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Agility-based knowledge management method for small and medium-sized enterprises

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Agility-based knowledge management method for small and medium-sized enterprises

Knowledge is a vital asset for organizations. It requires organizations to consider Knowledge Management (KM) activities in their processes. Nowadays, KM is relatively well applied in large organizations, but various constraints are faced by Small and Medium-sized Enterprises (SMEs). This article aims to define an agility-based KM method for the SME context. A lot of research has been performed in the direction of facilitating knowledge sharing in agile projects, while our research aims to present an original and concrete KM method for SMEs by integrating agility principles. We point out that (i) the KM combined with Agile Scrum practices could adapt to SMEs' specificities, and (ii) SMEs present several positive specificities for the agile-based KM implementation. An application of the method is built in collaboration with Axsens-bte, a SME company specializing in consultancy and training in the supply chain and industrial methods.

Keywords: Knowledge Management (KM); Agile methodology; Scrum; Small and medium-sized enterprises (SMEs)

1. Introduction

Nowadays, knowledge workers and knowledge are vital assets for organizations. Organizations face an ever-increasing amount of knowledge, leading to strong expectations regarding efficient and effective Knowledge Management (KM) processes. KM has been relatively well studied for large organizations, but there is a tendency to neglect Small and Medium-sized Enterprises (SMEs). The literature has focused on this domain only recently (Sartori & Frederico, 2020). Yet, SMEs, representing 99% of all businesses in the EU (The commission of the European Communities, 2003), still face various constraints on KM. SMEs differentiate themselves with particular characteristics compared to large organizations, especially regarding the lack of resources and KM experience (Durst & Edvardsson, 2012; Sartori & Frederico, 2020). As a result, the standard KM approach, such as formalization and codification using ontology

techniques, is often inaccessible to SMEs. Research reveals that the literature in this domain is fragmented and dominated by unrelated studies and is still worthy of future research (Cerchione et al., 2016; Durst et al., 2015; Massaro et al., 2016).

Regarding the practical implementation in SMEs, we did this research in collaboration with Axsens-bte, a SME company specializing in consultancy and training in the supply chain, industrial methods, and quality management. Axsens-bte allowed us to share their KM experiences and to apply the research result to build and validate this contribution. As observed within Axsens-bte, KM is critical for business sustainability, especially in the case of employee movements (e.g. retirement and position change). However, the knowledge is not formalized nor captured during daily work due to the lack of resources and the lack of a dedicated and simple KM process. The employers and employees of SMEs are often absorbed by day-to-day business operations and thus prevented from tackling the challenge of effective KM. On the other hand, SMEs also present positive characteristics compared to large organizations for the KM application. Some of those characteristics are flexibility, simplicity, and a high level of internal trust (Sartori & Frederico, 2020). Therefore, it is worthwhile to find a tailored KM method that is suitable for SMEs, which could cope with their specific constraints and, at the same time, exploit their advantages.

This article aims to present an agility-based KM method for SMEs by adopting best practices from the Scrum framework, one of the most commonly used agile methodologies. As one of the major innovations in software development, agile methodology emerged from the agile manifesto in 2001 (Kent et al., 2001). Besides the software domain, the agile concept has also been studied in the literature of other fields, such as agile enterprise (Dove, 1999) and agile Manufacturing (Soepardi A. et al., 2018).

At the beginning of the century, agile software development was initialized in response to diverse challenges faced in this domain. The Agile manifesto emphasizes the values of

collaboration, the short delivery timescale of working products, retrospective and customer satisfaction. With these values, software development has successfully coped with its constraints, such as the constantly changing customer requirements. Furthermore, various practices have been developed to apply the agile methodology, such as Extreme Programming (Kent & Cynthia, 2005), Scrum (S. Rubin, 2012; Schwaber & Sutherland, 2020). Scrum is one of the most widespread agile practices, which defines a framework of processes, roles, and artifacts for deploying agile projects. Scrum is commonly applied in various domains beyond software development to solve complex problems in which the ability to explore, inspect and adapt is critical (S. Rubin, 2012). The Scrum framework is used in this paper as the fundamental model for integrating agile principles into SME KM.

The research combining KM and agile methodology is not new, as both domains treat intangible information products (Meyer & Zack, 1996). KM is essential in today's software development (Gandomani et al., 2019). The term "agile knowledge management" is used for this research field (Levy, 2009). In this article, the connection between these two topics will be discussed but from a different point of view, striving to answer this question: *"is it possible to have an agile-based KM method that could promote KM in SMEs?"*

The research methodology used to answer this question is based on literature reviews and the experience of our industrial partner Axsens-bte, a SME company. Axsens-bte has dealt with consulting and training activities for many years in a knowledge-rich context. Experiences provided by several Axsens-bte employees have been considered in this research. An application of the research output is applied in Axsens-bte for evaluation and validation of the method.

This article is organized as follows: In Section 2, we give an overview of KM, KM in SMEs, agile methodology, and Scrum. In addition, we show the related studies on the connection between KM and agile. Section 3 describes the agile-based KM method by

integrating Scrum best practices. Section 4 presents an application of the proposed method in the SME company Axsens-bte. And Section 5 concludes with some limitations of this research and provides recommendations for future research on this topic.

2. Related works

2.1 Knowledge management in SME

Knowledge plays a critical role in contemporary companies for either large or small organizations. Moreover, with the ever-increasing knowledge, effective and efficient KM is essential for all organizations to create sustainable competitive advantage and keep achieving customers' expectations (Demartini & Beretta, 2020). In today's industry 4.0 context, with the emergence of new technologies such as artificial intelligence, smart objects, Internet of Things (IoT), etc., organizations are facing opportunities and also challenges to improve their KM in terms of knowledge acquisition and exploitation, to ultimately sustain their competitiveness (Ardito et al., 2021; Bettiol et al., 2020).

