

Proposal of an adaptable, need-fitting Knowledge Management System design tool for SMEs.

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Abstract: *Knowledge Management (KM) capabilities are critical for Small and Medium Enterprises (SMEs). It allows them to be more competitive, and to leverage one of their key resources: Knowledge. However, the body of knowledge on KM in SMEs is very scarce, and most of the attempts to implement KM in SMEs fail, because of the inadequate models provided. In order to achieve successful km implementation, SMEs specificities must be studied. The purpose of this paper is to introduce a tool allowing us to describe precisely SMEs, in regard of KM. It is based on an extensive literature review on knowledge management in SMEs, knowledge management and SMEs characteristics, and critical success factors. We identified 96 elements that can be used to provide data on the way to achieve an efficient knowledge management implementation and use it in a SME. By answering a set of questions on these elements, the user is guided in the construction of a knowledge management system fitting the needs and the specificities of the enterprise while using as little resources as possible. By providing an accurate description of a SME, as well as a tailor-made knowledge management system, our tool increases the probability of a successful knowledge management implementation.*

Keywords : *Knowledge Management, SMEs, innovation, Knowledge Management System.*

I. INTRODUCTION AND CONTEXT

Advantages offered by knowledge management (KM) to companies using it are no longer to be demonstrated. The body of research shows that implementing KM allows companies to achieve greater reactivity, enhance their innovation capabilities, have greater efficiency in processes and procedures, or even gain market shares [1] [2] [3] [4] [5] [6] [7] [8] [9]. Such KM systems are widespread in large companies, for which abundant literature exists on its implementation [3]. However, Zieba [3] suggest that Small and Medium Enterprises (SMEs) do not manage their knowledge the same way large firms do, thus making systems adapted to large companies unusable. Even though knowledge is a key element for SMEs [10] [11], literature on KM in SMEs is scarce, especially on subjects such as the implementation of KM systems [12] [13], despite the fact that SMEs make up 99.8% of the world enterprises and employ more than 67% of active workers[14] [15]. In term of numbers, Ben Moussa [16] states that only 16% of KM implementation attempts in SMEs are successful, because of the lack of adapted KM systems. Since the 2000s scholars started working on KM implementation in SMEs, as well as on KM strategies and tools adapted to SMEs, in which

resources are limited. But as stated by Durst and Edvardsson [4], this field of research is young and requires more attention. An extensive literature study taught us that applying the existing large firms KM models to SMEs doesn't work [1] [17] [18], because SMEs are not scaled down large companies. Thus, using a functioning KM system made for large firms doesn't mean it will work well in a SME, which has resource limitations [17]. Wong [19] states that SMEs have characteristics that make them different from large firms, as well as unique regarding to each other [20]. This is why a generic KM system can't be used, and it is necessary to create a tailor-made one. Yet, research on this subject remains mostly theoretical, and lacks elements to move from theory to practice as well as means to take the user's need in account. There are currently only few links between literature hypotheses and KM practices in SMEs [11]. It is thus necessary to take into account the usability of the existing KM systems, as well as SMEs real needs.

In the context of our CIFRE thesis, we work on the implementation of a KM system in a high technology SME. We aim to create a tailor-made KM system for this firm, and, on a wider scale, for any SME wishing to implement a light and easy to use KM system. To achieve this, we go through multiple stages: We first describe and characterize the SME, regarding the different characteristics found in the KM literature. Thanks to this description, we can then make an assessment on the firms' readiness level and the amount of work that need to be done to implement KM. Through the use of analytic tools such as Analytic Hierarchy Process (AHP) [25] or the House of KM Tool Selection (HoKMTS) [26], this description also allows us to build a KM Tools database fitting the needs of the enterprise, and to design a tailor-made KM system, based on multiple building blocks chosen in accordance with de characteristics of the firm. We will then implement this system in the SME, and provide a change management support, as well as an improvement through iterations to make it persistent.

