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PDF Citation Solutions for operatively supporting Knowledge Reuse in the technical context: a first evaluation model

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Abstract

Purpose: *This study aims at investigating if Citation/Reference Management Software environments are suitable to general Knowledge Management, reuse, and sharing purposes. It answers to the question "Does the use of a Reference/Citation Management Software meet the requirements of Knowledge Management?"*

Design/Methodology/Approach: *In order to respond to this question, the SERVQUAL model for assessing service quality was employed to elaborate a focused questionnaire on three Reference Management solutions. A focus group of 12 users belonging to a technical department, a design studio, and a research group of a university was asked to use three software solutions and to respond to the questionnaire on facilities, tools, and functions of these environments.*

Findings: *The analysis of responses has shown that, although these environments may be helpful for general Knowledge Management and reusing of documents in various formats, they can not be totally extracted from the context in which they were born, namely PDF storage.*

Originality/Value: *Many companies designed customized personal sharing and reusing solutions to be used within its boundaries. However, not all organizations and groups have time and money enough to be spent for a Knowledge Management tool. That is way it is interesting to know if cheap existing software solutions, originally created for other purposes, properly respond to their desired profile.*

Keywords

Knowledge Management, Knowledge Reuse, Knowledge sharing, Reference Management Software, Citation Management Software, PDF Management.

1 Introduction

It happens more and more often that, in technical departments, universities, research centres, or companies, a problem is solved through the precious aid of solutions belonging to the historian of the company experience. Instead of finding or designing a new solution, employees and researchers look for old solutions to similar (or analogous) problems that the company faced in the past. As a matter of

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fact, if the new problem is somehow connected to an old one, the old solution may fit the new problem, so that time is saved. This brings companies and research centres looking for new storage solutions, namely tools for Knowledge Management (KM). This leads us to introduce Knowledge Management, or, a step before, knowledge.

What is knowledge? Francis Bacon said "knowledge is power". More academically, "the organization's knowledge is professional intellect, such as know-what, know-how, know-why, and self-motivated creativity, or experience, concepts, values, beliefs and way of working that can be shared and communicated" [1]. Although different typologies and definitions have been proposed, what can be summed up is that knowledge is more than just mere data and information. While data is the basis for creating information and knowledge, and information refers to a context, knowledge comes from the processing of the perceived information and contextualization of a person [2]. So, data is raw numbers and facts; information is a flow of messages or processed data; knowledge is actionable information possessed in minds [1]. Similarly, knowledge is defined as "the 'knowing' embedded in people's experiences, skills, expertise, competencies, capabilities, talents, thoughts, ideas, ways of working, intuitions, and imaginations that manifests itself in the tangible artefacts, work processes, and routines in an organization" [3]. There are two kinds of knowledge: tacit, also called informal or implicit, and explicit knowledge, or formal [2,3,4]:

- *tacit knowledge* is the unexpressed, unarticulated, and personal knowledge that an individual possesses [3]. It is bound to the person and to his/her context, so difficult to communicate and formalize [2];
- in contrast, *explicit knowledge* can be recorded, codified, documented, collected, stored, and disseminated. It is not bound to a single person, is structured as data, so can be shared easily with users [2,3].

Interestingly, it has been estimated that 80% of the most important knowledge is tacit [3].

Knowledge Management (KM) is "organizing to know" [3]. Specifically, it is "an attempt to turn employees knowledge into a shared, firmwide asset" [3], i.e., "managing the corporation's knowledge through the process of creating, sustaining, applying, sharing and renewing knowledge to enhance organizational performance and create value" [1]. KM has two components: the management of data and information, namely the management of explicit knowledge; and the management of the expertise, knowledge, and abilities of single individuals, i.e. the management of tacit knowledge. For effective KM, it is essential to capture both [3], although most organizations concentrate on storing and managing only explicit one. According to Davenport *et al.* [5], Gandhi [3], and Lai and Chu [1], there are four types of KM projects:

- *creating* knowledge repositories;
- *improving* knowledge access to facilitate transfer;
- *enhancing* a knowledge environment;
- *managing* knowledge.

The classification is a bit different according to Natali and Falbo [4]:

- *creation* of items using the conventions of the company;
- *capture* essential contents of these knowledge items;

- *retrieval and access* with the aim of dissemination;
- *use* and reuse.

The concept of KM is strictly connected to the tools supporting it, namely **Knowledge Management Systems**. They are aimed at facilitating creation, access, and reuse of knowledge, and their main goals are to promote knowledge growth, communication, preservation, and sharing [4]. According to Liao [6], there are seven core categories for classifying KM technologies: KM framework, knowledge-based systems, data mining, information and communication technology, artificial intelligence/expert systems, database technology, and modelling. Natali and Falbo [4] cited three main KM technologies among the available emerging tools: ontologies, XML, and software agents. An ontology is an explicit specification of a conceptualization, i.e. ontologies define the shared vocabulary used in KM systems and processes to facilitate representation, communication, storage, and search [7]; using XML (eXtensible Markeable Languague), metadata help in annotating knowledge items; while software agents are used to connect members of organizations to available knowledge, not only on knowledge search, but also on knowledge filtering and dissemination [4].

