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RESEARCH ARTICLE

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# A project knowledge management framework grounded in design science research

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Knowledge management (KM) dynamics have caused a lack of traceability and loss of explicit and tacit knowledge during a project's lifecycle. In addition, individuals desire ease of use and accessibility, suggesting that social media (SM) should be integrated. For this purpose, this research analyzed a solution with a technical instrument, through a design science research approach, with the intention of answering the research question: How well does knowledge project management work with the integrated use of project management tools? The Social Media for Project Management (SM4PM), a prescriptive framework for guiding the integrated use of SM in project management (PM), was instantiated to evaluate KM in PM in a public security organization. Data collection was done through interviews, direct observations, document analysis, and focus group. These data were analyzed using MaxQdaPlus. After the implementation, SM4PM was refined and redesigned. Results showed that SM support KM in activities related to PM, giving strong evidence that SM4PM can be generalized to solve a class of problems, such as collecting lessons learned naturally during the project lifecycle, managing the knowledge in PM, and understanding the relationship between processes and their integration. As a contribution, the study empirically applied "theory to practice" by instantiating a technical instrument based on the "theory of doing well" and applied "theory from practice" to refine this technical instrument. This applied research solves a class of problems involving KM in PM during the whole project lifecycle with a unique artifact.

## 1 | INTRODUCTION

As knowledge is unique, intangible, difficult to copy, and rare, it has strategic value, becoming a vital resource and a new economic currency (Ragab & Arisha, 2015). Knowledge, like any other value, should be held and developed in order to grow. To this end, knowledge management (KM) is necessary. KM is a multifaceted discipline (Alavi & Leidner, 2001), and over the years, KM studies have been developed under different lens: looking deeply at activities such as creating, retaining, and transferring (Alavi & Leidner, 2001; Argote, McEvily, & Reagans, 2003); exploring individual characteristics, perceptions, and behaviors (Connelly, Ford, Turel, Gallupe, & Zweig, 2014); and considering organization (Lancini, 2015), group, and individual (Topping, 2016) as a unit of analysis.

In this multifaceted view, we first have to understand the definition of KM. In Levy's (2009) view, KM has four components: process, technology, context, and culture. Alavi and Leidner (2001) also include a knowledge application process, giving relevance to applying the knowledge. Analyzing the set of ideas of the authors mentioned, they are aligned with Wiig's (1997)KM aims definitions (p. 2): "the overall purpose of KM is to maximize the enterprise's knowledge assets and to renew them constantly." In these perceptions, this study considers the following KM definition: a management of knowledge with process, technology, context, and culture components (Levy, 2009) with the objective to create, store/retrieve, transfer, and apply the knowledge (Alavi & Leidner, 2001) to achieve the purpose of maximizing the enterprise's knowledge assets and of renewing them constantly (Wiig, 1997).

  

This KM definition is aligned with the objective of knowledge in projects in which contextualization expands the project management (PM) concepts to cover organizational strategy (Svejvig & Andersen, 2015). Understanding that knowledge is the most relevant resource for PM, Gasik (2011) proposed a full consistent model for project knowledge management (PKM). PKM is the management of knowledge throughout the organization and inside/outside the project. The author considered two knowledge scales in projects: (a) microknowledge, the knowledge to perform a single activity, and (b) macroknowledge, the whole knowledge possessed by an individual in a given level: (1) individual, (2) project, (3) organization, or (4) global (Gasik, 2011). Gasik's PKM was used as a theoretical base of this current study because he proposed the systematization of the project knowledge that meets this study's KM definition. Gasik's PKM processes the microknowledge by macroknowledge in all organizational levels, increasing the possibility for influencing project execution.

The use of a PM software as a KM tool benefits the management of projects as it can also support KM in PM activities (Oun, Blackburn, Olson, & Blessner, 2016). However, individuals want a tool that can be integrated into a set that is being used, not another tool to be managed (Evans, Gao, Mahdikhah, Messaadia, & Baudry, 2016). Besides, knowledge is intangible and it has to be documented in the organization repository to guarantee that organizations will not lose this asset. Yet knowledge documentation is usually undervalued. It cannot be considered only a register in the repository. A documentation process requires knowledge classification, such as identification of the piece of knowledge that is new, the definition of knowledge unit, externalization to share with team members, and registration (Gasik, 2011). Validating a framework of the integrated use of tools to support KM in PM will help to start closing this gap. This study is in line with Topping (2016, p. 19), who suggests conducting research that will "enable a holistic view of the knowledge lifecycle within organizations."

This applied research addresses a class of real-world problems (KM in PM) by validating a technological instrument (artifact), under Gasik's PKM base. This strategy is in agreement with the claims of Ahern, Leavy, and Byrne (2014), Svejvig and Andersen (2015), and Whetten (1989), who seek to reconcile the theory (apply Gasik's PKM to solve the management of the knowledge in projects) with the practice (validate an artifact under Gasik's theory; Blomquist, Hällgren, Nilsson, & Söderholm, 2010), which brings as a benefit the theoretical and practical contributions of the study.

