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# KNOWLEDGE WASTE IN ORGANIZATIONS: A REVIEW OF PREVIOUS STUDIES

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## Abstract

In this paper, we are interested in the knowledge that is "wasted" in organizations, that is existing relevant knowledge that is overlooked in the process of knowledge conversion. Given the competitive pressure firms are facing in today´s business environment, a waste of knowledge is not only costly but also dangerous. This means that we consider knowledge from a knowledge at risk perspective. Having this in mind, the purpose of this paper is to review research on knowledge waste in organizations to establish our current body of knowledge regarding this topic. The study consists of a systematic review of 51 peer-reviewed articles addressing knowledge waste in organizations. To the best of the authors' knowledge, no systematic literature review on this topic has previously been published or presented. The topic seems to be a promising field for intensive research and offers a variety of future research avenues. In view of practitioners, the study´s finding may enable an increased awareness towards the areas where existing knowledge is at the mercy of "waste". This can assist practitioners to better cope with risks related to this waste and, therefore, better exploit the (limited) knowledge base available.

**Keywords:** Knowledge waste; Intangible assets; Knowledge management; Systematic review; Knowledge loss

## 1. INTRODUCTION

Among the different knowledge management activities (e.g. knowledge identification, knowledge creation, knowledge dissemination etc.), it seems that knowledge creation is viewed as more important than the other activities. Markus (2001), however, stresses (she talks about reuse) that the effective reuse of knowledge should take a stronger role, as it is clearly associated with organizational effectiveness. In the same vein, researchers have highlighted the link between the reuse of knowledge and developing competitive advantage (Szulanski, 1996). Consequently, one can assert that a strong consideration of existing knowledge can help firms to improve performance and thus sustain competitive advantage. Based on it, in this paper we will focus on knowledge that is not used. More precisely, we are interested in the knowledge that is "wasted" in organizations, an existing relevant knowledge which is overlooked in the process of knowledge conversion. (Ferenhof, 2011). Given the competitive pressure firms are facing in today´s business environment, a waste of knowledge is not only costly (Bolisani *et al.*, 2013) but also dangerous. As initiatives, which are, after all, repeating already existing knowledge instead of creating new knowledge or recombining it in new ways, it can result in situations in which valuable resources and time are bound and thus not available to other more important business operations. Consequently, this may be damaging not only for the company concerned but also for the economy, as continuously reinventing the wheel blocks from developing. In short, we look at knowledge from a knowledge at risk perspective, i.e. addressing situations in which knowledge that is not used becomes a liability or a risk (Durst, 2012). Against this background, the purpose of this paper is to review the research of knowledge waste in organizations to establish our current body of wisdom regarding this topic.

## 2. THEORETICAL BACKGROUND

The relevance of knowledge assets as fundamental strategic factors of successful business that have been widely recognized. (Barney, 1991; Drucker, 1993; Grant, 1991). In fact, more and more organizations attribute their competitiveness to their knowledge assets and specifically their exploitation, and consider knowledge as their distinguishing feature (Nonaka *et* Takeuchi, 1995). In such an environment, the suitable management of knowledge assets has become a strategic task for company success.

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According to Wiig (1993), knowledge management consists of seven activities: creation, sourcing, compilation, transformation, dissemination, application and value realization. In this context many studies have described ways of converting knowledge into value for organizations. One of them is the SECI model proposed by Nonaka *et* Takeuchi (1997) that involves four main activities: externalization, socialization, combination and internalization. The aim of this model is to extract the tacit knowledge of the people, convert it into explicit knowledge, archive it in the company, make other people learn and internalize it, so that it becomes tacit knowledge again. This proceeding sounds simple in theory, but in practice these processes are not that straightforward. These processes are accompanied by mistakes and disruptions, so instead of taking advantage of the knowledge available the danger is high that it is actually "wasted".

In order to address this challenge, particularly the activities of sourcing, compilation and application, many frameworks and models have been developed that propose the use of ontologies to tackle this issue. For example, Lee *et al.* (2006) state that ontology in conjunction with Semantic Web Technologies may help to represent and share various types of engineering change-related knowledge in specific contexts. On the other hand, Sherimon *et al.* (2012) highlight that ontologies have the potential for enabling true knowledge sharing and reusing among heterogeneous agents, both human and computer. Picking up this idea, Zhang *et al.* (2012), in a design context, suggest the use of ontology for modeling Product Service System (PSS) in order to improve prototyping for knowledge management and knowledge reuse.

Others authors (e.g. Aubry *et al.*, 2011; Buttler *et* Lukosch, 2013; Komi-Sirviö *et al.*, 2002) applied the idea of lessons learned (LL) to deal with the challenge. LL can be defined as the documented knowledge that is gained from experience for the purpose of improving future performance (Buttler *et* Lukosch, 2013). Komi-Sirviö *et al.* (2002) support the creation and maintenance of a LL database as an effective means to store and share knowledge in organizations. Aubry *et al.* (2011) confirmed that LL-related activities are good means to transfer knowledge. In project-based organizations (PBOs), for example, individuals collect and use LL in order to prevent the "reinvention of the wheel" or repetition of mistakes (Aubry *et al.*, 2011; Buttler *et* Lukosch, 2013). The reuse of knowledge is applied for knowledge sourcing, compilation and dissemination and focuses on the ability to locate and use previously generated knowledge (Watson *et* Hewett, 2006; Wee *et* Chua, 2013; Zhang *et al.*, 2013).

Thus, different actions have been developed to manage knowledge in a better way, but those actions could be improved (i.e. being more effective) if one would take into consideration the waste of knowledge that occur during the life cycle of knowledge management (KM) as proposed by Wiig (1993).

## 2.1 KNOWLEDGE WASTE

According to Ferenhof (2011), knowledge waste can be described as any failure in the process of knowledge conversion, better known as spiral of knowledge creation of Nonaka *et* Takeuchi (1997). Thereby, Ferenhof proposes that the waste can present itself in different ways: reinvention, lack of system discipline, underutilized people, scatter, hand-off, wishful thinking.

