

Design of Literature Management Tool

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Abstract. This study aimed to design a literature management tool which can support the use and management of literature during the entire research project. In the design process, user requirement of literature management tool is collected through interviews. The functional framework of the tool is proposed based on the interview results and relevant literature. Function design and interface design are represented in the prototype, and the prototype is used for testing usability and user satisfaction. The test results shows subjects' acceptance of the tool. Further development of the tool is discussed.

Keywords: User-centered design · Literature management tool

1 Introduction

Research process can be divided into six stages, namely choosing a topic, literature research, constructing research framework, data collection, data analysis, writing and publishing. Literature related information is essential throughout the research process since researchers need to clarify research topic and build methodology by studying existing literature. In different stages, literature related activities can be different, and these activities can be classified as literature acquisition, literature organization, literature reading and literature retrieval. Currently there are reference management tools, readers and note-taking tools which can support research work. However, most of these tools can only support one or two stages of research process. The objective of this research is to design a literature management tool (denote with “Tool”) to provide users with help and convenient operation as far as possible in the stages of research process which literatures are involved. Hence, the function of Tool is constructed based on research process, and aimed to support literature related activities in one tool.

2 Literature Review

Existing studies regarding personal knowledge management provide implications for functional design of Tool. The implications include the following:

- Personal knowledge management tool should provide task space which is related to the research topic: if a research project is considered as task, the information space which includes all task-related information will become a task space [1].
- It is necessary to establish a task-focused set of files to facilitate management of these files [2]. Some researchers believed that the personal file management systems

should simulate the file management in the physical environment, in which task-related paper documents are put together to form an overview of the task, and the placement of paper documents can reveal the importance and progress of the task [2].

- Research information management systems should be able to support knowledge management activities, and establish an organized, searchable and editable knowledge base. Using different directories for the files can make information retrieval easier. Different directories give the file multiple attributes [3].
- Name of files should be meaningful, concise and be able to allow users to identify content of files [4].
- Folders which contain project-related file can serve as a reminder and plan [7]. Folder can be regarded as a tool for classification.
- Screen reading tool should allow user to annotate on the file, but the annotations will be stored separately, provide various telegraphic annotations such as highlights and underlines, make sure that annotating will not influence reading [5].

3 User Requirement Gathering

3.1 Method

Research forms an important part of daily life of college teachers, postgraduates and research assistants. Therefore, they are regarded as potential users of Tool. Face-to-face interviews were conducted. There are fifteen interviewees attending the interview. All the subjects are from department of Industrial Engineering, Tsinghua University. Five of the interviewees are teachers, and they all have engaged in research work for more than seven years. There are nine postgraduates participating in the interview, which all have published their research results in journals or conference. One research assistant attended the interview, and she has been doing research for five years. All these interviewees have research experience. They are familiar with research process, and they need to read a lot of literatures in their work. Therefore, they are the target subjects of the interviews.

They were asked a few questions in the interviews, including:

- Methods and tools that interviewees used for literature management, such as how they categorize and retrieve literature, how they read and annotate literature, and how they use literature information.
- Problem regarding literature management that interviewees encountered in research process.
- Interviewees' requirement of an ideal literature management tool.

3.2 Results

Methods of Literature Management. Interviewees described their three-step research process: problem clarification, problem solving and results interpretation. Their research process and relevant activities are summarized in Table 1.

Table 1. Literature-related activities

Research process	Literature related activities	Activity description
Clarify problems and target (choosing topic and searching relevant literature)	Search literatures	Search via web-browser
	Collect literatures	14 interviewees download manually
		1 interviewees download via literature management tool (Zotero)
	Organize literatures	Organize literatures by using folders
		Organize literatures in literature management tool
Solve problems (construct research framework, data collection, data analysis)	Read literatures	Annotate
		Take notes in separate file
	Find literatures they already read for reference	Scan in the folder
Report the result (writing & publishing)		Search in the folder
		Search on the internet again
	Search new literature to support the result	Search via web-browser
	Find literatures they already read for reference	
	Read notes	
	Insert citations and bibliography	Use literature management tools
		Insert manually

Some interviewees built their own ways to organize literature systematically. One PhD candidate renamed literature using “Author-Year-Journal-Title” format. Interviewees are willing to rename literature because a unified format can facilitate later retrieval and provides important literature information.

Different interviewees used different ways to classify literature. Project, research themes and time are their major criteria to categorize literature. When a literature is related to several categories, interviewees will put the file or shortcut in different folders.