The work presented here focuses on the first part: characterizing the specificities of a SME. Our literature study allowed us to identify the important characteristics of SMEs regarding to KM. Our paper is organized as follows: Section two focuses on the important characteristics for KM in SMEs. Section three explains how we use these characteristics. Section four presents the tool we designed to help users easily describe their enterprise. Section five concludes this paper.

II. CHARACTERIZING SMALL AND MEDIUM ENTERPRISES

In order to design a tailor-made KM system, we first need to define the needs and specificities of the target. To achieve this, we have to identify the characteristics associated with KM in the studied SME. They belong both to the characteristics describing SMEs and the characteristics describing KM used in firms (cf. Figure 1), and allow us to make sure that each relevant specificity of the firm regarding to KM is taken into account. Hence, we formulated the following research question.

RQ: What elements allow us to describe a SME on the basis of important features with regard to KM?

To answer this question, we worked on the different characteristics found in the literature.

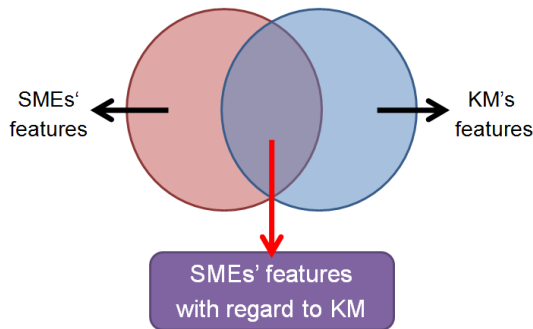


Figure 1. TARGET CHARACTERISTICS

Most of the papers about KM in SMEs focus on the SMEs' characteristics regarding to KM. They allow us to describe SMEs and deduce important elements about how they operate, as well as efficient ways to achieve the KM they really need. Some papers also focus on critical success factors (CSFs) and critical failure factors (CFFs) of KM in SMEs. These factors, obtained through quantitative studies, describe the elements that have to be managed in order to guarantee a successful KM implementation.

A. The Small and Medium Enterprises characteristics

We performed an extensive literature study on the SMEs' characteristics with regard to KM in order to find every important characteristic and cover each aspect of SMEs. This study yielded 96 unique interesting characteristics, CSF, and CFF proposed by different authors [1] [3] [13] [17] [19] [22] [21] [24] [27] [28].

Through a brainstorm phase, we sorted these elements in 2 categories: the "enablers" (73 elements), useful for designing and implementing a KM system; and the "sustaining characteristics" (23 elements), useful to achieve a sustainable and efficient KM system operation, measure its efficiency, and make sure that nothing was forgotten. As the "sustaining characteristics" are only useful when the KM system is already implemented, we will focus on the 73 "enablers" in the rest of this paper, as they're the most interesting for our KM system tailoring work.

The "enablers" combine 62 characteristics and 36 CSF in 73 elements, some belonging to both categories. Through brainstorming sessions and a qualitative study, we identified 3 distinct types for these elements. They allow us to sort the elements regarding their potential use in a KM system design and implementation work, each type answering to a particular

question, thus allowing a complete description of the SME. These types, which are "supporting" elements, "existing" elements and "KM nature" elements, are described below.

The "supporting" category gathers 35 characteristics facilitating KM implementation and use in the firm. These elements, relating directly or indirectly to KM allow us to ease KM implementation, and manage the problems that could rise. These elements might already exist in the firm before the implementation or the design of the KM system.

The "existing" category gathers 8 characteristics supporting KM relying on the firm's existing processes and KM related practices. They allow us to identify if KM related work is already being done, even if it is not identified as KM, and if it is possible to leverage work processes to improve our KM system functions. The advantage is that, by using existing processes, we cause less change in employees work operations, which means less learning time and training, a reuse of existing work supports, and in the end, less resource consumption in the enterprise.