Reinvention is a type of waste that happens if the organization does not take advantage of the designed solutions, components, projects, experiences or knowledge previously created and/or acquired (Bauch, 2004). After project completion or expiration of maintenance contract, often the knowledge is not internalized, not put in use, or simply forgotten over time. This is likely to lead to efforts that can be equated with "reinventing the wheel" which represent themselves as repeated projects, mistakes or recurring issues (Almarshad *et al.*, 2010). So instead of reusing good practices, and thus supporting innovative practice, and preventing the reinvention of the wheel (Aubry *et al.*, 2011) likely outcomes are wasted activities and reduced project performance (Cheng, 2009; Dani *et al.*, 2006). As effective knowledge transfer is considered as one of the key success factors for company performance (Cheng, 2009), this knowledge reinvention must be avoided or reduced to a minimum. Consequently, if an organization is to succeed in reusing its knowledge assets, resources can be invested in continuous improvements of present and future knowledge stocks, instead of being wasted in efforts of reinvention (Fong, 2005).

Lack of system discipline covers a number of factors related to the clarity of objectives outlined in the organizations. More precisely it covers unclear goals and objectives; unclear rights, roles, responsibilities and rules; poor delivery dates; insufficient willingness to cooperate as well as incompetence or lack of training (Bauch, 2004).

Underutilized people refer to organization members that are not using their skills and expertise in full. Often this is a consequence of missing roles and responsibilities given to them, when in reality, they could assume much more if the process was designed more effectively (Locher, 2008).

Scatter refers to actions that make knowledge become ineffective because of flow disturbances, which is basically the disruption of interaction that is required for collaboration.

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This category can be divided into two sub-categories: communication barriers and poor tools. Communication barriers directly prevent knowledge flow occurrence. They include: a) physical barriers such as distance, computational incompatible formats, etc.; b) social barriers such as the firm´s hierarchy and management behavior that prevent communication and thus the flow of knowledge, and c) skill barriers that refer to people who are not capable of transforming data into usable knowledge (Ward, 2007). Poor tools, on the other hand, refer to the assumption that tools should support the flow of knowledge and not stifle this flow. As a consequence, the users of these tools may seek to take shortcuts, copy unsuitable operating modes, and therefore cause failures by being forced to use tools that have not been analyzed for their relevance and suitability. By insisting on using these tools, processes end up in a death spiral, i.e. the more one tries to improve the processes the worst the failures (Ward, 2007). Or, to put it another way, the scattered knowledge results in knowledge leakage, and knowledge leakage results in organizational inefficiency (Hu, 2008).

One example of scatter is highlighted by Cheng (2009), who states that knowledge from one project can be separated and scattered in different phases and owned by different participants. This is imaginable in temporary virtual organizations as well as in consulting firms. Those firms normally fail to capture and transfer knowledge that is scattered on those phases and thus increases the likelihood of waste, such as "reinventing the wheel". According to Padova *et* Scarso (2012), large enterprises also scatter knowledge objects. According to these authors, this is demonstrated by the number of documents the firms continuously create and store. It is difficult to access knowledge that is scattered across different projects, processes, trades, and people (Hu, 2008). In the same vein, Lijuan (2011) highlights that the main objective of KM implementation is to effectively manage knowledge which is scattered throughout business activities or hidden in the minds of staff.

Hand-off occurs when one separates knowledge, responsibility, action and feedback. It results in decisions made by people who do not have enough expertise to make the decision effectively or do not have the opportunity to accomplish it. Useless information and waits can be specified as subcategories (Ward, 2007). According to Ward (2007), information is useless when it does not help in understanding the customers, because the information does not add value to flow, innovation, and improved decision-making. Instead it would actually be created to fulfill someone's own interests. Waits, on the other hand, normally occurs through the establishment of standard conventional sequencing of activities, which creates a batch processing and causes slow processes. A single path to follow, instead of multiple streams or paths of information and a large variation of work in the batch cause the waste of scatter (Ward, 2007).

Wishful thinking means to follow the subject's own reasoning, based on interests, wishes rather than on facts or rationality, or decision-making is based on one's own perception of reality respectively. For Ward (2007), this means operating in the dark, blindly making decisions without consistent and backing data. This aspect can be divided into specification test and discarded knowledge. Specification test is a practical conventional pattern. This means it cannot be assessed whether a good or service is ready for commercialization, i.e. it is statistically impossible to execute enough tests to be confident that there are zero defects (Ward, 2007). On the other hand, discarded knowledge happens for a number of reasons. For example, teams and superior focus on the product or service launch, thereby leaving aside the capture of knowledge. While the specification tests used do not provide enough information to be used in forthcoming projects and, to make it even more complex, just a few people know how to turn the data available into usable knowledge (Ward, 2007).

In conclusion, the authors of this paper believe that the (negative) consequences of knowledge waste are high. The organization is in a continued reinvention process and loses valuable financial and non-financial resources. For example, the waste of knowledge may reduce the time resources available to innovation, thus challenging firm´ competitiveness (Baxter *et al.*, 2008). Another consequence could be that the firm fails to offer high quality solutions (Demian *et* Fruchter, 2009). Additionally, any investments in KM activities would be very difficult to justify, as one of the main reasons for disappointment regarding these investments is assigned to missing knowledge reuse (Liu *et al.*, 2013). Given the role of knowledge as the most important strategic factor for firms (Spender 1996) such waste needs to be understood by both the academic and practitioner communities.

## 3. METHODOLOGY

In the review process, the authors adopted the principles of a systematic review as recommended by Jesson *et al.* (2011) namely: Mapping the field through a scoping review, comprehensive search, quality assessment, data extraction, synthesis, and write up.

First, a research plan was developed comprising the research questions of interest, the keywords, and a set of inclusion and exclusion criteria. The paper's onjective was to determine the current status of research on knowledge waste.

