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A framework to acquire explicit knowledge stored on different versions of software

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ABSTRACT

Context: In organizations, especially small and medium ones (SME's), explicit knowledge is stored in different sources of hardware or software. These sources have become obsolete due to constant technological innovation and the growing obsolescence of hardware, and have made the knowledge they contain unreachable. These organizations are forced to seek alternatives that allow them to use the knowledge they already possess, but are unable to exploit.

Objective: To present and execute a framework for the acquisition, classification and dissemination of explicit knowledge among the organization for those who may use that knowledge in their daily activities.

Method: A framework is developed to acquire the explicit knowledge from different sources and versions of software. Its efficiency has been verified through its' application in a pharmaceutical company.

Result: The knowledge has been transferred from an unreachable place so that it can be exploited by the organization. Access control has been added for increasing the level of security where the knowledge is stored. In the implementation, the framework was tested with a general application presenting very favorable results.

Conclusions: In general, the effectiveness of the framework was tested, showing that knowledge recovery from different versions of software is possible. In that way, the problem observed on SME's can be solved in an efficient and replicable form.

1. Introduction

Systems related to information have an accelerated growth as knowledge goes hand in hand with the technological development that is constantly evolving [1]. When a product hits the market, there is already another in line that will replace it, always responding to the rapid changes and the pressure of global competition [2]. This pressure works as a catalyst in advancing technological developments in fast and unimaginable ways [3]. Within organizations, it is common to adopt new technological elements that entail several challenges. One is the risk of loss of explicit knowledge within key systems of organizations, due to incompatibility between the key enterprise software and the hardware where it is contained. This happens because the software that the company has does not have the necessary support for its implementation or they simply cannot be operated under different environments to which they were originally programmed.

In SME's [4], implementation of new technology is considered a cost rather than a benefit, great care has to be taken when the strategic technological tools of the organization have their operation changed. Instead of buying new systems, the company chooses to maintain compatibility between the existent systems [5]. That is, to continue with the same software and hardware as long as possible, mainly because of the cost that the acquisition of a brand new system represents.

SME's have certain characteristics that could be considered as justifications as to why they choose to continue with the same hardware and software for several years, such as:

- The software development is based on lightweight processes aimed to be used by staff.
- They usually have dynamic and flexible structures with a non-traditional and, sometimes free flow administration.
- Typically their management processes are carried out through informal mechanisms based on face-to-face relationships.
- They do not have sufficient staff to perform specialized functions.
- They have little or no budget for buying expertise.
- They are financially vulnerable companies with limited financial resources [6].

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In today's technological era, organizations should have updated systems to meet the needs of business changes [7], that is, there will come a point in which they should upgrade their systems. It will be then when the following questions will arise: what is going to happen with older systems? And what about the information stored in previous hardware?

Organizations should make decisions that affect their future work, such as:

- Continue with no hardware changes to access old systems.
- Perform hardware changes and adaptations for the use of old systems.
- Change hardware for new systems and keep old equipment for consultations.
- Change hardware and data migration to new software.

In either case, the cost involved about having stored data and information should be taken into account, especially when these have been given a real value and are a liability for the company if they are lost or misplaced.

2. Background

Knowledge can be seen as a collection of objects, rules and best practices [8]. It is the state of awareness, understanding and amassed thoughts gained through experience and education. It is present in the form of ideas, judgments, intuitions, competencies and skills of the individual [9]. It has become a key factor [10] in the current environment of change, complexity, uncertainty and rapid economic growth, and with the rapid advances in technology and increased competitiveness [9]. Its management aims to perform a conversion of knowledge from its individual to a collective state [11], and in practice, to improve the organizational capacity through the optimization of the resources of both, individual and collective knowledge; where skills, abilities, experiences and routines are included, without neglecting technology.

There are two classifications in which knowledge can be cataloged: tacit or explicit [4]. The first is knowledge that has not been encrypted and is considered difficult to encode. The second is the encoded knowledge, articulated in words, figures, and numbers. It is objective and can be shared in the form of specifications, standards or data [12]. In this article, the aim is the acquisition of explicit knowledge that is stored in the systems that the company has; and is at risk of being lost when a change is made, regardless of the reason for it.

For organizations within our current globalized era, knowledge and technology have become a focal point [13] and it is considered one of the most important resources of organizations [14,10], because it represents a competitive advantage in the market [15]. This knowledge usually resides in employees [4,16], so it is necessary to understand the role of individuals in the process of knowledge creation, as they are the ones who handle software and systems within companies and decide or know about where and how [17] knowledge has been previously stored.

2.1. Knowledge Management (KM)

The purpose of KM is the conversion of individual to collective knowledge and its transfer may be defined as the transmission of knowledge from a place, person or responsibility to another [18]. For example, between knowledge brokers, who are described as intelligent agents who handle, maintain, distribute, question and communicate knowledge, either as a primary or secondary function, knowledge can be found in many places like human beings or computer programs [19]. They are also considered highly autonomous and as both interactive and fixed components of software [20].

Seven critical factors for KM have been identified in the literature: human resources, information technology, leadership, organizational learning, organizational strategy, organizational structure and organizational culture [8,21,22].