When reading on screen, all interviewees annotate the text. One PhD candidate uses a rigorous method to annotate. He uses yellow highlight to mark important points, green underline to mark definitions, red underline to mark conclusions, and purple underline to mark important references. Visual cues may be useful to help user recall the context and meaning of the annotations. Most of interviewees organize important annotations in separate editable file.

Tools of Literature Management. There are ten interviewees using EndNote. They use it to insert citations and bibliography, and they are not satisfied some functions of

EndNote, such as notes, inconvenient reading PDF in the tool and search. One teacher uses Zotero in the Windows platform to download literatures classify literatures. She uses Sente in Mac client to annotate literature, and she likes the function that the annotations can be quoted and copied into documents easily.

Calls for Innovative Function. Interviewer proposed some imaginary functions and discussed with interviewees. They thought unified interface, using tags to management literature, picking out annotations automatically, setting reading status and setting interlinks between literatures and notes were good.

Interviewees also talked about their own requirement of an ideal literature management tool, including:

- View or edit literature relationship in the tool.
- Tool should provide introduction pages of every category, the introduction pages include description of the category and literatures related to the category.
- Customize bibliography format easily.
- Share is necessary.

4 Functional Framework

4.1 Literature Acquisition

In the stage of literature searching and downloading, user can use Tool to complete the following operations:

- Download literatures by using web-browser add-on.
- Import PDF files from local disk. Tool will automatically read and record the literature information, including references.
- Edit literature information.
- Search references. References of the literature will be read and presented as a list, users can select the reference which they want to know more and search the selected reference by simply clicking the search button.

4.2 Literature Organization

After importing literature information and downloading PDF files, researchers usually need to organize and manage PDF files for convenient search and use. Tool can help users manage their literature as follows:

- Set PDF file rename formats. Tool can read metadata of the literature, such as title, author, publication time and journal. When importing literature information and download full text for the first time, Tool will pop up a window in which user can choose rename format of the PDF file from several formats offered by the tool, such as “Author-Title-Publication time”, and user can also customize rename format.
- Use tags to classify literatures. Tags are divided into three categories: theme, projects and research methods. Tags are personalized literature information. Users can edit or add tags to literatures when viewing literature information.

- Manage tags. When creating a tag, users can write a description for the tag. Tags can be created, merged and moved. In the page of tags management, users can add associated literatures to the tag as a batch.
- Synchronize personal library on different devices.

4.3 Literature Reading

In the process of literature reading, Tool will provide several features to ensure a convenient and pleasant reading experience:

- Set reading status and degree of importance. There will be visual cues of read status on the list of literatures. That is, unread literatures are marked in bold, read literature are displayed by using normal font, and green color will fill half of the grid of literature title to indicate reading unfinished (see Fig. 1). When opening reading-unfinished literature, Tool will ask whether to continue the reading.
- Provide a variety of annotation formats and annotations can be easily picked out. The tool has its own PDF viewer, which offers a variety of annotation formats, including different color highlight and underline. User can customize the meaning of the annotation formats. For example, when a sentence is marked as definition, the sentence will be picked out as annotation and classified as definition.
- Provide function of literature summary editing.
- Take notes. The notes can be independent of literature. And the notes can be classified by using tags, and be associated with several literatures.

4.4 Literature Retrieval

- Filter literature. Literature information such as title, author, journal, publication time, read status and importance, can be used as filter, which can facilitate narrowing the search range, and user can read a specific range of literature optionally.
- Search literatures. The tool provides two search methods: quick search and advanced search. Quick search is keyword search. When using advanced search, user can input or select several search criteria, including metadata of literature, and personalized literature information, such as tags.

4.5 Facilitate Writing

The tool also provides functions to support writing:

- Export annotations and notes. Annotations and notes can be exported as the form of a PDF or editable documents. Users can export annotations of a single literature, and can also export annotations of literatures classified by tags.
- Establish outline for writing. User can create outline in the tool before writing, and add knowledge items (such as literature, annotations and notes) to the points in the outline. Outline can be exported to facilitate writing.
- Provide add-on of text editor to generate references.

