Networking-based Personalized Research Environment : NePRE

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***Abstract*—With advancement in information technologies and a better mobile environment, the paradigm of service is shifting again from web portals to individual applications based on any network. On the other hand, as more investment is being made in R&D, the efforts to enhance R&D productivity are becoming important. This study proposes a service model of Networking-based Personalized Research Environment (NePRE) for developing the tool to assist researchers in their R&D efforts. It can be easily utilized by researchers in their R&D information activities. To do this, we compare services and tools in terms of information activities in R&D. And we also analyze changes of information environment in terms of personalization. Subsequently, we design a service model of NePRE. Finally, we define its key functions to assist researchers with respect to their six information activities in R&D life-cycle.**

Keywords-research support; persoanlization; R&D life-cycle.

I. INTRODUCTION

With advancement in information technologies and a better mobile environment, the paradigm of service is shifting again from web portals to individual applications based on any network. On the other hand, as more investment is being made in R&D, efforts to enhance R&D productivity of researchers are becoming more important. Light-weight applications are already being developed and disseminated to assist researchers in their R&D efforts. Unfortunately, however, the utilized data are limited to overseas database with a weak linkage to domestic academic information resources. Furthermore, it is not still easy to perform information-aid R&D since users have to access each service individually. In addition, recent changes to information environment makes personalized service more important for convenient information usage by researchers.

This study proposes a service model of networking-based personalized research environment for developing the tool to assist researchers in their R&D efforts. It can be easily and conveniently utilized by researchers in their R&D information activities.

This paper is organized as follows. In Section 2, we describe existing science and technology information services, and discuss changes in information environment. Section 3 introduces our design of a networking-based personalized research environment. Subsequently in Section 4, we define six key informative functions to assist researchers in R&D. Finally in Section 5, we discuss conclusions and future works.

II. RELATED WORKS

A. Existing Science and Technology Information Services

Services and tools were already developed and being made good use of assisting researcher's R&D activities. They provide useful information ranging from papers, patents or other academic information to that on projects or researchers. Furthermore, they also offer research support features through bibliographic information management. Representative services and tools are as follows.

- SciVal Suite [1]: This provides a critical information about performance and expertise to help enable informed decision-making and drive successful outcomes. It is composed of SciVal Spotlight, SciVal Strata, and SciVal Experts. It helps decision makers responsible for research management to assess institutional strengths and demonstrable competencies within a global, scientific landscape of disciplines and competitor. And it helps decision makers to identify researcher expertise and enable collaboration within the organization and across institutions. And it also helps them to measure individual or team performance across a flexible spectrum of benchmarks and measures.
- Mendeley [2]: This is a reference manager and academic social network. It makes your own fully-searchable library in seconds, cite as you write, and read and annotate your PDFs on any device. It manages bibliographic information, and helps researchers generate references when they write them in a paper. In addition, it helps finding collaborative researchers of the world, and supports composing community with them.
- RefWorks [3]: This is an online research management, writing and collaboration tool. It is designed to help researchers easily gather, manage, store and share all types of information, as well as

 ISBN: 978-1-61208-438-1

generate citations and bibliographies. If researchers need to manage information for any reason whether it is for writing, research or collaboration, RefWorks is the good tool.

- National Digital Science Library (NDSL) [4]: This is an integrated science and technology information service including paper, patent, and research reports by KISTI of Korea. It provides the specialized search service and integrated search to 0.1 billion of contents. It promotes efficient access to quality science and technology information based on cooperation networks.
- National Science and Technology Information Service (NTIS) [5]: This has been built as a national R&D knowledge portal for providing information regarding national R&D projects in connection with each ministry and institution. In NTIS, standard metadata are connected and managed by systematically, which needs joint use thereof in the cross-ministerial level, for example, avoiding redundant similar projects in advance. Each ministry builds a system which supports real project management for the process from receiving R&D projects to outcome management, connects and just provides standard information to the NTIS.
- Research Information Center (RIC) [6]: This is a virtual research environment being jointly developed by the Technical Computing Group at Microsoft and The British Library. The purpose of the RIC is to support researchers in managing the increasingly complex range of tasks involved in carrying out research. Specifically, to provide structure to the research process, easy access to resources, guidance and tools to manage information assets, along with integrated collaboration services.
- ResearchGate [7]: This allows researchers around the world to collaborate more easily. It discovers scientific knowledge, and makes your research visible. For a common purpose of advancing scientific research, it links researchers from around the world. It is changing how scientists share and advance research in digital age.