The "KM nature" category gathers 19 characteristics that have impact on how the KM system is built, its processes, its contents, its actors, etc. These characteristics give us data useful to better define the real firms' need, thus allowing us to adapt our KM system to fit them. The common criterion is that a change on one of these elements leads to a direct change on how KM must be done in the firm. It consists of SMEs' specificities that we have to take into account to create a tailor-made KM system because it gives them their uniqueness. These are elements such as contextual data; operational related elements; the firms' culture; as well as data describing the knowledge management needs of the firm. From an initial list of 32 candidate characteristics, and through brainstorming sessions and by fusing characteristics based on the same concepts, 19 unique and not redundant characteristics were selected. This allows a faster and easier use of our KM system design methodology by decreasing the time needed to use it, while maintaining the coverage of every important aspect of KM in SMEs [19].

Using these 3 categories, we are able to make a complete description of the enterprise, thus knowing the inputs (the firm specificities) and outputs (the firm's KM needs) of the KM system that we are going to set up. They are supplemented by CSFs and CFFs, which allow us to make sure that the firm is ready to implement KM, and that the content of the KM system will ensure its success.

B. Critical success and failure factors

Until the beginning of the 2000s, research on CSF mostly revolved around large firms, with little consideration for SMEs, which had different sizes and specificities [17]. Nowadays, we can find lots of papers focusing on creating and updating CSFs, to adapt the field of research to SMEs [19] [21] [22]. Unlike characteristics described above, which are specific to each SME, CSFs and CFFs are universal and apply to every SME.

CSFs and CFFs of KM are areas that must receive attention during the KM system design, implementation and use, in order to guarantee its success [23]. If practices relating to CSFs already exist, it is necessary to promote them. If they don't, it is mandatory to develop them. External factors aren't

studied, as they are independent and not manageable by the firm [24].

Our literature review allowed us to identify 40 papers about CSFs suitable for SMEs, often based on empirical studies. Through surveying SMEs that implemented, or tried to implement KM, the authors determined common factors for success and failure. The results allowed them to establish a classification of the most and the least important factors. In most papers, factors related to Management and leadership, firm's culture, KM strategy, resource availability (time and finance), and processes and procedures are deemed the most important [22] [19]. Special attention will be paid to these, as they help us to measure the enterprise readiness for KM implementation, and the amount of work that will have to be done. These factors can be directly used in the context of our work. Just like characteristics defined above, they constitute a 4th type of elements. We totalize 36 CSF/CFF for the "enablers" category and 18 for the "sustaining characteristics" category.

Characteristics, CSFs and CFFs focus on different sectors of the firm. In order to better understand their effect on the different parts of the enterprise, we chose to sort them according to these domains.

C. The firm's 11 domains.

To give an all-inclusive and precise vision of the enterprise, we distributed our elements in 11 domains entirely describing firms, taken from a CSF study from Wong and Aspinwall [19]. This repartition allows us to have an overview of each area of the firm, and of its state with regard to KM. The 11 domains from Wong and Aspinwall [19] are: Management leadership and support; Enterprise culture; Available resources; Employees training and education; Information technology; Strategy and purpose; Motivational aids; Process and activities; Human resource management; Organizational infrastructure; and measurements. As measurements are based on indicators, that we chose to use later, this domain was put aside. We added an "Enterprise knowledge" area, allowing us to better describe the enterprise knowledge flows and actors. The classification of the 96 elements was made in a qualitative manner, through a brainstorm phase.

To handle every element easily, we defined its category (enabling element or sustaining element), its type (KM nature characteristic, supporting characteristic, existing characteristic, and CSF/ CFF) and its field of application in the firm (the 11 domains). Through the use of the characteristics and CSFs/CFFs, it is possible to entirely describe a SME. This answers to our previous research question.

To achieve this, each type of element has a particular utility

that will be developed in the following section.