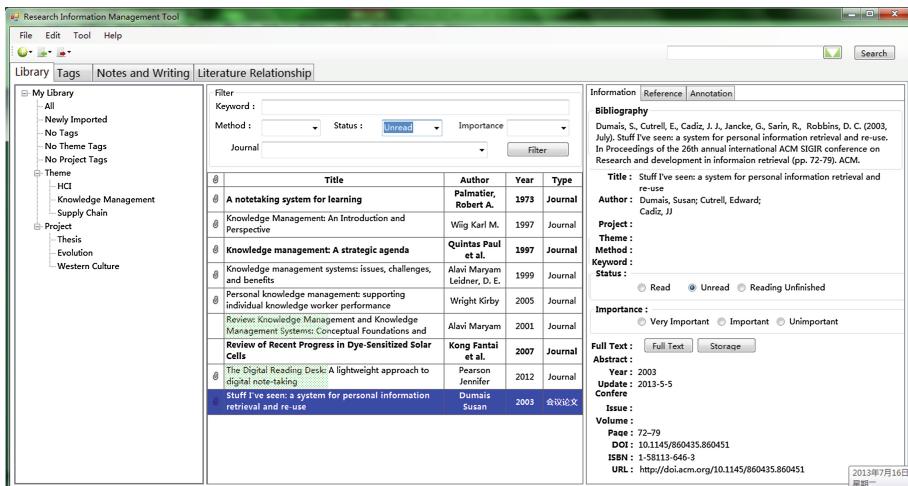


Fig. 1. Library

4.6 View Relationship Between Literatures

The tool will calculate the relationships between literatures based on literature information, user's reading status and use of literatures, and the tool will graphically demonstrate the relationships. It will help users to see literature relationship clearer.

5 Interface Design

There are four modules of the tool, library, tags, notes and writing, and literature relationships. Tabs are used to present these modules. The high-fidelity prototype is developed using VB.NET.

5.1 Library

The library module is shown as Fig. 1. The left column displays classifications of literatures. When users select a kind of category in the left column, the middle column will show a list of literature related to the category. Users can use filters presented in the middle column to narrow the literature range. After selecting a literature in the middle column, the literature information will appear in the right column. The right column is the edit area. There are three function modules, namely literature information, references and annotations. In literature information module, user can view and edit literature information, type in tags for article, and open PDF viewer to read the full text. User can edit and search references in the reference module. The annotation module is used for managing and exporting annotations.

5.2 Tags

Figure 2 shows the tags module. Tags are displayed in the form of tree structure in the left column. The right column is the area for viewing and editing. There are two modules in the right column, overview and add reference to tag.

When user selects a tag in the left column, the overview module will show the description of the tag, the literatures and sub-tags included in the tag, and notes marked by the tag. User can export the annotations and notes included in the tag.

In Add reference to tag module, user can search literatures first, then select the target literatures. As a result, the selected literatures will be added to the selected tag.

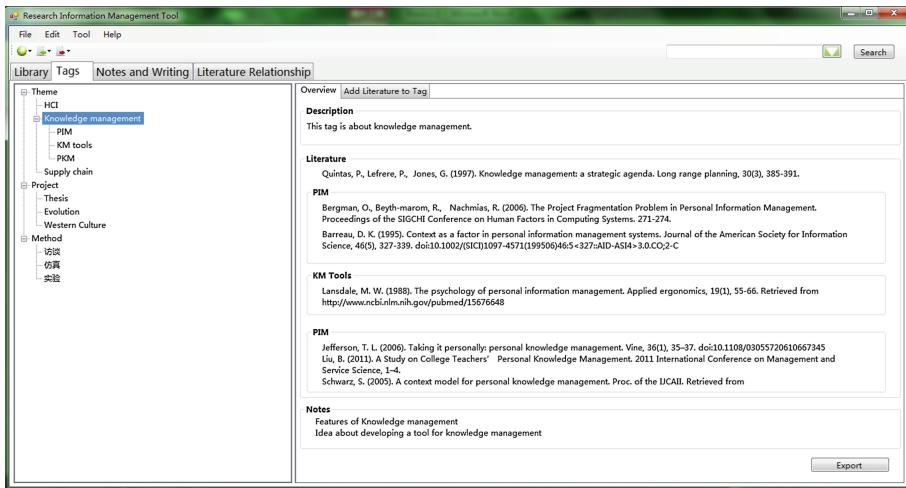


Fig. 2. Tags

5.3 Notes and Writing

Notes and Writing module is used for managing outlines and notes. The outlines and notes are presented in the form of tree structure in the left column. There are three modules in the edit area (i.e. the right column), overview, edit and create new outline.

When selecting an outline in the left column, user can view and edit description of the outline, and view content of the outline, including points and knowledge items related to the outline. Outline can be exported.

In Edit module, the outline is presented in the form of mind map. User can rename, add and remove points. If users want to add a knowledge item to a point, they can simply drag the knowledge item from the right column to the appropriate position. User can add points by clicking button or pressing hotkeys (Fig. 3).

