to the telephone network and thousands of websites have been set up to provide agricultural information to rural residents. China's agricultural informatization program has begun to attract international attention and a few studies have been published [4][7]-[12].

In China, however, these concepts are currently incorporated into a single program—Rural Comprehensive Information Service Station (RCISS), to improve rural access to communication infrastructures, including telephone, television, and the Internet; and to provide applications of so-called "comprehensive information services,"[11] including township government websites, information services stations, and agriculture-related websites and e-commerce portals [11].

Thus far, China's government has been unable to provide a lucid conceptualization or explicit definition of RCISS. Jun (2010) described "comprehensive information services" as information services provided, via mainstream communications media and technologies (such as telephone, television, Internet, and probably also print media), to meet rural information needs related to production processes as well as political and societal participation. According to the notice *on the basic specification for the construction and service of Rural Comprehensive Information Service Stations* issued by MIIT's (Ministry of Industry and Information Technology of the People's Republic of China), a RCISS should have the following five basic requirements:

(1) a fixed location
(2) a set of information equipment
(3) an information officer
(4) a management system
(5) a long-term mechanism.

It was also required to match the local economic and social needs and to collect and provide farmers with information on policies and regulations, technology consulting and counseling, market prices, production and management, disease control, job hunting, cultural, etc. From the above information, we conclude that RCISS is a township or village level program designed to provide access to information services via the Internet and other media to meet rural informational needs. It was aiming to "Bridge the digital divide" in "the last one mile." RCISS includes the following: modern breeding technology, production management, cultural knowledge, information

doi:10.4304/jsw.9.6.1376-1381

technology, e-commerce business and paid agents of water, electricity, telephone, and television services. Armed with RCISS provided information, farmers can handle relevant business in their own village. Officials declare that the RCISS and its application level have been significantly improved.

After an investigation of 52 villages and their 727 farmers in Ningbo, Zhiwei Yu [12] found that although the government made significant investments in the rural informatization construction, the role of RCISS to improve farmers and rural backwardness has not yet been achieved. No matter how informatization attributes to the GDP growth [13], the first basic question we should explore is the way in which RCISS is utilized.

In this paper, we put forward a tri-index evaluation method to describe the utilization of RCISS in Ningbo City, China. After the introduction and literature review, we utilize the tri-index evaluation method. Then the results of the assessment of RCISS in Ningbo are identified and discussed. Finally, we draw the conclusions.

II. Literature Review

As rural informatization is an important component of the national informatization development process, it is the basis for decision-making based on an objective assessment and analysis of the degree of rural informatization at the national and regional levels. The means to assess the development of rural informatization have great practical significance to the Chinese government for formulating practical strategies and policies for the development of rural informatization [9]. Many researchers evaluated rural informatization levels [3][7][9]. There are two main areas of focus. One is the evaluation indicator system and the other is the evaluating method [14].

It is essential for promoting the healthy development of Chinese agriculture informatization to research the problems of the rural informatization construction and establish a scientific and reasonable evaluation indicator system [3].

After the concept of informatization was proposed, many researchers used the evaluation indicator system, including the following, nation-wide and regional informatization, enterprises informatization, etc., This method has been relatively established. Porat and Rubin (1977) firstly systematically proposed the measurement method of the information economy in his book called "Information Economy". He firstly used the ratio of information industry Gross National Product (GNP) to Gross National Product (GNP) and the ratio of information industry labors to occupied population as the measurement factor for analyzing the development of informatization [3]. In 1965, Xiaosong Qiqing proposed the informatization indicator system which consists of four factors and eleven secondary indicators to measure the level of social informatization, and he used the index of informatization [3] in measuring. The rural informatization level is evaluated according to regional informatization [3]. Liu and Zhang (2011) stated that less research on the agriculture informatization evaluation system has been carried out in China and the indicator systems continue to function at the regional or nation-wide informatization level.

There are many methods for multiple objectives, comprehensive evaluation, such as the analytic hierarchy process, factor analysis, RITE's Index of Information, Information Society Index (ISI) [15], the United Nation's Information Utilization Potentials, and fuzzy evaluation, among others. Liu and Zhang listed the principal components analysis, multiple criteria method COPRAS, Grey Criteria Method, Data Envelopment Analysis, the Fuzzy Synthetical Evaluation Method, comprehensive evaluation method based on Analytic Hierarchy Process and Gray Relation Analysis Method, etc. [3]. However, some methods are defective and are subjective on weighted decisions, are too complex in calculation, or are lack of accurate decision data [9].