If knowledge is isolated and cannot be accessed, it has no value for the company. That is the reason why diffusion or transfer is necessary. In order to carry that out it is required to recognize, assimilate and apply the knowledge [10]. The agents are considered as autonomous, communicative and perceptive for they are able to perceive and respond to changes in the environment [23]. It also requires knowing how the transfer of knowledge between agents is made, and the different levels that it has. For example, within or across organizational boundaries, between groups or departments within the same or different organizations [24], the flow of data and information forms the basis for the transfer process. Also, there are different ways that can be made either through personal or informal communication, or by using information systems [25,23].

New KM initiatives have to take into consideration several factors such as new organizations, cultures, forms and systems of rewards to improve social relationships [21] and thus, facilitate knowledge transfer. There are studies that emphasize the importance of using information systems to manage collective and individual knowledge, for which they use different combinations of media to share knowledge [26]. The software typically operates in an environment that can be a computer system, existing networks or software in which the software solution is embedded [20]. Database systems are used extensively and effectively helping use corporate information [23].

In the real world, environments and businesses need to change quickly and progressively, and system adaptation is inevitable in order to maintain customer satisfaction [7]. This adaptation means to ensure timely adaptation of the ever more integrated computer systems, in order to maintain compatibility between the systems and the ever-changing circumstances with, within and under which they operate [27]. The system will degrade over time, because the changes tend to increase complexity. The costs of this evolution can scale to very complex changes until the company should decide between reengineering, migration, new development or replacement [28] of the systems that it has.

2.2. Small and medium enterprises

Knowledge has been described as a key element of the organization and must be handled properly to ensure a competitive advantage. When it is integrated in the key business systems, its availability to staff is important since unavailable knowledge is worthless. As time passes systems tend to become obsolete which affects a large number of organizations, regardless of it being a small or medium enterprise (SMEs) where you can observe the problem clearly because system upgrades can be even more complicated than in large enterprises. Nowadays, this situation can be solved using Software As A Service (SAAS), which is a type of rental software that is independent of hardware.

The use of SAAS on SME's is still limited, cloud computing as well as its application of creating value while improving company performance is just beginning, having advantages such as lower cost of access, lower investment capital and new services development [29], also its compatibility with new hardware and latest updates.

When members within companies have adopted software, it is considered institutionalized, which means the innovation has reached a certain degree and invulnerability is taken for granted, considered appropriate or even legitimate and reaches a level of standard. There are three levels of acceptance: partial, the rapid diffusion and saturation or legitimization [30], so the ultimate objective for the framework is to be replicated and institutionalized.

All of the above applies to new systems, so, what about the old systems and the knowledge that they hold? Once the importance of knowledge has been established, we can get an idea of the cost involved when knowledge is misused. It has already been established

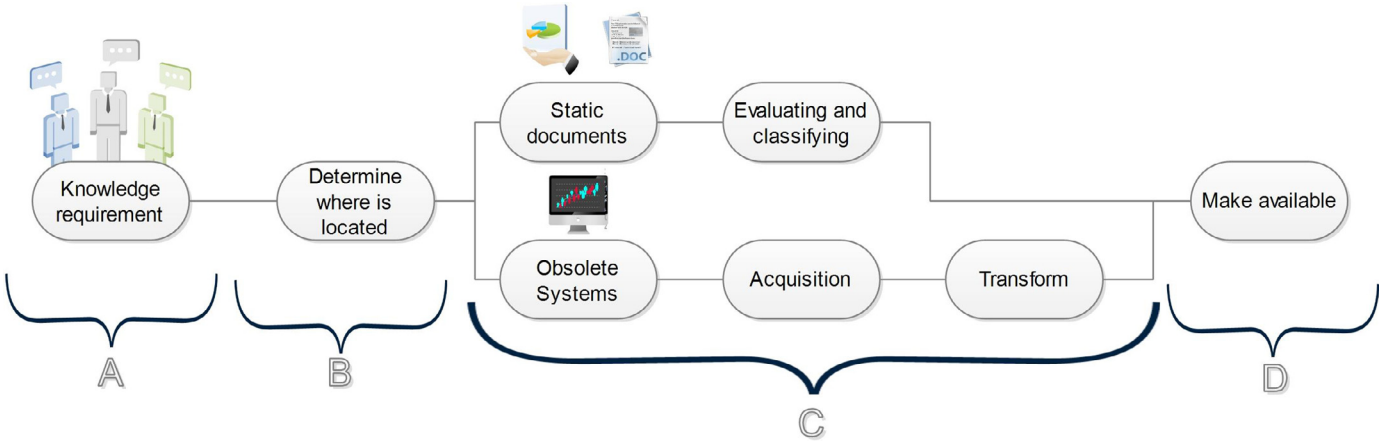


Fig. 1. Typical scenario.

that when the system is old a problem of compatibility or lack of use by staff can appear, this behavior can be the reason for valuable explicit knowledge loss, that is why it is pertinent to generate a framework that allows the acquisition of that knowledge, avoiding its disappearance and promoting its use in the company.