We conducted two different researches, the first one focused on understanding the definition of knowledge

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waste and loss that may occur in companies. The query of this research was "knowledge AND (waste OR discard OR fling OR toss OR "toss out" OR "toss away" OR "chuck out" OR "cast aside" OR "dispose" OR "throw out" OR "cast out" OR "throw away" OR "cast away" OR "put away" OR "missing" OR "squandered" OR "stray" OR "straying" OR lost OR loss OR "knowledge waste" OR "knowledge loss" OR "waste of knowledge". The second query used "knowledge management" AND (reinvention OR "lack of system discipline" OR "underutilized people" OR scatter OR hand-off OR "wishful thinking" OR "knowledge waste" OR "waste of knowledge" OR "knowledge reuse". Additionally, inclusion and exclusion criteria were specified. The inclusion criteria were: peer-reviewed academic papers, English language and the databases Compendex, Scopus and Web of Science. Grey literature such as reports, books and non-academic research; and other languages than English represented exclusion criteria. Moreover, an excel data sheet was produced consisting of key aspects related to the research aim. In the given case these were: name of author(s), year of publication, research aim/objectives, theoretical perspective/ framework, method, main findings, and name of the journal.

Second, once all relevant issues had been specified, two of the authors accessed the databases and looked for suitable articles. The first search had been carried out on June 4, 2013 and resulted in one hundred thirty-nine hits. The second search took place on March 10, 2014 and resulted in three hundred and seventy hits. A third round was conducted on July 1, 2014 which brought about twenty-seven additional hits; resulting in total number of five hundred thirty-six hits.

The third step consisted of two procedures. Firstly, the authors jointly worked through the abstracts to make sure that they actually covered the pre-defined scope. This procedure yielded a final selection of three hundred fifity-five articles. Secondly, the three hundred fifty-five papers were divided among the authors. Subsequently, the authors entered the relevant data regarding the research purpose in the excel sheet. Then, the authors jointly went through each data entry and discussed the content. In the case of possible reservations on the part of the author who had not read the article, the authors went through the article in question. This procedure resulted in a further reduction of the number of papers. In the end, the authors reached a final selection of Fifty-one articles, which fulfilled the criteria, set and thus represented the basis for analysis. This approach helped to alleviate the risk of any inconsistency in the analysis and the conclusion drawn from there.

Fourth, the final excel sheet was jointly discussed involving all authors. This discussion enabled the authors to categorize the findings under themes, which in turn, helped to clarify what is known about knowledge waste and to which areas the body of knowledge is limited. Fifth, the final stage of the review process was devoted to writing up the findings.

## 4. PRESENTATION OF FINDINGS

Among the Fifty-one papers that formed the basis for our analysis, the oldest publication is from 1999 and the most recent ones are from 2013. Most papers were published in 2006, 2008, 2011, 2012, and 2013, which suggests that the topic is of emerging interest and relevance.

In the sections below we present our analysis concerning the following aspects: general observations, which outline the research methods applied. After that, the study's main findings according to the themes identified are presented.

### 4.1 General observations

With regard to the methodology, the most common method applied is the case study approach. This is followed by surveys and model approaches. Other methods such as ethnography (e.g. Demian *et* Fruchter, 2006), mixed methods approaches (e.g. Aubry *et al.*, 2011) are less frequently used.

The Fifty-one papers were published in different journals, which can be assigned to the fields of operations, technology and management; information management; sector studies; general management; entrepreneurship and small business management; and organization studies. This suggests the topic interests a broad audience.

Research in this area has been conducted in different countries and regions and thus seems to be of a global interest as can be seen in Table 1.

4.2 Body of knowledge regarding knowledge waste

We summarized the main findings of the investigated studies under seven broad themes:

- Application of KM approaches for knowledge reuse
- Consequences/implications of knowledge loss/waste
- Factors promoting/hampering knowledge reuse
- ICT solution
- KM practices relating to knowledge reuse
- Theoretical framework/Theory development
- Other issues

In the following the findings for each theme are presented.

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**Table 1.** Research on knowledge waste by author, year and first author country

