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A System for Paper Registration to Institutional Repositories

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Abstract. An institutional repository is a system for archiving digital research outputs such as scholarly papers. While using this system is a simple way to return the benefits of academic research to society, the number of papers currently archived in institutional repositories across the world is insufficient. We have, therefore, developed a system that can increase the number of papers archived in institutional repositories. The main aim of this system is to reduce the workload of researchers and librarians in paper registration for an institutional repository by using external databases. As a result of our trial implementation and evaluation of the system, we found that its application resulted in a four-fold increase in the number of papers registered in a month, but did not decrease the working efficiency of the participating librarians. Moreover, by analyzing log data for the system's implementation, we have acquired further knowledge related to researchers who need librarians' support in paper registration for an institutional repository.
Keywords: information management, data mining, system development, institutional repository, university library.

1 Introduction

The benefits of academic research should be returned to the society. A simple way to do this is to make available research outputs such as scholarly papers on the Internet. A Web system for archiving such research outputs in an institute is called its *institutional repository* (*IR*). IR should be widely prepared as a way to access academic information. As of March 2017, more than 4,400 institutes have their own IRs [5], including 527 in Japan [4]. However, far fewer papers have been archived in the IRs than have actually been published. Björk et al. [20] estimated that approximately 20% of the scholarly papers published in 2008 would be freely available from the Internet and only approximately 3% be available from IRs.

The aim of our study is to increase the number of scholarly papers available from IRs. Our approach to the aim is improving systems related to IRs to reduce the workload for registering papers to the IRs. We formalized two kinds of workloads: that of researchers and that of staff for an IR. The staff consists of librarians or other people who work at the library in most institutes, and we call

them *IR managers* in this paper. Additionally, we focus on journal articles and conference papers, because IRs contain very few of these papers. For example, their shares are respectively 14.6% and 1.8% of the total contents in all IRs in Japan as of March 2017 [3]. In the rest of this paper, the word *papers* refers to journal articles and conference papers.

Our approach, improving IR-related systems to reduce the workload for paper registration, is currently a realistic approach. Existing approaches to increase papers in IRs have difficulties in the following points. A simple approach is to mandate researchers (authors) to register their papers to IRs. Actually, a number of institutions mandate (on some conditions) researchers to register their papers to their IRs [6]. The related policies [1] of the National Institutes of Health (NIH) had a great deal of effects on the researchers and publishers concerned. However, not every institution can apply this solution immediately for every kind of research: this mandate should be adopted with adequate consideration given to every stakeholder. Another possible approach is to improve IR-related systems to make clear the merits of registering papers to IRs for researchers. A merit for researchers is that downloads of a paper from an IR may lead to it being cited in other papers. A correlation between the numbers of the downloads and the citations of a paper has been reported for some IRs [21, 25]. Another merit for researchers is that information on users' interest may be obtained from access log for their papers archived in an IR. For both merits, however, the IR needs sufficient papers for a meaningful correlation or an access tendency to be found.

We developed a system which assists researchers and IR managers in registering papers to an IR. The system consists of two subsystems. The first subsystem searches external databases of scholarly papers, such as Scopus [7] and Web of Science [11], for published papers written by researchers in the institute. Then, the researchers avoid having to input the metadata, which includes elements such as title, author, and publisher, of their papers by reusing those from the external databases. There exist some studies based on the same idea to reduce the workload of researchers by reusing the metadata that have already been registered for other purposes. Some universities have developed their unified system of IR and researcher database [23, 24]. In Kyushu University, the IR was connected to the researcher database by hyperlinks on the lists of research activities [16], and the data submitted for both systems can be reused [15, 14, 17, 18]. The second subsystem also utilizes external databases of the copyright policies of publishers, such as SCPJ [8] and SHERPA/RoMEO [9]. In the subsystem, the copyright policies of the publishers are confirmed automatically by searching external databases. Symplectic Elements [10], a commercial tool for managing scholarly information, has a function based on the same idea. The subsystems were developed separately, and their details have been reported by Baba et al. [12] and Sakaguchi et al. [26], respectively.