3. Previous or related studies

KM provides methods and techniques that help organizations process and reuse their knowledge. Technology initiatives may not be the main objectives of KM but they are important enablers [31], that is the reason why a review of previous studies can be helpful. As a result studies that could be applied to re-acquire explicit knowledge as well as some methodologies where found, however, most of them focus on tacit knowledge; the distinction between these two types of knowledge has been widely studied [12,4], a possible reason for it is the perception that tacit knowledge is more difficult to share and not readily codified [16] sometimes the production of new knowledge has more weight than the exploit of the one that is already captured [32,33]. The conversion to explicit knowledge to be used on KM tools [34], initiatives to manage knowledge through including database integration and conversion, internet architectures, artificial intelligence or technical support for decision making [35] corporate memory generation focused on efficient representation of tacit knowledge [23], development of frameworks to facilitate transfer [33] or how to get interaction between groups [36] are some study cases on acquisition and re-use of knowledge.

After the review, the lack of studies on re-acquisition of explicit knowledge is evident, most of the studies and frameworks assume that if knowledge is already encoded and captured it can be exploited. The following is a typical situation used to portray that such assumptions are not necessarily true. Fig. 1 shows four sections, there is staff within the company that requires explicit knowledge, the person who has the requirement should determine where it is located, which can be carried out either using its contacts or reviewing previous documents. Once it is determined where the knowledge is, if these are static there must be a classification, whether it is an obsolete system must find who has access and somehow its recovery is needed, once there is a recovery, transformation is the next step, that is, a conversion to a format that can easily be displayed like Word or Excel documents and then make them available.

Knowledge requirements (Section A, Fig. 1), may come from different levels, one of them can be the senior personnel that required some knowledge, whether for planning, strategies or making decisions, they usually do not get involved with operation as a result; they do not have direct access to the base system of the company, therefore they request direct personnel for reports.

The senior's direct personnel may not have access to the system either, but they do have a wide social network in where to find someone that has access. Section B, the determination of where the knowledge is located is made by people who know the operation and use of the system, however another problem can arise if they do not have a compatible computer to access the system, and those that have the ones that are compatible do not know how to use the system, this can result in delays to get what was required; which means, only a small group is able to determine if knowledge is on obsolete systems or static files (Section C).

The group identifies if the knowledge is contained on software or in static documents, the small group with the expertise are the ones that made the explicit knowledge assessment and classification while another person can perform the acquisition and transformation so knowledge can be later available (Section D).

4. Proposed framework

This research focuses on the acquisition of explicit knowledge corresponding to Fig. 1 Section C, this knowledge can be found in different forms such as spreadsheets, text documents, unstructured repositories [21,32] as the knowledge is already encode the misconception that its already available arises [33] however there are some things to take into consideration like, unstructured files, isolated networks, turnover [23] or withdrawal of personnel [8] this situation leads to explicit knowledge is "lost" because, even if it's still there, the identification turn to be really difficult so most of the time a recapture instead of re-acquisition or re-structuring is made [16] .

In Fig. 2 the proposed framework to recover explicit knowledge is shown. It consists of four stages that will be described on the following paragraphs.

Because of the lack of acquisition-based explicit knowledge studies, the following Fig. 2 shows a framework (Fig. 2) that allows acquiring this knowledge from the different versions of software and the most common sources of knowledge of a company or organization so it can be put to good use.

4.1. Knowledge evaluation

The human factor is necessary in order to make an identification of knowledge within the organization. This factor is the one that holds the knowledge within the institution and directly uses the system that is in the process of obsolescence, also is the one that can determine what knowledge is valuable and which is irrelevant.

Knowledge evaluation refers to weigh up knowledge already on the company; to carry this out the following is needed:

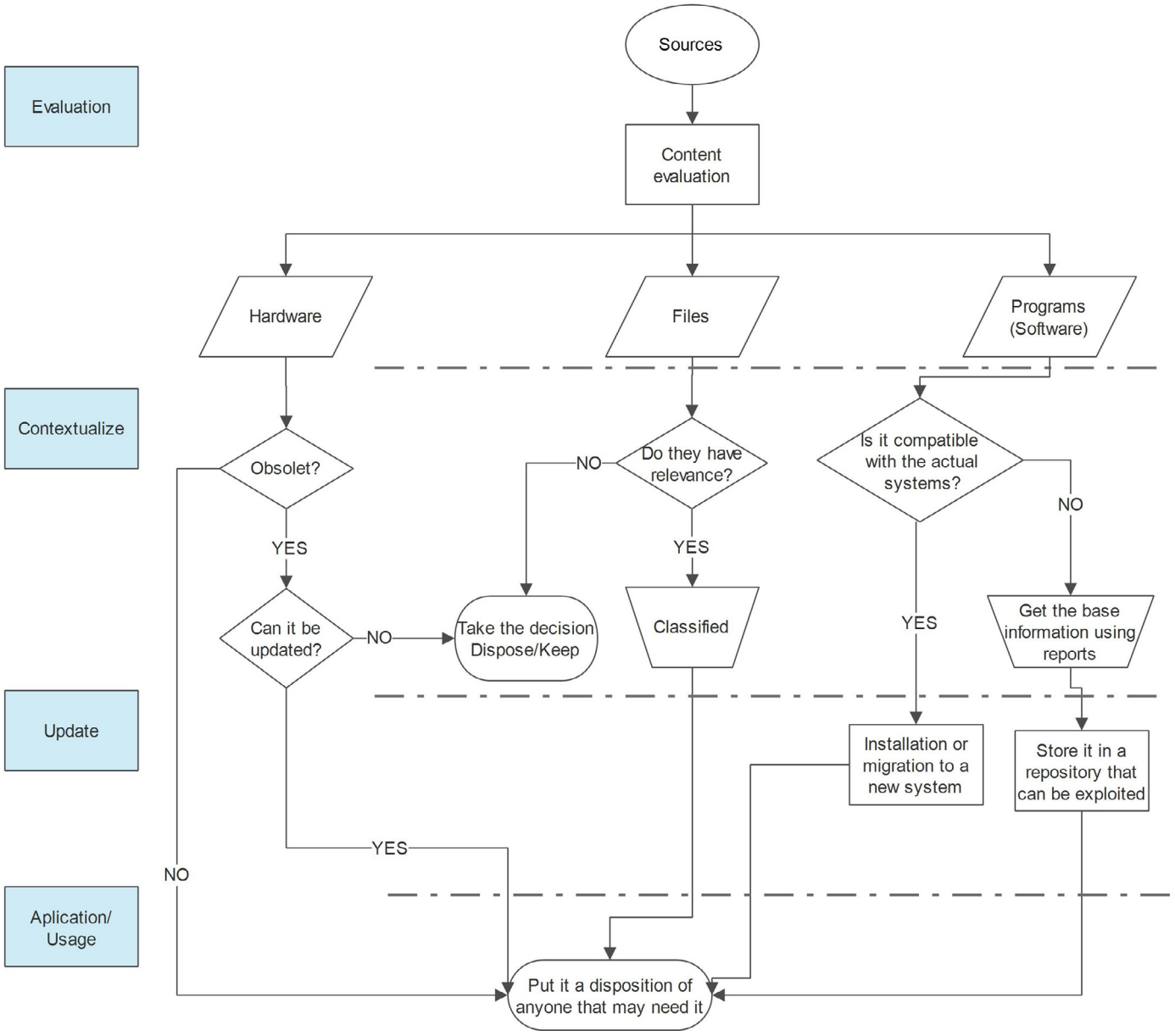


Fig. 2. Framework for re-acquisition of explicit knowledge.

- Determine the areas of the company that will be included on the study.
- Get a list of member of the areas where the study will be conducted as well as the basic information like name, current post, years of service, used to select the key personnel.
- The selected personnel should be as representative as possible.
- It will be better to select personnel that have more years working on the company or who are in a higher position of the institution.
- Include at least one representative of each area of study.

There are several techniques for data collection that can be used for identification like the conducted interview with a focus on research, observations without direct participation, semi-structured site interviews, review of documents [37], among others.

One thing that needs to be taken into account is that in order for the acquisition and the dissemination of knowledge to take place, a good relationship on the staff has to take place this is because the amount of knowledge transfer will increase according to the trust that the company inspires into the personnel [38], the dissemination increases knowledge value and ease of use [39], and social relations determines the amount of effort that individuals have to exert in order to find what they need. Therefore a social network analysis is need to determine the flow of communication and the relations between individuals which will help to make an approximation of the cost needed to find the required knowledge.

With the data collection, determine the places where knowledge is located, the different types of hardware, software and files that are used the most and determine which one represents the most difficulty to be obtained.

4.2. Contextualize

Once there is an identification of the potential places where explicit knowledge is stored, and the information about which is the important knowledge, as well as the potential problems to acquire it, the next step will be to contextualize it.

For the hardware: determine if the hardware is in good conditions and if is still working, if that is the case then no action is need to be

```
Initial variables
        Array[]
        Matrix[][]
        Archive
Procedure
        //Fill matrix with the data on archive
                While there is a row {
                        Fill data on matrix
                }
        //Show matrix for visualization
                While there are rows on matrix {
                        Add to table
                }
        Show table
        //Insert data on two tables, the first is for a control with a unique identifier
and unique values, the second one have details that and can be more than one for
each identifier.
        Insert into table BDmaster
        Insert into table BDdetail
        //Once the data has been added to the database, is easier to access from
different places, either using an Excel file or a program to visualize the information.
```

Fig. 3. Base pseudo code.

taken however, if the hardware is outdated or in the process of obsolescence a decision has to be made, either the hardware is updated or if it cannot be done, get backups or a recovery, the first one will allow the usage of knowledge for another period of time, while the second is made when there is no other option to take.

For files: determine if the files are relevant if they are not, take the decision of keep it or dispose it. The knowledge that is store should be classified this way it can be easier to make it available for those that request it.

For programs: determine whether they are compatible with existing systems, and considering the high rate of renovation if they have compatibility, migrate to new systems and, if not, re-acquire what you already have stored in the form of reports, it is usually possible to obtain the information in this way (through reports) and thereby facilitate migration to repositories that do have support and are available so it can be put to disposition of those that need it.

4.3. Update

As addressed in the previous section, knowledge must be stored in an accessible repository so it is necessary to update the form in which it is stored. Although knowledge or documents can be stored in physical files, this is inefficient and for several years with the use of IT, these repositories occupying space and resources have been digitized, now occupying databases that are more accessible and from where you can exploit the knowledge and information to put it to work properly, its structure and the requirements of the database must be planned, either be created or adapted to the characteristics of the organization.

This acquisition and upgrading from old software is necessary first to have access to the old software, assuming that it is possible to get reports in the form of text files, a general representation can be seen in the following pseudo code (Fig. 3).