To be effective, a KM System should be integrated to a software process. Since software engineering environments integrate collections of tools supporting software engineering activities across software lifecycle, it seems an obvious step to integrate KM facilities in a software environment [4]. Early IT applications for KM were Decision Support Systems (DSSs) and Expert Systems (ESs), that improved human decision and replaced it entirely. KM tools may be various, depending on the field they are used for and on the organization which employ them. Examples of knowledge repositories mainly intended for universities are: ***Kalliope***, a Hewlett-Packard KM repository of internal documents written by software engineers in support of their software development activities; ***Refquest***, a searchable internet-based reference information knowledge base developed by Ithaca College Library; ***Common Knowledge Database*** (CKDB), developed by Rutgers University to facilitate knowledge sharing between various campuses; ***Reference Desk Manager***, a web-enabled, keyword searchable KM database developed by Oregon State University; the ***Faculty Database***, ***Reference Desk Programme***, and ***Collection Development Helper*** are KM databases developed at Cal Poly library to assist librarians' work; ***INFOMINE***, a virtual library of internet resources such as databases, electronic journal, e-books, articles, and other information [3]. These examples include most of all library-oriented tools. Talking about companies and their need to store, manage, and reuse knowledge, some examples of KM tools for enterprises were collected by Huysman and de Wit [8,9], who presented case-study findings on practices of knowledge sharing in 10 large firms. Among them, we would like to cite: ING Barings, that introduced an intranet to support knowledge exchange between different countries; Cap Gemini, in which consultants use both informal personal and electronic networks; IBM, which installed an intranet for knowledge reusing, with a precise focus on standardization and ready-made solutions; Unilever, which started over ten years ago to systematically collect, exchange, create, and leverage knowledge using it as weapon against the competitors; Stork, that introduced Integrated Process Innovation (IPI) to enable communities to share knowledge and allow new knowledge to come into existence; the Ministry of Housing, which used the internet so that electronic communities could exchange thoughts; Postbank, in which personnel at the front office used a knowledge base to support both client interactions and training of the call-centre operators; National Netherlands, whose insurance employees made use of organizational knowledge stored in a knowledge base. Other valuable companies that put into practice KM using tools for exchanging and sharing are: Ernst & Young, HP consulting, Cooper & Lybrand, Arthur Andersen, Teltech, HP, Microsoft [1]. Customized or personal solutions are also proposed non-stop. For instance, Babar and Gorton [10] developed a framework for managing technical, i.e. explicit, and contextual, i.e. implicit, knowledge. To support this framework, they developed Process-centric Architecture Knowledge Management Environment (PAKME). It is a web-based architecture knowledge management tool that is aimed at providing knowledge management support for the software architecture process.

In this sense, knowledge storage, sharing, and reuse are strictly connected. When a problem comes up, the employee or the researcher may read up on similar problems to solve it. If the source of his information, and even the solution, comes from within the boundaries of the organization he joins, the acquired knowledge is not only helpful, but even ready to be used and targeted to the context. So, as said previously, an ideal KM tool should be able to carry both explicit and implicit knowledge. This goal can be achieved if the stored knowledge keeps not only documents, but also the elaborations that these documents have undergone. If it is possible to keep trace of these elaborations, the document is considered as well contextualized. It is not only useful for sharing and communication purpose, but also for personal one. A worker can come back to old filed documents and immediately see for what he used them, which post-processing he made on them, which were the keywords he associated. Essentially, this is *keeping trace of mental processes*.

Accordingly, providing the own organization with a valuable Knowledge Management software may be a convenient and cheap practical solution, also for small and medium enterprises and research centres. Particularly, attention have to be focused on software environments that handle common and sharable document formats. Since Portable Document Formats (PDFs) represent the most used formats for interchange, a focus on PDF management software is made. That is why it should be interesting to investigate how well-known already existing Citation Management Software and Reference Management Software solutions for PDF managing could help in KM, sharing, and reuse. Renowned Reference Management Software solutions are ***Mendeley***, ***EndNote***, ***Zotero***, ***Refworks***, ***Papers***, ***Reference Manager***, ***Aigaion***, ***CiteUlike***, ***Biblioscape***, ***Bookends***, ***JabRef***, ***Refbase***, ***WIKINDX***, ***BibSonomy***, ***Connotea***, and ***2collab***.

The aim of this paper lies in answering to the question: “Does the use of a Reference/Citation Management Software meet the requirements of Knowledge Management?”. In practice, it consists for us in examining and analysing some PDF software facilities, and state if they can be efficiently employed in more than one field within technical framework.

2 The proposed method: evaluating citation solutions for knowledge reusing in the technical context

Technically, Reference Management Software solutions are software for scholars and authors to record and utilize bibliographic citations. Generally speaking, they may be considered as kinds of KM tools focused on PDF storage, codification, and reuse, although other formats may be imported and managed. A Reference/Citation Management Software is provided with various features, functions, and facilities for documents storage. Generally, a Reference Management Software:

- may be a off-line program to be installed, a program to be installed connectable with the internet, or an on-line platform;
- lets the user import various formats files and keeps them in a sorted and ordered collection, organized depending on customer's need;
- gives the possibility to classify each of the imported files, selecting the kind of document (article, book, paper, thesis, database, report,…), setting its category and its features, such as year, author, title, and other points;
- automatically classify the documents that have their features already clear and complete, such as a PDF article that has been legally downloaded from an official editor website;
- gives the possibility to create groups of documents;
- lets the user modify the documents features, assign keywords, underline, highlight, and leave notes;
- export the bibliographical reference of the document in many forms.