We also conducted a trial implementation of the developed system in Kyushu University from November 2012 to March 2013, and investigated the transitions of the number of the papers registered to the IR and the time spent for the

registration by the IR managers. As a result, we found that the number of paper registrations to the IR increased by approximately four times, and the working efficiency of the IR managers (that is, the number per a unit time per a single IR manager) did not decrease even though the amount of work increased. Additionally, we conducted some analyses on the log data of the trial implementation to find hints for improving the system. Both the ratio of the responses to the requests sent from the system and the time from the request to each response were used for classifications of the authors of the papers. The results of the analyses indicate the kinds of the researchers whom IR managers should mainly support. The main part of the analyses was conducted previously by Baba et al. [13].

The rest of this paper is constructed as follows. Section 2 describes the developed system and the trial implementation for evaluating the system. Section 3 shows the results of the evaluation and the analyses of the responses obtained in the implementation. In Section 4, we discuss some findings in the results and future directions of our study.

2 Methods

We developed a system for paper registration to IR, and implemented the system for an IR to evaluate its effects.

2.1 The System

The system we developed aims to reduce the workload of registering papers to IR in order to increase the number of papers in IR. The system consist of two subsystems correspond to two approaches to the purpose.

Preparatory Investigation Prior to developing the system, we investigated the process of paper registration to IR, especially the management of information and status in the process operated by IR managers [26], and then found two approaches to reduce the workload. We distributed a questionnaire and received answers from 133 universities in Japan, and also conducted interview surveys at 20 universities. The results are formalized as the workflow in Fig. 1. The statuses and the transitions in them were defined in accordance with the results of the investigation. As a result, we found that most work of IR managers is categorized into confirmations of two kinds of copyright policies: one for the author and the other for the publisher. Managing the status of the confirmations for a large number of papers in parallel is hard work for IR managers.

On the basis of the results of the investigation, we developed a system to increase the number of paper registrations to IR. We made two approaches, one is requesting researchers to register their paper to IR, and the other is supporting IR managers to manage the status of the confirmations. Fig. 2 is the overview of the system. The system consists of two subsystems, the Paper Registration Request System and Copyright Policy Confirmation System, which correspond to the two approaches, respectively.

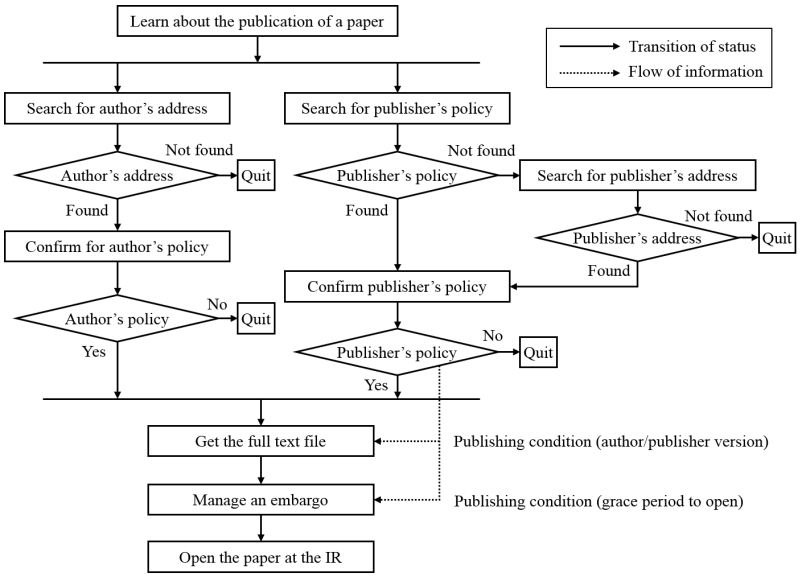

Fig. 1. Workflow of process for paper registration to IR.

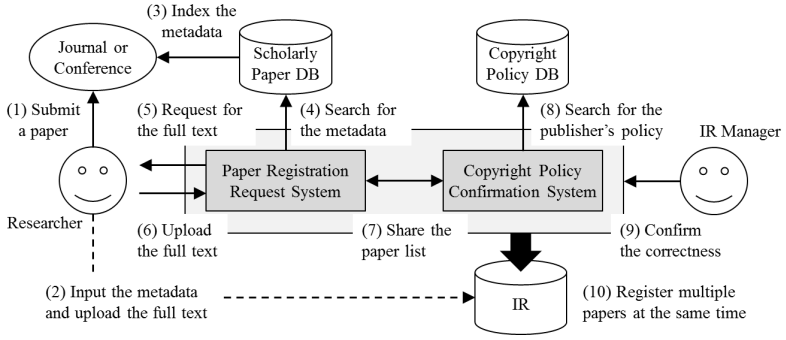

Fig. 2. Overview of the system for paper registration to IR (the colored part).