The transformation of the text files is obtained with the application of the code shown in Fig. 3, which inserts the data from the file into a database for its consequent exploitation. Some technological tools such as SQL can be used as the main engine for the database, and PHP or ASP to create Web platforms. The selection of tools is based on the requirements and capabilities needed; however, it is best to use resources that are already within the company or institution.

4.4. Application/use

The application is carried out after the knowledge has already gone through the stages of identification, assessment and the re-acquisition (explicit knowledge was processed and kept on explicit form) in a way that can be applied to implementation and then different applications can make use of them, for example, if it is in a database you can use Excel to connect to it, or create a simple query sentence, a technological tool [40] is viable in this case because it can facilitate viewing the contents of the database, and managing the static previously classified documents, helping its view or reuse.

It is important to consider that within the company there may already be a software tool that could be used for the purposes of making available the knowledge after it has been transformed, that is the reason of why the initial stages of identification are important. If the institution does not have a software to do this, you can implement a basic system; for example, there are several free systems like Gestionnaire Parc Informatique (GLPI), or osTicket who have knowledge repositories that can be integrated into a computer inside or outside the institution, that can be applied, and whose requirements can be easily solved; as justification the best use of the documents and optimization of existing systems can be cited.

5. Framework application

The proposed framework was applied on a SME company of pharmaceutical type its main activity is the marketing of homeopathic medicine; the problem that arises in the company is that they have a lot of explicit knowledge, some of it, contained in a system that is already in the process of obsolescence, however the migration of all information to a new system would take a long time, so the proposal was to take initial data and start from there with the use of a new software; that may be a good prospect for the implementation of the framework with which it is intended to win back the knowledge that is in the system in order for it not to be lost with the new implementation.

The relationship between 40 staff members was analyzed, they are all involved in the commercialization department of the company and are all considered operational personnel. Based on their antiquity and their role in the company, 14 were considered the most representative.

Table 1
Interaction of personnel in the company.

Identifier	Area	Hierarchy	Year of enrollment	Works with	Relation with study
ALM02	Storehouse	High	2000	Obsolete system/files	Yes
ALM03	Storehouse	High	2002	Obsolete system/files	Yes
VEN01	Commercialization (sales)	Medium	1996	Obsolete system/files	Yes
SIS03	Information systems	High	2006	Obsolete system/files	Yes
CL01	Purchasing department	High	2014	Obsolete system/files	Yes
CL01	Logistics	High	2014	Obsolete system/files	Yes
MKT01	Marketing	Medium	2014	Shared files	Yes
MKT02	Marketing	Medium	2013	Files	Yes
SIS02	Information systems	Medium	2014	Obsolete system/files	Yes
FAR01	Pharmacy	Medium	2007	Custom made system	Yes
FARM02	Pharmacy	Medium	2005	Obsolete system/files	Yes
LAB02	Laboratory	Medium	2002	Files	Yes
LAB04	Laboratory	Medium	2007	Files	Yes
ALM03	Storehouse			Obsolete system/files	Yes
SIS01	Information systems	Medium	2013	Shared documents/files	
				Obsolete systems	Yes

Table 2
Interview's questions guide.

Guide questions
1. How long have you been in your post?
2. Have you developed another activity besides the one that you currently have?
3. Which is your primary line of work
4. What kind of technological tools do you need to effectively make your primary line of work?
5. Is there any information that you are sharing?
6. In which form did you normally share information
7. Departments that usually ask information from me
8. What do I do when information that I don't have is asked from me?
9. The information is asked with a specific format?
10. Departments from which I need information
11. In which format do I usually ask for information?
12. Which technological tools do I use?
13. In my opinion the information that i have can be used for other departments?
14. Usually where do I find the information that is asked of me?
15. Where do I store information on my daily work?
16. Do I have ever had any problems to obtain the information that I need?

The framework was implemented in 6 months, time interval that includes the creation of the framework, its implementation and generation of results. However, this time frame can increase based on the continuous evaluation and addition of more information from old systems and archives that are relevant to other departments.

5.1. Knowledge evaluation

In the evaluation the human factor is taken into account in order to ponder the knowledge, following the steps that are proposed in the framework.

Determination of areas: those with direct relation with commercialization (marketing, purchasing, warehouse, laboratory, pharmacy).

Get a list of areas staff members: the list was coded to make it as anonymous as possible.

Select the most representative personnel from the staff: this was determined with the examination using Table 1 in which some aspects are taken into account, such as (i) the years working for the company, (ii) areas where the personnel have worked, (iii) interaction with other departments; such information can be easily obtain within the company, the interaction between departments will also be useful however it cannot be obtain unless an initial survey is conducted. In Table 1, the employee information is displayed; it is general data that can be obtained from the human resources department of most organizations.

The information was obtained using a targeted interview with the questions in Table 2 used as a guide. The interviews were performed throughout a month and each lasted up to 15 min. They were scheduled according to the availability of the staff members selected.

The analysis of the social network was carried out using the tool NodeXL, that requires the recovery of the data, number of employees, one-on-one interactions, departmental interactions and the selection of those departments that will be studied; once all this information if available, it can be added to the software. The whole process took 6 months to be carried out, and we were able identified the relationship between departments and its recurrence in a month (see Table 3).