Since the construction of RCISS was generalized on 2009, no paper has been published on the evaluation indicators and methods of RCISS. This paper introduces a simple and clear tri-indicator evaluation method and makes a case study on the utilization comparison of RCISS in Ningbo, China.

III. The Tri-indicator and Evaluating Method

It is hard to assess the economic and social effect at the beginning of RCISS's implementation. According to the statistic service frequency of RCISS, the comparison among sub-areas can be shown by the service frequency, the variety of service and the fluctuation of service provided. We designed a tri-indicator evaluation method which includes three indicators:

(1) relative index of service (γ)
(2) diversity of service (δ)
(3) volatility of service (υ).

A. Relative Index of Service (γ)

Service frequency is an objective statistic value. The higher service frequency shows more services have been provided through RCISS. Generally, we can use the mean value of service frequency, but the average service frequency cannot show us the specific situation in an area. We put forward relative index of service (γ) as the comparison indicator among sub-areas. We suppose there are N RCISS in a sub-area and the service frequency is sum_i in a sub-area. We set a step L (it is better if we set the L value according to some easily-understood meaning) to regroup the service frequency into K zones for all sub-areas, and then we can count the number of RCISS in every zone. To emphasize the greater service frequency a RCISS provides, we use the geometric sequence with common ratio ½ as the weighting coefficient and then the relative index of service (γ) can be calculated as follows:

$$\gamma_i = 1 - \sum_{k=0}^{K}\left(2^{-k}\alpha_{i,k}\right) \quad (1)$$

Where, K is the amount of regrouped zones, $K = [\max(sum_i)/L] + 1$ and $\alpha_{i,k}$ is the percentage of the RCISS number of k^{th} zone in i^{th} sub-area and $\alpha_{i,k} = \frac{N_{i,k}}{N_i}$.

100%, in which $N_{i,k}$ is the RCISS number of k^{th} zone in i^{th} sub-area and N_i is the total RCISS number in i^{th} sub-area and $0 \le k \le K$.

Obviously, the value of L can be adjusted according to the situation of the RCISS in different stages or different areas. The smaller L is, the bigger K will be and γ_i will be smaller but more precise.

B. Diversity of Service (δ)

Generally speaking, RCISS was developed to provide various information services. However, it is usually carried out from one or several at the beginning of implementation. The relative index of service (γ) can show us which sub-areas provide more information services, but cannot determine how many kinds of services are provided.

Diversity of service (δ) is an indicator that measures the variety of services. We set there are J indexes to count the total service frequency in a sub-area. Any index with zero service frequency will be counted to the calculation of the diversity of services. We define $z_{i,j}$ as the number when there are (J-j) indexes that have no service in i^{th} sub-area, and we can calculate the diversity of services （δ as:

$$\delta_i = 1 - \sum_{j=0}^{J}\left(2^{-j}\beta_{i,j}\right) \quad (2)$$

Where, $\beta_{i,j}$ is the percentage of the RCISS number with (J-j) indexes who have no service in i^{th} sub-area and $\beta_{i,j} = \frac{z_{i,j}}{N_i} \cdot 100\%$ and N_i is the total RCISS number in i^{th} sub-area.

Certainly, we can set a low value z_0, not 0 for every index. In this case, $z_{i,j}$ will be the number when there are (J-j) indexes that provide service less than z_0 in i^{th} sub-areas. If we let z_0=0, it will be easier to calculate and it is suitable for the beginning stage of RCISS implementation.

C. Volatility of Service (υ)

The relative index of service (γ) also cannot tell us the fluctuation a RCISS's information service. To some extent, a lower level of government or organization should try to fulfill the task from the upper one. It is always a phenomenon that some RCISS can provide almost major services in one or two months, especially at the end of a year. We develop the volatility of service (υ) to describe the tendency of service fluctuation in a sub-area. We define $sum_{i,m}$ as the service frequency in i^{th} sub-area monthly. Then, the volatility of service (υ) can be calculated as follows:

$$\upsilon_i = {}^{\sigma_i}/_{\mu_i} \quad (3)$$

Where μ_i is the average of the service frequency of i^{th} sub-area, and $\mu_i = \frac{1}{M}\sum_{m=1}^{M} sum_{i,m}$. M is the total months included. σ_i is the standard deviation of the service frequency and $\sigma_i = \sqrt{\frac{1}{M}\sum_{m=1}^{M}(sum_i - \mu_i)^2}$.