Some authors researched on Reference Management Software environments. Mead and Berryman [11] took a look at some PDF-manager solutions, such as ***EndNote***, ***Refworks***, ***Mendeley***, and ***Papers***, with a librarians-oriented point of view. Fenner [12] compared the facilities of ***Zotero***, ***EndNote***, ***Mendeley***, ***Refworks***, ***CiteULike***, ***JabRef***, ***Papers***, ***Citavi*** relying on different evaluation criteria, namely 'search', 'share', 'store', 'read', and 'write', in order to help the reader "with finding the right tool to get started". Butros and Taylor [13] provided a comparison between EndNote, RefWorks, Mendeley, and Zotero, including advantages and disadvantages of each one. Fitzgibbons and Meert [14] compared the results between searches conducted in academic databases' search interfaces with the ***EndNote*** search interface. Gilmour and Cobus-Kuo [15] compared ***CiteULike***, ***Refworks***, ***Mendeley***, and ***Zotero*** in terms of offered features and the accuracy of the bibliographies that they generate. Similarly, Hensley [16] examined four of the most popular reference managers from the perspective of both the patron and the librarian. McMinn [17] reviewed the current level of service and support provided for the bibliographic management applications.

These software are widely employed especially in research centres and universities, where the need of systematization of articles and general PDF documents is higher. However, since PDFs are used in all fields, and since many of these PDF software solutions also handle other formats, it is up to this study to state if these tools can be employed in all fields and all organizations. That is why we developed a customized user-oriented model based on SERVQUAL, a model of service quality, for testing the most popular Reference Management Software tools.

SERVQUAL is an instrument proposed by Parasuraman, Zeithaml, and Berry, also called PZB from the names of its authors, for assessing customer perceptions of service quality in service and retailing organizations [18]. We chose it as the basis of our model because it follows a costumer-oriented approach to state if Reference Management Software solutions are considered by costumers as suitable for KM. It is important to note that we do not want to evaluate software performances, but to establish whether there is or not a compatibility of these software solutions with general KM, reusing, and sharing activities.

Exploratory research of Parasuraman, Zeithaml, and Berry revealed that the criteria used by consumers in assessing service quality fit 10 potentially overlapping dimensions, labeled "service quality determinants" [19]. These categories are:

- *reliability*, that involves consistency of performance and dependability and also means that "the firm honors its promises";
- *responsiveness*, which concerns the willingness or readiness of employees to provide service and involves timeliness of service;
- *competence*, that means possession of the required skills and knowledge to perform the service;
- *access*, which is approachability and ease of contact;
- *courtesy*, that means friendliness, respect, politeness, consideration of contact personnel;
- *communication*, that relies on keeping costumers up-to-date and informed in language they can understand and listening to them;
- *credibility*, which involves believability, trustworthiness, honesty, namely "having the customer's best interest at heart";
- *security*, that is the freedom from risk, doubt, or danger, i.e., physical safety, financial security, and confidentiality;
- *understanding/knowing the customer*, which concerns making the effort to understand the costumer's needs;
- *tangibles*, that include physical facilities, tools or equipment provided by the service [19].

In order to insert this model in the context of PDF storage solutions, we fit these categories to a software framework and customized them for the context. The form of these questions is aimed at finally stating if these Citation Management solutions are as powerful as to be used in various contexts for general KM, reusing, and sharing. It is important to note that these categories are overlapping, in the sense that an aspect of one of them may also belong to another category. In our framework:

- *reliability* is the 'completeness' of the tool facilities in the research. This parameter is aimed at stating if the tool in question is complete for research and reuse purpose. The related questions that a user should answer to are the following:
    1. do the general descriptive fields well describe documents? Are they exhaustive for a complete knowledge storage and management?;
    2. does the software automatically keep trace of the researches/post-processing of the documents?;
    3. is there the possibility of manually keeping trace of the researches/post-processing of the documents (for instance, through notes, keywords, and underlining tools)?;
    4. do the generic search tool explore title/author/year/others […] of the documents or also the whole text?;
- *responsiveness* concerns cost strategies and the willingness or readiness to provide service. Cost of the service, support tools and missing things are investigated with a KM, reuse, and sharing point of view. The questions may be:
    5. is the cost of the service proportional to its facilities?;
    6. are there any support tools?;

7. is there anything missing in the service?;