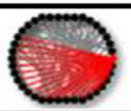
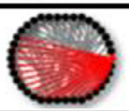
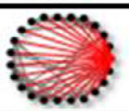
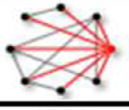
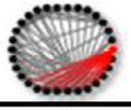
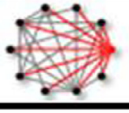
The analysis was conducted in two parts, first from person to person including all the company's staff, with the information obtained with the first one and a second one was made, the staff was grouped by departments to get a map of knowledge flows between them.

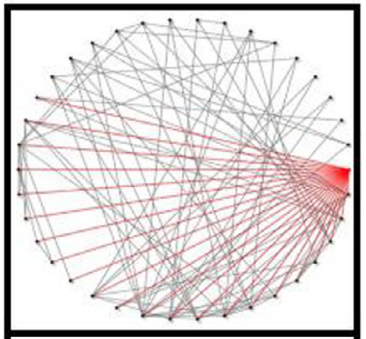
The first part was to get the list of personnel and after that, using the interview to obtain the relationship between staff, the direct observation of staff was also useful.

Finally 158 direct interactions were found, those were pooled yielding 108 different weights which means that there are interactions that has a mayor occurrence, this was used to identify whether the staff was a giver or receiver of knowledge. Subsequently, this information was used to get the analysis of the areas that was useful since it determined the ones with the poorest interactions as well as those with the greatest; this can be seen in Table 3.

Once the interaction was determined, the next step was to get the flow of knowledge in order to identify the staff givers and sinks of

Table 3
Interaction graphics till 2.5 level.

Vertex	In-Degree	Out-Degree	Subgraph 2.5	Subgraph 2	Subgraph 1.5
cl01	13	9			
ven04	6	2			
alm02	5	2			
lab01	5	2			
mkt03	5	2			
alm03	4	5			
lab02	3	5			
sis03	2	9			
sis02	1	8			



cl01 greatest interaction Vertex

Table 4
Explicit knowledge forms and repositories.

Data types	Observations	Proposed repositories	
1	Macropro	The software that is actually used, plain text	Information migration to database
2	Xls	Excel files used locally	Information migration to database
3	Smart(BD)	Invoice program, using SQL database	Invoice information that is already stored in a database
4	Shared files	Shared files	Communal repository on FTP server with user control access
5	Ordinatio	Book with information of the medications that are used	Book
6	Books	Medication books	Books
7	Docx	Local files, generally reused formats	Communal repository on FTP server with user control access
8	Pdf	Files that are usually send to clients	Communal repository on FTP server with user control access
10	Insightly	Ticket system of marketing	Tickets system from sales, only used on marketing, giving the fact that it is already shared, there is no need to add it to a repository
11	Email	It is usual that the people inside the company stored its information on emails and go check them once they need the information again	The email will keep on being used because it is a means of communication one on one between client and sales executives

knowledge, the initial idea was that the ones with the greatest interaction have to be the managers, however, this study was conducted on a SME and this type of company usually have a more relaxed interaction which benefits the communication between the staff, as a result the ones with more interaction could be anyone within the personnel. In Table 3 the interaction of staff is shown adding 3 more hops, this means the direct one and the total network it can reach using the first connection, the social network analysis shows the extent of the net and aid in the determination of who can be a knowledge bearer, there was a case in which one staff member addresses himself as a bearer but the analysis shows otherwise.

5.2. Contextualize

The static files were evaluated, the questions 6, 14 and 15 (see Table 2) identified that, in this study in particular, the knowledge is stored on different types of systems and computers, with different versions and formats, the knowledge was explicit but in many forms so the contextualization was made getting the results shown in Table 4 that also contained the proposed repository in which they were finally stored.

The different documents and archives found, where grouped based on ten different types, column 4 of Table 4 shows the repository that was proposed for each one in order to get the most of them and to be able to put them to use. There were basically 3 forms in which to classified the documents: to keep them in the same format or place, grouped them on a repository or convert them and added them to a database, while the first one applied to documents that are irrelevant to all other areas but the one there are used on the second and third corresponds to the knowledge that could be useful for more than one area. Whereas if it is information stored long ago in the system of the company, this is collected and stored in order for it to be more easily accessible, this was carried out as part of the framework's update section.

5.3. Update

This section is related to the change that must take place in the files so they can be effectively added to the proposed repository. Rare cases where found when there was no need to make any changes however most of the time a transformation was carried out on the explicit knowledge for its later addition to a repository where it would be available when required.

To get the knowledge from the company key system a text file was used, said file was processed by an intermediate system; the obtained data was showed on a table previous to its insertion on a database. The intermediate system used for this transition is explained on the application section below.

5.4. Application

For the exploitation of existing knowledge, an application that allows conversion of knowledge from the key system of the company was developed, taking into consideration that the system can generate plain text files as reports, an intermediate software was developed; its function, to get the text file, process it and insert the data that it contains into a database, from which it can be exploited. Also helping the new software development by young programmers since it is easier for them the usage of data contained in a database that in plain and scatter files, aiding to make information accessible from most commonly used programs such as Excel.