Nevertheless, overseas bibliographic management tools lack linkages and utilization of diverse academic information resources, while domestic information services still remain at information search for R&D activities and don't have sufficient means for sharing individual information resources.

B. Changes in Information Environment

Recent information environment can be considered in terms of service personalization as follows.

- Open expansion of information and data: the demand for publicly available information and data is increasing due to government's 3.0 and activation policies of creative economy in Korea. Furthermore, there are more projects for publishing and sharing public data. In addition, there are an increasing number of data standardization as Linked Open Data (LOD) and LOD construction.
- Enhancement of personal information protection: people are more aware of protecting personal information and leakages of personal information in terms of the society and technology. Therefore, regulations and institutions are improved for enhancing personal information protection, and people involved therein have studied how to further enhance the technology. In particular, as the Personal Information Protection Act is enforced since 2011, collecting, using, providing, processing and managing personal information is strictly regulated to minimize personal information leakage. In addition, because increasing open and shared data contribute to combining and integrating the data to form information to identify personal identity, more efforts are required to protect personal information.
- Popularization of social networking service: a popular trend is currently to make a connection between online users about common subjects to share and use information and knowledge. Various social networking services and platforms, for example, facebook, youtube, twitter, Kakaotalk, LinkedIn, and ResearchGate are now used. The outlook is that they are connected with web portals or mobile services to further enhance social networking services.
- Very big contents: big data and IoT (Internet of Things) technology is developing fast, and services using them are appearing. Data are now more abundant and diversified than before, and non-literature data as well as literature-centered data will be more importantly handled.
- Advances in web platform technology: as web technology develops, services in various formats have been developed and distributed, for example, mobile apps and web apps. In particular, web-based application S/W based on web standard HTML 5 is even more valued, that can be installed and used in all devices from smartphones to smart TVs where web browsers operate.

Table 1 summarizes implications and direction toward good services when we look into changes of information environment in terms of service's personalization. That is, linking opened and standardized data is more important than directly constructing many contents. Also personal services should depend on personal participation rather than collecting personal information. For contents curation from very big contents, social networking is becoming more important in order to utilize group intelligence. Since web applications are based on the web, they can be operated just by web browsers. That is, web applications can be easier than web portals for personal usage on any device.

 ISBN: 978-1-61208-438-1

TABLE 1. CHANGES OF INFORMATION ENVIRONMENT

Division	Implication	As-Is→To-Be
Open expansion of information and data	.useful contents are more plentiful and various .link and usage of open contents are possible .link is possible by standardized methods(API, LOD)	Construction →Link
Enhancement of personal information	.collection of personal information from web become difficult . construction of personal profile information in web is difficult	Usage of personal information→ Personal partiipation
Popularization of social networking service	.information link is possible and important .share of information is important .easy collaboration .participation of community is important	Personal intelligence → Group intelligence
Very big contents	.curation is important .topic-based information link and statistical analysis are important .variety and instantaneity of useful contents	Search → Analysis
Advances in web platform technology	.services independent from devices and web browsers is important . resources usage of cloud environment is important	Web portal → Web application

With open expansion of information and data, enhancement of personal information is a challenging status to the personalization of services. Fortunately, social networking services were already popular over the world, and they were enhanced to communicate and to collaborate each other on any subject. Therefore, social networking can be used to realize personalization of a service.