The KM discipline has been developed over thirty years and studied extensively. KM is defined as the “systematic, explicit, and deliberate building, renewal, and application of knowledge to maximize an enterprise's knowledge-related effectiveness and returns from its knowledge assets.” (Wiig, 1997). It deals with creating value from an organization or a company's knowledge (Bergmann, 2002). We could identify the essential steps of KM from Wiig's definition (Wiig, 1997). These steps are “building”, “renewal” and “application” of knowledge. Researchers and practical experience have proposed various KM models to consider different situations. (Heisig, 2009) analyzed 160 KM frameworks worldwide and concluded five core common KM activities, which are “Identify”, “Create”, “Store”, “Share”,

and “Use”. However, until today, there is no common consensus on a KM process standard (Durst & Edvardsson, 2012; Tenório et al., 2020).

Many large organizations have formally implemented the KM, recognizing the importance of knowledge and the criticality of managing it correctly. KM also significantly impacts SMEs’ business efficiency (Sundram et al., 2020) and innovation performance (Zhou et al., 2021). However, successful KM for large organizations cannot be used directly by SMEs, and there is a lack of research concerning the KM process tailored for the SME context (Durst & Edvardsson, 2012; Sartori & Frederico, 2020). SMEs' specificities distinguish them from large organizations in terms of KM (Sartori & Frederico, 2020). As stated by Wong (Wong, 2005), contrasting with large organizations, in which the motivational aids and organizational infrastructure were considered critical for KM, the resources, training, and human resource management are more vital in SMEs KM. This finding also aligns with the systematic literature reviews of J. T. D. Sartori, in which 35 negative and eight positive specificities for KM implementation in SMEs are presented (Sartori & Frederico, 2020). The negative specificities like “lack of resources”, “more informally and fewer rules”, and “lack of skills or expertise on KM” are predominant. Nevertheless, SMEs also present positive specificities for KM implementation like “more flexibility”, “high level of internal trust”, and “higher socialization and proximity”. An adapted KM process for SMEs should cope with their negative specificities and also take advantage of their positive specificities.

In Table I, based on the literature review of (Tapissier et al., 2018), a list of basic SME KM requirements is summarized with four characteristics: “Simple”, “Adaptable”, “Complete” and “Practical”.

To respond to these SME KM requirements, in this article, we propose a tailored SME KM by integrating the agility concept, especially the Scrum framework.

Table I: Basic SME KM requirements from the literature review (adapted from (Tapissier et al., 2018))

SME KM essential Requirements	
Simple	The KM must be simple and efficient due to the limited dedicated resources (e.g. people, budget, time) in SME.
Adaptable	The KM must be adaptable, which enables the consideration of the complex and competitive SME environment.
Complete	The KM must consider all the steps in the KM process to create valuable knowledge items at the end.
Practical	The KM must be supported by standardized guidance and examples to ease the implementation.

2.2 Agility, agile methodologies, and Scrum method

2.2.1 Agility and agile methodologies

“Agility” is defined as “ways of planning and doing work in which it is understood that making changes as they are needed is an important part of the job” according to the Cambridge dictionary. The agility concept has been studied in the literature for its application in different domains, such as agile enterprise (Dove, 1999), agile software development, agile manufacturing (Soepardi A. et al., 2018), agile problem solving (Llamas, 2017), agile human resource management (Heilmann et al., 2020). This article focuses on the agile software development methodology and, more precisely, one of the most commonly used agile practices, the Scrum method.

Agility has been mainly applied in the software development domain since the establishment of the agile manifesto in 2001 (Kent et al., 2001). Software development faced challenges such as constantly changing customer requirements, the need for collaboration between developers, the work on intangible products, etc. The agile manifesto formalized core agility values, which introduced a new vision to the software development domain. It helps to establish a collaborative, flexible to changes, adaptive and responsive culture inside the team

and among the networks. These advantages respond well to the SME KM requirements presented in Section 2.1.

Moreover, various practices have been developed for agility, such as Extreme Programming (XP) (Kent & Cynthia, 2005), Scrum (S. Rubin, 2012; Schwaber & Sutherland, 2020), and several specific practices proposed to large organizations, like the scaled agile framework (SAFe) (Durisic & Berényi, 2019). Instead of defining a list of prescribed actions, Scrum provides a framework of processes, roles, and artifacts to drive an agile project. The organization can adapt this framework with its specificities and other practices. A suitable KM for SMEs is a complex issue that needs to be supported by this kind of practice. For these reasons, the Scrum framework is used in this paper as the basic model to integrate agile principles into SME KM.

2.2.2 Scrum framework

Scrum defines a people-centric and straightforward framework for deploying agility in the software development sector. This framework is based on honesty, openness, courage, respect, focus, trust, empowerment, and collaboration (S. Rubin, 2012). The Scrum framework defines a set of practices, and artifacts, as shown in Figure 1 (Schwaber & Sutherland, 2020).

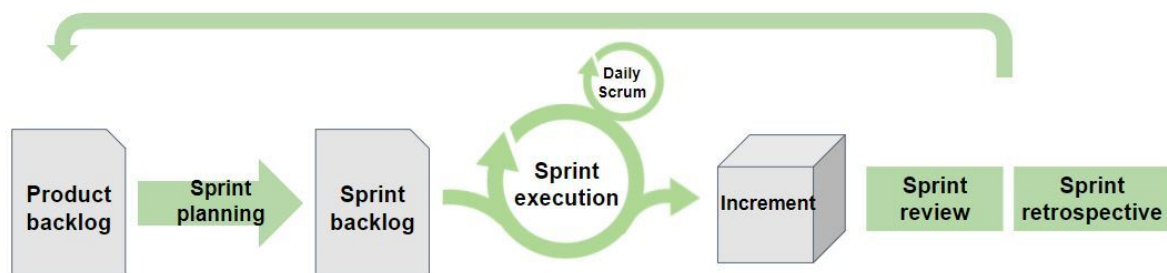


Figure 1: Scrum framework

The set of practices includes (i) the establishment of “Sprint planning”, aiming to define the work to be done during the iterations to respond to customer requirements. The planning is constituted of valuable and realizable work items for the final product. (ii) short, time-boxed,

and iterative work sessions called “Sprint” or “Sprint execution”, where the product value is created within one or several iterations, according to the “Sprint planning”. (iii) a set of inspection meetings which are “Daily Scrum”, “Sprint Review”, and “Sprint retrospective”, aim to collectively inspect, adapt and improve the daily work (“Daily Scrum”), the Sprint results (“Sprint Review”) and the way of working (“Sprint retrospective”).