The application is made in a high level language, Java to be more specific, using the pseudo code shown in Section 4 (Fig. 3) as guideline. The steps are the generation of a text report from the key system of the company, a review of the data to be inserted on the database using a review screen and the insertion into a database from which the knowledge can be consulted when required.

The classification of the static files for its reuse makes evident the need for a repository that is able to search for files. In order to do so, the use of a technological tool was pinpointed, and considering that the company did not have any, a free software tool was proposed. The GLPI is a technological tool, a web system based on PHP and MySQL database. This tool has several features, including FAQs and a knowledge base where you can create and upload files, classifications are made for each post in which a brief explanation of the content is done also adding files information and having target posts (directly to those that may need it). With the use of GLPI more control over what each user can have at its disposition can be made, for example, marketing information is only available to marketing personnel but using the access control from the GLPI it can be easily shared to another group, single person or to anyone with a user name and password improving the use and reuse of explicit knowledge.

6. Discussion

It was possible to apply the framework. During the execution of each of the steps, limitations such as time to perform the targeted interviews or staff turnover where faced, both as a result of changes in the company where the study took place causing an increase of workload.

In what concerns the first point, related to identification, the limitations are mainly external; one of them was a disposition problem to support the studies by a little number of the selected staff, one particular case was a person that expressed that the knowledge from other departments wasn't required in its line or work. This person regards himself as a bearer, however, when analyzing the results of the interactions, this person was requiring explicit knowledge from other departments, which contradicts what was initially indicated.

In relation to contextualization, the main concern was to identify the appropriate personnel for the interview. They are the key factor for information retrieval; they know where knowledge is stored and how to recover it.

On the updating section, the analysis of the format in which files from the old system were stored was time demanding. This was needed for the transition from the plain text file to the database. Once this was done, the conversion could take place with no problems at all.

The application section took place with no significant difficulties; however there was a request to add a visualization section that was not considered at the beginning of the program; as the addition did not represent any major problem, it was added to the program. Also, the implementation of the software used as a repository management where static files were added, was rapidly adopted by the users and is considered a huge success.

7. Conclusions

In the SME where the framework was tested, good results were obtained, especially in the area of commercialization. After the implementation, users that have access to the system can access knowledge almost immediately, avoiding the need to contact a third party to get the knowledge that they require.

Deliverables in each stage would lead to greater benefits. In this study, data retrieved by intermediate systems was used for the development of a more functional system that could load text files from the old system.

On the other hand, the web-based system enables a higher level of interaction between users and aids the interaction with other departments using the knowledge base, and has the advantage of a specific target for each post. The documents are also classified, which helps their use.

While applying the framework there was an improvement on knowledge transfer, data and information. This helps to decrease the time spent identifying where to find knowledge, making it accessible, improving efficiency and increasing the performance of the company.

Finally, it is believed that the framework can be replicated on SMEs and even larger enterprises. Considering the characteristics of these types of companies, the use of a framework that has no investment and that can take advantage of the systems within the organization represents a good advantage. Also, the application of the framework had turned out to be useful in this SME. As was stated, it is thought to be useful, as a future work, that this methodology be applied on larger companies and also on companies from other fields, which would be helpful to verify if it is effective in different scenarios.