This study aims to answer the research question: *How well does KPM work with the integrated use of PM tools*? This paper is structured according to the design science research (DSR) approach (Wieringa, 2014). The underlying research problem has been discussed in this section. The research background is described in Section 2. Section 3 presents the research steps. A framework of integrated use of PM tools is proposed in Section 4 (artifact design). In Section 5, the application of the framework is tested in an organization in two strands: (a) assessment of the artifact (design evaluation) and (b) assessment of the context (qualitative research). In Section 6, theoretical and practical contributions are presented. Section 7 concludes the paper.

## 2 | RESEARCH BACKGROUND

According to Gasik (2011), there is a knowledge scale with two values: microknowledge (the knowledge necessary to perform a task) and macroknowledge (the total knowledge possessed by the individual in an organization level). The author complements his idea with the knowledge of the organizations as a whole, with four subvalues to macroknowledge, considering to whom the knowledge belongs: individual macroknowledge (team member), project team macroknowledge, organizational macroknowledge, and global macroknowledge. The purpose, in the light of KM, is to conduct processes to provide the necessary expertise of each macroknowledge subvalue (individual, project, organization, and global) in each scale (microknowledge and macroknowledge), meaning that each process has its own lifecycle (Gasik, 2011).

Microknowledge lifecycle is formed by knowledge identification and knowledge acquisition (Gasik, 2011). Once the knowledge necessary to execute a task is identified (knowledge identification), the necessary knowledge is sought within the organization. It can be recovered from organizational memory (repository) or absorbed from training by an expert inside the team/organization or outside the organization (knowledge acquisition). Acquired knowledge socialized with the owner of the knowledge and combined with both knowledge (individual and knowledge owner) creates new knowledge that will be applied to solve a real problem (Gasik, 2011).

The transmission of the new knowledge has two main paths: transfer and sharing (Gasik, 2011). Transfer is a sender and receiver flow of knowledge, an act of a communication of codified or noncodified knowledge in which an individual receives it and executes socialization in his mind. Sharing is the act of registering knowledge by an individual where it is accessible to those who will need it (Gasik, 2011). Conversely, Alavi and Leidner (2001) considered both concepts as knowledge transfer.

Microknowledge lifecycle at project level starts when the project manager analyzes the knowledge possessed by team members to perform the project task (Gasik, 2011). The necessary knowledge is acquired from an external source or from the repository. In this sense, instruments, tools, and dynamics methodology are ways to induce a collective creation (Gasik, 2011).

Besides knowledge lifecycle, Gasik proposed a vertical flow between organizational levels. The organization provides the project standardization following a certified body of knowledge and a strategy of knowledge development (Gasik, 2011). Bottom-up direction goes upwards by the created knowledge to serve other projects. Top-down direction happens in recovering knowledge from organizational memory.

Once understanding microknowledge lifecycle and vertical flow of knowledge, Gasik (2011) constructed a project-level macroknowledge lifecycle with four main phases: (a) organizational knowledge analysis, (b) KM preparation, (c) executing KM, and (d) knowledge summarization. In the organization knowledge analysis, the knowledge environment, the place to collect it, and the organization knowledge strategy are analyzed. The next phase, KM preparation, has two processes: project understanding and KM planning. In the project understanding, the need for knowledge is mapped

(project's initial macroknowledge). Once the knowledge needed is defined, the planning process considers the individual knowledge gap to be covered and aligns the techniques of KM with project needs (Gasik, 2011). Executing the KM phase involves processes of knowledge mobilization and knowledge development. Mobilization makes efforts to acquire the knowledge requirement, whereas the development process creates the specific knowledge for executing project activities. The knowledge summarization phase has the role to collect and register the knowledge created during the project lifecycle. Each phase produces a product (initiated project at organizational knowledge analysis phase, KM plan at KM preparation, used knowledge at executing KM, and obtained knowledge at knowledge summarization).

Figure 1 depicts the project-level macroknowledge lifecycle and its relationship with a project's group of process.

The theoretical pillar of PKM motivated an interest in reviewing PM and KM processes. The application of technology brings infrastructure and environment to actualize, enhance, and reinforce (Alavi & Leidner, 2001) processes of PM and KM. Social media (SM) are a class of tools that encourage knowledge transfer, enabling interaction and making people meet in a virtual "ba" (Levy, 2013), which support KM in PM. For this purpose, taking into account SM that support PM activities also support KM (Narazaki, 2017), a framework (artifact) for guiding the integrated use of SM in PM was chosen to be instantiated in a project.

## 3 | METHODOLOGY

We conducted this study using the DSR approach and technical action research (TAR) method, technology acceptance model (TAM), and qualitative analysis to evaluate how well KPM works by means of the integrated use of PM tools.