- *competence* means 'adequacy' of the tool facilities for the research. It is important to state if the tools offered by the software in question adequate for valuable Knowledge Management. The questions are:
  8. how correct is the automatic compilation/codification (autofill) of the document by the software?;
  9. are the research tools (e.g. joint Google Scholar) competent and exhaustive enough?;
  10. are the bibliographic tool (for extracting references) precise enough?;
- *access* is 'easiness' of the research. It seems to be one of the most important features that helps this study in investigating whether the software solution is suitable for knowledge reuse and share or not. These are the related questions:
  11. is it easy to find an article in the software database?;
  12. is it easy to set features on these documents?;
  13. is it easy to edit anything?;
  14. generally speaking, is the tool easy to handle at the first use?;
- (*courtesy* is suppressed);
- *communication* means speaking a language that users can understand. We believe that a correct and comprehensive formalization of the knowledge is the basic starting point for managing and sharing knowledge. The related questions are:
  15. are the graphical formalization and the interface well readable?;
  16. are the automatic codification and the fields understandable?;
  17. how are notes and underlining options?;
  18. is there affinity with the instrument?;
- (*credibility* involves automatic mapping from the public database, such as ScienceDirect and SpingerLink, so it may be considered synonymous with *competence*);
- *security*, as in the original definition, is the freedom from risk, doubt, or danger, i.e., physical safety, financial security, and confidentiality. It is represented by these questions:
  19. does the tool respect privacy?;
  20. does the tool (and the eventual connected sharing tools) respect confidentiality?;
  21. is the log-in covered by username and password access?;
- *understanding/knowing the customer* concerns adaptation to the costumer. The possibility of customizing the tool is something helpful and desirable, because enables the user to have a own customized tool, suitable for his needs. The questions are:
  22. is there the possibility of customizing the tool?;
  23. is there the possibility to create other new descriptive fields for describing documents (e.g. new categories)?;
  24. generally speaking, can the tool be adapted to user's needs?;
- *tangibles* include tools provided by the service. The 'tangibles' we are going to investigate on are mainly focused on KM, sharing, and reusing purposes. These are the questions:

25. in the basic version of the program (free in case of Mendeley and Zotero), is the available space (megabytes for the storing) enough for your needs?;
26. are there any research tools (e.g., joint Google Scholar)?;
27. is there the possibility to create groups of documents?;
28. are there any reference tools?;
29. are there any sharing tools?;
30. are there any on-line tools?;
31. does it work off-line?;
32. is it possible to use it on other devices connectable to the internet (smartphone, tablet, other computers,...) with the same username and password?

What we propose is a customized model of SERVQUAL that aims at testing and evaluating some Reference Manager Software solutions. These questions mainly aim at analyzing the facilities of these software environments with a KM/reuse-oriented approach. In particular, these questions are focused on the codification modes of the documents because a correct, precise, and updated storage is a core process for reusing and sharing. Preliminary interviews with a focus group of researchers and small company employees allowed us to consider questions 2, 3, 4, 22, 23, 24, belonging to *reliability* and *understanding/knowing the customer*, as the most focused on Knowledge Management and reuse purpose.

3 Experimental Validation

The focus group was created joining 4 members of a technical department, 4 members of a design studio, and 4 researchers of a small research group of a public university. For their positions and roles in their organizations, they were considered by our work group as smart and brainy. We asked these 12 people to use the most common, used, and cited Reference Management Software solutions, i.e., ***EndNote***, ***Mendeley***, and ***Zotero***. We created these groups in such a way that, among each group and for every software in question, half the group had used the tool in question yet, while the other half had never used it.

The focus group was created joining people from a technical department, a design studio, and a university research group because they are examples of organizations which more necessitate a KM/sharing/reuse tool, but, due to possible lack of time and/or money, they can not implement a new KM software or buy one commercially available.

It was asked to each of these users to use the three PDF tools for a week, then they completed a written questionnaire with the questions above and a “Likert scale” from 1 (no/very bad) to 5 (yes/very good). The results are reported in Figures 1, 2, and 3. In each of these figures the reader can find a table containing the grades given by the users to the single questions, grouped in our SERVQUAL categories. Then, for every software, a mean of grades of every question, a mean of these means, and a final mean for the overall software ‘behaviour’ is computed. These means were plot and shown in Figures 4 and 5.

Figure 1. Marks received for EndNote. The first column is the category of our SERVQUAL model adaptation; in the second column the number of the question is inserted (see section 2 for the extended question forms); the subsequent coloured columns contain marks given by no-users and users of technical department, design studio, and research group; the last three columns has the means of marks of each question, of each category (means of the means of each question), and global (means of means of each category), respectively.