| Author(s) | Year | Country |
|---|---|---|
| Allsopp et al. | 2002 | Cranfield University, UK |
| Aubry et al. | 2011 | Montreal Quebec Canada |
| Ba et al. | 2008 | University of Connecticut, Storrs, CT, USA |
| Baxter et al. | 2007 | Cranfield University, UK |
| Baxter et al. | 2008 | Cranfield University, UK |
| Bennet & Bennet | 2008 | Mountain Quest Institute, Marlinton, West Virginia, USA. |
| Berkani & Chikh | 2010 | Faculty of Computer and Electrical Engineering, Algeria |
| Berkani & Chikh | 2013 | Faculty of Computer and Electrical Engineering, Algeria |
| Biong & Ulvnes | 2011 | Norwegian School of Management, Oslo, Norway |
| Boh | 2008 | Nanyang Technological University, Singapore |
| Chai & Nebus | 2012 | National University of Singapore. Singapore |
| Chauhan & Bontis | 2004 | University of Pennsylvania, USA |
| Cheung et al. | 2008 | University of Hong Kong, Hong KOng |
| Dave & Koskela | 2009 | University of Salford, UK |
| Demian & Fruchter | 2006 | Loughborough University, UK |
| Demian & Fruchter | 2009 | Loughborough University, UK |
| Durst & Wilhelm | 2012 | University of Liechtenstein, Vaduz, Principality of Liechtenstein |
| Durst & Wilhelm | 2011 | University of Liechtenstein, Vaduz, Principality of Liechtenstein |
| Ficet-Cauchard et al. | 1999 | GREYC-ISMRA, France |
| Fong & Dettwiler | 2009 | The Hong Kong Polytechnic University, Kowloon, Hong Kong |
| Fong & Lee | 2009 | The Hong Kong Polytechnic University, Kowloon, Hong Kong |
| Fruchter & Demian | 2002 | Stanford University, Stanford, California, USA |
| Garcia-Fornieles et al. | 2003 | Cranfield University, UK |
| Gu et al. | 2011 | The Hong Kong Polytechnic University, Hong Kong |
| Hsiao et al. | 2006 | National University of Singapore, Singapore |
| Kulkarni et al. | 2006 | Arizona State University, USA |
| Kumar | 2012 | Stockholm University School of Business, Stockholm, Sweden |
| Lee et al. | 2006 | Massachusetts Institute of Technology, USA |
| Lettice et al. | 2006 | University of East Anglia, Norwich, UK |
| Lin & Fan | 2011 | DePaul University, Chicago, USA |
| Liu et al. | 2013 | National University of Singapore, Singapore. |
| Majchrzak et al. | 2004 | Marshall School of Business, University of Southern California, USA |
| Majchrzak, A; et al. | 2013 | University of Southern California, USA |
| Markus | 2001 | University of Southern California, USA |
| Massingham | 2008 | University of Wollongong, Australia |
| McQade et al. | 2007 | University of Limerick, Limerick, Ireland |
| Menolli et al. | 2013 | Pontifícia Universidade Católica do Paraná, Curitiba, Brazil |
| Michael | 2007 | University of Wollongong, Australia |
| O'Leary | 2001 | University of Southern California, USA |
| Padova & Scarso | 2012 | Ernst & Young, Milano, Italy |
| Petter & Randolph | 2009 | University of Nebraska at Omaha, Omaha, NE, USA |
| Petter & Vaishnavi | 2008 | University of Nebraska at Omaha, USA |
| Sarnikar & Zhao | 2008 | Dakota State University, Madison, SD, USA |
| So & Bolloju | 2005 | ity University of Hong Kong, Hong Kong |
| Soon et al. | 2010 | Central Queensland University, Mackay, Australia |
| Tserng et al. | 2009 | National Taiwan University, Taiwan |
| Watson & Hewett | 2006 | University of Delaware, USA |
| Wee & Chua | 2013 | Nanyang Technological University of Singapore, Singapore. |
| Wu | 2009 | National Sun Yat-Sen University, Taiwan |
| Zhang et al. | 2013 | Shanghai Institute of Technology, China |
| Zhang et al. | 2012 | University of Bath, UK |

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### *Application of KM approaches for knowledge reuse*

Three papers were assigned to this theme (Table 2). The authors report the contribution of knowledge management tools and techniques to knowledge reuse. For example, Ficet-Cauchard *et al.* (1999) propose a CBR module that makes easier the retrieval of information and knowledge steps. While Garcia-Fornieles *et al.* (2003) highlight that their integrated WBS approach is able to cope with changing information availability of the different stages of the project life cycle.

Table 2. Literature on the application of KM approaches for knowledge reuse

| Year | Author(s | Research aim/objectives | Theoretical background/ framework | Method | Main findings |
|---|---|---|---|---|---|
| 1999 | Ficet-Cauchard et al. | To represent and structure the knowledge of different IP experts so as to enable knowledge sharing and reuse. | n/a | Theoretical case-Study | Proposition of a CBR module that provides assistance to knowledge reuse. It enables retrieval of information and knowledge steps, thus enabling users to build a plan by combining parts of other plans. Criteria for selecting cases are based on a definition of IP tasks and a description of images. |
| 2003 | Garcia-Fornieles et al. | To present an integrated WBS approach for managing the work scope in aircraft modification projects to reuse knowledge | n/a | Action Research | This paper has contributed to understand the dynamic nature of the WBS through a project life cycle. A concurrent engineering approach for information generation and sharing has been taken and an agreed integrated WBS has been developed that incorporates the different views and needs of the people involved in an aircraft modification project. |
| 2007 | Michael | The main objective of the paper is to tell the story of the impact that Open Text Livelink had on 95,000 employees and their information sharing practices in a corporation that spanned a presence in over 150 countries between 1996 and 2002. | n/a | Case study conducted with Southern Networks Corporation | The paper highlights the role of people in the success of KMS and provides examples of the knowledge sharing dynamics. |

### *Consequences of knowledge loss/waste*

Three papers provide insights into the consequences of knowledge loss/waste (Table 3). McQade *et al.* (2007), for instance, stressed the different types of knowledge that may be lost because of exiting (experienced and expert) employees, i.e. communication skills and understanding of the company culture.

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**Table 3**. Literature on the consequences/implications of knowledge loss/waste

| Year | Author(s) | Research aim/objectives | Theoretical background/ framework | Method | Main findings |
|---|---|---|---|---|---|
| 2011 | Biong & Ulvnes | This study examines how the key contact employee's human capital, the social capital between the contact employee and the client, and the service company's structural capital affect the decision whether to follow the key contact employee to another professional service firm. | Literature on human capital, social capital and structural capital | Survey conducted in 327 large advertising firms | Higher levels of structural capital can reduce the value of the contact employee's investments in human capital should the employee leave. |
| 2012 | Kumar | To examine the effects of human capital loss on relationships with clients in knowledge-intensive born global firms, and explain how firms address the challenges resulting from employee attrition. | Literature on IC and dynamic capabilities | Multiple case study involving four KIS firms from India | The findings provide new insights into the risk factors involved in the development of customer intimacy. |
| 2007 | McQade et al. | To identify the potential loss of company knowledge and expertise as experienced and expert employees retire. | n/a | Series of face to face interviews with experienced and expert people located in five countries | In addition to the potential loss of technical product and process knowledge and expertise, there is a loss of expertise in interpersonal communication skill both in the company and in communication with companies and people who are suppliers and customers, in knowing the company culture and the way things are done and in the loss of maturity and stabilising influence. |

***Factors promoting/hampering knowledge reuse***

The majority of papers can be assigned to this theme (Table 4). Regarding factors hampering knowledge reuse the studies highlighted the failure to provide learning benefits (Chauhan *et* Bontis, 2004), novelty of problems, conditions within organizations (e.g. social norms), types of available knowledge, and methods of reusing knowledge (Petter *et* Randolph, 2009), overall costs involved (Watson *et* Hewett, 2006). As regards factors supporting knowledge reuse, the contribution of the owner/managing directors as creator and driver of KM activities (Wee *et* Chua, 2013), willingness of people to contribute valuable knowledge (Watson *et* Hewett, 2006) were mentioned.