III. USING CHARACTERISTICS AND CRITICAL SUCCESS/FAILURE FACTORS

A. The KM system design process

Characteristics defined above allow us to describe important SMEs elements in regard of KM. Our hypothesis is that, by taking account of the underlying firm's specificities, it is possible to design a tailor-made KM system fulfilling the firm's needs, without unnecessary elements. This absence of superfluous tools and processes implies fewer resource consumption for the KM system design, its implementation and its sustainability. As one of the particularities of SMEs is that they have limited resources, we think that, by limiting the resources consumed by the KM system, we could improve its success chances. Thus we have to adapt KM implementation and activities to the firm's specificities, to consume as less resources as possible.

In order to put such design process in practice in a SME, we have to study each characteristic it has and make the necessary adaptations to ensure the success and the effectiveness of the KM system. We established a 3 step process to perform the necessary activities:

Firstly, we describe the enterprise needs and specificities, thanks to the characteristics and CSFs/CFFs described above. It allows us to identify strong points, weaknesses, and in the end, the best way to design and implement KM in that particular firm.

Secondly, we make the necessary changes in the enterprise in accordance with CSFs, CFFs and relevant characteristics to maximize the chances of success through actions in the firm. We then design the KM system in accordance with the enterprise specificities defined thanks to the characteristics. If an SME doesn't have a particular specificity, or if one isn't applicable, modifications can be made to the KM system, as it will be modular.

Thirdly, our KM design process ends by the KM system implementation, and work to make it sustainable. (Cf. figure 2)

B. The role of each type of elements

To complete the first part of our process, each element type must be studied. Each type allows us to get data related to different design tasks, such as: Enterprise description; Enterprise needs; existing reusable elements; or determination of the best way to achieve KM. Each studied element gives information on the firm, thus allowing us to know precisely how our KM system will need to work, and what effort will be needed to guarantee its success. The role of each type of

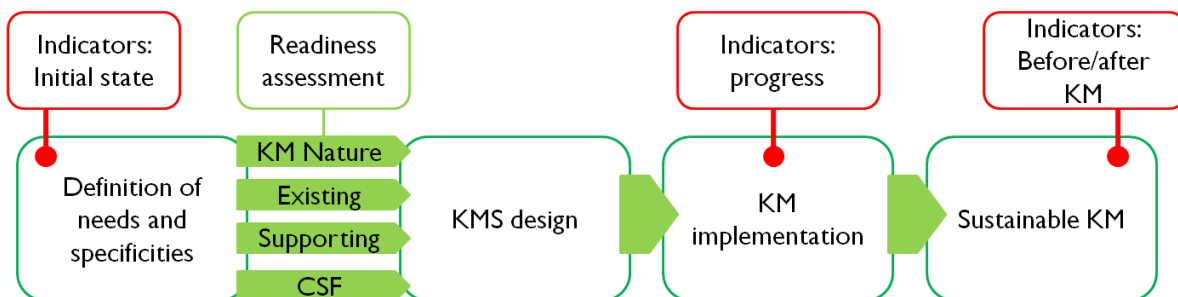


Figure 2. CONCEPTUAL BUILDING BLOCK EXAMPLE

element is as follows:

1) *Critical Success and Failure Factors*

The CSFs and the CFFs allow us to know if it is necessary to make changes to the firm, as well as giving us measurements of its readiness level. If many CSFs/CFFs are not acceptable in the studied SME, more work will have to be done to higher the success chances of the KM system. If changes are necessary, they have to be done before trying any KM implementation. In the end, CSF/CFFs will allow us to detect areas of the firm that need to receive attention or require action to ensure a successful KM system implementation. A readiness assessment for KM implementation can be made based on CFFs and CSFs.