Along with these practices, Scrum defines three artifacts: (i) “Product backlog”, the single source for the whole process. It contains a prioritized list of what is needed for product development (what is to be done, and in what order). “Product backlog” items could be broken down into smaller and more precise realizable items. (ii) “Sprint backlog”, which is a subset of the “Product Backlog” with which the developers establish an actionable plan to achieve the Sprint goal. (iii) the “Increment”, which is the result of the “Sprint execution” according to the planning. It is additive to prior increments and is potentially shippable to the customer.

The Scrum framework is realized by the “Scrum team” which is a self-managing cross-functional team including (i) the “Scrum Master”, who is responsible for ensuring that the Scrum framework and agile values are well understood and deployed, (ii) the “Product Owner”, who is responsible for effective “Product backlog” management and communication, with the duty to maximize the product value according to the product vision as defined by the customer. (iii) the development team, a group of people with specific skills to create values of what has been requested in the Product Backlog by the Product Owner.

2.3 The connection between KM and agility

KM and agile are both concepts that various groups of academics and organizations have explored. Many researchers acknowledge the connection between these two disciplines. The related discussions mainly focus on, such as (i) the critical role of KM in an agile enterprise. The KM is considered as one of the enabling competencies in such an organization (Dove,

1999). And (ii) the need to enhance KM techniques in an agile software development project, which is a highly knowledge-centric field in which implicit knowledge is prevalent. Consequently, it is challenging for an effective KM in this kind of project (Gandomani et al., 2019). The term “Agile knowledge management” has been proposed for this research field (Levy, 2009).

Though the research orientation is not the same, the connection between these two disciplines pointed out by these researchers shows furtherly their compatibility. KM and agile concepts are essential for organizations to create a sustainable competitive advantage. And both of them could help organizations to respond to customers’ requirements promptly.

2.4 Contribution

In addition to the connection between the two disciplines, agile Scrum methodology is an excellent answer to SME KM specific requirements. KM and software development have common constraints. They are both abstract concepts dealing with intangible information products (Meyer & Zack, 1996), aiming to help organizations cope with problems such as lack of resources and a lack of collaboration mindset (Levy, 2009). Lessons learned from the agile Scrum process could cope with the SME’s negative specificities. Moreover, it could also take advantage of SME positive specificities like flexibility and high internal trust level. However, existing research does not propose a concrete KM method based on agile methodology, which could be very helpful for SMEs. Based on the bibliographic study and the experience shared by Axsens bte, in what follows, we continue to highlight the connection between the KM and agile disciplines and propose a Scrum-based KM method for SMEs.

3. Adapted agile Scrum KM method for SMEs

3.1 K-Scrum method

In this section, we present a Scrum-based KM method, the K-Scrum (“K” stands for Knowledge), along with the definition of each step, the artifacts, and the involved actors.

The adapted K-Scrum method focuses on knowledge creation and capture, which includes the codification of the captured/created knowledge and its assessment before the knowledge-sharing phase (Dalkir, 2005). This phase aims to define complete, codified, and validated knowledge according to the company’s needs, which is ready to be shared and applied in the afterward phases.

The proposed K-Scrum method is illustrated in Figure 2. It includes:

- five sequential steps: “Detect”, “Plan”, “Process”, “Validate”, and “Store”.
- four artifacts: “Knowledge Request (KR) backlog”, “K-Sprint backlog”, “Processed knowledge”, and “Validated Knowledge”.
- and a K-Scrum community aiming to create together valuable knowledge for the company, which consists of: “Knowledge detector(s)”, “Knowledge manager”, “Knowledge processor(s)”, and “Knowledge reviewer(s)”.

The K-Scrum process steps and the different roles are described in detail in the following sections from 3.3.1 to 3.3.5, with a summary in section 3.3.6.

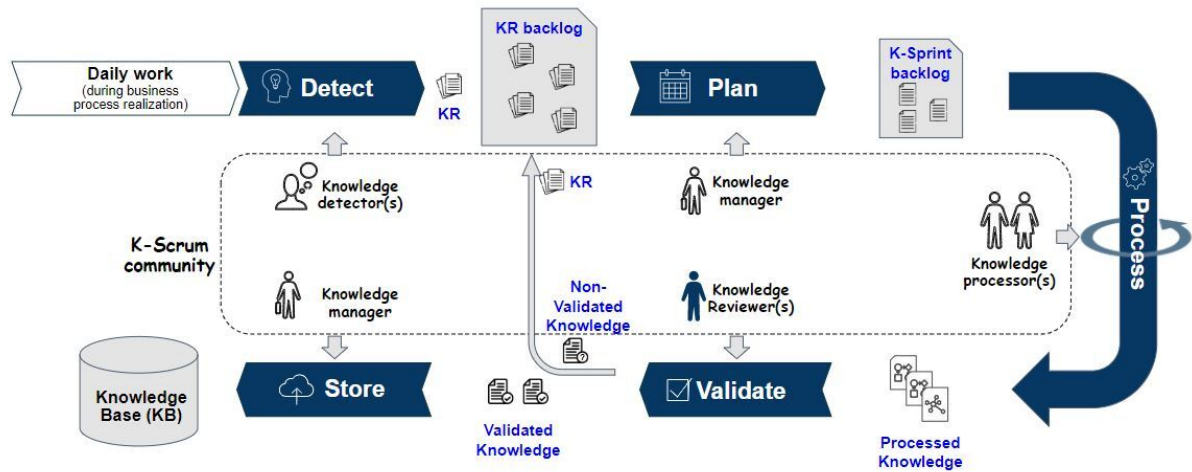


Figure 2: K-Scrum method including the artifacts and community actors

3.2 SME KM policy

For a successful deployment of the proposed method, it should be noted that the SME manager(s) should also be engaged in the method deployment, especially for the role assignment, resource, and work environment. A SME KM policy defined by SME manager(s) is a prerequisite for deploying the method. This policy needs to be adjusted according to the SME context. Some essential points need to be addressed by this policy, such as (i) the definition of the knowledge which is valuable for the company according to its global vision, (ii) the definition and the assignment of the roles including “Knowledge detector(s)”, “Knowledge manager”, “Knowledge processor(s)”, and “Knowledge reviewer(s)”, and (iii) the rules for each step, including for example the general capacity assignment, the work session duration, and frequency of the step “Process”.