In social science, description-driven research should be complemented by prescription-driven research that uses rigorous testing and grounding (Aken, 2004). The technological rule is based on the application of a causal model oriented by descriptions in which a practitioner intervenes by using their experience, deep context understanding, and knowledge of the technical rule to achieve operational validity (Aken, 2004). In that view, we not only test the artifact validation but also do social context investigation, in line with the academic claims, giving a qualitative approach that contributes to social knowledge. For this purpose, we used Wieringa's DSR conception, which considers two DSR cycles: design and empirical cycle. The design cycle was done to find an artifact that fits Gasik's KPM. The empirical cycle was carried out to treat the artifact in order to validate it and to assess the context where the artifact was instantiated.

Data quality is essential to inspire confidence in the findings, and this is achieved by the rigor of the method. Consequently, we constructed our study in the research stages on Peffers, Tuunanen, Rothenberger, and Chatterjee (2007), complemented by Wieringa (2014), which includes the context analysis. Figure 2 presents the research design for this study, linking each objective, research instrument, data collection instrument, and analysis technique. The research stages are based on Peffers et al. (2007) DSR procedure and are presented in the column research stages. The checklist is presented by Wieringa (2014) and is used to design the research.

In the DSR empirical cycle (demonstration), the artifact should be applied in the context to be validated. During the validation, the artifact can be improved to better achieve the stakeholders' goals. In this setting, the researcher is playing three important roles: (a) technical

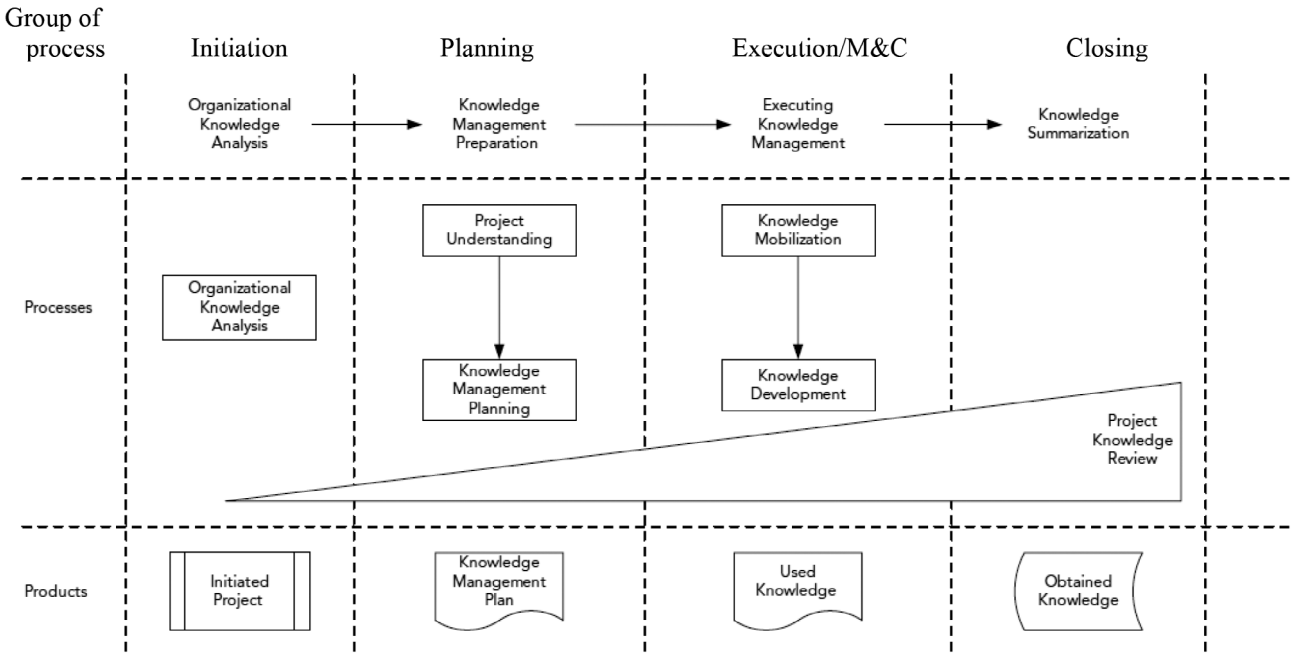


**FIGURE 1** Project-level macroknowledge lifecycle. Source: Adapted from Gasik (2011)

researcher that designs an artifact instantiation, (b) empirical researcher that investigates the artifact instantiation and the context, and (c) helper that applies improvement in the artifact to help a client (Wieringa, 2014). We validate the artifact by using TAR method, which integrates the researcher's action in the research (Dick, 2007; Wieringa, 2014). A participative researcher matches the DSR goals because the artifact should be developed, instantiated, and redesigned in collaboration with the practitioners. In the same way, practitioners acquire knowledge, experience, and potentially useful results. An inner benefit is an improved relationship between universities and organizations (Wieringa, 2014). The research roles and the TAR steps are depicted in Figure 3.

In the evaluation step, we analyzed data via four data collection techniques: (a) semistructured interview, (b) direct observation, (c) document analysis, and (d) focus group (FG). The protocol of the semistructured interviews has two blocks. The first one contains questions to evaluate the context, whereas the second one evaluates the artifact instantiation by means of TAM (Yoon & Kim, 2007), in its ease of use, usefulness, and convenience.