**Table 4.** Literature on factors promoting/hampering knowledge reuse

| Year | Author(s) | Research aim/objectives | Theoretical background/ framework | Method | Main findings |
|---|---|---|---|---|---|
| 2011 | Aubry et al. | To provide an understanding of Project Management Offices (PMOs) as communities of practice. | Literature related to project management office, communities of practice, and governance. | Mixed methods approach (i.e. multiple case studies, qualitative and quantitative methods, and social network analysis) | The initial results suggest that the community of practice theory presents legitimacy in the study of knowledge management within organizational project management. |

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| 2004 | Chauhan & Bontis | To examine a possible way to improve groupware implementations. | Literature on organizational learning and groupware | Semi-structured interviews with a UK global information provider | The findings show that groupware's failure to provide full learning benefits is a result of a mismatch between the technology and the organizational context |
| 2008 | Cheung et al. | To examine the effects of knowledge reuse on individual creativity outcome | Literature on knowledge reuse and creativity | Subjects from a pool of undergraduate business school students from a Hong Kong university (128 students), experimental design | The results suggest that knowledge reuse resulting from an intranet based repository type of knowledge management system actually inhibits the creative performance of individuals, especially on the qualitative dimension. |
| 2009 | Demian & Fruchter | To look into the importance of exploring the evolution of a design before reusing that design. | Research on design knowledge reuse | N/A | The paper highlights the role of storytelling as a helpful metaphor to be adopted in a tool to explore design evolution. |
| 2012 | Durst & Wilhelm | To examine and understand how the danger of knowledge attrition unfolds in the case of a German medium-sized business in the printing sector | Literature on KM | Case Study based on a series of semi structured interviews with members of a German medium-sized enterprise active in the printing sector | The findings demonstrate the influence of a precarious financial situation on activities related to knowledge management and succession planning. Although the organization members are aware of obvious needs for improvement within the firm, their actual scope of action is centered on the execution of current orders. |
| 2009 | Fong & Lee | To show the nature of property professionals' acquisition, sharing and reuse of knowledge in their work. | Literature on knowledge and its management and property management | Survey conducted with management firms in Hong Kong | Property managers have close contact with professionals within and beyond their profession, allowing them to tap into and share knowledge across organizational boundaries. Although property managers are willing to share knowledge with others, the study revealed no evidence to show that there are formal knowledge management strategies in PM firms. |
| 2002 | Fruchter & Demian | This paper presents ongoing research on design knowledge reuse that introduces the notion of knowledge in context from a corporate perspective. | Literature on KM | Ethnography study conducted in a structural design office in California | The authors identified three steps in the process of internal knowledge reuse: find, explore evolution history, and explore project context. They also describe CoMem, a prototype corporate memory system that supports these three activities using three modules: an overview, a project context explorer, and an evolution history explorer. |
| 2011 | Lin & Fan | To investigate the factors that affect employees' behavioural intention of continued usage of EKRs in public accounting firms. | Literature on electronic knowledge repositories, expectation-confirmation theory | Survey conducted in four large public accounting firms | The findings offer insights in the factors that impact individuals' attitude and intention to use EKRs, and elucidate how firms can leverage EKRs to promote knowledge reuse and retention. |
| 2013 | Majchrzak et al. | To explore the Wiki affordance of enabling shaping behaviour within organizational Intranets supported by Wikis. | Research on organizational knowledge reuse | Online survey involving 168 individuals | In conclusion, while previous theories of knowledge reuse assumed that integration was done implicitly and/or limited to a few privileged individuals or organizational routines, Wikis help us to reflect on knowledge reuse when such an assumption is no longer warranted. Wikis make integrative behaviors explicit, broadly distributing to the entire community the opportunity to shape. |
| 2012 | Padova & Scarso | To show that a codification, technology-based approach to KM cannot be successfully pursued without taking into due account the cognitive and organizational aspects of the application context. | Literature on KM | Descriptive and exploratory case study conducted with Ernst & Young | Highlight the importance of having convinced people to change their minds and behavior |

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| 2009 | Petter & Randolph | To examine the reuse of knowledge associated with soft skills among IT project managers, specifically when managing user expectations. | Literature on KM in IT, knowledge transfer and reuse | Case study involving interviews with IT project managers from a single organization | The authors identified several themes associated with reusing knowledge on IT projects: novelty of problems, conditions within the organization, types of available knowledge, and methods for reusing knowledge. |
| 2005 | So & Bolloju | To provide an understanding on IS/IT professionals' intentions to share and reuse knowledge in the context of information technology service operations. | Literature on KM and IT management | Survey, 170 working IT professionals who were studying a part-time master degree program at a large university | The results indicate that the theory of planned behavior is an adequate model for investigating behavioral intentions of knowledge sharing and reuse in the context of information technology service operations. |
| 2010 | Soon et al. | This research focuses on the examination of how knowledge, created by a learning and teaching community in forums within an online learning environment, can be reused when a subject is run again or handed over to a different colleague later. | Literature on learning and teaching | Eight experienced subject coordinators who have used online forums in teaching. They were from three different university schools and different disciplines. | The findings indicated that a lot of "wheel reinventing" of subject material writings can be saved and teaching preparations can be improved by reusing knowledge from past sessions. Although the focus group used for this research, was conducted in one university, it is believed that the findings are applicable to the reuse of knowledge in e-learning environments in general. |
| 2006 | Watson & Hewett | To develop a multi-theoretical model that addresses (1) the willingness of individuals to contribute their knowledge to the system; and (2) the rate at which individuals access and reuse knowledge within the system. | Literature on KM, expectancy theory | Survey to a sample of 900 employees from a multinational services firm | Demonstrate the link between the costs involved in the implementation of a KM system and company advantage. Additionally, the importance of having employee willing to contribute valuable knowledge to the system was underlined. |
| 2013 | Wee & Chua | The objectives of this study are two-fold. The first is to examine the peculiarities of KM processes that are unique in SMEs from three perspectives, namely knowledge creation, knowledge sharing and knowledge reuse. Secondly, to identify enablers and impediments of these KM processes that influences the competitiveness of SMEs. | Literature on KM in SMEs | Case study involving 21 participants from four Singaporean SMEs | In SMEs, knowledge creation takes the form of innovative customized solutions to meet customers' needs; knowledge sharing occurs through cross functionality, overlapping roles, and facilitated by close physical proximity in open workspaces; and knowledge reuse is often made tacitly, where common knowledge is prevalently embedded within the KM processes of SMEs. |