3.3 K-Scrum method steps

3.3.1 Detect

The K-Scrum process is triggered by a knowledge need detected by the actor “Knowledge

detector(s)”, who could be anyone in the organization detecting a need to create or update the knowledge in the organization. For a business process, the detectors are usually the ones who are involved in the process operation in their daily work. They are responsible for formulating the KR.

A “Knowledge Request (KR)” should be formalized by the “Knowledge detector” to capture exhaustive information about the need. During people’s daily work, two types of KRs could be detected: knowledge capture or creation requests. The first type concerns the need to capture knowledge from already available sources. For instance, a request to standardize and internalize knowledge from an article or a webinar. The second type concerns the need to create knowledge starting from scratch (e.g. a request to create a new process for the company). This type of KR solicits more allocated resources from the company.

There are three basic elements for a complete KR: who, what, and why. A simple record is used to collect these elements: [who], [what], and [why]. A KR example could be: “[*Quality manager*]: [*Standardised checklist for audit process*], [*is useful to conduct a quality audit and to go through all the quality subjects.*]”. The “who” is the “Knowledge detector”, who detects the need. The “what” corresponds to the description of the request. It is the goal that the K-Scrum community needs to achieve. And the “why” pointing out the rationale of the request. Other KR-related information like useful documents, the source, and the detection date can also be recorded in this stage.

The KRs formalized by the “Knowledge detector(s)” are collected by the “Knowledge manager” and managed in a list called “KR backlog”. This backlog is a “living” document that is updated every time there is a new KR. It is the unique resource for the whole process, which provides a global view of all the KRs and their status.

3.3.2 Plan

The second step is managed by the “Knowledge manager”, who is accountable for maximizing the value of the final knowledge resulting from the whole K-Scrum method by providing effective management over the entire process. The “Knowledge manager” guarantees the method with his/her management skills (e.g. communication, team management). The “Knowledge manager” doesn’t need specific expertise in a given domain. Moreover, for SMEs, due to the resource constraints which is underlined by the literature, it could also be challenging to find someone with specific KM expertise. In this method, only one “Knowledge manager” is needed. In case several “Knowledge managers” are assigned, the estimation of the different parameters (e.g. KR priority) should be done collaboratively, and a consensus should be built (Leoneti et al., 2022; Wibowo & Deng, 2013).

In this step, the “Knowledge manager” defines a short-term and feasible plan named “K-Sprint backlog”, with the support of (i) the “Knowledge detector(s)” to understand each KR in the “KR backlog” if not straightforward enough, and (ii) the people who work on the KRs (Knowledge processor(s)), to take into account the allocated capacity of the K-Sprint work session of the step “Process” (which will be described in the section 3.3.3).

Two sub-steps are defined for this step: “Priority estimation” and “Capacity verification”.

(1) Priority estimation: The KR priority is calculated based on the three parameters presented below.

- **Relevancy (R)**: is the KR relevant to the company’s global vision, and the expected knowledge is valuable to the company? R is quantified on a scale from 1 to 4 representing the least relevant to the most relevant KR as presented in Table II.

Table II: KR relevancy

R = 1	The KR is indirectly linked to the company’s strategy and the expected knowledge is not valuable to the company.
R = 2	The KR is directly linked to the company’s strategy, but the expected knowledge is weakly valuable to the company immediately.
R = 3	The KR is indirectly linked to the company’s strategy, but the expected knowledge is valuable to the company.
R = 4	The KR is directly linked to the company’s strategy and the expected knowledge is valuable to the company.

- **Urgency (U):** is the KR urgent? U is quantified on a scale from 1 to 4 representing the least urgent to the most urgent KR as presented in Table III.

Table III: KR urgency

U = 1	The KR is not urgent and no need to be considered during the next four K-Sprint work sessions.
U = 2	The KR is not urgent but it needs to be considered in one of the next four K-Sprint work sessions.
U = 3	The KR is urgent and needs to be considered in one of the next two K-Sprint work sessions.
U = 4	The KR is very urgent to be considered in the upcoming K-Sprint work session.

- **Required workload (W):** how many resources need to be allocated to work on the KR? W is quantified on a scale from 1 to 4 representing the KR requiring the heaviest workload to the lightest workload, as presented in Table IV. This parameter is not only used to estimate the KR priority but is also essential for the next sub-step, “capacity verification” to compare with the allocated capacity in the next K-Sprint work session. More details will be given in the second sub-step.

Table IV: KR required workload

W = 1	The KR requires more than 100% of allocated capacity in the next K-Sprint work session, which means that the KR cannot be completed at one K-Sprint work session. In this case, the KR should be refined by the “Knowledge Manager”.
W = 2	The KR requires 50% - 100% of allocated capacity in the next K-Sprint work session, which means that at most two of this kind of KR could be treated at one K-Sprint work session.
W = 3	The KR requires 20% - 50% of allocated capacity in the next K-Sprint work session, which means that at least two of these kinds of KR could be treated at one K-Sprint work session.
W = 4	The KR requires less than 20% of allocated capacity in the next K-Sprint work session, which means that more than five of these kinds of KR could be treated at one K-Sprint work session.