EndNote		grades from technical department				grades from design studio				grades from research group				means		
category	*question*	no user	no user	user	user	no user	no user	user	user	no user	no user	user	user	mean on greades of each question	mean on grades of each category	total mean
reliability (completeness)	*1*	5	5	5	5	5	5	5	5	5	5	5	5	5	2,96	3,90
	2	1	1	2	1	1	1	1	1	1	1	1	1	1,08		
	3	5	5	5	5	5	5	4	5	5	5	4	4	4,75		
	4	1	1	1	1	1	1	1	1	1	1	1	1	1		
responsiveness	*5*	3	3	2	1	2	2	2	3	1	1	1	2	1,92	2,92	
	6	4	4	5	5	4	3	4	5	5	4	5	4	4,33		
	7	2	2	3	3	3	2	4	3	1	1	2	4	2,50		
competence (adequacy)	*8*	3	3	4	5	4	4	5	4	4	5	5	5	4,25	4,53	
	9	5	5	4	4	5	5	5	5	4	4	5	4	4,58		
	10	4	4	5	4	5	5	5	5	5	5	5	5	4,75		
access (easiness)	*11*	4	4	5	4	4	4	5	5	3	4	5	4	4,25	4,15	
	12	5	5	5	5	4	5	5	5	5	5	5	5	4,92		
	13	4	4	5	5	5	5	5	5	5	5	5	5	4,83		
	14	3	2	3	2	2	2	3	2	3	3	3	3	2,58		
communication	*15*	2	3	3	3	1	1	2	3	2	1	3	3	2,25	3,48	
	16	4	4	4	5	5	4	4	4	3	4	5	4	4,17		
	17	4	5	4	4	4	4	5	5	5	4	5	5	4,50		
	18	3	5	4	2	4	3	2	3	3	3	2	2	3,00		
security	*19*	5	5	5	5	5	5	5	5	5	5	5	5	5	5,00	
	20	5	5	5	5	5	5	5	5	5	5	5	5	5,00		
	21	5	5	5	5	5	5	5	5	5	5	5	5	5		
understanding / knowing the customer	*22*	4	4	5	5	4	3	4	4	4	4	5	5	4,25	3,86	
	23	4	4	4	4	5	4	3	4	5	5	4	5	4,25		
	24	3	2	3	4	3	3	4	4	2	2	4	3	3,08		
tangibles	*25*	4	4	4	4	4	4	3	3	4	4	3	4	3,75	4,34	
	26	5	5	5	5	5	5	5	5	5	5	5	5	5,00		
	27	5	5	5	5	5	5	5	5	5	5	5	5	5		
	28	5	5	5	5	5	5	5	5	5	5	5	5	5		
	29	5	4	5	5	5	5	5	5	5	5	5	5	4,92		
	30	5	5	5	5	5	5	5	5	5	5	4	5	4,92		
	31	5	5	5	5	5	5	5	5	5	5	5	5	5		
	32	1	1	1	1	2	1	1	1	1	1	2	1	1,17		

Figure 2. Marks received for Mendeley. The first column is the category of our SERVQUAL model adaptation; in the second column the number of the question is inserted (see section 2 for the extended question forms); the subsequent coloured columns contain marks given by no-users and users of technical department, design studio, and research group; the last three columns has the means of marks of each question, of each category (means of the means of each question), and global (means of means of each category), respectively.

Mendeley		grades from technical department				grades from design studio				grades from research group				means		
category	*question*	no user	no user	user	user	no user	no user	user	user	no user	no user	user	user	mean on greades of each question	mean on grades of each category	total mean
reliability (completeness)	*1*	5	4	4	4	5	5	4	5	4	5	3	5	4,42	3,81	4,25
	2	2	2	1	1	1	2	1	1	1	1	1	1	1,25		
	3	5	4	4	5	5	5	5	5	4	4	4	5	4,58		
	4	5	5	5	5	5	5	5	5	5	5	5	5	5		
responsiveness	*5*	5	5	5	5	5	5	5	5	5	5	5	5	5	4,36	
	6	5	5	4	4	4	5	5	5	3	3	4	4	4,25		
	7	4	3	3	2	5	3	4	3	5	4	5	5	3,83		
competence (adequacy)	*8*	4	5	3	5	5	3	4	4	3	3	4	4	3,92	4,33	
	9	4	4	4	5	5	5	5	5	3	4	3	3	4,17		
	10	5	5	5	5	5	5	5	5	5	5	4	5	4,92		
access (easiness)	*11*	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
	12	5	5	5	5	5	5	5	5	5	5	5	5	5		
	13	5	5	5	5	5	5	5	5	5	5	5	5	5		
	14	5	5	5	5	5	5	5	5	5	5	5	5	5		
communication	*15*	5	5	5	5	5	5	5	5	4	5	5	5	4,92	4,96	
	16	5	5	5	5	5	5	5	5	5	5	5	5	5		
	17	5	5	5	5	5	5	5	5	5	5	5	5	5		
	18	5	5	5	5	5	5	5	5	5	4	5	5	4,92		
security	*19*	5	5	5	5	5	5	5	5	5	5	5	5	5	4,89	
	20	5	5	5	4	4	4	4	5	5	5	5	5	4,67		
	21	5	5	5	5	5	5	5	5	5	5	5	5	5		
understanding / knowing the customer	*22*	2	3	1	1	1	2	1	1	2	2	1	1	1,5	1,92	
	23	1	1	1	1	2	1	1	1	1	1	1	1	1,08		
	24	4	3	4	1	2	2	4	4	2	3	4	5	3,17		
tangibles	*25*	3	3	1	1	5	3	5	5	4	3	1	2	3	4,70	
	26	5	5	5	4	5	5	5	5	4	4	4	4	4,58		
	27	5	5	5	5	5	5	5	5	5	5	5	5	5		
	28	5	5	5	5	5	5	5	5	5	5	5	5	5		
	29	5	5	5	5	5	5	5	5	5	5	5	5	5		
	30	5	5	5	5	5	5	5	5	5	5	5	5	5		
	31	5	5	5	5	5	5	5	5	5	5	5	5	5		
	32	5	5	5	5	5	5	5	5	5	5	5	5	5		

Figure 3. Marks received for Zotero. The first column is the category of our SERVQUAL model adaptation; in the second column the number of the question is inserted (see section 2 for the extended question forms); the subsequent coloured columns contain marks given by no-users and users of technical department, design studio, and research group; the last three columns has the means of marks of each question, of each category (means of the means of each question), and global (means of means of each category), respectively.