IV. The Results and Discussion

Ningbo is a seaport city in the northeast of Zhejiang province, People's Republic of China. Holding sub-provincial administrative status and separate state-planning status. As of the 2012 census, the municipality has a population of 7,639,000 inhabitants, 3,663,000 of whom reside in the urban area mainly located in Cixi, Yuyao, Zhenhai, Beilun, Yinzhou, Jiangbei, Fenghua, Ninghai and Xiangshan. It lies south of the Hangzhou Bay, facing the East China Sea to the east. Ningbo borders Shaoxing to the west and Taizhou to the south, and is separated from Zhoushan by a narrow body of water.

Figure 1. Main sub-areas in Ningbo

TABLE 1.

NINE SUB-AREAS AND THE RCISSS IN NINGBO

Sub-area	Towns	RCISSs	Density (1000/km²)	Per capita net income of rural resident(¥)
Yuyao	22	267	.556	17977
Cixi	19	275	.766	20383
Fenghua	11	370	.382	17675
Ninghai	18	368	.334	14757
Xiangshan	18	494	.391	16388
Jiangbei	8	107	1.160	17224
Zhenhai	6	63	.926	19801
Beilun	9	173	.640	20370
Yinzhou	23	387	.619	20831
total	134	2504		

In 2009, Ningbo City started construction of RCISS. Till 2010, there had been 2,226 RCISS in Ningbo. In 2011, more than 4,000 people had taken part in the training for use of the RCISS [16]. We choose the nine sub-areas (as shown in Table 1) in Ningbo, China, which include 134 towns and 2,504 RCISSs (2012), to perform the case study on the utilization comparison evaluation with the tri-indicator evaluation method.

A. Relative Index of Service (γ) in All Sub-areas of Ningbo

We set L=228, which means there is at least one service in every index each month in a RCISS. The $\alpha_{i,k}$ and γ_i are calculated as Table 2.

According to formula (1), we know when $k \ge 4$, $\gamma_i(k=4) - \gamma_i(k=5) = 2^{-5}\alpha_{i,5} \le 3.125\%$, $\gamma_i(k=4)$ is very close to the true value of γ_i. Therefore, we can use $\gamma_i(k=4)$ as the relative index of service. Of course, the greater k we choose, the more accurate γ_i will be. It also

brings forward another discussion question—how to set the value of the step *L*. If *L* is too great, the *K* will be too small and the γ_i will be imprecise and may not show the difference among the sub-areas. If the step *L* is too small, the γ_i will particularly dependent on the data in the first four zones and also cannot show the difference. So we should choose the suitable *L* and let the value of 5*L* cover mainly data we should analyze.

TABLE 2.

THE γ IN ALL SUB-AREAS OF NINGBO WHEN L=228

	$\alpha_{i,k}$								
	Yuyao	Beilun	Fenghua	Ninghai	Cixi	Jiangbei	Xiangshan	Yinzhou	Zhenhai
k=0	10.10%	6.40%	69.20%	4.60%	14.90%	20.60%	3.40%	86.80%	1.60%
k=1	82.40%	92.50%	20.30%	91.00%	55.60%	78.50%	56.30%	12.90%	87.30%
k=2	5.20%	0.60%	3.20%	4.10%	29.10%	0.90%	28.50%	0.30%	4.80%
k=3	1.50%	0.60%	2.20%	0.30%	0.40%	0.00%	5.70%	0.00%	1.60%
k=4	0.00%	0.00%	2.70%	0.00%	0.00%	0.00%	2.60%	0.00%	0.00%
≥5	0.80%	0.00%	2.40%	0.00%	0.00%	0.00%	3.40%	0.00%	4.80%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
$\gamma_i(k=4)$	47.21%	47.13%	19.41%	48.84%	49.98%	39.93%	60.45%	6.68%	53.35%
Rank	5	6	8	4	3	7	1	9	2

In this paper, considering the RCISS in Ningbo has been supplemented only several years, all the RCISS have not much service frequency. So we chose *L*=228 and then 4L=912 to cover most of the service frequency in all sub-areas. Certainly, we can also make *L* less. Supposed *L*=52, it means there is at least once service frequency in a RCISS weekly. The results of γ_i are shown in Table 3.