III. DESIGN OF A NETWORKING-BASED PERSONALIZED RESEARCH ENVIRONMENT

We first established three views of personalized research environment. First of all, in the function view, functions are defined through how information is used to retrieve, collect, analyze, collaborate, store and writhe outcomes - in the R&D process [8][9][10] from the step of ideas & planning to the step of outcomes. The functions can be summarized as in Table 2.

Next, the contents view defines what information can be utilized concerning service functions required in a relevant R&D process. In order to satisfy the requests listed on Table 2, it is essential to share and use information resources held by individual researchers in addition to domestic and overseas scientific technology information. Individual knowledge tools should allow users to utilize various information resources - involving domestic and overseas information resources and individually held one.

TABLE 2. FUNCTION VIEW OF SERVICE

Activities	R&D Activities	Function requirements
Search	.Identification of research trends, core patents .identification of research-related topic and concept .discovery of research topic .store of academic search results	.Categorization and management of searched results .Expert recommendation .recommendation of research topic .categorization and management of academic search results
Collect	.Collection of bibligraphy and its original literature	.Auto-management of bibliographic information .recommendation of materials related to concerning topic .articles viewing based on bibliometric information
Analyze	.analysis of technology ripple effect .Statistical analysis .analysis of citation relation among technology groups	.Technology trend, topic analysis .Data statistics .provision of relation map
Collaborate	.Researcher network analysis .Management of personal R&D profile	.data share with collaborative researchers .construction and collaboration of community .writing memos in document and sharing them
Store	.store of academic information resources	. categorization and management of academic information resources
Publish	.Organization of research results .writing papers	.Support writing document based on template

Table 3 summarizes the contents that NePRE manages and uses for supporting researchers.

TABLE 3. CONTENTS VIEW OF SERVICE

Division	Description
External resources	paper, research report, patent, fact information, R&D project information, standard, trend/analysis information, bibliographic information, organization information
Internal resources	paper, research report, patent, memos, images, personal profile, web resources

Finally, the operation view defines how to link and take advantage of information resources in individual knowledge tools. Table 4 shows the operation view. It defines data

 ISBN: 978-1-61208-438-1

categorization and relationships based on bibliographic information such as patent and research reports. The tools are designed in a structure to offer information assisting R&D activities and at the same time to get feedbacks of and save information resources created in that process.

TABLE 4. OPERATION VIEW OF SERVICE

Division	Description
Platform-based	Link overseas and domestic S&T information resources by using KISTI science and technology knowledge platform as hub
Biobliometric-based	Categorize, store, search by using bibliographic information Such as paper, patent, research report
Bi-directional link	Provide, store, and manage bidirectional information between tool and researchers

IV. SIX KEY FUNTIONS IN NEPRE

In this paper, we present conceptual model and design principles on a personal research environment that can be easily used with installation on various device environment of each individual researcher in Figure 2. Researchers perform various R&D information activities that are ‘search’, ‘collect’, ‘analyze’, ‘collaborate’, ‘store’, ‘publish’ in R&D process.

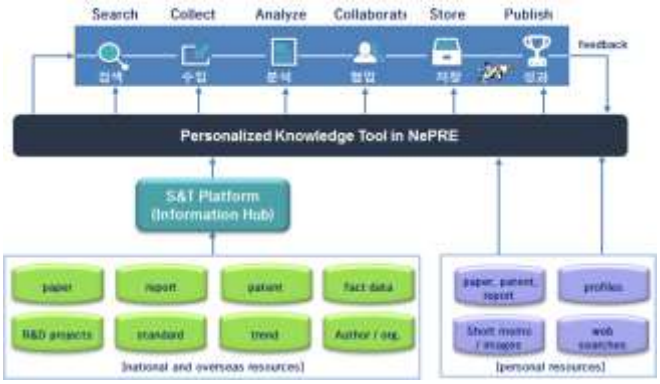

Figure 1. Conceptual model of personalized research environment

Both opened S&T information resources and researchers’ personal resources can be converged and used. That is, it is essential to integrate and use individual researcher’s information resources as well as Korea’s and overseas science and technology information resources in order to facilitate various information activities carried out in R&D by researchers. The aforementioned personal knowledge tool must be able to be installed and operated in various types of device environment preferred by each researcher [11]. In addition, they must be connected in a standardized manner to use national and overseas information resources.

