information science and service innovation as viewed from the perspective of information science is referred to as "forward linkage," and the same relationship as viewed from the perspective of service innovation is defined as "backward linkage." In concrete terms, based on the likelihood that author keywords for journal papers within the clusters of information science, library science, and computer science will appear in abstracts of papers in the clusters within service innovation, we calculate the depth of the relationships between the various clusters that belong to both fields. Finally, we discuss the appropriate policy for promoting service innovation based on the knowledge infrastructure.

Methodology

First of all, the methodology for creating academic landscape is shown. Analyzing schema is depicted in Fig. 1. The step (1) is to collect the data of the knowledge domain. We collect citation data from the Science Citation Index Expanded (SCI-EXPANDED), the Social Sciences Citation Index (SSCI), and the Arts & Humanities Citation Index (A&HCI) compiled by the Institute for Scientific Information (ISI), which maintains citation databases covering thousands of academic journals and offers bibliographic database services, because these are three of the best sources for citation data. The problem, how we should define a research domain, is difficult to solve. One solution is to use a keyword that seems to represent the research domain. When we collect papers retrieved by the keyword, we can make the corpus for the research domain.

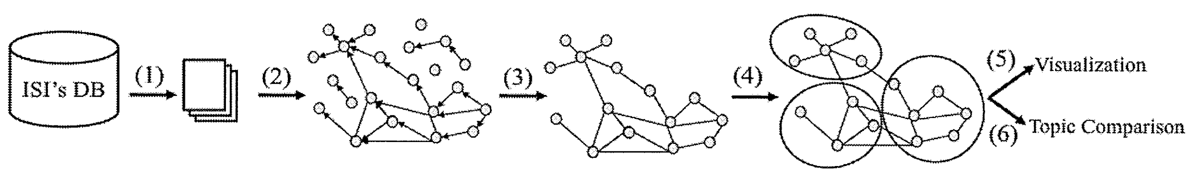

Figure 1. Methodology proposed in this paper.

The step (2) is to make citation networks for each year. We construct citation networks by regarding papers as nodes and intercitations as links. The network created for each year facilitates a chronological analysis of citation networks. According to a previous study, intercitation, which is also sometimes known as direct-citation, is the best way to detect emerging trends (Shibata et al., 2009, Shibata et al., 2010, Sakata et al., 2010). In network analysis, only the data of the largest component on the graph was used, because our study focuses on the relationships among documents, and we therefore want to eliminate from our study those not linked with any others in step (3).

After extracting the largest connected component, in step (4), the network is divided into clusters using the topological clustering method (Newman, 2004), which does not need the number of clusters by users. Newman's algorithm discovers tightly knit clusters with a high density of links within cluster. In step (5, 6), experts in the research domain assign a name to each cluster manually after they had seen titles and abstracts of the papers in each cluster, supported by the methodology of visualization developed by Adai et al. (2004).

Second, we calculate "Information Science Linkage of Service Innovation." The linkage is defined as the degree of distance in the semantic connections between service innovation clusters on the one hand and information science clusters on the other. The degree of distance in these semantic connections may be employed as an indicator of the depth of the relationship among different research fields.

For respective clusters of information science, we calculate the semantic connection to each cluster of service innovation. We define this linkage, as viewed from the perspective of information science to service innovation, as "forward linkage". And the inverse linkage, as viewed from the perspective of service innovation to information science, is called as "backward linkage".

More formally, let *linkage(I,S)* be the linkage between a cluster *I* of information science cluster and a cluster *S* of service innovation:

$$linkage(I,S) = \begin{cases} \sum_{w} \dfrac{freq_s(w_I)}{|A_s|} & \textit{forward linkage} \\ \sum_{w} \dfrac{freq_s(w_I)}{|W_I|} & \textit{backward linkage} \end{cases},$$

where W_I is a set of author keywords, which are assigned to a paper by its author(s), of papers in *I*, w_I is an individual keyword in W_I , A_s is a set of abstracts of papers in *S*, and $freq_s(w_I)$ denotes a term frequency of w_I in A_s. The forward linkage is normalized with the size of A_s so that linkages from one of information science clusters to service science clusters are uniformly evaluated. And the backward linkage is normalized with the size of W_I.

The number of abstracts in each cluster of service science is shown in Table 1 and the number of author keywords in each cluster of information science is shown in Table 2.

In our experiment, we exclude an author keyword that its frequency is less than a certain threshold. We set the threshold as 100 based on our preliminary experiment.

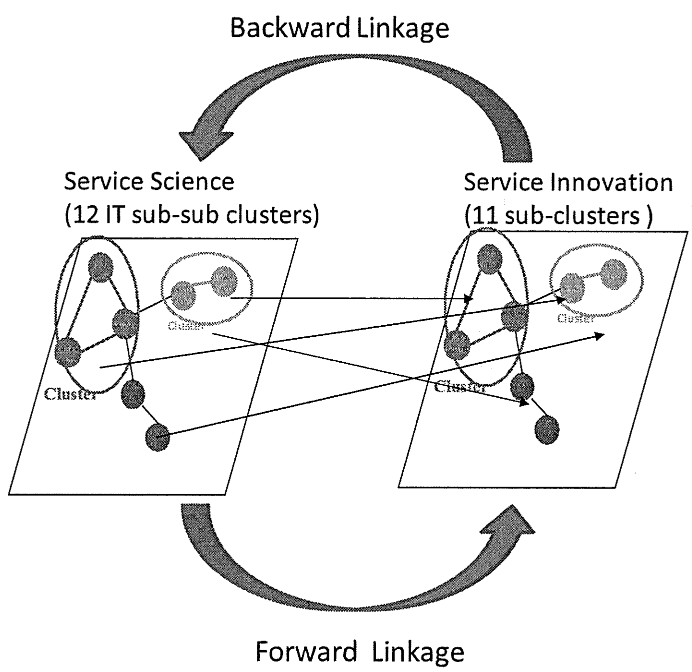

Figure 2.Concept of information science linkage

Results

With respect to service innovation, the number of academic papers that form the target of this analysis stands at 54,928. Our results shows that there are mainly two groups of elements related to service innovation: applications of service innovation such as health and medical care, IT, and public service, and basic theories for service innovation such as management, ecosystem, and QoS (Table 1).

Table1.Major sub-clusters of service innovation (SSME)

Service Cluster	Label	# of Abstracts
1	Management	1783
2	Medical Care	1660
3	Mental Health Care	1276
4	Ecosystem	901
5	Quality of Service (QoS)	903
6	Public Service	837
7	Public Medical Care	627
8	IT and Web	454
9	Patient Satisfaction	351
10	Clinical Pharmacy	305
11	Telemedicine	308

The number of academic papers related to information science, library science, and computer science stands at 314,806. Major sub-clusters include (1) machine learning, neural network, computer vision and computer graphics, (2) artificial intelligence, network, information retrieval, information theory and database, (3)distributed or parallel computing, computer architecture and information system, (4)fuzzy, (5)bioinformatics, (6)security and cryptography, (7)library and information science, (8)computer physics, (9)math application, (10)telecommunication, (11) reliability, (12)graphics, display and color, (13)computer and geo science, (14)health information, (15)circuit device. Our analysis targets the top three sub-clusters which include more than 60,000 papers. Major sub-sub-clusters of the top three sub-clusters include machine learning, computer vision, neuroinformatics, computer graphics, artificial intelligence, telecommunication network, information retrieval, information theory, distributed computing, computer architecture, information system, and multimedia (Table 2).