Paper Registration Request System One of the subsystems in the developed system, the Paper Registration Request System, requests researchers by using e-mail to register their papers to the IR [12]. In most research institutions, papers are registered to IRs at researchers' discretion. This subsystem reduces the workload of researchers for inputting the metadata in addition to that of IR managers for the confirmation of author's policy. The solution is obtained by using external databases of scholarly papers.

The idea of the subsystem is illustrated in the left part of Fig. 2. (1) "Researcher" submits his/her paper to "Journal or Conference." In the current situation, (2) "Researcher" has to input the metadata and upload the full text file of

the paper to "IR." The problem is that the number of papers in "IR" is smaller than that in "Journal or Conference." We focused on the fact that (3) there exist databases of scholarly papers that are indexing papers in "Journal or Conference," and some of them are widely used on the Internet and are producing APIs. (4) "Paper Registration Request System" searches on "Scholarly Paper DB" for the papers written by researchers in the institution concerned. (5) The subsystem requests "Researcher" to upload the full text files by using e-mail for a large number of papers at one time in accordance with the result of the search. The subsystem creates an upload site of the full text file for each paper, and the e-mail for a request contains the URI of the upload site for the paper. Then, (6) "Researcher" has only to upload the full text file without filling the metadata, and this registration is due to the copyright policy of the researcher.

Copyright Policy Confirmation System The other subsystem, the Copyright Policy Confirmation System, supports IR managers with confirmation of the policies of the publishers, such as "Archiving is allowed for both pre-print and post-print" and "Archiving is not allowed." The subsystem utilizes external databases of publisher's copyright policies for the confirmation, which is expected to improve the efficiency of managing the complex statuses related to the confirmation for a large number of papers. In the current situation, this confirmation is being operated with case-by-case improvements based on individual experiences of each IR manager.

The idea of the subsystem is illustrated in the right part of Fig. 2. (7) "Copyright Policy Confirmation System" shares a list of papers with "Paper Registration Request System." (8) For the papers in the list, the copyright policies of publishers are confirmed by searching "Copyright Policy DB" automatically. Currently, however, it is difficult to obtain the correct copyright policies for all publishers from such databases. In this case, (9) "IR Manager" has to inquire to the publishers to confirm the policy. In some cases, the publisher asks the period during which the paper is not allowed to be opened in an IR (a so-called "embargo"). "Copyright Policy Confirmation System" also helps "IR Manager" to manage the status of the registration processes for each paper such as "Confirm publisher's policy" in the workflow in Fig. 1. After these processes, (10) the final registration of papers to the IR is made.

2.2 Evaluation

We experimentally implemented the developed system proposed in Subsection 2.1 for an actual IR to evaluate the effects of the system. We also analyzed the responses to the implementation to extract useful information for improving the system.

A Trial Implementation We investigated the number of the papers registered into the IR in Kyushu University from January 2011 to March 2013 and the total man-hours for the paper registration process in the period. We implemented the

proposed system from November 2012 to March 2013. We used Scopus, SCPJ, and SHERPA/RoMEO as the external databases for the two types of policy confirmation. Before this implementation, all paper registration had been conducted by researchers at their discretion though the default interface of DSpace [19, 2] except for some direct entrustments from researchers to librarians.

The number of paper registrations and the relationship between the number and the time spent for the registration were used as the measures for evaluation with respect to the purposes of the two subsystems, respectively.

For the purpose of the first subsystem, we examined the following numbers:

- p_1: the number of the papers written by researchers of Kyushu University (the affiliation of at least one author is Kyushu University) and indexed by Scopus in 2010 and 2011,
- p_2: the number of the papers in the papers of p_1 such that the e-mail address of the contact author was found in the list of the official e-mail addresses of the professors in Kyushu University,
- r: the number of the request e-mails sent to researchers, that is, the number of the papers in the papers of p_2 that were allowed to be opened by the publisher and had not been archived in the IR, and
- u: the number of the full text files uploaded by the system.

Then, the *requesting ratio* is defined to be the ratio of r to p_1.