As shown in Table 3, the different step *L* will result in different outcomes. Because we know when *L*=228, and *k*=2, 2*L*=456, it covers most of the data. If we make *L*=52, the results will be more precise and certainly the value of γ will be greater. At the same time, the different step *L* will also lead to a changeable rank because $\alpha_{i,k}$ is changed. When *L*=228, Zhenhai ranks second and Ninghai ranks fourth; when *L*=52, Zhenhai ranks fourth but Ninghai becomes second. It shows us there are more RCISSs in Ninghai than in Zhenhai which provided relatively more information services. It also means Zhenhai was just crossing the threshold to provide information services compared with Ninghai.

TABLE 3.

THE EFFECT TO γ BY DIFFERENT STEP *L*

	Yuyao	Beilun	Fenghua	Ninghai	Cixi	Jiangbei	Xiangshan	Yinzhou	Zhenhai
$\gamma_i(k=4)$ when *L*=52	59.07%	56.22%	23.63%	79.72%	65.92%	48.32%	83.36%	7.00%	65.38%
Rank	5	6	8	2	3	7	1	9	4
$\gamma_i(k=4)$ when *L*=228	47.21%	47.13%	19.41%	48.84%	49.98%	39.93%	60.45%	6.68%	53.35%
Rank	5	6	8	4	3	7	1	9	2

B. Diversity of Service (δ)

The service frequency is counted through 19 indices which are classified into four categories. The Convenience services include (1) policy and legal advisory services, (2) agricultural science and technology information service, (3) agricultural supply and demand information services, (4) rural cultural and life services, (5) Internet Information Services, (6) E-commerce services, (7) job hunting information service, and (8) payment and recharge services. The Grassroots government services include (9) data reporting services, (10) making the financial and other affairs in villages public, (11) receipt service, and (12) posting Service. The Education and training services include (13) basic skills training on computer and networks, (14) education and training on health care, education, science and technology et al., (15) training on the use of agricultural services network platform, (16) E-commerce platform training services, (17) village employment education and training services, (18) Party-building Training Services; and the fourth category is (19) special services.

According to formula (2) and the status of RCISS in Ningbo, we divide the diversity of services into six groups. *NN* means there is no service in all the 19 indices; *LL* represents the service exits only in 1 to 3 indices; *MM* means the service exits in 4 to 8 indices; *HM* means service exits in 9 to 13 indices and *HH* represents the service exits in 14 to 18 indices. The diversity of service (δ) is calculated in Table 4.

TABLE 4.
THE δ OF THE NINE SUB-AREAS IN NINGBO

	$\beta_{i,j}$								
	Yuyao	Beilun	Fenghua	Ninghai	Cixi	Jiangbei	Xiangshan	Yinzhou	Zhenhai
HH	9	3	10	29	19	0	6	0	11
HM	8	14	8	22	15	1	10	0	24
MM	19	36	7	25	15	4	17	1	48
LL	54	40	6	18	36	75	63	13	16
NN	10.1	6.4	69.2	4.6	14.9	20.6	3.4	86.8	1.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
δ_i	56.7	62.5	24.4	75.4	60.5	41.0	59.1	6.7	74.9
Rank	6	3	8	1	4	7	5	9	2

Generally speaking, the greater δ will contribute the greater γ. As shown in Table 4 and Table 2 (and Table 3), the rank of γ and δ of Jiangbei, Fenghua, Yinzhou, Ninghai, Zhenghai, Cixi, Yuyao basically coincide. But the rank of γ in Beilun and Xiangshan disaccord with δ. It means Xiangshan did well in providing several kinds of information services but not various services and Beilun provided various but relatively little information services.

C. Volatility of Service (υ)

We calculated the volatility of service of the nine sub-areas in Ningbo according to their monthly service frequency in 2012. The results are shown in Table 5.