Zotero		grades from technical department				grades from design studio				grades from research group				means		
category	*question*	no user	no user	user	user	no user	no user	user	user	no user	no user	user	user	mean on greades of each question	mean on grades of each category	total mean
reliability (completeness)	*1*	5	5	5	5	4	4	5	5	5	4	5	5	4,75	2,90	4
	2	1	1	1	1	2	1	1	1	1	1	1	1	1,08		
	3	4	4	4	4	5	5	5	5	5	5	5	5	5		
	4	1	1	1	1	1	1	1	1	2	1	1	1	1,08		
responsiveness	*5*	5	5	5	5	5	5	5	5	5	5	5	5	5	3,72	
	6	3	3	3	3	2	3	3	4	3	3	4	2	3		
	7	3	4	2	4	3	4	3	3	3	2	4	3	3		
competence (adequacy)	*8*	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
	9	5	5	5	5	5	5	5	5	5	5	5	5	5		
	10	5	5	5	5	5	5	5	5	5	5	5	5	5		
access (easiness)	*11*	4	3	5	4	3	4	5	5	3	3	4	5	4	4,71	
	12	5	5	5	5	5	4	5	5	5	5	5	5	4,92		
	13	5	5	5	5	5	5	5	5	5	5	5	5	5		
	14	5	4	5	5	5	5	5	5	5	5	5	5	4,92		
communication	*15*	4	4	5	5	5	4	5	5	5	5	5	5	4,75	4,35	
	16	5	5	5	5	5	5	5	5	5	5	5	5	5		
	17	4	3	4	5	4	4	4	4	4	3	4	5	4		
	18	4	3	4	4	4	3	3	4	4	3	4	4	3,67		
security	*19*	5	5	5	5	5	5	5	5	5	4	5	5	4,92	4,97	
	20	5	5	5	5	5	5	5	5	5	5	5	5	5		
	21	5	5	5	5	5	5	5	5	5	5	5	5	5		
understanding / knowing the customer	*22*	1	1	1	1	1	2	1	1	1	1	1	1	1,08	1,69	
	23	1	1	1	1	1	1	1	1	1	1	1	1	1		
	24	3	3	3	3	2	3	4	3	3	3	4	2	3		
tangibles	*25*	3	4	4	3	4	4	4	3	4	3	3	3	3,5	4,68	
	26	5	5	5	5	5	5	5	5	5	5	5	5	5		
	27	5	5	5	5	5	5	5	5	5	5	5	5	5		
	28	5	5	5	5	5	5	5	5	5	5	5	5	5		
	29	4	5	4	5	5	4	5	5	4	4	4	4	4,42		
	30	5	5	5	5	5	5	5	5	5	5	5	5	5		
	31	4	4	5	4	5	5	5	5	5	5	5	5	4,75		
	32	5	4	5	3	5	5	5	5	5	5	5	5	4,75		

Figure 4. Plotted means of single questions responses. The x-axis represent the question numbering, while the y-axis is the mean of marks received by the focus group for each question.