For the calculation of the priority, other parameters could also be considered by the “Knowledge manager” according to the organization's KM policy. With these three presented parameters (R, U, and W), KR’s priority (P) can be calculated using the following formula. The result is a value between 1 and 64, representing the least prioritized KR to the most prioritized KR:

$$P_{KR} = R * U * W$$

The KR represents high priority if the KR is relevant, urgent, and requires few resources. This kind of KR will be considered as soon as possible in the “Process” step. If the KR priority is low, it will be considered in a future K-Sprint work session, or it could be refined into smaller, more precise, and realizable sub-KRs to augment its priority. The refinement of KR is performed by the “Knowledge manager” with the support of the “Knowledge detector(s)” and/or other K-Scrum community members.

- (2) Capacity verification: Once the KR priority is defined, we can have the most prioritized KR's list. However, not all these KR's can be treated immediately. During this step, the “Knowledge manager” needs to compare the KR's total workload with the K-Sprint work session capacity assigned by the SME manager(s) in the KM policy. The objective is to define a feasible action plan with the assigned capacity and to adjust it according to

“Knowledge processor(s)” availability. The total KR workload “W” cannot exceed 100% of the capacity of the next K-Sprint work session.

These two sub-steps result in a prioritized and realizable list of KR, named “K-Sprint backlog”. This backlog is an action plan for the interactive K-Sprint work session performed in the following “Process” step.

3.3.3 *Process*

During the third step “Process”, the “Knowledge processor(s)” work on the “K-Sprint backlog” to create valuable knowledge for the organization incrementally.

The “Knowledge processor(s)” could be one person or a group of people who are able to complete the K-Sprint backlog KR. This activity requests the “Knowledge processor(s)” to have specific information treatment competence to create clear and complete knowledge based on the KR.

The “Process” step is realized within a time-boxed and iterative K-Sprint work session. This format allows the “Knowledge processor(s)” to have dedicated time to work on the backlog and to perform regular reviews on the progress and the way of working at the end of each K-Sprint work session.

During each K-Sprint work session, the “Knowledge processor(s)” works on the K-Sprint backlog items to convert them into valuable knowledge with clear knowledge statements and classification(s). Both of them are important for knowledge sharing and application.

- Knowledge statement: by involving competent “Knowledge processor(s)”, the detected KR are being processed to complete, well-formulated and structured knowledge.
- Knowledge classification: the knowledge is classified with labels such as its domains, application context, etc.

The result from this “Process” step is the “Processed knowledge”, the expected valuable knowledge complying with the KRs in the “K-Sprint backlog”. It is the input for the next “Validate” step for “Knowledge reviewer(s)”.

3.3.4 *Validate*

The next step, “Validate”, aims to review the “Processed knowledge” after the iterative K-Sprint work session.

This step is realized by the “Knowledge reviewer(s)”, whose responsibility is to provide a minimum validation of the “Processed knowledge” before integrating it into the knowledge base as “Validated knowledge”. The “Knowledge reviewer(s)” should have expertise in a specific knowledge domain and can assess and review the “Processed knowledge” according to the initial KR and the organization's knowledge policy. The “Knowledge reviewer(s)” could also be someone from the SME network.

There are two possible outputs from this step: “Validated knowledge” or a “new KR”.

- The “Processed knowledge” is validated. It becomes “Validated Knowledge” which is ready to be stored in the organization’s Knowledge Base (KB) and be used for sharing and application.
- The “Processed knowledge” item is not validated. It needs to be completed or clarified. In this case, a new KR has to be created along with the comments from the “Knowledge reviewer(s)”. The KR is then managed by the “Knowledge manager” to put it in the right place in the artifact “KR backlog” and to follow the whole process.

3.3.5 *Store*

The final step “Store” is the end of this proposed K-Scrum process. With the “Validated knowledge” from the previous step, the “Knowledge Manager” saves the formalized knowledge

with its statement and classification into the KB, containing all the valuable knowledge assets of the company.

3.3.6 K-Scrum method summary

The five K-Scrum steps are presented in Table V below, with the information on the: supplier (the main actor who provides the inputs), input (what is provided), process (what is done), output (what is generated), and customer (the main actor who receives the output).

Table V: K-Scrum steps summary

Supplier	Input	Step	Output	Customer
Knowledge detector(s)	Information from daily work (including business processes deployment)	Detect	KR	Knowledge manager
Knowledge manager with support from Knowledge detector(s) and Knowledge processor(s)	KR backlog	Plan	K-Sprint backlog	Knowledge processor(s)
Knowledge processor(s)	K-Sprint backlog	Process	Processed knowledge	Knowledge reviewer(s)
Knowledge reviewer(s)	Processed knowledge	Validate	Validated knowledge or KR for non-validated knowledge	Knowledge manager
Knowledge manager	Validated knowledge	Store	Updated KB	The company

3.4 Discussion on the K-Scrum method for SME KM

As discussed in the bibliographic study in Section 2.1, the KM process in SME is requested to focus on different aspects due to the SME specificities compared to large organizations. By integrating the agile Scrum framework into the KM, the proposed K-Scrum method presents the following specificities that can comply with the SME KM-specific requirements, as shown in Table VI. It could cope with SME negative specificities like lack of resources and KM expertise, and it also takes advantage of SME positive specificities like flexibility and a high level of internal trust.

Table VI: SME basic KM requirements compliance

SME KM basic requirements	K-Scrum method specificities
Simple	This method proposes a simple framework for KM, which is easy to be implemented and does not require additional resources from the company.
Adaptable	This process provides a generic framework that could apply to different contexts. Guided by the backlogs, the most prioritized requests will be treated in time. Also, with the regular scrum meeting after each process iteration and the validation meeting, the whole process and the result could continuously be inspected and adapted for further improvement. The adaptability could cope well with the SME's complex and competitive environment.
Complete	The proposed K-Scrum reinforces the knowledge acquisition phase with agile principles from the detection of knowledge needs to the creation of complete and valuable knowledge.
Practical	The K-Scrum provides a framework for the necessary steps, roles, and artifacts, which is fundamental for creating standardized guidance in SMEs.

In addition to these specificities, the K-Scrum method also presents the following advantages (Table VII), which are essential for SMEs KM.