TABLE 5.
THE υ OF THE NINE SUB-AREAS IN NINGBO

	Yuyao	Beilun	Fenghua	Ninghai	Cixi	Jiangbei	Xiangshan	Yinzhou	Zhenhai
μ_i	1879	742	2710	3699	2908	357	10611	101	964
σ_i	1568	639	4539	7568	5601	145	7206	58	1251
υ_i	0.83	0.86	1.67	2.05	1.93	0.41	0.68	0.58	1.30
Rank	4	5	7	9	8	1	3	2	6

Obviously, if the RCISSs in a sub-area provided little information service, the υ would be relatively low, such as Jiangbei and Yinzhou (shown in Table 5). Xiangshan, Ninghai, Cixi and Zhenhai got higher υ than the others. It means lots of the RCISSs in those sub-areas got high service frequency in one or two months.

If we just decide which sub-area provided better services by service frequency (or the average of service frequency), we will be misled by Fenghua, which got relatively higher average of service frequency, but lower in γ and δ. It shows us there are several RCISSs in Fenghua who provided pretty good services but almost the others did not perform well.

It is interesting that when δ is greater, the υ is always smaller. As shown in Table 4 and Table 5, the sum of the rank of δ and υ has almost the same value. When there is one kind of service, it must be difficult to enhance the service frequency during a short period. Otherwise, if they provide many kinds of service, it is always easy to make the service frequency greater in a short period, especially at the end of a year.

V. CONCLUSIONS

It has been four years since the MIIT carried out the construction of RCISS. According to the background of RCISS and the objective, a tri-indicator evaluation method was set forward in this paper, which included three indexes: relative index of service (γ), diversity of Service (δ) and volatility of service (υ). And a case study on the utilization comparison of the RCISSs in Ningbo was made by using the tri-indicator evaluation method.

According to the results of RCISS in Ningbo, we can divide the nine sub-areas into four groups. The best of them was Xiangshan, which had highest γ and also did well in δ and υ; Ninghai and Zhenhai had their characteristic utilization of RCISS, Ninghai did well in δ and υ, Zhenhai did well in γ and δ; Yuyao, Beilun, Cixi, Jiangbei can be classified as the steady development of RCISS; Yinzhou and Fenghua are beginning the utilization of RCISS.

Although there are several dimensions of the rural penalty, principal among them are a low density of population and, therefore, a low density of most markets, and greater distance to those markets as well as to information, labor, and most other resources [2]. However, we have not identified any relationship between the tri-indicators and the density or per capita net income of rural resident (shown in Table 1).

Lack of capabilities/skills and services to use the new technologies are among the main challenges [10]. ITs, as other technologies, are necessary but not sufficient for success in rural area [2][17]. As Edward [2] said, "telecommunications is not a magic solution for rural economic development." Neither is RCISS a magic solution for the development of rural areas in China. We

advise further study on how to improve the utilization efficiency of RCISS and how to benefit the rural residents by RCISS.

ACKNOWLEDGMENTS

Thanks for the help and support from Professor Zhengxin Chen and Yong Shi, College of Information Science and Technology, University of Nebraska at Omaha. This research is supported by the soft science project of Ningbo Science and Technology Bureau (#2011A1007), the project from the Ningbo strategic office in cooperation with Chinese Academy of Social Sciences (#NZKT201221) and National Natural Science Foundation of China (#71271191).

REFERENCES

[1] R., Kanbur, and X. Zhang. Fifty years of regional inequality in China: A journey through central planning, reform, and openness. *Review of Development Economics*, Vol. 9, pp. 87-106, Feb. 2005. "doi:10.1111/j.1467-9361.2005.00265.x"

[2] E. J. Malechi, Digital development in rural areas: potentials and pitfalls, *Journal of Rural Studies,* Vol. 19, pp. 201-214, Apr. 2003. "doi: 10.1016/S0743-0167(02)00068-2"

[3] P. Liu and X. Zhang. Investigation into evaluation of agriculture informatization level based on two-tuple. *Technological and Economic Development of Economy*, Vol. 17, pp. 74-86, Mar. 2011. "doi:10.3846/13928619.2011.554007"

[4] C. Liu. The myth of informatization in rural areas: The case of China's Sichuan province, *Government Information Quarterly*, Vol. 29, pp. 85–97, Jan. 2012. "doi: 10.1016/j.giq.2011.06.002"

[5] H. E. Hudson. *From rural village to global village—telecommunications for development in the information age.* Mahwah, NJ: Lawrence Erlbaum Associates. Jan. 2006.