Table2.Major sub-sub clusters of service science

Information Science Cluster	Label	# of Keywords
1	Machine Learning	825
2	Computer Vision	657
3	Neuroinformatics	782
4	Computer Graphics	552
5	Artificial Intelligence	722
6	Telecommunication	615
7	Information Retrieval	571
8	Information Theory	513
9	Distributed Computing	576
10	Computer Architecture	631
11	Information System	550
12	Multimedia	592

We calculate the co-occurrence of characteristic terms in paper abstracts belonging to the 11 SSME sub-clusters and author keywords for essays belonging to the 12 sub-sub-clusters belonging to information science. The co-occurrence matrix shows the raw data of co-occurrence (Table3). The biggest number is 12,816 and the smallest number is 1,014. The pair which has biggest number is the pair of innovation sub-cluster #1 (Management) and information science sub-cluster #5 (artificial intelligence).

Table 3.Co-occurrence matrix

		Service Innovation Cluster										
		1	2	3	4	5	6	7	8	9	10	11
Info.	1	11,716	8,726	5,137	5,051	11,094	4,213	3,566	3,951	1,870	1,613	1,923
Science	2	8,773	6,618	3,920	3,765	7,963	3,184	2,748	2,816	1,392	1,207	1,488
Cluster	3	10,925	8,407	4,866	4,972	10,577	4,032	3,426	3,798	1,827	1,607	1,943
	4	7,011	5,398	2,944	3,104	7,740	2,550	2,268	2,353	1,090	1,014	1,111
	5	12,816	9,814	6,083	5,311	11,933	4,631	3,935	4,685	2,108	1,849	2,225
	6	7,779	6,012	3,449	3,587	11,038	3,003	2,483	2,740	1,298	1,171	1,358
	7	12,127	9,172	5,683	4,765	10,529	4,471	3,633	4,320	1,955	1,700	2,078
	8	7,493	5,927	3,341	3,293	10,101	2,990	2,573	2,477	1,263	1,127	1,357
	9	10,048	8,444	5,107	4,369	12,177	3,798	3,367	3,654	1,702	1,584	1,731
	10	8,823	7,078	4,029	3,641	11,353	3,227	2,818	3,139	1,422	1,388	1,543
	11	12,778	9,694	6,015	5,186	11,588	4,672	3,945	4,555	2,081	1,833	2,210
	12	10,775	7,390	4,742	4,448	11,456	3,940	3,140	4,039	1,666	1,380	1,821

Then we normalize the raw data, using the size of abstracts or author keywords as denominator. It became clear that artificial intelligence, information retrieval, and distributed computing values were high for forward linkage (figure2). It may be considered that these sciences are being applied heavily in cutting-edge service innovation. Values in the three fields of quality of service (QoS), management, and medical care were high for backward linkage (figure3). It may be considered that information science is being used very heavily in the context of innovations in these fields. On the other hand, values in the three fields of public service, mental healthcare, and patient satisfaction were low. We believe that the degree to which information science is being applied is lower in these fields than in others.