5.4 Literature Relationship

User can see the literature relationship in the literature relationship module. The tool provides five literature relationships, namely reference, co-author, time axis, project

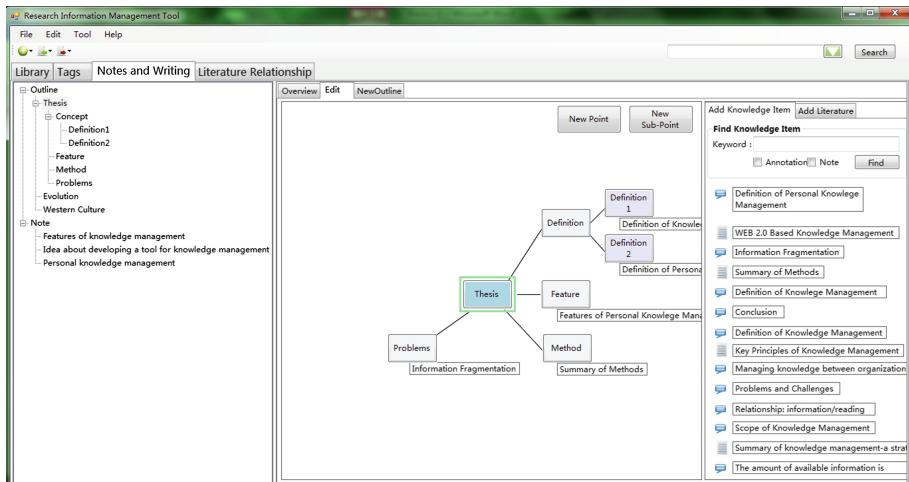


Fig. 3. Notes and writing

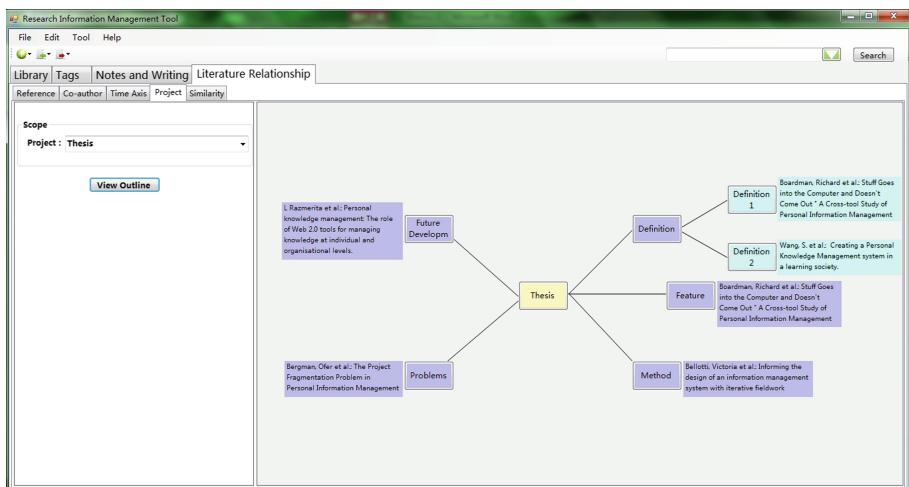


Fig. 4. Literature relationship

and literature similarity. For example, Project Module shows the relationship between the points of outline and literatures (Fig. 4).

6 High-Fidelity Prototype Test

6.1 Test Design

There are two prototype tests. Low-fidelity prototype is designed on the platform of Microsoft Visio 2010, and prototype test is conducted to figure out problem of usability

and interface design. Five postgraduates from Tsinghua University attended the test. Improvements of interface design and functional design are made on high-fidelity prototype. Another prototype test has done on this prototype to investigate user's acceptance of Tool. There are eleven subjects attending the high-fidelity prototype test. All the subjects are postgraduates from Tsinghua University.

In high-fidelity prototype test, scenario tasks, questionnaires and interviews are used to collect data. The tasks include the following:

- Task 1: import PDF files. This shows how to create library by using Tool.
- Task 2: view literature information. In the task, participants will view and edit literature information, mark and summarize when reading full text, search a specific reference, and export annotations. The new features shown in the task are: using tags to classify literatures, picking out and exporting annotations, and setting read status.
- Task 3: search literature by using advanced search.
- Task 4: view Tags module. Participants will experience classification method of using tags by viewing, merging and creating tags, and exporting annotation and notes included in the tags.
- Task 5: view outlines. Notes and Writing module is involved in this task. Participants will see how Tool contributes to writing through editing and exporting outlines, and creating a new outline.
- Task 6: view literature relationship.