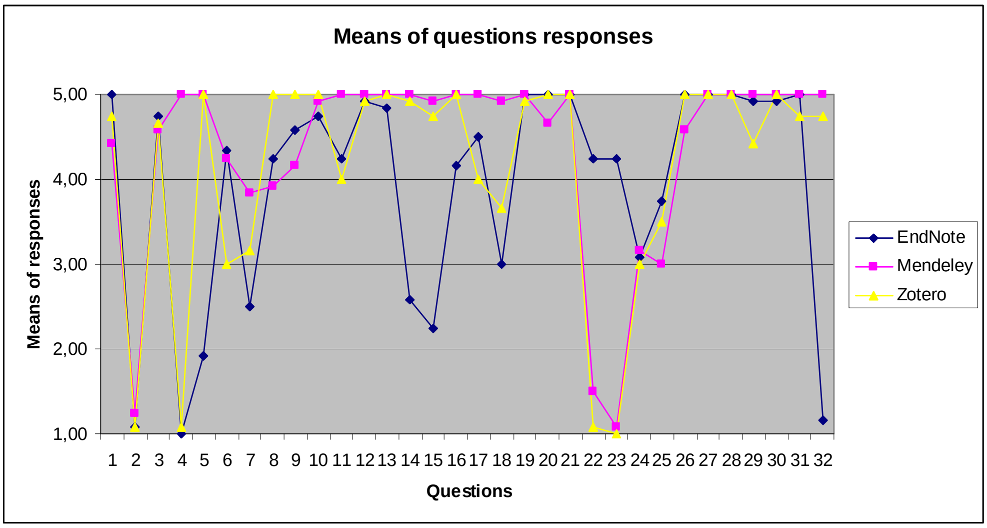
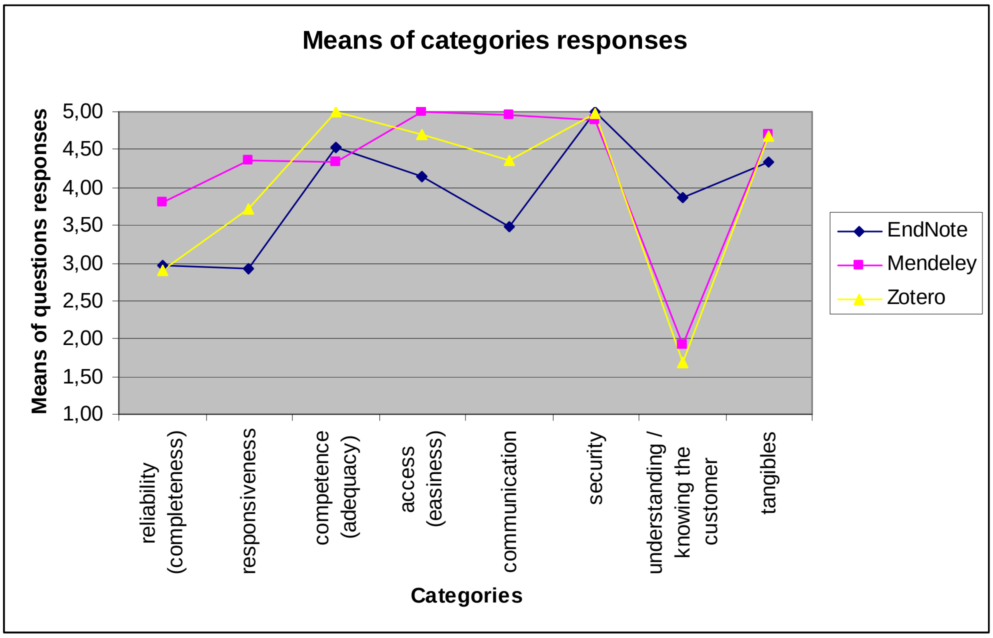


Figure 5. Plotted means of single categories responses. The x-axis represent the categories, while the y-axis is the mean of marks received by the focus group for each category.



A first general evaluation of the three software solutions shows that Mendeley was the most appreciated, although the final ‘scores’ are not so different. The results are 3,87 for EndNote, 4,25 for Mendeley, and 4 for Zotero.

Let’s start comments with the resulting similarities among the three software solutions. The bad new for all these tools is that they do not automatically keep trace of the post-processing made on the documents (low grades in question 2). The most striking example of this missing is that a researcher always performs some internal keyword search in articles and documents, so that he knows if that document contains information on his area or topic of interest. It would be very smart for a PDF software to automatically keep trace of these internal searches and researches. So, for all the software environments, if the user wants to remind himself or others which kind of post-processing the document has undergone, he has to annotate it on the sticky-notes offered by the tools, store it in the keywords section, or underline the text. The good new is that the three environments have these tools available, as shown by responses to question 3. High marks to questions 10 and 28 shows that all have tools for bibliographic references extraction and that these tools are valuable. The three software environments also received good excellent grades concerning security, as can be seen by *security* category involving questions 19, 20, and 21. Concerning *tangibles*, in particular questions 27, 29, 30, and 31, all the PDF tools have the possibility to create groups, have sharing tools, and work both on-line and off-line.

Concerning the differences between the three software solutions, surely the most important points to be noticed are two. The first one is that Mendeley has a generic search tool which also looks inside the text of the documents, while EndNote and Zotero do not have this function, as responses to question 4 showed. On sure, it is a very helpful and powerful feature for the purposes of Knowledge Management and reuse. The second one concerns *understanding/knowing the costumer*, in particular questions 22 and 23, for which EndNote gained the best results. That is because all the three solutions associate to every documents a document type and, consequently, some fields (author, year, journal,…); only in the case of EndNote, when type “Generic document” is associated to a document, the software gives the user the possibility of customizing some fields. It may be a valuable tool for Knowledge Management. By contrast, EndNote received low mark concerning affinity, easiness to handle a the first use, and readability of interface, namely questions 18, 14, and 15, respectively. The overall marks (Figure 5) given to *access* (easiness) and *communication* confirm it. Furthermore, it seems from the grades that EndNote is somehow less exportable (to smartphone, tablet, or other personal computers) than the other tool. Indeed, while Zotero and Mendeley have correspondent applications for iPhones and iPads, EndNote has not an equivalent tool.

These questionnaire results were validated through brief interviews to the 12 respondents. Generally, they were quite impressed by all the three tools, although 9 of them showed preference for Mendeley, said they would use them in the future for work, and considered it to be the best for Knowledge Management and reuse purpose. Furthermore, 10 of the respondents said that EndNote was a little bit old and seemed to be not suitable for importing other formats; although it is possible to import all most common formats, it is not a default option.