2) *Supporting characteristics*

"Supporting" characteristics makes it possible to determine the specificities in favor of KM implementation in the studied SME. Taking account of these elements will allow an easier KM system implementation. Specificities determined thanks to these characteristics will allow us to draw a whole picture of the firm's valuable elements for KM. Every existing specificities in favor of KM will be taken into account. Thanks to this analysis, "missing" specificities favoring KM can be detected and added to the enterprise processes to gain advantage from them (e.g. an IT communication tool in a firm that doesn't use one). In the end, KM related elements of the firm will be leveraged to enhance the adaptation and the effectiveness of the KM system, as well as making its implementation easier. These characteristics also allow us to make a readiness assessment of the firm preparation for KM introduction and use.

3) *Existing characteristics*

"Existing" characteristics rely on processes and procedures concepts related to KM already existing in the firm. It can be interesting to include them in our KM system, as employees won't need additional training to use them. If the SME already uses KM tools, it can be useful to study how employees perceive them, how they use them, and if they were successful or not, as it can provide practical feedback. If management systems already exist in the firm, such as quality management, it can be interesting to use them to include KM tasks in everyday activities, thus encouraging employees to use it. In the end, these characteristics will help us implement our KM system in the firm's workflow.

4) *KM nature characteristics*

"KM nature" related characteristics are used to create the tailor-made operating part of our KM system, by allowing us

to choose different elements for the construction of its processes. Pre-established in our method, these conceptual elements will be picked in regard to each "KM nature" expressed characteristic, in order to achieve the most adapted system possible for the company and its needs. This category relies on 19 characteristics, each one associated with different conceptual building blocks (or conceptual bricks) which propose different operating patterns, adapted to specific situations. Every possible outcome for each characteristic is linked to a specific block. By studying these characteristics, we can describe the firm's specificities, and select the most adapted conceptual building block for each case. Thus, we can easily and quickly constitute a KM system by combining each building block, selected through their links to each expressed characteristic. We thereby obtain a KM system strictly answering to the firm's need, without unnecessary elements, and taking into account each of its important specificities. Thanks to this, a smaller amount of resources will be needed during the set up and the use of the KM system, which is a true advantage for SMEs, in which resources are scarce. If a conceptual building block doesn't fit a SME specificity, we can adapt an existing one, or create a new one to suit the need. It can then be added to the other building blocks database, hence allowing us to improve our tool on each use.

The advantage of this model is that it is modular. Every characteristic is linked to multiple interchangeable conceptual building blocks, offering different functioning possibilities (Cf. figure 3). For example, using day to day KM or long term KM can be interchanged by changing knowledge flux targets, depending on what the company needs to achieve. If resources and the situation allow it, it would even be possible to use multiple building blocks linked to the same characteristic simultaneously. We could think of using KM on both day to day and long term activities. Others elements, such as the size of the company could also be taken into account during the building block selection. Future works will focus on this aspect.

C. *Data aggregation*

At the end of this descriptive phase, an aggregation of the different characteristics and the CSF/CFFs is carried out. It allows us to fully describe the SME's need for the implementation and the use of the KM system. "KM nature" characteristics give us key functioning principles of the KM system to be implemented, "existing" elements allow us to better adapt the system to the enterprise, and "supporting" characteristics help us to better use the KM related specificities of the firm. CSFs and CFFs will allow us to identify what changes must be done on the firm, in order to

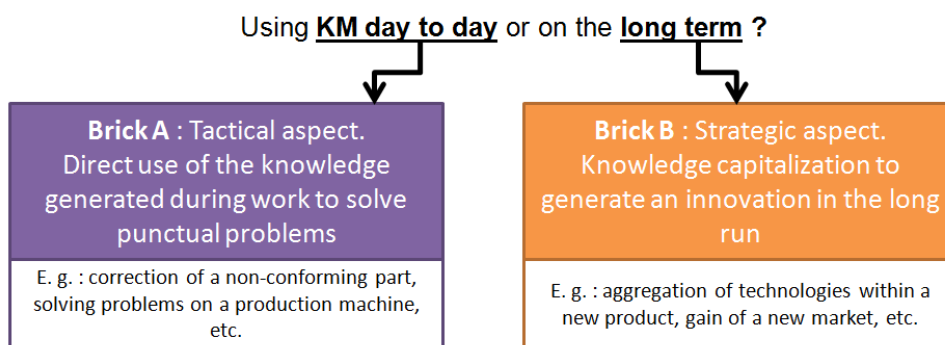


Figure 3. KM DESIGN AND IMPLEMENTATION PROCESS

implement the KM system in the best conditions possible and to make it sustainable.