The NePRE provides a collection of functions to support the R&D life-cycle of researchers as follows.

- **Search**. The NePRE provides researchers with a easy access to better resources based on statistical analysis of citation. For example, the resources having many references from other resources are selected preferentially, or the resources strongly referenced by similar researchers are selected. The search operation executes contents curation over simple search via participation of other researchers. The contents curation finds high quality of resources that can be more reliable using similar researchers’ experience while simple search just finds the resources closely matched to input keyword.
- **Collect**. A number of information resources have been already identified due to national and international policy of data open. The NePRE provides means to gain access to and leverage content. The user can automatically receive updates from specific resources sites, using e-mail and RSS feeds. Good articles can be recommended or identified by some researchers involved to similar topics. This suggests that open and shared resources are managed centered on individual user. The NePRE provides a link to the content supplier’s site for share. The underlying content sources are defined as the Korea Institute of Science and Technology Information, academic community, publishers, or third party. All users would have subscriptions to all commercial resources likely to be available.
- **Analyze**. The NePRE provides an insight about technologic trends, competition relationship, and promising technologies. The NePRE supports analysis of technology’s ripple effect, researcher network, convergence relationships between technology groups. And the NePRE helps us finding research topics, identify key patents, and understand status of technology development based on technology keywords. In addition the NePRE provides opinions of feasibility or necessity of any research.
- **Collaborate**. The NePRE is designed to make it easy to identify potential collaborators, create community, and share the results of other researcher like other tools [7][12]. Both national and international information resources are outlined and summarized via the participation of other researchers. The NePRE encourages researchers to work together to develop and populate their research results like RIC and ResearchGate. For collaborative research, community participation and enhancements are very important. Therefore, the NePRE provides means to encourage communities such as following researchers, following research, categorization for community customized services, sharing calendars per community, and personalization via a following function like SNS.
- **Store**. The NePRE offers an enhanced function to allow the researcher to save searches on cloud environment for seamless usage from any device.

 ISBN: 978-1-61208-438-1

The NePRE supports clipping or scrapping searched results. The cloud storage stores metadata associated with the documents, together with links to the full-text where permitted. When the resources are stored on a cloud environment, they are automatically related other resources each other and identified to be unique. The user can also easily access to all resources across various kinds of devices. Each user accesses to individual storage on cloud environment via an online account. Manage information resources. In addition, each user accesses to the resources of third party or local databases. It categorizes resources according to personal criteria.

- **Publish**. The NePREl supports publication life-cycle, from literature search and retrieval, papers annotation, and bibliography management to self – archiving like RIC [6]. The NePRE supports making template-based document such as papers, patents, and research reports. The NePRE supports automatically managing and listing up references, and helps researchers finding sources of resources. The NePRE supports writing short memos within documents and it helps share them with colleagues or in community.

V. CONCLUSION AND FUTURE WORK

This study suggests a service model of networking-based personalized research environment for developing personal knowledge tools researchers can use easily in their R&D. To do this, we first compared services and tools in terms of information activities in R&D. And we also analyzed changes of information environment in terms of personalization. In the suggested model, functions required for each information use type in R&D are defined. Contents concerned are extended and defined to integrate and use individual researchers' information resources as well as national and overseas science and technology information resources. The connection focusing on personal tools, not web portal-centered connection, is employed, and the method of operation is defined to facilitate connection and integration of information by using bibliography information of various information resources. Finally, we presented the outlook of six key informative functions of NePRE in R&D life-cycle.

In the future, we will compare NePRE to other tools through case study. In addition, future studies will focus on establishing a method of efficient connection and use of science and technology information resources by means of personal knowledge tools. It is necessary to study how to facilitate efficient classification and storage of individual researchers' information resources, and integration with connected data. It is necessary to study how to design light-weight personal knowledge tools.

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