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ICT solutions

Six papers proposed ICT solutions to better cope with knowledge reuse (Table 5). For example, Allsopp *et al.* (2002) developed a relational database based on the CommunKads to facilitate knowledge reuse. Baster *et al.* (2008), proposed a framework to integrate requirements and the design of knowledge reuse. Gu *et al.* (2011) proposed a method to discover and capture organizational knowledge for reuse. Lee *et al.* (2006) developed a model to facilitate the accumulation of knowledge for reuse and finally Zhang *et al.* (2013) proposed a novel method to reuse knowledge. The authors demonstrated the usefulness of risk archetypes and scenario models as suitable means to knowledge retrieval and reuse.

Table 5. Literature on ICT solutions

| Year | Author(s) | Research aim/ objectives | Theoretical background/ framework | Method | Main findings |
|---|---|---|---|---|---|
| 2002 | Allsopp et al. | To develop a relational database architecture to retain and export CommonKADS specifications of Expert System and agent components to facilitate knowledge resuse across a wide range of applications. | CommonKADS methodology | Design of database followed an iterative approach | Demonstrated that CommonKADS knowledge model can be stored in a relational database. |
| 2007 | Baxter et al. | To describe an approach for reusing engineering design knowledge | Literature on design reuse | The methodology is based on a interaction between a product model and a process model. Mainly theoretical/conceptual. Yet, the approach is tested using a case study example | The method proposed highlights the need to reuse engineering design knowledge. Three knowledge types are supported: process knowledge, product knowledge and task knowledge |
| 2008 | Baxter et al. | To propose a framework to integrate requirements management and design knowledge reuse | Literature on design reuse and requirements management | Requirements management method. Mainly theoretical/conceptual. Yet, the approach is tested using a case study example | The proposed framework enables the application of requirements management as a dynamic process, including capture, analysis and recording of requirements. |
| 2011 | Gu et al. | To introduce a Multi-faceted and Automatic Knowledge Elicitation System (MAKES) for the purpose of discovery and capture of organizational knowledge | N/a | Case study in a public organization of Hong Kong | Using the MAKES the time, the cost and the workload on taxonomy development and maintenance can be reduced. |
| 2006 | Lee et al. | To develop a model and prototype support system for ECM to facilitate the accumulation and reuse of the knowledge generated in collaborative engineering change processes. | Literature on KM | Modeling | According to the authors, the proposed model offers the following advantages: 1) it provides a basis for the integration of informal and unstructured off-line collaboration with structured online workflows, 2), the collaboration model demonstrated how Semantic Web technology can help represent and share various types of engineering change-related knowledge in context. 3, in order to store, search, and retrieve engineering cases efficiently, the CBR technique was used along with the concept-based similarity measure. |
| 2013 | Zhang et al. | To propose a novel method to reuse the process knowledge with different manufacturing resources. | Literature on manufacturing KM | Theoretical case study | To propose a prototype system that can be used for knowledge capture and reuse |

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Insights into KM practices relating to knowledge reuse

Four papers were assigned to this theme (Table 6). The authors of this category discuss the importance of knowledge management practices to reuse knowledge. In example, Dave *et* Koskela (2009) focused on knowledge creation and transfer process. Demian *et* Fruchter (2006), also deal with the process but the developed a computer system to deal with this issue. Durst *et* Wilhelm (2012) highlight the knowledge attrition and examined the risks of it. Fong *et* Lee (2009), give emphases on the nature of the property of knowledge acquisition, share, transfer and reuse. Hsiao et al. (2006) studied how KM can assist on knowledge reuse. Wee *et* Chua (2013) identified impediments and enablers for knowledge reuse based on the peculiarities of the KM process.

**Table 6.** Literature on KM practices relating to knowledge reuse

| Year | Author(s) | Research aim/ objectives | Theoretical background/ framework | Method | Main findings |
|---|---|---|---|---|---|
| 2006 | Demian & Fruchter | To investigate the process of knowledge reuse by architecture, engineering, and construction (AEC) practitioners as a precursor to designing a computer system that would support this reuse | Literature on KM | Ethnography including interviews and workplace observations of AEC practitioners. More precisely a structural design office of Z Inc. Structural Engineers and Builders in Northern California was involved | The study indicates that knowledge reuse in AEC design practice occurs largely through social knowledge networks. Even when reuse from an external repository occurs, a human expert is usually needed to provide proactive input on what to reuse and contextual information on the designs being reused. These observations are attributed to the effectiveness of internal knowledge reuse, the reuse of knowledge from one's personal experiences. The study also shows the contribution of a corporate memory to design knowledge reuse. |
| 2011 | Durst & Wilhelm | To examine how a medium-sized enterprise might identify and manage its critical knowledge. | Literature on KM | Case Study based on a series of semi structured interviews with members of a German medium-sized enterprise active in the printing sector | The study's aim was to gain better insights into how a medium-sized company manages its knowledge. The particular interest was to find out how the firm handles knowledge attrition caused by staff turnover or long-term absence of critical staff members. The findings are summarised in a static knowledge map. |
| 2004 | Majchrzak et al. | To better understand the knowledge reuse process when radical innovation is expected. | Literature on knowledge reuse | Case-Study involved 6 cases of reuse for innovation at Jet Propulsion Laboratory | The authors found that reusers in the JPL context balanced the paradox of identifying a non-traditional untested conceptual approach to the problem against the need for risk reduction by picking only those approaches in which they had some confidence. |
| 2001 | O'Leary | This article focuses on explicit knowledge and the extent of its reuse. This article investigates the extent to which people reuse knowledge to solve decision problems. | Literature on KM and knowledge reuse | Case study involving the big 5 professional services firms (i.e. Arthur Andersen, Deloitte & Touche, Ernst & Young, KPMG Peat Marwick, and PriceWaterhouseCoopers). | This research shows the extent of knowledge reuse within a period and over time. |