To make this phase easier to perform, we created a table containing every element described above. It is designed for people willing to set up a knowledge management system in an SME, without specific KM knowledge prerequisite.

IV. THE CHARACTERISTICS TABLE

A. *Practical elicitation of the characteristics*

In order to make the description work easier and to assist the user, we designed an interactive table gathering both characteristics and CSF/CFFs. These elements are sorted by domain (see II. C.). This arrangement allows the user to answer to every question concerning the same domain successively and gather all the needed information from a particular domain (e.g. strategy, marketing, quality...) of the firm at once.

The characteristic table is an IT tool in which each element of the table is formulated as a question and is presented in the form of a multiple choice test with:

- Its type (Nature, support, existing, CSF/CFF);
- An explanation of the characteristic;
- A set of arguments indicating the implications it has in the company;
- The expected answer of a typical SME as an example;
- A set of possible answers (Cf. table 1).

By answering to each question by checking the most appropriate answer, we can quickly and easily position the SME among the different possibilities offered. It allows us to know what the firm is, but also what it isn't.

This table was design to help the user in the elicitation of the enterprise characteristics. By using this user friendly, step-by-step tool, we aim to decrease the complexity underlying the large amount of characteristics. It also gives the user enough information on each characteristic so that he can make an informed choice. The tool must be simple enough to use so that managers in SMEs will give it a chance. In the future, we want to propose an IT tool allowing the user to carry out these tasks more easily.

B. *Using the firm's specificities*

After this elicitation step, a summary of the responses in the different domains is carried out, in order to highlight the important points for the KM in that SME. Answers to "KM nature" characteristics allow a straightforward selection of the conceptual building blocks, and thus propose the key principles for an adapted KM system. We then aggregate the results of the 11 domains with these principles to design the tailored KM system to implement, including the elements already existing in the enterprise.

This way, we achieve a fast knowledge management audit of the firm by using "KM nature", "existing" and "supporting" characteristics, allowing designing the KM strategy. We also carry out KM implementation readiness assessment in each domain, as well as a selection of indicators suiting the firm needs to prepare KM performance measurement thanks to CSF/CFFs, "existing" and "supporting" characteristics. In the end, we obtain a KM

system tailored to fit the firm's needs by using "KM nature" and "existing" characteristics, as described in II. B.

To use this table, a simple familiarization with terms related to KM is necessary, as all the needed information is given during the elicitation phase. It is thus fast and easy to get a first diagnosis, without the need of an expert, and can be done by owners or managers in SMEs (or anyone with enough knowledge about the firm specificities).

However, designing and implementing the KM system still needs to be done by an expert, and managers and/or owners of the SME will have to take part in the design, as it requires well knowing the firm's specificities.

Our tool is still in a design and improvement phase, and will soon be tested on a high-technology SME. This will allow us to do a first iteration and to generate several conceptual building blocks, which will be used as a basis for further work.

V. CONTRIBUTION, FUTURE WORKS AND CONCLUSION

To conclude, our tool allows us to take into account the initial KM need and the characteristics of a SME, and to propose a KM system meeting the needs of the firm, both in terms of KM and adaptation, while consuming a minimum of resources. The characteristics study also allows us to solve potential problem in order to guarantee the KM system success. The main interest of our work lies in the fact that it brings KM theory into practice, which is actually lacking in the literature. Moreover, to our knowledge, there is no existing tool that performs these functions. Generally, articles are limited to the study of characteristics and factors, without explaining how to put them into practice in order to obtain an effective KM.