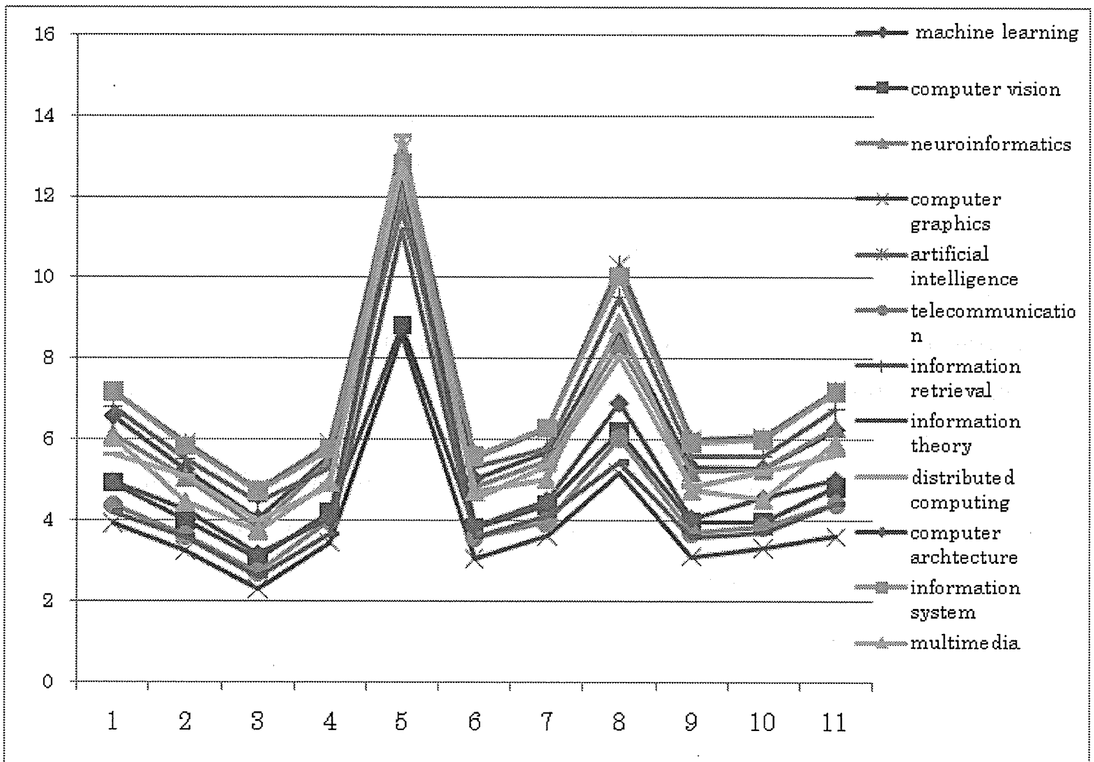

Figure 2. Forward Linkage

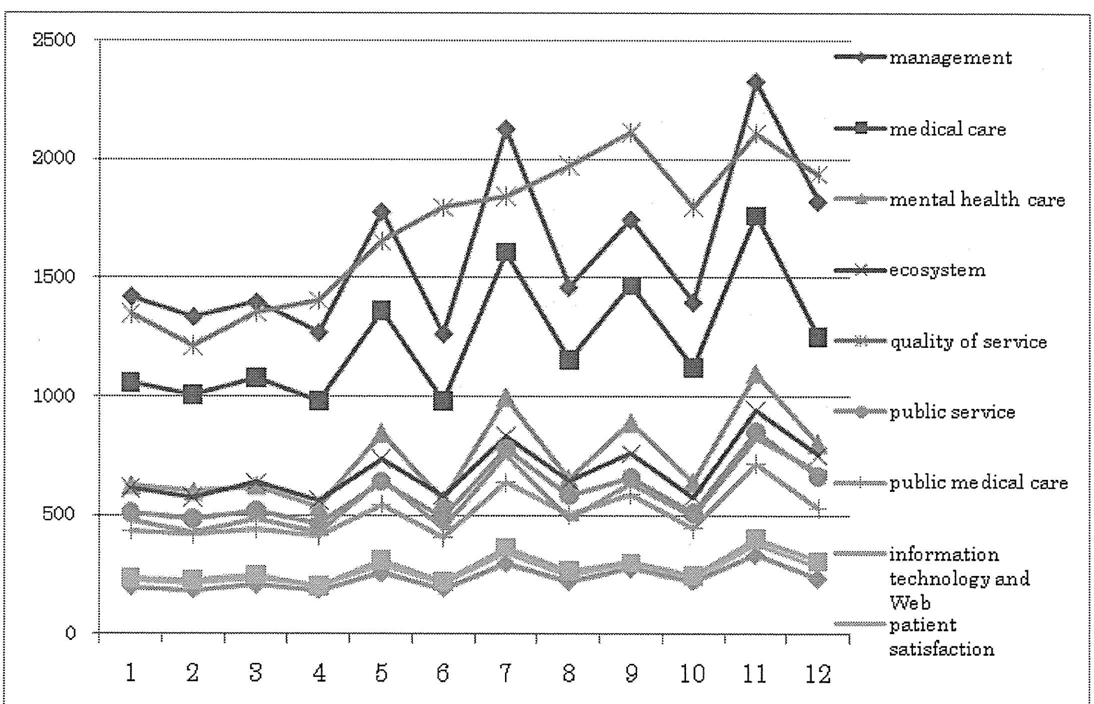

Figure 3. Backward Linkage

Discussion

First, the results of the analysis described above clarified which information sciences are used heavily in service innovation. It is known that these fields possess deep links with forms of information engineering such as data mining, the web, and cloud computing. Moreover, these fields are similar to the list of technologies specified as particularly important by experts in the Technology Strategy Roadmap of service engineering issued by the Japanese organization NEDO (NEDO, 2008). The roadmap mentioned forty nine technology elements and the relationship between technology and industry, even though these descriptions lack concreteness of linkage. The technologies which are indentified in both NEDO roadmap and our results include machine learning, neural network, distributed computing, information theory and multimedia. Our method, which used bibliometrics, produced results similar to those obtained by multiple experts working over a long period of time. In a rapidly changing field like information science, it is important to regularly obtain updated information; however, this is difficult using a method, typically referred to as the T-plan, in which experts form a consensus. Our method has the potential to contribute to technology strategies in a field in which technology continues to progress rapidly.

Second, we determined which areas of innovation make heavy use of information science and which do not. In the field of medical care, the high value we obtained demonstrates that digital health and EHR research is being vigorously conducted worldwide (Oren et al., 2003, Eslami et al., 2007, Huckvale et al., 2010). By contrast, in other fields related to medical treatment, such as mental healthcare and patient satisfaction, usage of information science is relatively low. It is believed that information science linkage improvement strategies have had a significant effect in these related fields. Public service—a field for which we judged use to be low—has been specified in OECD's Innovation Strategy (2010) as one toward which it is particularly important that public sector takes innovation-conscious attitudes. Our analysis suggests that it is important to develop strategies for accelerating the spread of information science in public sector.

Conclusion

It is with this recognition that policies for strengthening international competitiveness regarding service innovation are being adopted by many countries. While planning and implementing these policies, what is required in essence is an objective analysis regarding the current status of knowledge related to this field and the linkage between science and innovation. However, the knowledge infrastructure of this kind is inadequate. Therefore, we developed the way to identify the meta structure of knowledge and measure "information science linkage of service innovation".

With respect to service innovation, our results show that there are mainly two groups of elements related to service innovation: applications of service innovation and basic theories for service innovation. In the field of service science, we also identified major knowledge groups such as machine learning, pattern recognition, computer vision, objectively. Then we calculated the co-occurrence of characteristic terms in paper abstracts belonging to the SSME sub-clusters and author keywords for papers belonging to the sub-sub-clusters related to information science. We clarified which information sciences are used heavily in service innovation. It is known that these fields possess deep links with forms of information engineering such as data mining, the web, and cloud computing. We also determined which areas of innovation make heavy use of information science and which do not. In the field of medical care, the high value we obtained demonstrates that digital health and EHR research is being vigorously conducted worldwide. By contrast, in other fields related to medical treatment, such as mental healthcare and patient satisfaction, we found a big room to promote the spread of information science in public sector.

Overall, we have demonstrated the possibility of using bibliometrics to objectively identify the meta structure of knowledge and measure semantic relationships between science and technology.

Acknowledgement

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Bibliometric Analysis of Service Innovation Research: Identifying Knowledge Domain and Global Newwork of Knowledge

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Abstract—**It is widely recognized that the concept of service innovation is significant for innovation strategy and economic growth. However, since the term "service innovation" represents a broad sense, there does not exist common understanding about what is service innovation even among experts. We developed a methodology to determine the structure and geographical distribution of knowledge, as well as to reveal the structure of research collaboration in such an interdisciplinary area as service innovation by performing journal information analysis, network analysis and visualization. Our results show that there are mainly two groups of elements relating to service innovation. Knowledge in these areas has been growing rapidly in recent years. In particular, the fields of ecosystem and IT and Web are exhibiting a high growth. We also demonstrated that the global network of knowledge is formed around the powerful hub of the US. The research competency of Asian countries lags behind that of the US and EU. With respect to research collaboration, we indentify a big room left for enhancing international collaborations. Our methodology could be useful in forming policies to promote service innovation. Finally, we proposed creation of an international collaboration fund.**

I. INTRODUCTION

The concept of service innovation or service science, management and engineering (SSME) proposed by IBM is widely recognized as a key driver for the economic growth. Then service science is emerging area of research [1, 2] Maglio and Spohrer [3] defines service science as the study of service systems, which are dynamic value co-creation configurations of resources. Spohrer et al.[4] argues that service science can be thought of as a mashup or integration of many areas of study known as service management, service marketing, service operations, service engineering, service computing, service human resources management, service economics, management of service innovation and others. Wu [5] discusses that the concept of SSME is an emerging interdisciplinary approach that combines fundamental management, and engineering theories. Such concept plays a significant role in policy making in many countries. In Japan, the government established a roadmap named Technology Roadmap of Service Engineering, which describes the goal of service innovation. However, the sense of concept SSME is so broad that there is not the common and deep understanding about what is service innovation even among experts [3, 5]. Although the roadmap mentioned above describes forty nine technology elements and the relationship between technology and industry, these descriptions lack concreteness because it is so conceptual. Therefore, prior to developing roadmap, it is necessary to make the academic landscape of SSME in order to understand what have been researched relating to this topic. Then, the first aim of this paper is to identify the way to create the academic landscape. Service science, service innovation or SSME has the interdisciplinary nature of approach [5, 6]. Tracking the evolution of interdisciplinary research domain, such as SSME, is a significant but difficult task by its nature. Previous study argued that interdisciplinary research should not be conceptualized with discipline [7]. Existing categories like journal categories may not matter because interdisciplinary researches vary beyond the boundaries of journals. Some indicators measuring interdisciplinary such as diversity of classifications and topological measures are proposed and evaluated in the previous papers [8,9]. Experts are not able to track the entire trends in such research areas as each research specializes and is segmented.