Table VII: K-Scrum additional advantage for SMEs

Additional advantages	K-Scrum method specificities
Flexible	The process is flexible to changes, which is inherited from the key values of agile. Any change can be captured easily in the KR backlog and be taken into account in time.
Collaborative	This framework based on agile helps the company to establish a collaborative environment. Research pointed out that a social constructivist approach is critical for KM (Dalkir, 2005). Instead of requiring a single resource to manage the company's knowledge, this method engages people to contribute and work in one community, enables interactions, and encourages knowledge sharing. Moreover, the high level of internal trust in SMEs could promote collaborations and the K-Scrum process.
Mature	The agile Scrum process has been deployed for two decades for software development, and its effectiveness has also been recognized in other domains. The K-Scrum method helps companies to integrate this mature process for the KM.
Productive	The K-Scrum method enables a frequent delivery of valuable knowledge thanks to the time-boxed and iterative K-Sprint work sessions in step "Process". It can help SMEs to establish the first database of valuable knowledge quickly and continually enrich this database. It also helps to promote the entire KM cycle (including knowledge sharing and application) and to motivate people to contribute. It can also avoid the loss of critical knowledge with its shortened delivery lead time.

4. Application illustration

To assess the effectiveness of the K-Scrum method described in the previous section, an application is illustrated in this section. The method is applied in Axsens-bte, a SME

specializing in consultancy and training in the supply chain, industrial methods, and quality management. Axsens-bte deals with activities in a knowledge-rich context. They struggled to manage the overloaded knowledge without a standardized and dedicated KM method.

The application concerns knowledge creation and capture for a business unit of 5 consultants. They provide service for one of the customers in the supply chain and quality management domain. After more than ten years of collaboration with customers, the knowledge and experience in this business unit are very rich, although it is not formalized nor captured. As a result, knowledge acquisition and exploitation activities are critical for the sustainability of the business unit, especially for the retirement and position change of consultants. However, constraints like the lack of resources are present in this small group for an efficient and effective KM.

Nowadays, consultants are asked to complete a lesson-learned template at the end of their mission. Several constraints are identified in this process: additional time and resources are requested, people miss important information at the end of the mission, verification and validation of the content relevancy are limited. Moreover, it is also noticed that the reusability of the captured lessons learned is limited. Therefore, how to manage the continually overloaded knowledge effectively is crucial.

The K-Scrum method has been applied in this context. An “Axsens K-Scrum” template has been created to support the deployment of this method. An extract of this template is shown in Figure 3.

Axsens K-Scrum															
1. Knowledge detection				2. Knowledge plan				3. Knowledge processing				4. Knowledge validation		5. Knowledge storage	
Ref.	Content	Date	Source	Detect or	Relevancy (4 = very relevant)	Urgency (4 = very urgent)	Implementation workload (4 = very easy)	Priority level (R * U * J)	K-Sprint backlog plan	Category	Statement	Status	Validated	Reviewer	Stored
1	[Project manager]: [production process involving all impacted functions for customer requirements review] [could help to have a global view of risks that are critical to project success].	01/07/20xx	Project lessons learned	RR	4	4	4	64	K-Sprint N°1	#Production #Customer #Requirement	"Internal review of the contract by the consultancy director, the Business unit responsible, and the involved consultants"	5. Stored	<input checked="" type="checkbox"/>	RR	<input checked="" type="checkbox"/>
2	[Project manager]: [risk management process including the verification of risk mitigation actions.] [could useful to evaluate the actions effectiveness].	05/07/20xx	Risk management	AE	3	1	2	6				1. Detected	<input type="checkbox"/>		<input type="checkbox"/>
3	[Consultant]: [A dedicated MFT function guideline for complex problem-solving process.] [could help us to identify the root cause].	14/07/20xx	Problem-solving process operation feedback	MC	2	2	2	8					<input type="checkbox"/>		<input type="checkbox"/>
3.1	[Consultant]: [Criteria to classify operation problems with complexity] [makes the problem-solving process more efficient].	24/07/20xx	KR3	MC	3	2	3	18	K-Sprint N°1	#Problem solving #Operation #Problem assessment	"The problem complexity is assessed at the beginning of each problem solving process".	3. Processed	<input type="checkbox"/>		<input type="checkbox"/>
3.2	[Consultant]: [A multi-functional team including at least management, operation, and quality functions for complex operation problems], [could help to identify the real root cause(s)].	24/07/20xx	KR3	MC	2	2	4	16	K-Sprint N°1	#Team #Problem solving #Operation #Complex problem management, operation, and quality functions"	"A multi-functional team for a complex problem is a mandatory step for problem-solving". "A multi-functional team should include at least management, operation, and quality functions"	3. Processed	<input checked="" type="checkbox"/>	DD	<input type="checkbox"/>
4	[Quality manager]: [Standardised analysis process and feedback loop for improvement suggestions], [encourage people for continuous improvement].	02/08/20xx	Quality management	DD	2	2	3	12				1. Detected	<input type="checkbox"/>		<input type="checkbox"/>

Figure 3: “K-Scrum” template extract

The K-Scrum method defines a set of roles for the deployment of the process. In this business unit consisting of 5 consultants, one person is often assigned to two or several roles. For example, a consultant could be assigned simultaneously as a “Knowledge processor” and “Knowledge reviewer”. Also, external resources such as colleagues from other business units could be invited to be “Knowledge reviewer(s)”. In this application case, a “Knowledge manager” profile has been defined by Axsens-bte managers and this role has been assigned to one of the consultants. The profile contains criteria such as good communication skills, the ability to develop, prioritize and manage work effectively, and knowledge of Agile methodology. The experience in knowledge management is a supplemental asset.

As illustrated in Figure 3, each line represents a KR detected progressively during the mission by the consultants (“Knowledge detector”). The list of KRs represents the artifact “KR backlog”. This backlog is then reviewed by the “Knowledge Manager”, represented by one consultant, to ensure the correct definition of the request. If needed, the “Knowledge manager” could request clarification from the “Knowledge detector”.

The different columns are used to follow the five steps of the K-Scrum method (“Detect”, “Plan”, “Process”, “Validate”, and “Store”).