***Theoretical framework/theory development***

Sixteen papers were aimed at developing a theory of reuse and theoretical frameworks respectively (Table 7). Ba *et al.* (2008) aimed at effectively organizing, integrating, and reusing knowledge. Bennet *et* Bennet (2008) focused on developing a framework regarding the characteristic of sustainability of knowledge for communities. Berkani *et* Chikh (2010) proposed a process for knowledge reuse within a community of practice. In their 2013 paper, Berkani *et* Chikh (2013) semantically described the community of practice learning assets. Chai *et* Nebus (2012) focused on the efficiency of knowledge reuse. Kullkarni *et al*. (2006) developed a system to share and reuse knowledge based on the perceptions of usefulness and user satisfaction. Lettice *et al.* (2006) presented a measurement framework to capture the importance of the knowledge for the new product development process. Liu *et al.* (2013) provided a systematic framework to analyse knowledge reuse. Markus (2001) proposed a theory of knowledge reuse by emphasizing the role of knowledge management systems. Massingham (2008) developed a conceptual model that shows the impact of knowledge loss due to exiting employees. Menolli *et al.* (2013) proposed social tool to learn and facilitate the knowledge reuse. Petter *et*

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Vaishnavi (2008) used the narratives to improve knowledge reuse among software project managers. Sarnikar *et* Zhao (2008) proposed a pattern-based knowledge framework for automating the knowledge flow at organizations. Tserng *et al.* (2009) proposed and approach to extract knowledge and develop a project's risk ontology. Wu (2009) presented a methodology to manipulate form-based knowledge. Finally, Zhan *et al*. (2012) developed an integrated framework for knowledge reuse to product service systems.

**Table 7.** Literature on theory development/theoretical frameworks

| Year | Author(s) | Research aim/objectives | Theoretical background/ framework | Method | Main findings |
|---|---|---|---|---|---|
| 2008 | Ba et al. | To develop a method that is aimed at effectively organizing, integrating, and reusing knowledge and model components from various sources across an organization | Literature related to KM and knowledge representation | Based on a three-tier web-based architecture (as their organizational computing environment) | Presentation of a model that is intended to act as a decision support tool for operational and strategic corporate decision-making problems. |
| 2008 | Bennet & Bennet | To investigate the characteristics of building sustainable knowledge for communities and cities with a focus on the social process of knowledge mobilization | Literature on knowledge and reuse | Conceptual paper | The authors propose a new frame of reference for looking at social knowledge mobilization and knowledge sustainability. |
| 2010 | Berkani & Chikh | To propose a process for knowledge reuse within a Community of Practice of E-learning (CoPE) | Literature on KM and knowledge reuse in CoPs | n/a | The proposed process is based on the identification and representation of knowledge and is supported by two pillars: (1) members' profiles for adaptive knowledge access; and (2) the definition of the intentions of reuse. |
| 2013 | Berkani & Chikh | To semantically describe the CoPE's learning assets using semantic annotations | Literature related to the representation of learning assets and online communities | Mainly theoretical/ conceptual. Yet, the framework is illustrated using a case study example | The paper proposes a new way for representing learning assets using contextual semantic annotations in order to foster the sharing and reuse between members of the community. |
| 2012 | Chai & Nebus | To prescribe a KM strategy that maximizes organizational knowledge reuse efficiency (KRE). | Literature on interpersonal knowledge transfer and KM systems and their use, and Ozanne and Churchill's five-stage model | Theoretical reasoning including a simulation | Development of a theoretical model, which takes into account the reuse process to explain how an organization can maximize its KRE by implementing a KM strategy contingent on organizational characteristics. |
| 2006 | Kulkarni et al. | To examine a KM success model that incorporates the quality of available knowledge and KM systems built to share and reuse knowledge such as determinants of users' perception of usefulness and user satisfaction with an organization's KM practices. | Literature on KM | Modeling | The authors propose a KM success model derived from the IS success model of DeLone and McLean and Seddon. |
| 2006 | Lettice et al. | To present a measurement framework to capture the importance of the use of knowledge within the new product development (NPD) process. | Literature on knowledge measurement | Literature Review | Provide a synthesis of research on NPD metrics discussed from a knowledge perspective |