In such a situation, for policy makers, creating an academic landscape of interdisciplinary research and effective investment on those technologies has become a significant task in order to develop their competitive competence and also to realize the economic growth. In this paper, we develop a computational tool to support them to create an academic landscape among a pile of academic publication. There are two types of computer-based methodology, which can complement the expert-based approach: text mining and citation mining. As an example of the former, Kostoff et al. analyzed multi-word phrase frequencies and phrase proximities, and extracted the taxonomic structure of energy research [10,11]. In previous works, citation-based approaches, latter ones, were used to describe the network of energy-related journals using journal citation data or journal classification data [12]. In the citation-based approach, it is assumed that citing and cited papers have similar research topics. In this paper, we adopt the latter one.

Citation-based approach is useful to make an overview of research domains globally. Klavans and Boyack illustrated how to map science overall using journal citation interactions [13]. Rinia et al. pointed out the importance to consider the process how bibliometric measures are created [14]. By clustering the citation network, we can divide academic papers into groups of papers. Previous research investigated citation networks of academic publications relating to another interdisciplinary research, sustainability science, and extracted the major topics relating to this topic [15]. The first aim of this paper is to create an academic landscape in SSME research domain by using citation network analysis.

Although it is possible to grasp the structure of the intellectual world from the academic landscape, it is also meaningful to know the overall picture of geographical distribution of research and partnerships in research from the perspective of policy making. By understanding regional distribution and partnerships, it is possible to discuss the relationship between the number and nature of policies adopted in a particular region and the study of SSME, and it is also easy to develop a plan for global partnership in the field of research. Hence, the second aim of this paper is to draw a research network diagram that includes information on geographical distribution of knowledge and inter-regional collaboration. To create a research network diagram, we will use author information such as organisations to which authors are affiliated, nationalities of such organisations and co-authors from the same database used for the creation of academic landscape. There are several studies that use co-authorship as a quantitative indicator [16,17]. Co-authorship is used as an indicator of international collaboration [18,19,20]. Katz and Martin point out four key advantages of using co-authorship as an indicator of collaboration including its verifiability, statistical significance, data availability, and ease of measurement [21]. On the other hand, bibliometric analysis of multiple-author papers is not accurate as it can only be used to measure collaborative activities where the collaborating participants have entered their names on joint papers. We are aware of a bias where each research paper published separately despite the collaboration cannot be correctly identified. Nevertheless, this unique analytical method and data provides useful and clear empirical evidence, and when used with appropriate caution reveals new insights for international science policy. Our results can offer an intellectual basis for constructing a policy and strategy.

As stated above, the concept of SSME is yet to be clearly defined. This concept is mainly used in the US so far. It is possible that by using the term SSME as a query keyword, study fields growing in countries other than the United Stated will be underestimated. In evaluating academic landscape and research network diagram, it will be necessary to consider this possibility.

II. METHODOLOGY

First of all, the methodology for creating academic landscape is shown. Analyzing schema is depicted in Fig. 1. The step (1) is to collect the data of the knowledge domain. We collect citation data from the Science Citation Index Expanded (SCI-EXPANDED), the Social Sciences Citation Index (SSCI), and the Arts & Humanities Citation Index (A&HCI) compiled by the Institute for Scientific Information (ISI), which maintains citation databases covering thousands of academic journals and offers bibliographic database services, because these are three of the best sources for citation data. The problem, how we should define a research domain, is difficult to solve. One solution is to use a keyword that seems to represent the research domain. When we collect papers retrieved by the keyword, we can make the corpus for the research domain.

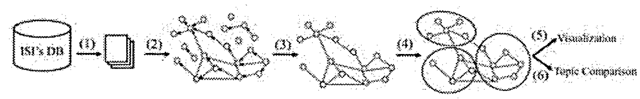

Figure 1. Methodology proposed in this paper.

The step (2) is to make citation networks for each year. We construct citation networks by regarding papers as nodes and intercitations as links. The network created for each year facilitates a chronological analysis of citation networks. According to a previous study, intercitation, which is also sometimes known as direct-citation, is the best way to detect emerging trends [22]. In network analysis, only the data of the largest component on the graph was used, because our study focuses on the relationships among documents, and we therefore want to eliminate from our study those not linked with any others in step (3).

After extracting the largest connected component, in step (4), the network is divided into clusters using the topological clustering method [23], which does not need the number of clusters by users. Newman's algorithm discovers tightly knit clusters with a high density of links within cluster. After the clustering, we visualize the citation networks and named the major clusters of emerging topics as in steps (5) and (6), respectively. In step (5), in order to visualize citation maps, we apply a large graph layout (LGL), an algorithm developed by Adai et al. [24], capable of dynamically visualizing large networks comprised of hundreds of thousands of nodes and millions of links. We visualize the citation network by expressing intra-cluster links in the same color, in order that the clusters are intuitively understood. In step (6), experts in the research domain assign a name to each cluster manually after they had seen titles and abstracts of the papers in each cluster.

Second, we create research network diagram by referring to the same database used for the creation of academic landscape, and for the extraction of data related to organisational affiliation of authors, geographical location of such organisations and co-authorships. Two types of data structure are developed: the data of research competency and of co-authorship. The data of research competency is obtained from the number of papers in each country or organization. The data of co-authorship is led by calculating all combinations of co-authors based on information about the author's organization. For example, if one paper is written by four different authors, and each author belongs to different organizations, the paper is considered to include six co-authorship relations. In addition, a co-authorship is defined as an international co-authorship if the authors belong to organizations in different countries. Authors in co-authored papers are not weighed by the order listed. Then, the data is visualized as a "research network diagram" with the author's organization as a node and co-authorship relation as a link between the nodes. In the diagram, organizations are grouped into the country they belong. In addition, combinations of organizations that have more co-authorship relations are identified. The hub of international co-authorships is also obtained.

III. RESULTS

In step (1) for creating academic landscape, we searched the papers using the terms "service* and (science* or management* or engineering*)" as the query. As a result, we obtained the data of 54,928 papers published until the end of 2008. The number of annual publications was shown in Fig. 2.