Since our goal was not to publicize a winner, a KM/reuse-oriented point of view must be taken. As said before, questions 2, 3, 4, belonging to *reliability* (completeness), and 22, 23, 24, belonging to *understanding/knowing the costumer*, were the most suitable to state if a general software solution could be appropriate for Knowledge Management. Marks on these categories are: 3 for EndNote’s and Zotero’s, nearly 4 for Mendeley’s *reliability*, respectively; nearly 2 for Mendeley’s and Zotero’s, nearly 4 for EndNote’s *understanding/knowing the costumer*, respectively. These results demonstrate that these software solutions may be used for reusing and managing documents, but they are not as suitable as to use them professionally on high level. Global means of their marks, all major than 3.8, show that their performances for the larger scope of reusing are appreciable, but it is not possible to extract them from their ‘PDF journal article’ context, which they are born for.

4 Conclusion

This work was a study aimed at stating if Reference Manager Software solutions are suitable for general Knowledge Management and reusing in various organizations, such as small companies, technical departments, research groups, and design studios. In order to answer to the question "Does the use of a Reference/Citation Management Software meet the requirements of Knowledge Management?", three of these software solutions, ***EndNote***, ***Mendeley***, and ***Zotero***, have been tested by 12 users belonging to a research group of a university, a design studio, and a technical department. A model for service quality, SERVQUAL, proposed by Parasuraman, Zeithaml, and Berry, was employed for designing 32 focused questions on the tested Citation Management Software solutions. The analysis of responses has shown that, although these environments may be helpful for general KM and reusing of documents in various formats, they can not be totally extracted from the context in which they were born, namely PDF storage. So, they are not powerful and complete enough to be placed in a framework which requires KM, reuse, and sharing at high level.

References

1. Lai, H. and Chu, T. Knowledge Management: A Review of Theoretical Frameworks and Industrial Cases. IEEE proceedings of the 33rd Hawaii International Conference on System Sciences. Pp 1-10 (2000)
2. Greiner, M.E., Böhmann, T., and Krcmar, H. A strategy for knowledge management. Journal of Knowledge Management. Vol 11:6, pp. 3-15 (2007)
3. Gandhi, S. Knowledge Management and Reference Services. The Journal of Academic Librarianship. Vol 30:5, pp. 368-381 (2004)
4. Natali, A.C.C. and Falbo, R.D.A. Knowledge Management in Software Engineering Environments. Proceedings of the 16th Brazilian Symposium on Software Engineering. Pp 238-253 (2002)
5. Davenport, T.H., De Long, D.W., and Beers, M.C. Successful Knowledge Management Projects. Sloan Management Review. Vol 4, pp. 43-57 (1998)
6. Liao, S. Knowledge management technologies and applications – literature review from 1995 to 2002. Expert Systems with Applications. Vol 25, pp. 155-164 (2003)
7. O'Leary, D.E. Enterprise Knowledge Management. Computer. Vol 31:3, pp. 54-61 (1998)
8. Huysman, M. and de Wit, D. A Critical Evaluation of Knowledge Management Practices. In: Ackerman, M., Pipek, V., and Wulf, V. Sharing Expertise: beyond knowledge management. The MIT Press, Cambridge, Massachusetts (2003)
9. Huysman, M. and de Wit, D. Practices of Managing Knowledge Sharing: Towards a Second Wave of Knowledge Management. Knowledge and Process Management. Vol 11:2, pp. 81-92 (2004)
10. Babar, M.A. and Gorton, I. A Tool for Managing Software Architecture Knowledge. IEEE 2nd Workshop on Sharing and Reusing architectural Knowledge Architecture, Rationale, and Design Intent. Pp 11-11 (2007)
11. Mead, T.L. and Berryman, D.R. Reference and PDF-Manager Software: Complexities, Support and Workflow. Medical Reference Services Quarterly. Vol 19:4, pp. 388-393 (2010)

12. Fenner, M. Reference Management meets Web 2.0. Cellular Therapy and Transplanation. Vol 2:6, pp. 1-3 (2010)
13. Butros, A. and Taylor, S. Managing information: evaluating and selecting citation management software, a look at EndNote, Refworks, Mendeley, and Zotero. IAMSLIC Conference Proceedings. Pp. 53-66 (2010)
14. Fitzgibbons, M. and Meert, D. Are Bibliographic Management Software Search Interface Reliable?: A Comparison between Search Results Obtained Using Database Interfaces and the EndNote Online Search Function. The Journal of Academic Librarianship. Vol 36:2, pp. 144-150 (2010)
15. Gilmour, R. and Cobus-Kuo, L. Reference Management Software: a Comparative Analysis of Four Products. Issues in Science and Technology Librarianship. Vol 66:66, pp. 63-75 (2011)
16. Hensley, M.K. Citation Management Software: Features and Futures. Reference & User Services Quarterly. Vol 50:3, 204-208 (2011)
17. McMinn, H.S. Library support of bibliographic management tools: a review. Reference Services Review. Vol 39:2, pp. 278-302 (2011)
18. Parasuraman, A., Zeithaml, V.A., and Berry, L.L. SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality. Journal of Retailing. Vol 64:1, pp. 12-40 (1988)
19. Parasuraman, A., Zeithaml, V.A., and Berry, L.L. A Conceptual Model of Service Quality and Its Implications for Future Research. Journal of Marketing. Vol 49:4, pp. 41-50 (1985)