Ease of use is the perception of using the artifact without effort, and usefulness is the measure of the belief that the use of the artifact would enhance performance (Ng, Shroff, & Lim, 2013). Convenience is the degree to which an individual can use the artifact whenever and wherever they need (Yoon & Kim, 2007).

| Main objective | Specific Objective | DSR Cycle (Wieringa, 2014) | Research stages (Peffers et al., 2007) | Research setup | Checklist (Wieringa, 2014) | Research instrument | Collect/Data analysis technique |
|---|---|---|---|---|---|---|---|
| **Evaluate the KM in PM through the instantiation of an integrative use of SM framework that supports PM activities** | Instantiate the artifact | Design cycle | Problem identification and motivation | Identify a gap | - | Systematic literature review | Articles |
| | | | | Problem awareness | - | | |
| | | | | Identify an artifact | - | Literature review | Identify, compare and select a framework |
| | | | | Acquisition of the object of study (OoS) | - | Partnership agreement | - |
| | | | | Problem requirement | What is the problem to be solved? | Interview | Content analysis |
| | | | | | What are the stakeholders' goals? | | |
| | | | Objective of a solution | Solution requirement | What is the artifact's requirements that motivated the stakeholder's goal? | Interview | Content analysis |
| | | | Design and development | Treatment design (customization) | - | - | Selected framework |
| | | | | Instantiation of the framework – setup | Which treatment will be applied? | Interview | Content analysis |
| | | | | | Which treatment instrument will be used? | Interview | Content analysis |
| | | | | | What is the treatment schedule? | Interview | Content analysis |
| | | | | | Treatment design validation? | Interview | Content analysis |
| | | | | Measurement design | Variable and constructs to be measured? | Interview | Content analysis |
| | | | | | Data source? | Interview | Content analysis |
| | | | | | Measurement instrument? | Interview | Content analysis |
| | | | | | What is the measurement schedule? | Interview | Content analysis |
| | | | | | How will the measurement be stored? | Interview | Content analysis |
| | | | | | Measurement design validation? | Interview | Content analysis |
| | Assess and refine the artifact Investigate the effects of the artifact in the context | Empirical cycle | Demonstration | Assessment of the artifact and context | What happened when the object of study was selected? | Observation | Content analysis |
| | | | | | What happened during sampling? | Observation | Content analysis |
| | | | | | What happened when the treatment was applied? | Observation | Content analysis |
| | | | | | What happened during measurement? | Observation | Content analysis |
| | | | Evaluation | Analysis | Data preparations applied? | Checklist | Content analysis |
| | | | | | Data interpretation? | Register | Content analysis |
| | | | | | Descriptions validations? | TAM | Content analysis |
| | | | | | What explanations exist for the observations? | Focus group | Content analysis |
| | | | | | Would the explanations be valid in similar cases or populations too? | Theoretical background | Content analysis |
| | | | | | What are the answers to the research questions? | Confirmatory focus group | Content analysis |
| | | | Communication | Declaration of results | - Master Dissertation<br>- Journal and Conference Articles | | |