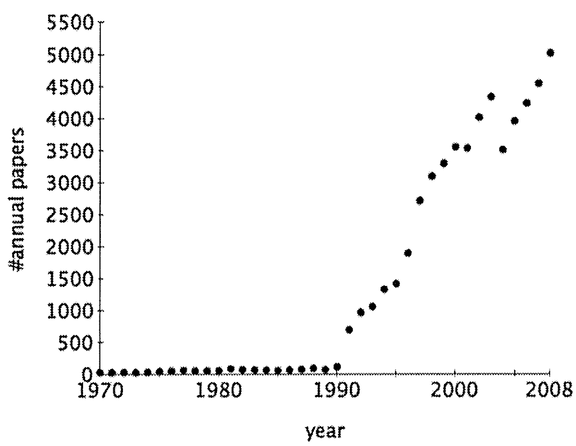

Figure 2. Number of annual papers relating to SSME.

After constructing largest connected component, as step (4), we divided papers into clusters with topological clustering method. With this clustering, citation networks as of 2008 were divided into specific clusters in step (4) and visualized as Fig. 3 in step (5). Focusing on the visualization in 2008, there were eight major clusters emerged in shown table1. Each contains more than 400 papers. The clusters #1, #2, #3, #4, #5, #6, #7 and #8 contained respectively 1,818, 1,681, 1,314, 914, 906, 866, 632, and 459 papers. Their combined publication dates averaged were 2003.0, 2002.7, 2000.8, 2004.1, 2002.7, 2002.2, 2001.8, and 2003.4. In the final step, step (6), our experts named each cluster, using semantic information such as the titles and abstracts of highly-cited documents in each cluster, shown in Table. 1. The clusters #1, #2, #3, #4, #5, #6, #7 and #8 related to management, medical care, mental health care, ecosystem, QOS, public service, public medical care, and IT & Web, respectively.

TABLE1. MAJOR8 CLUSTERS

Id	#papers	Average Publication Year	Name
S1	1818	2003.0	Management
S2	1681	2002.7	medical care
S3	1314	2000.8	mental health care
S4	914	2004.1	Ecosystem
S5	906	2002.7	QOS
S6	866	2002.2	public service
S7	632	2001.8	public medical care
S8	459	2003.4	IT & Web

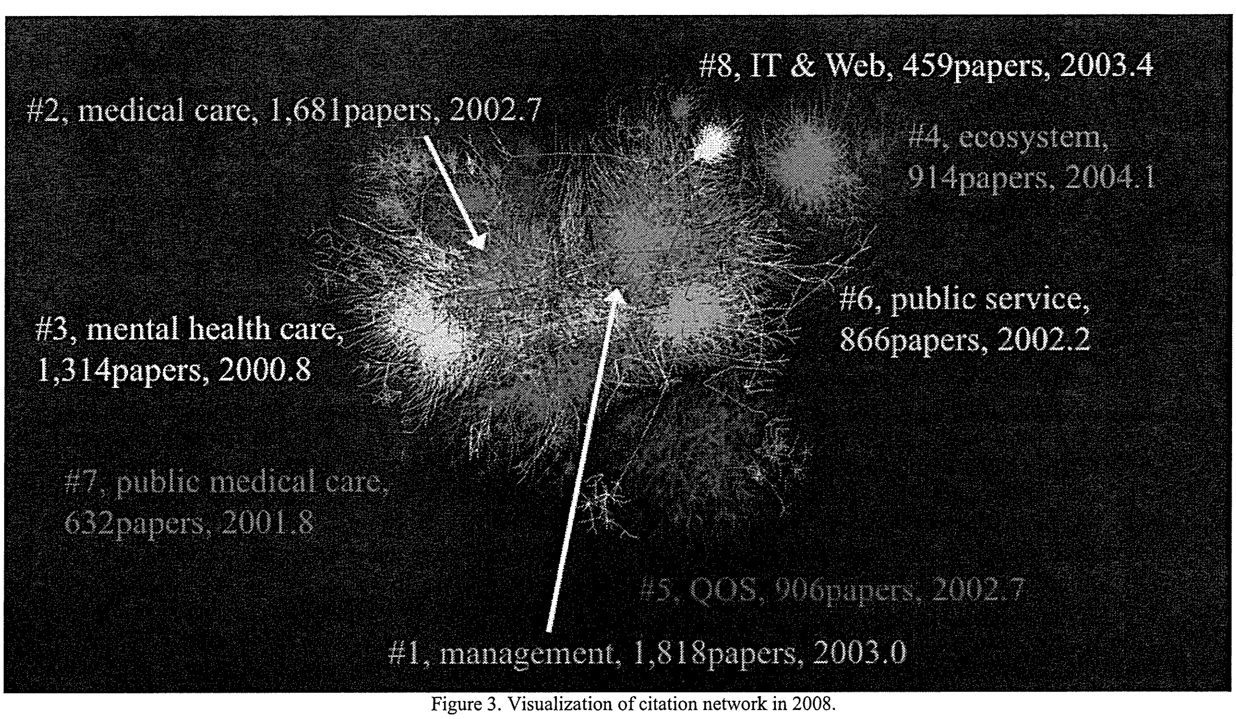

Figure 3. Visualization of citation network in 2008.

Next, a research network diagram is created. It was determined that the number of organisations to which authors of SSME related research papers are affiliated is 20,549, and the number of links among organisations based on the co-authorship is 72,484. Thus, a collaborative research network of 20,549 nodes and 72,484 links is formed in the field of SSME. The top five countries in the research competency are the US, England, Germany, France and Australia (Table 2). As a single country, it is notable that the US leads others by a significant margin. The research competency of EU as a total is slightly higher than that of US. Asian countries (China, Korea, India and Taiwan) are ranked between 10 and 18, although they show a rapid increase in their competencies. By analyzing the data of organisations (Table 3), it is clear that organisations with strong competency are often found in the US. Harvard University ranks first in the number of papers. Table 4 shows combinations of organisations that exhibit a high number of co-authorships. There are more co-authorship relations between organizations with high research competency. In addition, the number of collaborations between universities and their affiliated hospitals located nearby is notable. Geographically, many co-authorship relations are found in organisations within the same country, while international co-authorship is rare. In general, it has been noted that collaborative researches are often conducted by research organisations located within the same geographical region [19]. Nevertheless, collaboration in the SSME field is characterized by the dominance of domestic relationship compared to studies in the renewable energy field [25], which is growing rapidly. A research network diagram was created by consolidating the information described above (Fig. 4). Organizations in the same country are placed together and shown as a node. The size of each node shows the number of papers written by authors from the country. Each link between two nodes of different countries indicates that there is a co-authorships between countries. The Breadth of lines connecting the countries is proportional to the number of co-authorship. In a geopolitical sense, it is clear that the US is a powerful hub of the network. This is completely different from the network structure of renewable energy in which there is a well-balanced structure between North America, Europe and Asia [25]. In particular, there are thick lines between the US and countries such as Canada (1,319 links), England (1,319 links), Australia (506 links), Germany (475 links), China (414 links), Netherlands (325 links) and France (331 links). Among the relationships that do not involve the US as a hub, the thickness of lines between England and countries such as Germany (294 links), Australia (291 links) and Netherlands (281 links) is notable, illustrating that England is another major hub behind the US.