We are currently working on KM readiness quantification system and KM performance measurement features, based on CSF/CFFs, "existing" and "supporting" characteristics. Thanks to it, it will be possible to quickly know the difficulty and resource investment needed to implement a KM system in a SME, and to snapshot the initial KM state of the firm, allowing a comparison on advantages brought by KM implementation and a firm performance monitoring.

The next step will be to create a KM tool database including traditional tools (e.g. mails, wikis, data warehouses) as well as the newer KM tools such as enterprise social networks (yammer), team communication tools (slack, discord), team collaboration tools (Knowledge plaza), etc.

Thereafter, it will be necessary to validate our tool. A first iteration will be made within the framework of our thesis, but it will be necessary to test it in several others SMEs, in order to guarantee its universality and effectiveness. The advantage of the modular aspect of our design method is that, by allowing KM experts to add new characteristics to describe new SMEs, we can improve it if necessary. These validation tests will take time, as it will be necessary to wait until the end of a KM system implementation to know if it is well adapted to a company. A work on performance evaluation in the different specific cases of the companies studied will also be performed, as the use of indicators is a critical success factor. We thus have to choose them in adequacy with the KM system.

In the event that new conceptual building blocks are needed, it will be possible to design them and include them directly in our tool, just like any new element. This will contribute to its continuous improvement and versatility.

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Element Type	Characteristic	Explanation	Implications	Expected answer of a typical SME	Possible answers
Processes and activities of the SME					
Supporting, CSF	Easy and effective communication	Communicating with any other employee or reaching every employee at once is possible and easy.	Knowledge sharing is done through communication, thus a good communication allows an efficient knowledge sharing in the company.	Easy communication thanks to the low number of employees. It is easy to reach everyone at once.	<input type="checkbox"/> Easy communication <input type="checkbox"/> Difficult communication
KM Nature	Processes and procedures are flexible or rigid, and formal or informal.	To introduce KM in the SME, it is necessary to reconfigure its practices. It is easier if they are flexible. If the company works formally or informally, it will be necessary to adapt the KM activities so that they fit to the usual work.	Flexible practices allow an easier KM activities implementation with a reduced adaptation time. Adapting KM activities to formal or informal work allow a better acceptances and efficiency in the realization of KM tasks by the employees, as the way of working will only be slightly modified.	Processes and procedures are flexible and reorganizable. It is an advantage as it costs fewer resources. The way of working is often informal, thus KM activities should be informal.	<input type="checkbox"/> Rigid <input type="checkbox"/> Flexible <input type="checkbox"/> Formal <input type="checkbox"/> Informal
KM Nature	Using KM day to day or on the long term	Using KM day to day allows finding solutions to punctual problems, often linked to work procedures or specific product design steps. Long term use allows proposing global changes (e. g. on the way of work or the whole way products are designed), as well as using accumulated knowledge to create new products.	Day-to-day use makes it easier to perform "simple" tasks. It's a tactical aspect. Long term use allows leveraging accumulated knowledge to rethink the ways things are done. It's a strategic aspect.	SMEs often use day to day KM to give a fast answer to problems that may arise, as they don't have enough resources and time to make the investments needed for a long-term use.	<input type="checkbox"/> Day-to-day <input type="checkbox"/> Long term <input type="checkbox"/> Both
Existing	Knowledge sharing systems are used by the employees	Already existing KM systems are used by the employees in their work, as they need them for certain tasks. Examples: Blogs, intranet, wiki...	Reusing an already existing KM system allows employees to share knowledge more easily, as they already know how to use it. It also helps reducing the training time to use KM tools.	They are often few KM systems in SMEs, as most of them share knowledge informally, therefore not using a formal knowledge sharing system.	<input type="checkbox"/> Yes Which ones? <input type="checkbox"/> No
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Table 1.: EXAMPLE TAKEN FROM THE CHARACTERISTICS TABLE