**FIGURE 2** Research design. Source: authors

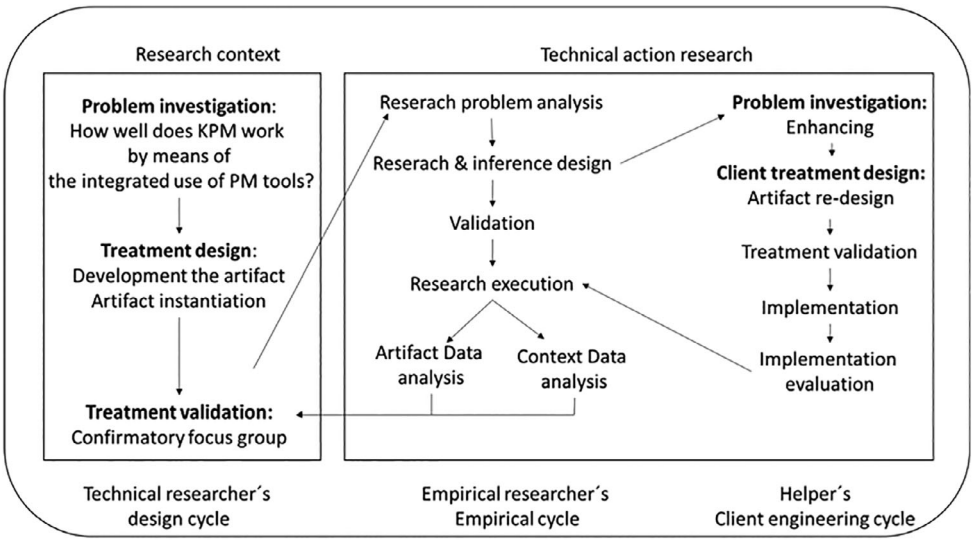


**FIGURE 3** Technical action research (TAR) activities. Source: Adapted from Wieringa (2014)

This study was held in the 6ª *Seção do Estado Maior* of PMESP (Sãp Paulo State Military Police), which is a governmental public security institution. PMESP has 83,799 military police on active service, covering 645 cities in São Paulo State with a budget of R$ 14.185.271.187,15 for the year 2017 (Law 16.347, 2016). PMESP has the following prerequisite, which makes it eligible to this study: a Project Management Office (PMO) that maintains PM process in order with an established reporting system that uses a project report framework, where responsibilities are addressed and have a data collection, analysis, and distribution method (Todorović, Petrović, Mihić, Obradović, & Bushuyev, 2015). The chosen project was the New Organizational Climate Survey (NOCS), considered strategic by PMESP as it is the most important data collection tool in the organization. This project lasted 11 months.

The instantiated artifact was applied in the validation of the requirements of the NOCS project. The goal of this part of the project was to collect and register, quickly and easily, the inconsistencies of the project with the most volunteer interaction. Everyone from 6ª *Seção do Estado Maior* participated in what the PMESP called the First Wave Test, together with the project team, with a total of 32 participants, including four civilians and 10 team members.

The test consisted of answering the NOCS using different platforms (Windows Chrome, Firefox, and others) and equipment (smartphone, tablet, and personal computer). During the test, when inconsistencies occurred, they had to be reported in the instantiated artifact. The First Wave Test lasted a week.

Nineteen participants composed the interviewee's sample (I1–I19). The sample experience in PM is on average 5 years. Sixty-six percent of the PMO team are graduates or have Master of Business Administration certification. All team members are graduates or have Master certification. The experience in working with projects and the high graduation level indicate that this sample is adequate to participate in the current study. All the interviews generated around 14 hr of recording with an average of 46 min per interview.

The codification of the interviews was carried out with the support of a MaxQdaPlus software. Data were treated in a dynamic and interactive process with five stages: (1) compilation, (2) decomposition, (3) recomposition, (4) interpretation, and (5) conclusion (Dey, 2003; Ritchie & Lewis, 2003; Yin, 2010). In total, 228 codes were created with 699 segments highlighted. The result of the interviews was presented to two FGs, with seven practitioners in each FG. The results of the two FGs were used to perfect the instantiated artifact. The treated artifact was presented to two confirmatory focus groups (CFGs).

## 4 | ARTIFACT DESIGN AND INSTANTIATION

Because the use of the same SM can support PM and KM (Narazaki, 2017), we looked for a framework that fits this study. In short, 11 frameworks related to SM and KM or SM and PM were dissected and compared. Some frameworks proposed a unique tool to cover the whole SM functionality (Câmara, Chaves, Soares, & Tessi, 2015), highlighting the simplicity and costless solution, but the inability to cover all function and activity needs could be a barrier to its usage. Other frameworks were constructed for a specific knowledge area or were unable to deal with an integrated use of SM (Bell, Van Waveren, & Steyn, 2016; Dokkun & Ravesteijn, 2016; Shang, Li, Wu, & Hou, 2011). Two frameworks were considered to fit the current research needs: Ballistic 2.0 (Chaves et al., 2016) and Social Media for Project Management (SM4PM; Ikemoto, 2017). SM4PM was selected because it considered the integrated use of SM in a simple framework (Ikemoto, 2017). Additionally, the integrated use of SM attends previous researchers and respondents' claims.

The SM4PM was proposed to create a collaborative environment and increase productivity in projects with the support of SM. Based on ground theory methodology, Ikemoto (2017) collected data from a literature review based on hermeneutics. The author made two cycles for collecting primary data, with interviews and an exploratory FG in the first cycle and another interview round and a CFG in the second cycle. Four categories of SM that support PM emerged from Ikemoto's (2017) research: (a) control, (b) communication, (c) dissemination, and (d) repository. Each category has a set of SM tools, and they are joined by integration. The level of integration depends on the organization's strategy because it can be a simple link or a complex and personalized solution. A CFG validated the SM4PM framework illustrated in Figure 4.

The literature review conducted to make clear the connection of the SM with both roles in KM and PM is summarized in Figure 5, which shows the link in the purpose of use of SM in KM and PM within SM4PM categories.

The SM4PM framework was instantiated in collaboration with the practitioner. The PMESP has two platforms: enterprise project management (EPM) and Polícia Militar (PM) social. EPM is a platform constructed under a collaborative strategy. Although the project