For the second subsystem, we additionally examined the time spent for the paper registration. Let N and T be the number of the registered papers and the total time spent for the registration process for each month, respectively. Then, the number of papers registered in an hour by a single IR manager is denoted by N/T.

Responses to Requests We analyzed the responses of researchers to the trial implementation. We define the *uploading ratio* to be the ratio of u to r. In addition to the requesting ratio, the uploading ratio should be improved to increase the number of papers in the IR. We analyzed the log data of the implementation to obtain useful information for improving the uploading ratio on the basis of the following two ideas.

One simple method to increase the uploading ratio is to resend the request e-mail to researchers who did not upload the full text file. We actually observed that some researchers who received plural requests (with respect to different papers) from the system uploaded the paper of an old request with that of a new request at the same time, which leads us to consider that resending requests should effectively encourage uploading papers. To decide the interval for the resending, we measured the time from the request e-mail to the uploading (the *response time*).

The other idea for improving the uploading ratio is to cluster the researchers by their different situations, such as their research area and activities, to produce attentive support. First, we classified the papers by the affiliation of the contact author into five categories and examined the uploading ratio and the response

Table 1. Effects of Paper Registration Request System in trial implementation.

Offering time	p_1	p_2	r	u
Nov. 2012	1,432	572	396	108
Dec. 2012	1,546	625	447	95
Jan. 2013	1,305	517	400	69
Feb. 2013	1,390	567	349	109
Total	5,673	2,281	1,592	381
Ratio to p_1	100%	40.2%	28.1%	6.7%
Ratio to p_2	-	100%	69.8%	16.7%
Ratio to r	-	-	100%	23.9%

time. Next, we classified the papers by the number of the papers written by each contact author, and conducted the same analyses as the first classification. The number of the papers for a researcher can be regarded as a factor of the activity of the researcher.

3 Results

3.1 Number of Paper Registrations

Table 1 shows the numbers defined in Subsection 2.2 as the results of the implementation of the proposed system. For the 19 months before the trial implementation, the average number of papers registered in a month was 23.3. In the result, the total number of the uploaded files u is 381, which was obtained in approximately four months. Therefore, the system increased the number (candidates) of paper registrations from 23.3 to 95.25 (= 381/4), that is, approximately four-fold.

Fig. 3 shows the working efficiency of the IR managers, where each value of N/T is the average for the latest three months including the month concerned because some IR managers register a number of papers to the IR after the registration processes for the papers has finished. In the result, N rapidly increases around November 2012, which was the starting time of the trial implementation. Note that the files uploaded by the system become open at the repository after some processes in the library; hence, the numbers of the registered papers do not completely correspond to u in Table 1. With regard to N/T, it is also rapidly increasing from the same point. However, we cannot affirm that the increase was caused by the system, because there exist some points of large values in the period before the trial implementation. Therefore, we can conclude at least that the working efficiency did not significantly decrease even though the target papers of the IR manager's work increased approximately four-fold.

3.2 Analyses on the Responses

Fig. 4 shows the relationship between the accumulated uploading ratio and the response time. The total number of the uploaded papers was 381 and the uploading ratio was 23.9% as shown in Table 1. From the results, the uploading

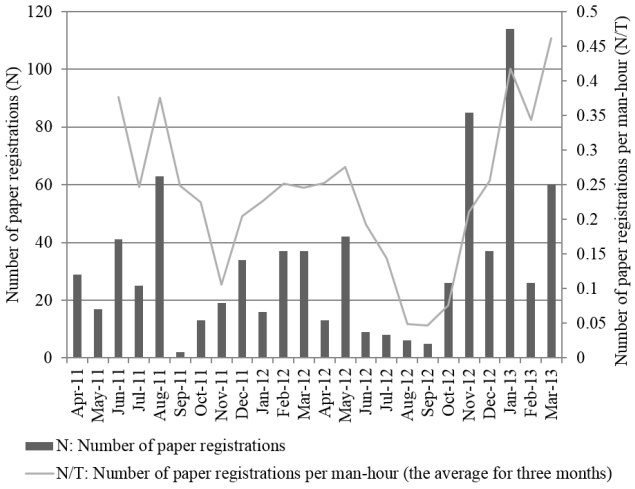

Fig. 3. Effects of Copyright Policy Confirmation System in trial implementation.