[6] ITU. World Telecommunication/ICT Development Report 2006: Measuring ICT for Social and Economic Development. *International Telecommunication Union,* Geneva, Switzerland. 2007.

[7] J. Xia and T. Lu. Bridging the digital divide for rural communities: The case of China, *Telecommunications Policy*, Vol. 32, pp. 686–696, Oct-Nov. 2008. "doi: 10.1016/j.telpol.2008.07.006"

[8] C. Ting and F. Yi. ICT policy for the "socialist new countryside"—A case study of rural informatization in Guangdong, China, *Telecommunications Policy*, Vol. 37, pp. 626-638, Sep. 2013. "doi: 10.1016/j.telpol.2012.03.007"

[9] L. Zhang, X. Liu, D. Li and Z. Fu. Evaluation of the rural informatization level in four Chinese regions: A methodology based on catastrophe theory. *Mathematical and Computer Modelling*. Vol. 58, pp. 868–876, Aug. 2013. "doi: 10.1016/j.mcm.2012.12.014"

[10] Y. Sun and H. Wang. Does Internet access matter for rural industry? A case study of Jiangsu, China, Journal of Rural Studies, Vol. 21, pp. 247–258, Apr. 2005. "doi: 10.1016/j.jrurstud.2005.02.002"

[11] J. Xia. Linking ICTs to rural development: China's rural information policy, *Government Information Quarterly*, Vol. 27, pp. 187–195, Jan. 2010. "doi: 10.1016/j.giq.2009.10.005"

[12] Z. Yu, G. Zhou and B. Wang. Analysis on the Starting Point and Path of Informatization in the Underdeveloped Rural Areas: A Survey of 52 Undeveloped Rural Villages of Ningbo. *Communications in Computer and Information Science*. Vol. 202, pp. 217-224. Jul. 2011. "doi: 10.1007/978-3-642-22456-0_32"

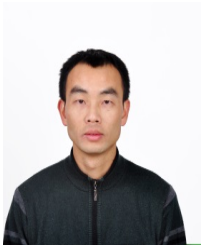
[13] L. Sha. Study on the measurement of and the relationship between informatization level and economic growth. Ph.D. *Dissertation Submitted to Tianjin University*. Aug. 2008 (in Chinese)

[14] X. Chen, G. Chen and M. Li. Classification and research advanced of comprehensive evaluation method. *Journal of management science in China*. Vol. 7, pp. 69-79, Apr. 2004. (in Chinese)

[15] A. Ricci. Measuring information society dynamics of European data on usage of information and communication technologies in Europe since 1995, *Telematics and Informatics,* Vol. 17, pp. 141–167, Feb-May. 2000. "doi: 10.1016/S0736-5853(00)00002-2"

[16] NBIT, RCISSs have covered the entire Ningbo city [EB/OL]. http://xxcyj.ningbo.gov.cn/homepage/show_view.aspx?id=5337&catid=19, 2012-1-11, available on September 16, 2013.

[17] S. Grimes. The digital economy challenge facing peripheral rural areas. Progress in Human Geography, Vol. 27, pp. 174–193, Apr. 2003. "doi: 10.1191/0309132503ph421oa"



Zhiwei Yu was born in Jiangxi, China, Aug. 1978. He received the Ph.D degree in machinery manufacturing and its automation from Zhejiang University, Hangzhou, China in Dec. 2006. He is currently an associate professor in School of Management, Ningbo Institute of Technology, Zhejiang University, Ningbo, China and a visiting scholar in University of Nebraska at Omaha, Nebraska, U.S.A. His current research interest includes rural informatization, information management, and innovation.

Xingsen Li received his Ph.D. degree in management science and engineering from School of Management, Graduate University of the Chinese Academy of Sciences, Beijing, China in 2008. He is currently a professor in School of Management, Ningbo Institute of Technology, Zhejiang University, Ningbo, China. He has been the secretary-general of Extension Engineering Specialized Committee, China Association of Artificial Intelligence. His research interests include Extenics, business intelligence, knowledge management and innovation.

Fangyao Liu received his bachelor in Statistics from Southwestern University of Finance and Economics, Chengdu, China in Jun. 2012. He is currently working toward his Master degree in Management Information System at University of Nebraska at Omaha, Nebraska, U.S.A. His research interest includes Statistics, Finance, Information system, Data mining.