TABLE2. THE TOP 30 COUNTRIES IN THE RESEARCH COMPETENCY

Country	Number_of_Papers
USA	7649
ENGLAND*	2572
GERMANY*	1466
FRANCE*	1116
AUSTRALIA	965
CANADA	923
ITALY*	788
SPAIN*	625
JAPAN	598
PEOPLES R CHINA	469
NETHERLANDS*	453
INDIA	425
SOUTH KOREA	339
SWITZERLAND	339
BRAZIL	319
SCOTLAND*	304
SWEDEN*	295
TAIWAN	287
FINLAND*	232
GREECE*	200
SOUTH AFRICA	192
NEW ZEALAND	180
NORWAY	180
AUSTRIA*	179
ISRAEL	177
MEXICO	177
BELGIUM*	169
RUSSIA	151
DENMARK*	150
IRELAND*	145
* Total of EU in the top30	8694

TABLE3.THE TOP 30 ORGANIZATIONS IN THE RESEARCH COMPETENCY

Organization	Country	Number of Papers
HARVARD UNIV	USA	544
UNIV CALIF LOS ANGELES	USA	487
UNIV TEXAS	USA	453
UNIV MANCHESTER	ENGLAND	449
UNIV TORONTO	CANADA	448
UNIV MICHIGAN	USA	393
UNIV MARYLAND	USA	392
UNIV N CAROLINA	USA	390
UNIV ILLINOIS	USA	374
UNIV MINNESOTA	USA	371
JOHNS HOPKINS UNIV	USA	344
UNIV PENN	USA	344
UNIV WISCONSIN	USA	319
YALE UNIV	USA	315
UNIV PITTSBURGH	USA	309
COLUMBIA UNIV	USA	304
UNIV COLORADO	USA	289
UNIV CALIF SANFRANCISCO	USA	287
UNIV CALIF BERKELEY	USA	277
UNIV SYDNEY	AUSTRALIA	275
STANFORD UNIV	USA	274
UNIV MELBOURNE	AUSTRALIA	271
DUKE UNIV	USA	262
UNIV SO CALIF	USA	252
UNIV NEW S WALES	AUSTRALIA	243
MONASH UNIV	AUSTRALIA	242
OHIO STATE UNIV	USA	242
UCL	ENGLAND	230
UNIV QUEENSLAND	AUSTRALIA	228
INDIANA UNIV	USA	223

TABLE4. THE TOP 30 PAIRS OF CO-AUTHORED ORGANIZATIONS

Organization1	Country1	Number of Co-authored	Organization2	Country2
BRIGHAM & WOMENS HOSP	USA	59	HARVARD UNIV	USA
UNIV CALIF LOS ANGELES	USA	56	RAND CORP	USA
HARVARD UNIV	USA	47	MASSACHUSETTS GEN HOSP	USA
MONASH UNIV	AUSTRALIA	34	UNIV MELBOURNE	AUSTRALIA
UNIV NEW S WALES	AUSTRALIA	33	UNIV SYDNEY	AUSTRALIA
GRP HLTH COOPERAT PUGET SOUND	USA	33	UNIV WASHINGTON	USA
UNIV CALIF SAN FRANCISCO	USA	32	UNIV CALIF LOS ANGELES	USA
UNIV TORONTO	CANADA	29	ST MICHAELS HOSP	CANADA
UNIV SO CALIF	USA	27	UNIV CALIF LOS ANGELES	USA
UNIV N CAROLINA	USA	27	DUKE UNIV	USA
UNIV TORONTO	CANADA	26	INST CLIN EVALUAT SCI	CANADA
BOSTON UNIV	USA	25	HARVARD UNIV	USA
UNIV WASHINGTON	USA	24	UNIV CALIF LOS ANGELES	USA
MCGILL UNIV	CANADA	24	UNIV MONTREAL	CANADA
USDA	USA	23	USDA ARS	USA
YALE NEW HAVEN MED CTR	USA	23	YALE UNIV	USA
HOSP SICK CHILDREN	CANADA	22	UNIV TORONTO	CANADA
HARVARD UNIV	USA	21	CHILDRENS HOSP	USA
VA PUGET SOUND HLTH CARE SYST	USA	21	UNIV WASHINGTON	USA
MCMASTER UNIV	CANADA	20	UNIV TORONTO	CANADA
UNIV CALIF LOS ANGELES	USA	20	HARVARD UNIV	USA
CASE WESTERN RESERVE UNIV	USA	19	UNIV HOSP CLEVELAND	USA
UNIV CONNECTICUT	USA	19	YALE UNIV	USA
JOHNS HOPKINS UNIV	USA	19	UNIV MARYLAND	USA
YALE UNIV	USA	18	VA CONNECTICUT HEALTHCARE SYST	USA
ROYAL PRINCE ALFRED HOSP	AUSTRALIA	18	UNIV SYDNEY	AUSTRALIA
BETH ISRAEL DEACONESS MED CTR	USA	18	HARVARD UNIV	USA
NEW YORK STATE PSYCHIAT INST & HOSP	USA	18	COLUMBIA UNIV	USA
UNIV LIVERPOOL	ENGLAND	18	UNIV MANCHESTER	ENGLAND
UNIV TORONTO	CANADA	17	UNIV HLTH NETWORK	CANADA