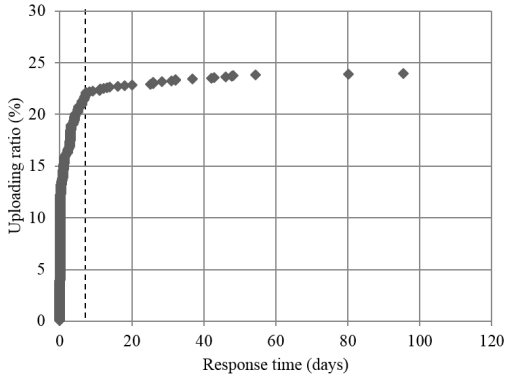

Fig. 4. Relationship between uploading ratio and response time.

ratio increases rapidly until approximately 7 days from the request. Therefore, an interval for resending the requests should be more than 7 days.

Table 2 shows the result of classification by the affiliation of authors. The uploading ratio was high in Agriculture and Science and low in Medicine. From these results, we expect that it would be effective to encourage researchers in the areas of medicine to upload their full text. The average response time was long in Engineering and short in Science. Therefore, some researchers in the areas of engineering are also expected to need a support. To shorten the response time, an individual support by IR managers may be necessary for a time until each researcher regards the paper registration to the IR as routine.

Table 2. Response analysis with classification by affiliation of authors.

Affiliation	r	u	Uploading ratio	Response time (avg.)
Medicine	528	98	**18.6%**	3.19 days
Science	344	97	28.2%	1.99 days
Engineering	311	75	24.1%	**5.59 days**
Agriculture	205	62	30.2%	3.61 days
Others	204	49	24.0%	3.78 days
Total	1,592	381	23.9%	3.50 days

Table 3. Response analysis with classification by activity of authors.

Activity	r	u	Uploading ratio	Response time (avg.)
1	362	100	27.6%	2.43 days
2	348	94	27.0%	4.72 days
3	240	39	**16.2%**	**6.90 days**
4	150	28	18.7%	1.11 days
5	152	45	29.6%	3.38 days
More than 5	340	75	22.1%	2.61 days
Total	1,592	381	23.9%	3.50 days

Table 4. Uploading ratio (%) with classifications by affiliation and activity of authors.

	1	2	3	4	5	5<	Total
Medicine	25.3	22.9	11.5	16.3	18.5	14.9	18.6
Science	33.8	31.7	15.0	20.7	30.0	31.7	28.2
Engineering	28.8	30.7	10.3	27.3	46.7	**2.0**	24.1
Agriculture	31.6	40.7	25.6	**0.0**	40.0	30.7	30.2
Others	21.1	15.2	40.0	10.0	36.4	40.0	24.0
Total	27.6	27.0	16.2	18.7	29.6	22.1	23.9

Table 3 shows the results for classification by the activity of authors, where Activity is the number of the papers found in Scopus for a researcher at the trial implementation (which corresponds to p_2 instead of r). The uploading ratio was low for the researchers whose activity level was 3 or 4. The average response time was long for the researchers whose activity level was 2 or 3. Therefore, very active researchers do not necessarily need a librarian's support, although being very active may increase the workload of paper registration. From the results, we can conclude that IR managers should focus on helping moderately active researchers.

Additionally, we conducted a cross tabulation for the two classifications. Tables 4 and 5 show the results of the analysis for the uploading ratio and the average response time, respectively. The uploading ratio was low for researchers in Agriculture with activity 4 and in Engineering with activity more than 5. The number r of the samples in the second category was 50 while that in the first category was 8. The average response time was long for researchers in Engineering with activity 3.

Table 5. Average response time (day) with classifications by affiliation and activity of authors.

	1	2	3	4	5	5<	Total
Medicine	2.80	7.16	0.82	1.57	1.13	1.04	3.19
Science	1.55	1.82	5.91	1.89	1.51	1.29	1.99
Engineering	3.31	2.81	**46.65**	0.57	6.41	2.06	5.59
Agriculture	1.72	4.63	0.90	-	3.70	5.04	3.61
Others	2.69	12.47	2.01	0.18	3.49	1.46	3.78
Total	2.43	4.72	6.90	1.11	3.38	2.61	3.50

4 Discussion

4.1 Major Conclusion

We can conclude that the number of paper registration to the IR was increased by the proposed system. A similar improvement is expected for other IRs in the same situation that the uploaded papers are significantly fewer than the published papers. The working efficiency of the IR managers was increased in a short term, but the effect of the system on this increase is not clear in view of its variance in a long term. Therefore, we can conclude that the working efficiency of the IR managers was not decreased by the proposed system.