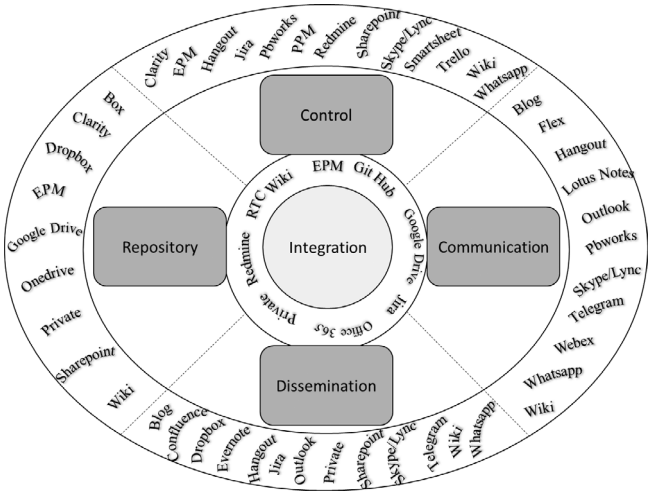


**FIGURE 4** SM4PM—a prescriptive framework for guiding the integrated use of SM in PM. Source: Adapted from Ikemoto (2017, p. 71)

| SM4PM Category | Purpose of use | PM authors apud Ikemoto (2017) | KM authors | Social Media | | | |
|---|---|---|---|---|---|---|---|
| | | | | Microblog | Blog | Publish | Productivity applications |
| Communication | Share information | Riemer and Richter (2010); Chaves et al., (2015); Richter et al., (2013), Polaschek et al., (2012) | Janes, Patrick & Dotsika (2014); Chua, & Banerjee (2013) | x | x | x | |
| | Communicate, collaborate | Lee and Baby (2013) | Breunig (2016); Jackson & Klobas (2013); Chua, & Banerjee (2013) | | | x | |
| | Socialization | Richter et al., (2013) | Maier, Schmidt (2015) | x | | | |
| | Capture knowledge instantly | (Cleveland & Ellis, 2013) | Chua, & Banerjee (2013) | x | | | |
| Dissemination | Information distribution | (Chaves et al., 2015) | Chua, & Banerjee (2013) | x | X | x | |
| | Shared knowledge | Grace (2009); Chaves et al., (2015); Westbrook (2012); Cleveland and Ellis (2013); Gloria et al., (2014); Rosa and Chaves (2014); Shang et al., (2011); Chaves and Veronese (2014) | Janes , Patrick & Dotsika (2014); Zhao & Chen (2013); Chua, & Banerjee (2013) | x | X | x | |
| | Access critical workplace issue | Lee and Baby (2013) | Breunig (2016); Janes , Patrick & Dotsika (2014); Chua, & Banerjee (2013) | | X | x | |
| | Interaction between team members | Gholami and Murugesan (2011) | Levy (2009); Zhao & Chen (2013) | | X | | |
| Repository | Knowledge base | Chaves et al., (2015) | Breunig (2016); Janes , Patrick & Dotsika (2014) | | | x | |
| | Management documentation | Chaves et al., (2015) | Janes , Patrick & Dotsika (2014) | | | x | |
| Control | Control of Scope; Definition of tasks; Follow-up activities | Chaves et al., (2015) | | | | x | |
| | Business performance | | Del Giudice & Della Peruta (2016) | | | | x |
| | Manage Lessons Learned | Grace (2009); Veronese (2014); Duffield and Whitty, 2015); Chaves and Pedron (2015); Parker et al., (2007) | Janes , Patrick & Dotsika (2014); Chua, & Banerjee (2013) | x | x | x | x |

**FIGURE 5** Social media for knowledge management in project management. Source: Authors

control role is well executed by this platform, it fails to leave lessons learned to the organization. PM social is the nickname of an IBM Connections platform. PM social runs a social role that community can open by itself to transfer knowledge. In PM social, individuals create communities to join other individuals to discuss subjects in common. For this purpose, participants have blogs, wikis, and document repositories integrated in the PM social platform. A community called NOCS was opened in the PM social to store the project requisites and the 15 system's maintenance reports.

For the communication tool category, the SM4PM was instantiated with two SM tools: (a) Lotus Notes, which is already integrated into EPM for formal communication. Lotus Notes is asynchronous, performing a passive communication; and (b) WhatsApp, an instant and organic communication tool, a channel where informal communication flows. A WhatsApp group was created with project team members, the sponsor and the participants of the First Wave Test.

The category dissemination was instantiated with a Blog in the PM social platform. According to Ikemoto's (2017) artifact, a dissemination category tool for PM is used for knowledge that is already explicit. This category completes the knowledge transfer process. The interaction is asynchronous where individuals seek knowledge and can contribute by discussing and enhancing the knowledge insert into the PM social.

The repository category is a virtual place where documentation of the project and management are stored (Ikemoto, 2017). The SM4PM repository was instantiated with SharePoint, the tool that is already integrated in the EPM platform. These SM tools for PM support processes of knowledge storage and retrieval.