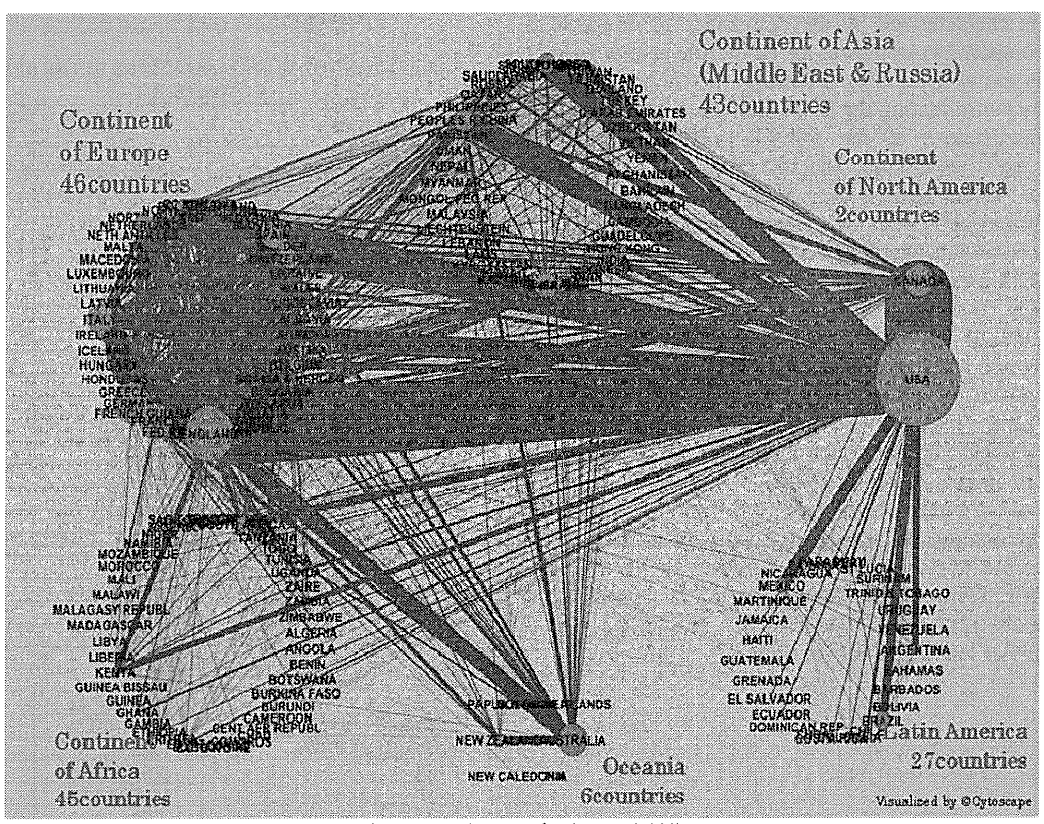

Fig4. Research Network Diagram (2009)

IV. DISCUSSION

As described above, we performed citation network analysis on SSME research domain. Our basic idea was papers dealing with a similar topic cite each other and are strongly connected, and papers dealing with different topics are weakly connected. Therefore, the division of a knowledge domain into strongly connected clusters by citation analysis can detect what kinds of topics are discussed in the SSME research domain. In the result, we could find there were mainly eight clusters. Moreover, this SSME research domain is so interdisciplinary that each of eight is not so strongly related to others.

The eight major clusters we extracted can be divided into two groups; basic research (#1 management, #4 ecosystem, and #5 QOS) and application for society (#2 medical care, #3 mental health care, #6 public service, #7 public medical care and #8 IT & Web). It is worth to be pointed out that SSME tends to deal the topics of public social systems, such as #2 medical care, #3 mental health care, #6 public service, and #7 public medical care, in terms of service innovations. This point is different from the definition by Spohrer et al[4]. As long as we discussed with the experts, there might be two reasons. The first one is that the lack of popularity of the concept SSME. Especially in the research fields which have clear boundary and have been already industrialized, the researcher might not mention about SSME even if they wrote about service innovations in their field. The second reason is the increasing attention toward public systems. The number of researches relating to public service, such as #6, has increased recently (as shown in Fig. 5(b) described in the next paragraph).

The detailed analysis of each cluster can reveal which clusters are emerging ones. Regarding to the average publication year shown in Table 1, #1, #4 and #8 seemed to contain a lot of recent studies. Fig. 4 indicates the number of annual publications in each cluster. In this figure, clusters #1, #2, #4, #6 and #8 are still so growing that they can be emerging research fronts, while #3 and #5 seems to peak around 2000 and to be mature at the end of 2008. Many previous studies identify that IT and web such as computer science, software engineering and grid computing are the base and driving force of service innovation [4, 26, 27]. OECD innovation strategy [28] points out that there is considerable scope to innovate in the delivery of public service. Our findings are consistent with these studies.

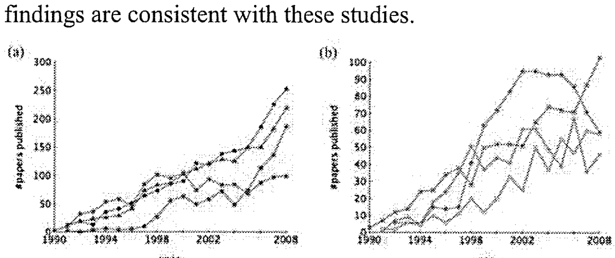

Figure 5. The annual number of publications in each cluster in 2008; (a)●: #1, ▲: #2, ■: #3, ★:#4 and (b)◆:#5, ×:#6, +: #7, O:#8.

With this method, we can extract the research topics in interdisciplinary research area such as service innovation by computational calculation. Currently, some research activities tend to research common concepts, crossing the boundaries of existing research areas or journals. However, we face increasing difficulty to create an academic landscape of these diverse research domains. Our topological approach can become a tool for future "Research on Research" (R on R) and can meet a commensurate increasing need as scientific and technical intelligence to discover emerging research fronts in an era of information flooding.

The research network diagram shows the knowledge distribution and collaborative relationships in the field of SSME objectively. In terms of the structure of co-authorship, there are more co-authorship relations between organizations in the same country or a close spatial proximity. This corresponds with other previous studies identifying the relationship between co-authorship of organizations and spatial proximity, culture, and language [18,19,20,29,30]. Furthermore, there are more co-authorship relations between organizations with high research competency. The motivation for this may include some of what Bozeman and Corley points out: access to expertise and equipment, to obtain prestige or visibility, to gain tacit knowledge, and to enhance productivity [31]. Modern technology is increasingly complex and demands an ever-widening range of knowledge and skills. Often, no single country or institution will possess all the knowledge and skills required. Previous studies have shown that a high level of collaboration is correlated with high paper productivity [18,32,33]. The number of international collaborations is small in the field of SSME. This fact indicates that it is possible to significantly enhance the efficiency of global service innovation by adopting a policy to promote collaboration. The need for service innovations to fuel economic growth and to raise the quality and productivity levels of services has never been greater [6]. In addition, SSME is a technology that could play a major role in finding solutions to global challenges such as an ageing society and sustainability of the Earth. Framework Programmes of Europe had played a major role in promoting collaborative researches in the field of solar cells in and out of Europe. We hope that a similar framework to promote researches by international cooperation is created based on the methodology discussed in this paper.

V. CONCLUSION

It is widely recognized that the concept of service innovation is significant for innovation strategy and economic growth. However, since the term "service innovation" represents a broad sense, there is not the common understanding about what is service innovation even among experts. We developed a methodology to determine the structure and geographical distribution of knowledge, as well as to determine the structure of research collaboration in such an interdisciplinary area as service innovation by performing journal information analysis, network analysis and visualization. Our results showed that there were mainly two groups of elements relating to service innovation: applications of service innovation such as health and medical care, IT and web, and public service; and basic theories for service innovation such as management, ecosystem, and QOS. Knowledge in these areas has been growing rapidly in recent years. In particular, the fields of ecosystem and IT and Web are exhibiting a high growth. We also demonstrated that the global network of knowledge is formed around the powerful hub of the US. On the other hand, in research collaboration, we demonstrated that most research is conducted within same country or a close spatial proximity and, therefore, there is big room left for enhancing international collaborations. These MAPs and diagrams could be useful in forming policies to promote service innovation. We proposed creation of an international collaboration programme to solve global challenges such as an ageing society and sustainability of the Earth.