4.2 Key Findings

We discuss how to improve the requesting ratio and the uploading ratio on the basis of the results in Section 3.

The requesting ratio is expected to be increased by improving the management of authors. In the results of the implementation, the copyright policy of the publisher prohibited opening the paper or was not clear for 588 papers, because 101 papers in the papers for p_2 had already been archived in the IR and the difference between p_2 and r was 689. As shown by Table 1, the request e-mails were not sent for approximately 60% of the papers for p_1, and the reasons were different from that about the duplication and the copyright policy. By the aid of the definition of the numbers, the reason is one of the following:

- The contact author was a researcher of an institution different from the university,
- The contact author was a student or a research fellow of the university, or
- The contact author was a professor of the university, but the e-mail address in the metadata was different from that in the list.

Therefore, the requesting ratio is expected to be increased by extending the scope of the requests to papers for which one of the authors (not only the contact author) is a professor, a student, or a research fellow (not only a professor) of the university. Also, the ratio would be increased by conducting a strict identification of authors. The author identification is improved by using the affiliation and the

research area of the author in addition to the name and the e-mail address. Additionally, the accuracy of the identification will be improved by connecting the system with other scholarly systems such as a researcher database [17, 18].

The uploading ratio is expected to be increased by implementing the system with the following modifications:

- The request e-mail is resent if a full text file is not uploaded within 7 days from the first request,
- The request e-mails are resent mainly to researchers in the areas of medicine and active researchers in the areas of engineering, and
- IR managers mainly support researchers in the areas of engineering, especially moderately active researchers.

The ratio can be ideally 100% depending on researchers, as can be seen by considering the definition of r. NIH estimated that the compliance rate for their policy, which requests funded researchers to deposit their research outputs to the repository PubMed Central, was approximately 75% as of 2013 [22]. Either way, it is expected that there is enough room for improving the rate 23.9%. These are results of the case study for the IR in the implementation; the same kind of analysis is applicable to other IRs to find researchers who need librarian's support.

4.3 Future Directions

More detailed analyses and interviews with researchers are necessary for improving the proposed system and its effective implementation. At the present time, we have the following hypotheses with regard to researchers.

- There are many kinds of journals and conferences for the research areas of engineering; hence, a huge amount of effort would be required for managing the source files for different formats and confirming the copyright policy of publishers. Therefore, the response time was long for the papers in engineering.
- The researchers who write a lot of papers likely have a good method (including a secretary) for managing the research material of their papers. Therefore, for very active researchers, the uploading ratio was high and the response time was short in spite of the large workload.

Verifying these hypotheses is a part of understanding potential users of the system.

Additionally, feedback from users of the system may be useful for improving the system. The subsystem was using databases of the copyright policies of publishers. However, there exist some publishers whose copyright policies are not found in the databases. Some of these publishers have their own copyright policies, and those are confirmed if an IR manager inquires to them. The results of inquiries are expected to improve the working efficiency of IR managers for the confirmation. In fact, the developed system can store the history of the inquiries

to publishers about copyright policies in each institution as local data, and the data can be shared easily among several institutions. For example, the results of inquiries are archived in the format for SHERPA/RoMEO and SCPJ, which uses different colors to represent publishers' policies, to cover unclear parts found in the results of searches in the databases. Also, the history of other operations in the developed system can be kept and referred to by users, which may be useful for improving the working efficiency.

5 Conclusion

We developed the system for registering papers to IRs and evaluated the system by a practical implementation of four months. From the results of the evaluation, we can conclude that the system increases the number of registrations of journal articles and conference papers to an IR and improves the efficiency of the paper registration process operated by IR managers. Additionally, we analyzed the log data of the trial implementation to improve the effect of the system and then developed some plans for further improvement of the system. The developed system accepts some standard data formats for input and output; hence, it is applicable to general IRs. The system is expected to help research institutions operate the IR, especially for small institutions that cannot spare enough workers for their own IR.

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