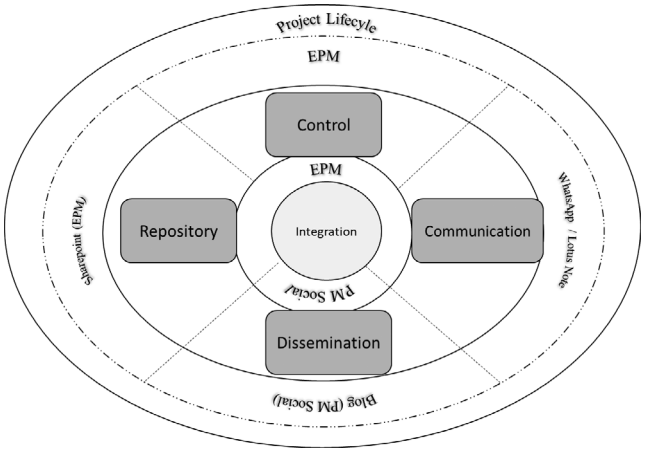


**FIGURE 6** SM4PM artifact instantiated in PMESP. Source: Authors

The purpose of the instantiation of SM4PM was to capture the knowledge spread in the SM tools used in PM during the whole project lifecycle, attending PMESP needs. Representing the knowledge flow capacity, the edge of the SM4PM artifact was replaced by a dotted line, delimited by the project lifecycle, as shown in Figure 6.

## 5 | DATA ANALYSIS AND DISCUSSION

The interview protocol investigated the interaction of practitioners in each of the five categories of the artifact. This section presents the

data analysis and discussion by category. The interviewees are identified by letter "I" followed by an identification number.

## 5.1 | Communication

The communication category provides an interpersonal connection for exchange of information and collaboration (Ikemoto, 2017). By doing a lexical search, with the support of the segment analysis, we perceive interviewees associating this category with the words whose roots refer to dissemination, repository, and collaboration, in this order of importance. Although dissemination and collaboration are in line with the concept proposed by Ikemoto (2017), repository was slightly modified because interviewees can recover the content of the conversation, considering it as a repository of images and conversations.

Regarding WhatsApp, analysis demonstrated that this SM is inclusive as affirmed by I7: "the Captain talks little to me (in face-to-face meetings). Already in WhatsApp, no. He reported and spoke (to me)". This feature empowers the participant because he was "losing a bit of insecurity by communicating through this tool" (I1). Participants demonstrated confidence in the tool because it "does not monitor or explore your behavior as Facebook does" (I4).

Another point that merits attention is the evidence of human extension and social behavior with the use of WhatsApp. I4 reports that "WhatsApp expresses the behavior of that person at that moment … it is instant communication. On WhatsApp, someone that is nervous will hardly ever not respond. They answer," denoting spontaneity in the use of this tool.

I4 and I7 also compared the act of consulting the tool constantly as social behavior such as *brushing your teeth* or *changing clothes*. In addition, the use of the smartphone brought a sense of belonging and intimacy described by I4 as *seems to be yours*. This evidence is confirmed by their uniforms "… there is a place to put the smartphone" (I12), evidencing that the smartphone can be considered an extension of the human body and the content an extension of his mind. These characteristics are evidence that WhatsApp can be considered an organic collaborative tool (Chaves et al., 2016).

Having image processing characteristics guarantees the quality of the information and avoids the loss of knowledge during the project life cycle. WhatsApp proved to be a virtual space where people exchange knowledge (Forcier, Rathi, & Given, 2013; Tsui & Fong, 2012) and reduces wasted time because "what's interesting in WhatsApp is also that several people reported the same problem. He did not have to re-detail a problem he had already detected" (I1).

The interviewees assert that it is possible to use this tool to update the project's information constantly. I19 explained how he reported inconsistency in the NOCS: "And then I photographed the page and reported via the WhatsApp's group that I was in." This attitude was followed by I16 and I12 and was confirmed by an annotation in the research journal. Such a fact is an example that knowledge transfer and project report can be done by the registration of images.

Reporting immediate feedback in a collaborative communication tool is a benefit, an important activity for the project manager. Complementing, I4 asserted that feedback also allows "debugging of distorted information." Feedback activity is evidence of the team integration by WhatsApp and evidence of knowledge mobilization.

According to I18: "All the information needs to be digested and transformed. SM give you that. What you read, you interpret and you make your judgment." In this passage, the interviewee described two mechanisms: internalization and socialization. When I18 says *read*, the knowledge goes inside an individual's mind (internalization). On saying *interpret* and *judge*, I8 means that the knowledge he already possesses socializes with the new knowledge that he acquires when reading (socialization). The treatment of the knowledge, from interviewee I18's viewpoint, is largely explored in socialization, externalization, combination, and internalization mechanism by Takeuchi and Nonaka (2008), in which knowledge develops. Corroborating and resuming the concept of socialization, I14 in FG2 said: "Socialization is an idea of maturation."

The participants narrate what happened during the test in WhatsApp or PM social. I3, I5, I7, I12, I16, and I19 reported that they "photographed the computer screen," "took the photo," "posted the photo," and declared "does not need explanation, I think he (analyst) will understand."

Although the system error is shown in an image, leading us to say that it is explicit knowledge, the narrative was substituted by this image, giving evidence that tacit knowledge can be transmitted by an image (Herbenio et al., 2016) by means of an technological artifact. This evidence is in agreement with Terzieva (2014), who lists storytelling as tacit knowledge.