- The “**Detect**” section consists of the KR: annotated reference, KR content, the detection date, source, and the detector name. It generates the first artifact, “Knowledge request (KR) backlog”.

For example, the following KRs are detected and captured in this application case:

Table VIII: KRs list extract from Axsens-bte database

Reference	KR content [Who], [What] and [Why]	Date	Source	Detector
KR1	[Project manager]: [The impacted functions should be organized to review customer requirements] [in order to have a global view of risks that are critical to project success].	01/07/20xx	Project lessons learned	RR
KR2	[Project manager]: [The risk mitigation actions should be verified regularly] [in order to evaluate the actions effectiveness].	05/07/20xx	Risk management	AE
KR3	[Consultant]: [A multi-functional team has to be organized to analyze complex operation problems] [because it helps us to identify the real root causes].	14/07/20xx	Problem-solving process operation feedback	MC
KR4	[Quality manager]: [The improvement suggestions need to be analyzed and responded to in time], [in order to encourage people for continuous improvement].	02/08/20xx	Quality management	DD

- The “**Plan**” section consists of the three parameters of each KR item: “Relevancy”, “Urgency” and “Required workload”. In this use case, each KR is assessed with these three parameters on a scale from 1 to 4.

- (1) “Priority estimation”: The multiplication of these three parameters calculates the final “Priority (P)” and the highest score represents the most priority KRs. If the KR priority value is low, the “Knowledge manager” can exclude it from the next K-Sprint work session (e.g. KR2 in Table VIII). Or, the “Knowledge manager” can refine the KR into two or several sub-KRs with support from the Knowledge detector and/or other K-Scrum community members. In this case, one KR is refined into two or several sub-KRs. As shown in Table IX.i and Table IX.ii, KR3 is divided into KR3.1 and KR3.2 as it requires a too heavy workload, resulting in a low priority.

KR3: [Consultant]: [A dedicated MFT function guideline for complex problem-solving process], [could help us to identify the root cause].

KR3.1: [Consultant]: [Criteria to classify operation problems with complexity], [can make the problem-solving process more efficient].

KR3.2: [Consultant]: [A multi-functional team including at least management, operation, and quality functions for complex operation problems], [could help to identify the real root cause(s)].

This sub-step helps to generate the list of prioritized KR's (Table IX.i and Table IX.ii).

Table IX.i: Initial KR's with estimated priority

Reference	R	U	W	P
KR1	4	4	4	64
KR2	3	1	2	6
KR3	2	2	2	8
KR4	2	2	3	12

Table IX.ii: Refined KR's with estimated priority

Reference	R	U	W	P
KR1	4	4	4	64
KR2	3	1	2	6
KR3	2	2	2	8
KR3.1	3	2	3	18
KR3.2	2	2	4	16
KR4	2	2	3	12

- (2) "Capacity verification": With the list of prioritized KR's, the "Knowledge manager" needs to crosscheck it with the K-Sprint work session capacity. As shown in Table X, a decision needs to be made as the total workload will exceed 100% if we plan all the high-priority KR's for the next K-Sprint work session. Considering the capacity, only KR1, KR3.1, KR3.2 are planned for the K-Sprint N°1.

Reference	W	Priority	(Cumulative Capacity)	K-Sprint backlog plan
KR1	4 (0%-20%)	64	(0%-20%)	K-Sprint N°1
KR2	2 (50%-100%)	6	-	(Excluded as low priority)
KR3.1	3 (20%- 50%)	18	(20%-70%)	K-Sprint N°1
KR3.2	4 (0%-20%)	16	(20%-90%)	K-Sprint N°1
KR4	3 (20%- 50%)	12	(40% - 140%)	(Excluded as potentially overloaded)

Table X: K-Sprint backlog decision

These two sub-steps “Priority estimation” and “Capacity verification” help generate the second artifact, “K-Sprint backlog”.

- The “**Process**” section contains two columns, which are “Knowledge statement” and “Category”. According to the K-Sprint backlog, the Knowledge processor(s) work on the planned KR during a time-boxed “K-Sprint” session (1-hour fortnightly for this application). The last artifact, “Processed knowledge”, is then generated (Table XI).

Table XI: Knowledge processing

K-Sprint N°1	Reference	Category	Processed Knowledge statement
01/09/20xx	KR1	#Production #Customer #Requirement	<i>“Internal review of the contract by the consultancy director, the Business unit responsible, and the involved consultants should be organized for project risk analysis”</i>
01/09/20xx	KR3.1	#Problem solving #Operation #Problem assessment	<i>“The problem complexity should be assessed at the beginning of each problem-solving process”.</i>
01/09/20xx	KR3.2	#Team #Problem solving #Operation #Complex problem	<i>“A multi-functional team for a complex problem is a mandatory step for problem-solving.” “A multi-functional team should include at least management, operation, and quality functions”</i>

- “**Validate**” section refers to the validation of the processed knowledge by the Knowledge reviewer(s). If validated, the knowledge will then be stored in the company KB. If not, a new KR is recorded and treated with the initial “Knowledge detector” and “Knowledge manager” (Table XII).

Table XII: Knowledge validation


Reference	Validate status	Reviewer(s)	Data	Action
KR1	Yes	Project manager	15/09/20xx	To be stored in the KB
KR3.1	No	Problem-solving method owner	02/09/20xx	New KR to be created with the knowledge detector
KR3.2	Yes	Problem-solving method owner	02/09/20xx	To be stored in the KB

- The “Store” section refers to the knowledge storage in the company’s KB. The processed and validated knowledge statement and category(es) are stored in a structured database. This database is also the foundation for future knowledge sharing and knowledge dissemination.

For example, the knowledge created from the KR1 is stored in the KB as N°xx1 with its statement and category (Table XIII). During the knowledge sharing and dissemination phase, it is furtherly integrated as a formal step in the company’s business process, as shown in Table XIII and Figure 4.