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| 2013 | Liu et al. | This paper aims to provide a systematic framework for organizations to analyze their knowledge reuse processes, and balance codification and personalization within their knowledge strategy according to cost/ benefit analysis | Literature on knowledge reuse | Modeling | The study highlights that organizations need to consider factors such as the number of reusable knowledge items, reuse patterns, and intra-organizational interest alignment which are critical to determine their optimal mix between codification and personalization. |
| 2001 | Markus | The purpose of this paper is to begin building a theory of knowledge reusability, with particular emphasis on the role of knowledge management systems and knowledge repositories | Literature on knowledge creation and knowledge reuse | Conceptual paper | There are at least four distinct knowledge reuse situations involving different types of knowledge reusers: shared work producers, shared work practitioners, expertise -seeking novices, and secondary knowledge miners. |
| 2008 | Massingham | To examine the impact of knowledge loss as a consequence of people exits | Literature on KM, knowledge loss and IC | Case study conducted with Australian Department of Defence | The author suggests a preliminary conceptual model that amongst others shows the causal links in the loss of knowledge caused by the exit of valuable employees. |
| 2013 | Menolli et al. | To propose an approach to learning objects and units of learning from social tools to facilitate knowledge reuse. | Literature on KM | Conceptual paper | Amongst others the approach suggests that it can help to maintain the organizational pattern and minimize the reinvention of solutions and the repetition of errors |
| 2008 | Petter & Vaishnavi | This research seeks to improve the reuse of a specific type of knowledge among software project managers, experiences in the form of narratives. | Literature on knowledge reuse | Conceptual paper | The authors proposed a model for project managers to reuse the experiences of others based on design theory. |
| 2008 | Sarnikar & Zhao | To propose a new approach called pattern-based knowledge workflows for automating the flow of knowledge in organizations. | Literature on knowledge flow models | Conceptual paper | Approach of formalizing ad hoc knowledge workflows based on knowledge workflow patterns |
| 2009 | Tserng et al. | To propose an approach to extract knowledge and develop a project´s risk ontology. | Literature on KM, information retrieval, knowledge ontology and risk management | Conceptual paper | Developed an ontology-based risk management approach |

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|---|---|---|---|---|---|
| 2009 | Wu | To present a methodology to manipulate form-based knowledge | Literature on KM, knowledge reuse and sharing, and cognitive fit theory | Modeling | Amongst others, the resulting system can alleviate the difficulty in knowledge reuse. |
| 2012 | Zhang et al. | This study aims to develop an integrated knowledge management and reuse framework for Product-Service Systems business in construction machinery industry. | Literature on KM and PPS | Modeling | The developed knowledge management and reuse system can help Product-Service Systems design for construction machinery. |

### *Other issues*

Four papers were assigned to this category (Table 8). Fong and Dettwiler (2009), for example, developed a model that looks into the knowledge creation relationship of entrepreneurial firms and environmental context.

**Table 8.** Literature on other issues related to knowledge reuse

| Year | Author(s) | Research aim/objectives | Theoretical background/ framework | Method | Main findings |
|---|---|---|---|---|---|
| 2008 | Boh | To examine the problem of knowledge reuse from repositories | Theoretically based on Argote (1999) and Szulanski´s (1996) frameworks | Mixed method approach (involving interviews and a survey) conducted in an organization that does management and technical consulting work | The study takes a first incremental step to building theory on knowledge reuse. It also provides some insights into complementing the use of knowledge repositories with person-to-person social interactions. It highlights the need to recognize that social processes can complement the use of knowledge-sharing mechanisms. |
| 2009 | Dave & Koskela | To discuss the importance of collaborative knowledge management in organisations, of knowledge creation and transfer, types of knowledge management systems and classification of knowledge work. | Literature on KM | Case study focusing on a particular knowledge sharing problem involving a SME operating in construction | The study shows the implementation of a collaborative knowledge management solution in the case company. |
| 2009 | Fong & Dettwiler | To develop a model that depicts the knowledge creation relationship of entrepreneurial firms in particular and its environmental context related to real estate management. | Literature on entrepreneurial firms and knowledge creation | Survey involving Swedish Gazelle companies | The paper shows that real estate decisions are strongly related to the particular environment and conditions that prevail for entrepreneurial firms. |
| 2006 | Hsiao et al. | To examine how knowledge management problems and technology adoption difficulties can be analysed through experts' practices embedded in their work contexts | Taxonomies of knowledge | Case study (process-tracing method) involving an Asian office of a leading US-based semiconductor-fabrication equipment | The research suggests that knowledge management problems and system adoption difficulties must be understood in relation to knowledge attributes (knowledge-as-object, knowledge-as-cognition, and knowledge-as-capability) and people's practices embedded in their work contexts. |

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## 7. CONCLUSIONS

Against the background of the growing concern of both scholars and practitioners regarding the implementation knowledge management initiatives, the aim of this study was to pay particular attention to the knowledge that is "wasted" in organizations, that exists relevant knowledge that is overlooked in the process of knowledge conversion. Even though many studies have focused on knowledge reuse, they have not highlighted the topic from knowledge at risk perspective meaning situations in which knowledge that is not used becomes a liability or a risk (Durst, 2012). Accordingly, the purpose of this paper was to review research on knowledge waste in organizations to establish our current body of knowledge regarding this topic. To do so we conducted a systematic literature review to identify suitable articles. A final set of fifty-one articles formed the basis for our analysis.

Our review makes clear that the body of knowledge regarding knowledge waste in organizations is still limited. The main findings were categorized into seven broad themes: Application of KM approaches for knowledge reuse, consequences/implications of knowledge loss/waste, factors promoting/hampering knowledge reuse, ICT solution, KM practices relating to knowledge reuse, Theoretical framework/Theory development, and other issues.

The findings suggest that the existing literature provides only fragmented insights into knowledge waste in organizations. Given the importance of knowledge to company, a better understanding of this aspect is very important. Our present study clearly underlines that the topic still calls for more research, which in turn offers scholars a variety of research avenues.

We consider the following future research directions as promising: the development of method to measure knowledge waste in organizations, the expansion of studies on the financial and non-financial impact of knowledge waste on companies, the provision of more empirical work that demonstrate the impact of different approaches and techniques, e.g. lessons learned, ontology on the reduction of knowledge waste in organizations.

The present study is not without limitations. A complete coverage of all the articles considering the issue of knowledge waste could not have been achieved, given the search proceeding chosen. So it may have left out papers that also addressed the topic but used a different language. Yet, it seems reasonable to assume that the review process covered a large proportion of the studies available. Finally, this paper proposes some research directions, which are not exhaustive but represent initial stages.

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