References

[1] H.M. Campos, P. Aguirre, F.S. Parellada, Technology strategy and new technology based firms, J. Technol. Manag. Innov. 4 (2009).
[2] S.K. Patil, R. Kant, A fuzzy AHP-TOPSIS framework for ranking the solutions of knowledge management adoption in supply chain to overcome its barriers, Expert Syst. Appl. 41 (2) (2014) 679–693.
[3] M. Workman, New media and the changing face of information technology use: the importance of task pursuit, social influence, and experience, Comput. Hum. Behav. 31 (2014) 111–117.
[4] H. Olander, P. Hurmelinna-Laukkanen, P. Heilmann, Do SME'S benefit from HRM-related knowledge protection in innovation management? Int. J. Innov. Manag. 15 (03) (2011) 593–616.
[5] K. Dalkir, Knowledge Management in Theory and Practice, MIT Press, Cambridge, Mass., US, 2011.
[6] F.J. Pino, O. Pedreira, F. García, M. Rodríguez, M. Piattini, The journal of systems and software using scrum to guide the execution of software process improvement in small organizations, J. Syst. Softw. 83 (10) (2010) 1662–1677.
[7] L. Xiao, D. Greer, Adaptive agent model: software adaptivity using an agent-oriented model-driven architecture, Inf. Softw. Technol. 51 (1) (2009) 109–137.
[8] L.A.Y. Al-hakim, S. Hassan, the role of middle managers in knowledge management implementation for innovation enhancement, Int. J. Innov. Manag. Technol. 2 (1) (2011).
[9] S.K. Chadha, E. Ritika, "Key Enablers in the Implementation of KM Practices: An Empirical Study of Software SMEs in North India," pp. 59–86, 2012.
[10] R. Larkin, J. Burgess, The paradox of employee retention for knowledge transfer, Empl. Relat. Inf. 13 (2) (2013) 32–44.
[11] W.S. Chow, L.S. Chan, Social network, social trust and shared goals in organizational knowledge sharing, Inf. Technol. Manag. 45 (7) (2008) 458–465.
[12] G. Anand, P.T. Ward, M.V. Tatikonda, Role of explicit and tacit knowledge in six sigma projects: an empirical examination of differential project success, J. Oper. Manag. 28 (4) (2010) 303–315.
[13] A. Anand, "Understanding knowledge management: a literature review," J. Eng. Sci. Technol. vol. 3, no. 2, pp. 926–939, 2011.
[14] B. Hoła, M. Sawicki, Tacit knowledge contained in construction enterprise documents, Procedia Eng. 85 (2014) 231–239.
[15] G. Martín-de-, Business review exploring knowledge creation and transfer in the firm: context and leadership ∗, Universia Bus. Rev. (40) (2013) 126–137.
[16] N.-C. Liu, M.-S. Liu, Human resource practices and individual knowledge-sharing behavior – an empirical study for Taiwanese R&D professionals, Int. J. Hum. Resour. Manag. 22 (4) (2011) 981–997.
[17] C.W. Yang, S.C. Fang, J.L. Lin, Organisational knowledge creation strategies: a conceptual framework, Int. J. Inf. Manag. 30 (3) (2010) 231–238.
[18] R. Krishnaveni, R. Sujatha, Communities of practice: an influencing factor for effective knowledge transfer in organizations, J. Knowl. Manag. 10 (1) (2012) 26–41.
[19] R.R. Hough, J. Kooistra, T.H. Hough, E. Incorporated, Growing intelligent agents for the delivery of knowledge: a structure, Systemica 13 (2001) 349–358.
[20] G. Beydoun, G. Low, P. Bogg, Suitability assessment framework of agent-based software architectures, Inf. Softw. Technol. 55 (4) (2013) 673–689.
[21] C. Bagnoli, M. Vedovato, The impact of knowledge management and strategy configuration coherence on SME performance, J. Manag. Gov. 18 (2) (2012) 615–647.
[22] S. Wang, R.a. Noe, Knowledge sharing: a review and directions for future research, Hum. Resour. Manag. Rev. 20 (2) (2010) 115–131.
[23] T.E. El-Diraby, J. Zhang, A semantic framework to support corporate memory management in building construction, Autom. Constr. 15 (4) (2006) 504–521.
[24] J.K. Hansen, How Knowledge is Transferred within the Danish Fashion Industry – Taking a Knowledge Management Perspective on the Creative Design Process (Master thesis), Copenhagen Business School, 2009.
[25] H. Sainio, "A Dynamic Model for Knowledge Transfer and Alliance Learning in Cross-border Strategic Alliances of Software Companies," December, 2007.
[26] Y. Zhao, M. Lavin, An empirical study of knowledge transfer in working relationships with suppliers in new product development, Int. J. Innov. Manag. 16 (02) (2012) 1250013.
[27] M.M. Lehman, J.F. Ramil, Software evolution – background, theory, practice, Inf. Process. Lett. 88 (1–2) (2003) 33–44.
[28] T. Mens, Y.-G. Guéhéneuc, J. Fernández-Ramil, M. D'Hondt, Software evolution, IEEE Softw. 27 (4) (2010) 22–24.
[29] J. Rodrigues, P. Ruivo, T. Oliveira, Software as a service value and firm performance – a literature review synthesis in small and medium enterprises, Procedia Technol. 16 (2014) 206–211.
[30] J. Marsan, G. Paré, M.D. Wybo, Has open source software been institutionalized in organizations or not? Inf. Softw. Technol. 54 (12) (2012) 1308–1316.
[31] O.M. Rodríguez-Elias, A.I. Martínez-García, A. Vizcaíno, J. Favela, M. Piattini, A framework to analyze information systems as knowledge flow facilitators, Inf. Softw. Technol. 50 (6) (2008) 481–498.
[32] M.W. McElroy, The new knowledge management, The New Knowledge Management, Butterworth-Heinemann, 2002, pp. 1–23.
[33] M.S. Al-Qdah, J. Salim, A conceptual framework for managing tacit knowledge through ICT perspective, Procedia Technol. 11 (Iccei) (2013) 1188–1194.
[34] C.R. do Rosário, L.M. Kipper, R. Frozza, B.B. Mariani, Modeling of tacit knowledge in industry: simulations on the variables of industrial processes, Expert Syst. Appl. 42 (3) (2015) 1613–1625.
[35] M. Mitri, Applying tacit knowledge management techniques for performance assessment, Comput. Educ. 41 (2) (2003) 173–189.
[36] S. Ryan, R.V. O'Connor, Acquiring and sharing tacit knowledge in software development teams: an empirical study, Inf. Softw. Technol. 55 (9) (2013) 1614–1624.
[37] R. Giuffrida, Y. Dittrich, A conceptual framework to study the role of communication through social software for coordination in globally-distributed software teams, Inf. Softw. Technol. 63 (2015) 11–30.
[38] B. Renzl, Trust in management and knowledge sharing: the mediating effects of fear and knowledge documentation, Omega 36 (2) (2008) 206–220.
[39] S.C. Yang, C.K. Farn, Social capital, behavioural control, and tacit knowledge sharing – a multi-informant design, Int. J. Inf. Manag. 29 (3) (2009) 210–218.
[40] Y. Yuan, J. Lee, Examining the role of knowledge transfer effect as a mediator variable among impact factors in knowledge innovation, Int. J. Bus. Inf. Syst. 7 (2) (2012) 205–225.