These tasks covered most of literature-related activities, and also shown new features. When participants completed a task, they were asked the reason why they made mistakes in the tasks, and their opinion about functions involved in the task. After all tasks were completed, participants filled in Post-Study System Usability Questionnaire (PSSUQ) [6] to assess user satisfaction. A short interview was conducted to collect participants' subjective evaluation of the tool. User behavior was recorded during the test. Completion time and number of mistakes were calculated to assess task performance.

6.2 Results

Participants were asked to explain their process of decision making for the wrong actions when completing tasks. Their explanations suggest that they made mistakes because of the limitation of the prototype. There should be several ways to complete tasks, but the prototype provides only one way that user can get feedback.

In PSSUQ, Question 1 to Question 8 test the Systems Usefulness, Question 10 to Question 15 suggest the Information Quality, and Question 16 to Question 19 indicate the Interface Quality [6]. Question 9 is not included since prototype did not show error recovery function. These questions are used to assess system usability satisfaction. Figure 5 suggests that the average scores of interface quality are higher, and average score of Question 18 ("This system has all the functions and capabilities I expect it to have." [6]) is the highest. This will indicate that, Tool designed from the perspective of research workflow, and it can meet users' requirements of literature management.

The average scores of information quality are relatively lower. Some participants thought that some expressions in the tool are confusing, so it is not easy to find the information they want.

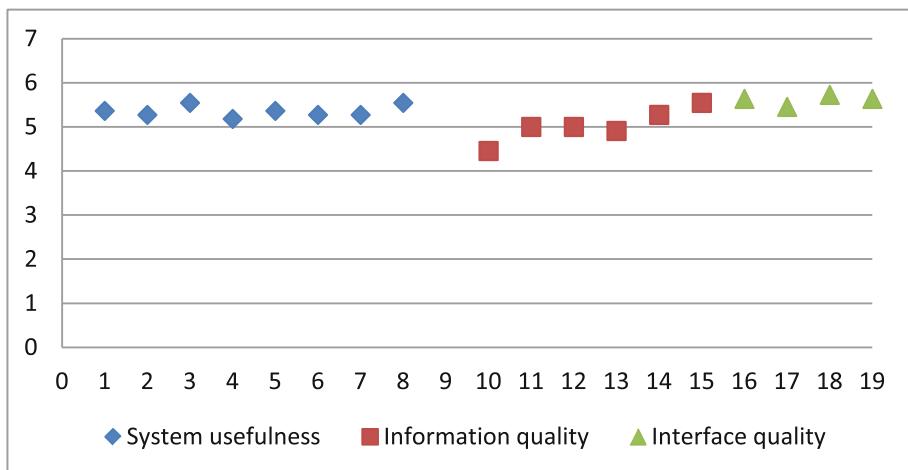


Fig. 5. Comparison scores of systems usefulness, information and interface quality

According to interview, methods and functions presented in task 1, task 2, task 4 and task 5 gain high degree of acceptance, and the function of exporting annotations and outlines is popular. The usability of library module, tags module and notes and writing module get positive feedback. The function shown in task 6 is a new, so the subjects are not sure whether they have the requirement of viewing literature relationships.

6.3 Improvement of Prototype

High-fidelity prototype has demonstrated complete functions and interfaces of Tool, and the design of functions and interface has been recognized through usability test. However, subjects thought the tool is complicated when they use it for the first time. To help user adapt to the interface quickly and get information they want timely, improvements should be made in the perspective of guidance and information presentation:

- When the cursor is moved into edit areas, Tool should remind users by changing the color of edit areas.
- Provide shortcuts to switch between pages easily.
- For some special expressions, the tool should provide clear explanation in the tutorial, and use bubble tips in the tool.
- Tutorial should be attractive, clearly and easy to understand. The distinctive functions and key operation methods should be shown in the tutorial.

7 Conclusion

The User Centered Design approach is used in this research, and the potential users are involved in every stage of Tool development. The functional framework is built based on literature review and requirement analysis.

The highlights of this research are listed as follows:

- Design Tool from the perspective of the whole research process. Tool can support most literature-related activities in the research process.
- Propose some distinctive functions, such as picking out annotations automatically, exporting annotations and outlines, tags management, literature relationships, and creating outline in the form of mind map.

The ultimate goal of the research is to develop a usable literature management tool. And it will be desirable if Tool can bring users good experience when they manage and use their literatures.

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