Table XIII: Knowledge Base example

Knowledge reference in KB	Knowledge statement	Knowledge category	Knowledge integration
Knowledge N°xx1	<i>“Internal review of the contract by the consultancy director, the Business unit responsible, and the involved consultants should be organized for project risk analysis”</i>	#Production #Customer #Requirement	Production process (PROC006) process description to be updated. (Figure 5)
Knowledge N°xx2	<i>“The problem complexity is assessed at the beginning of each problem-solving process”.</i>	#Team #Problem solving #Operation #Complex problem	Problem-solving process to be updated.

	Système de Management de la Qualité	
	Processus PRODUCTION	Indice de révision : F
PROC006		

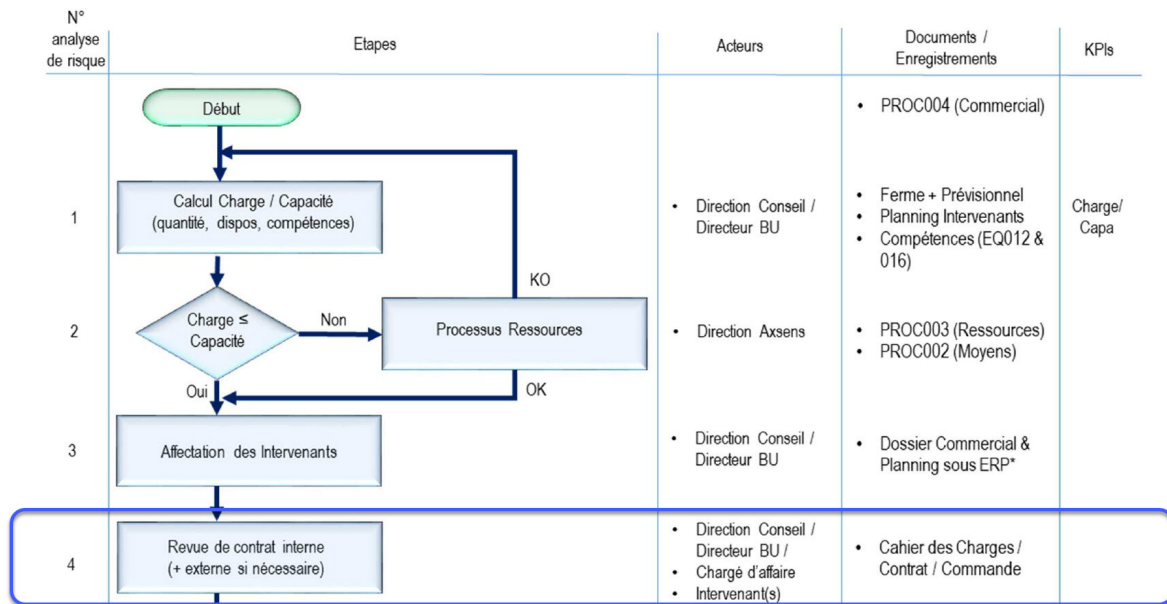


Figure 4: Knowledge integration example

Even though this business unit did not have much experience in KM nor in Agile methodology, with the proposed approach, which is simple, not time-consuming, and collaborative, the business unit has created the first set of valuable knowledge, and the involved people are motivated to continue to work on KM collectively. This first KB is crucial to ensure business sustainability, customer satisfaction, and competitive advantage. It is also the basis for tailored downstream KM processes (“knowledge sharing & dissemination” and “knowledge understanding & application”) aiming to help people find the relevant knowledge items efficiently in the KB.

5. Conclusion and perspectives

In this article, we show how agile Scrum best practices can be integrated into KM. The "K-Scrum" is a tailored and agile-based method for the SME context. Our findings indicate that

this method is suitable for SMEs and can promote fundamental agile values such as flexibility, collaboration, and quick delivery into the organization's KM.

The KM method in SMEs needs to focus on different aspects compared to large organizations. SMEs present negative specificities like the lack of resources and KM expertise. They also present some positive specificities, like the high level of internal trust. The K-Scrum method provides a simple, adaptable, complete, and practical framework responding to the basic SME KM requirements. Moreover, it is flexible, collaborative, mature, and productive, which could help KM implementation in SMEs and further promote knowledge acquisition and exploitation. This method has been applied in a real SME context. By following the process, it is stated that a valuable knowledge database could be created and continually completed collectively.

This research has some limitations. First, the presented method mainly focuses on the process from the KRs to validated knowledge (i.e., knowledge capture and creation phase), which is fundamental as it helps SMEs establish the first set of knowledge and motivate people to contribute to the process. However, it has been noticed during the application case that continuous improvement of the existing knowledge is crucial and should be further discussed. Secondly, the representation of validated knowledge is not standardized in the proposed method. And thirdly, the method has been relatively well deployed in a business unit for one mission but not yet in a whole SME company dealing with knowledge from different projects and domains. The constraints like change management, collaborative tools, people's long-term involvement, and company networks are still worth discussing for company-wide deployment. Considering these limitations, this research points to some perspectives for future research.

- *“How to improve the downstream KM phases (i.e., knowledge sharing and knowledge application) to propose a continuously improving KM method to SMEs?”* is an

inevitable topic. Once the “Validated knowledge” is stored in the knowledge base, further evaluation from the users (e.g. pair review or an evaluation system) could be captured to improve the existing knowledge. The update of existing knowledge could be done via a simple KR which could trigger the K-Scrum process. This collective evaluation system is currently under investigation.

- One of the primary knowledge sources for SMEs is the SME networks. SMEs can acquire knowledge by collaborating with other companies in their network. However, it is stated that this domain is still neglected, even if the network is crucial for the SME itself and also for the whole economic system (Cerchione et al., 2016; Esposito & Evangelista, 2016). The proposed K-Scrum process provides a collaborative method for creating and capturing knowledge. “*How could this method be used to establish a cross-companies KM among SME networks?*” is also worth further research.
- In today’s industry 4.0 context, new technologies like artificial intelligence, big data are emerging quickly, and they could further improve the organization’s KM efficiency. It is challenging for SMEs to leverage these technologies as it is time-consuming and requires a significant investment. “*How to help SMEs to leverage these new technologies in KM to keep their competitiveness in an industrial 4.0 context*” is worth more attention from both academia and industry organizations.

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