In this study, the term "SSME" was used in developing queries. It cannot be denied that the definition of the term affects analysis. Determining a better query setting suitable in the interdisciplinary area is another subject to be studied in the future.

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Meeting Report

The 6th Asia Cancer Forum: What Should We Do to Place Cancer on the Global Health Agenda? Sharing Information Leads to Human Security

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This forum discussed issues relating to the inclusion of cancer on the global health agenda, with the ultimate aim of achieving human security for all people. The forum discussed what methods are available to the cancer community in attempts to create a common data system for the rapidly growing Asian region. Discussions also focused on the preparations that can be made to consider and respond to the obstacles to the creation of an Asia-wide data and information network. It was also noted that in order to create a cancer information network, support would need to be provided to low- and middle-income countries and efforts made to ensure that data are comparable.

Key words: cancer information network – MDGs – human security – data comparability

OVERVIEW

The Asia Cancer Forum is a grouping that aims to discuss cancer science and policy issues among Asian countries. The basic concept of the forum is that discussion will enhance sharing and awareness of the issues and each of the participants will gain their own take-home message to apply to their own activities as the outcomes of the forum. The forum is operated through the research funds of the participating members and receives support in the form of Health and Labour Sciences Research Grants from the Ministry of Health, Labour and Welfare of Japan, as part of the Third Term Comprehensive Control Research for Cancer or its ongoing work to create an Asian network. The organizer of the forum is N.K. and it is chaired by H.A., both of the Research Center for Advanced Science and Technology (RCAST), the University of Tokyo.

The origins of the Asia Cancer Forum date back to 2004 when a group of Asian researchers launched a platform called the Asia High Technology Network to discuss issues in the field of medicine. The grouping engaged in discussions on the formation of an Asia Cancer Information Network. From 2008, the name of the research platform was changed to the Asia Cancer Forum and the first two meetings were held thereafter. The third meeting was held in February 2009, on the theme of 'Health, Information and Development'. The third meeting was held jointly with SciDev.Net and saw discussion focus closely on issues relating to the setting of the global health agenda. The fourth meeting was held in April 2009 under the theme of

'Asian Challenges in Shifting the Disease Burdens'. In November 2009, the fifth meeting was held in collaboration with the 20th Asia Pacific Cancer Conference (APCC) under the theme of 'What Should We Do to Raise Awareness on the Issue of Cancer in the Global Health Agenda?' The meetings to date have concentrated on ways to share information among Asian research colleagues, thus raising awareness of the importance of including cancer on the global health agenda.

The Sixth Asia Cancer Forum was held in conjunction with the World Cancer Congress UICC 2010, on 21 August 2010, in Shenzhen, People's Republic of China. The meeting consisted of two sessions consisting of six special presentations, followed by detailed discussions. Approximately 60 people were present and active discussions took place. The forum was organized by H.A. and N.K. (RCAST, the University of Tokyo). Invited speakers included H.S. (Hamamatsu University School of Medicine), A.N. (Chiba Cancer Center), T.M. (National Institute of Biomedical Innovation) and J.M. (Osaka University). Also in attendance were Joe Harford [National Cancer Institute (NCI)], Julia Schneider (NCI), X.H. (Chinese Anti-Cancer Association, President of World Cancer Congress UICC 2010), Andreas Ullrich (World Health Organization), David Hill (UICC) and I.A.W. (Asian and Pacific Federation of Organization for Cancer Research and Control).

INTRODUCTION TO THE ASIA CANCER FORUM

N.K. (RCAST) gave an introduction to the ongoing activities and initiatives of the Asia Cancer Forum. She noted that the incidence of infectious diseases in developing countries and the delay in formulating measures to respond to these diseases are recognized as issues requiring the attention of industrialized nations. Accordingly, infectious diseases are given due recognition on the global health agenda. However, cancer has still to gain the recognition it rightly deserves in the world of global health. This is due to the fact that it is generally viewed as a disease specific to individuals in industrialized nations, which occurs as a result of the individual's approach to personal health management.

Last year, the Fifth Asia Cancer Forum discussed issues relating to cancer and concluded that the highest priority should be for expert groups to share a common recognition of the necessity for cancer to be raised on the global health agenda. In the international community, there has also been increasing recognition of the necessity to 'begin discussion on placing cancer on the global health agenda', as evidenced by the Resolution of the United Nations on 13 May 2010 to hold a United Nations General Assembly Summit on Non-Communicable Diseases (NCDs).

However, the results of a survey implemented by the Asia Cancer Forum in April 2010, on the occasion of the 101st Annual Meeting of the American Association for Cancer Research (AACR), entitled 'Survey on Inclusion of Cancer in the Global Health Agenda', showed that interest in this issue is not particularly high among a great majority of specialists. Discussion on the inclusion of cancer on the global health agenda does not stop merely at the advocacy of humanitarian principles. In fact, what is needed now is a move away from the linear debate such as that which has dominated discussions of aid to developing nations in the past, and a move toward more complex projections. Therefore, it is necessary to gain the broad participation of cancer researchers in working to decipher the current challenges faced by industrialized nations, which could then be utilized in assistance to developing nations. In other words, it is necessary to establish a framework for resolving issues that face industrialized nations.

The world is now in an era in which developments in health innovation have a significant impact on the direction for global health.

In the initial stages of the genome-wide association study, it was thought that genetic differences by race increased the predisposition to the occurrence of a particular disease. However, as research has advanced, it has shown that although there are some statistics differences among races according to the genetic background, the genetic factors predisposing a person to the occurrence of disease are clearly shared by all humankind. In other words, any careful observations made in one specific region of the world are relevant to other regions.

Owing to the tremendous improvements in genome analysis capabilities, it is now possible to analyze genetic information to an incredibly detailed level. Furthermore, information technology (IT) has enabled quantitative tracking of the vast amounts of medical-related data that are created in the modern world. By continuously and automatically collecting and gathering information from various sources, including clinical data and medical records, and using this information to realize the creation of a system that would produce the required evidence for the purpose of providing each patient with the most appropriate and latest medical treatment, research could be used in a synergetic partnership with treatment. Through such technological breakthroughs, it would be possible to search out information relating to the culturally diverse acquired lifestyle customs that exist in Asia, even in persons of similar race, and work to reduce risk factors and even help to prevent further epidemics. It is for this reason that rather than basing research on persons of ethnicities removed from Asia, careful study of the fine differences that exist among the races and nationalities of the Asian region would result in a closer understanding of the nature of diseases in humanity as a whole.

Infectious diseases are characterized by their tendency to infect many people, while the variation in the disease itself is not so great. However, non-communicable diseases, and cancer in particular, have the characteristic of presenting differently from person to person. In other words, it can be seen that 'to understand cancer it is important to look at the