Other respondents agreed with I1 who stated "someone reported an inconsistency and another person reported the same situation and added another inconsistency in the same situation," increasing knowledge, creating new knowledge, as outlined in Alavi and Leidner (2001).

Knowledge transfer was cited in 26 passages of the interviewees, demonstrating a strong connection with the communication category. I13 asserted that showing "different views of the same problem" and "making it possible to follow the process as a whole" are benefits of sharing knowledge.

Despite the benefits of WhatsApp, a number of issues still pervade its use in PMESP. The tool is not yet institutionalized; consequently, there is no law and regulation regarding its use or prediction of support and structure. Lotus Notes is the official tool of the organization. It has as a relevant characteristic, as pointed out by the participants, information traceability and digital signature. The use of this tool follows the hierarchy and the chain of command. In the face of its formality, emotions are replaced by a more objective communication, with technical terms to express situations. By following a communicational hierarchy, Lotus Notes has been reported as a one-to-few communication tool.

I1 used Lotus Notes for *task designation* so that the team member understood "that this is a mission that he (team member) has to fulfill." I1 is transferring knowledge to team members by sharing. PM also uses Lotus Notes to "schedule or cancel meetings," affirmed I12.

All the examples above make explicit managements (PM and KM) at the same time in line with Oun et al. (2016), which affirms that

there is a positive association between KM system and PM knowledge areas. The first perception of PM social noticed from interviewees was the support of registration of the information exchanged during the project for "future consultations and even for the very learning itself" (I15), making it in a lesson learned.

## 5.2 | Dissemination

Interacting in the blog is a way to update information because users "exchange information about a particular project" (I11), sharing new information or a report situation, as requested in the First Wave Test. I8 suggested accessing PM social to "have access to legal documents and issues of the project for everybody to know," the organizational asset that is crucial for the project. Organizing explicit knowledge (organization assets and system management report) and learning from the tacit knowledge that comes from storytelling from images constitute a reconceptualization of PM similar to Ahern et al. (2014).

Other blog features were emphasized by I3, who says, "they can comment, they can replicate others, depending on the profile," which makes people part of the process as suggested by Kaplan and Haenlein (2010). By posting on the PM social blog, knowledge is recorded and can be "used for future consultations and even for the very learning itself" and "would take these difficulties into account or even explore the facilities we found there" (I15), showing that the lesson learned is recorded during the project life cycle and becomes an organizational asset. I3 summarizes the PM social blog as *a bank of good practices*. In a passage reported by I1, evidence of application of knowledge was found when the respondent states "they took the knowledge and applied it to correct what was wrong."

For dissemination of knowledge, information needs to be externalized by individuals. PM social blog was used as "a way to report how each one who was involved with the project was going through, what were the difficulties that were being encountered, and even how they were solved," said I15. It fosters discussion in knowledge mobilization direction, in the human process of knowledge flow in which individuals read the comment, socialize with their own knowledge in their mind, and externalize, replicating the comment, as proposed in Takeuchi and Nonaka (2008).

This solution can be used by other project teams, PM social blog being a bridge among teams, enlarging existing knowledge, as reported by Cheong and Tsui (2011) and in line with Lopez and Esteves (2013), who assert that SM contribute to transferring knowledge in the organization. Knowledge can also be transferred to stakeholders, users, and the institutional community as declared by I1, I3, I5, I6, I8, I10, I11, I14, and I15. Related to this theme of using images for storytelling the experience of the user, PM social blog is in the same line as WhatsApp.

## 5.3 | Repository

A repository is an organizational memory, a place in which knowledge is stored to be preserved and retrieved to be reused, conducting a sustainable process (Filieri & Alguezaui, 2014). SM4PM was instantiated with the use of SharePoint in the current category. Storing documents related to a project in SharePoint is a way of recording the project lifecycle. "It also serves as a query to remember, in view of the project that was executed," commented I15, which infers that a lesson learned should be recovered.

Storing documents extends the knowledge base, which is essential for future projects, as proposed in Todorović et al. (2015). Besides, it is an apprenticeship, a context of a landscape of learning that can also be found in Cheong and Tsui (2011). I13 affirmed that "with the suffering of people participating in the project, we have the perception that there was an error." I14 argues that the project history is built in SharePoint.

## 5.4 | Control

In this category, interviewees emphasize the importance of EPM that could be considered "a guide that should be followed" (I15) or "protocol" (I13), showing the importance of this tool for PM.

EPM has been found to be convenient to use wherever and whenever the user needs. "If somebody wants to access it at another time, he can do it" (I9) because "I can access it on any computer from the military police" (I9) or "If I'm home" (I1), which was confirmed in the WhatsApp dialogue and in the research journal where the researcher perceived the use of EPM client and server. With EPM, a project manager can "set up a project charter and assembling the work packages. So here we go, quite simply, launching the activities, the deadline, the beginning and the end, to see what the situation is, whether everything is going well or not," affirmed I9. This is useful to control the project's resources.

In PM activities, there was mention of "update project information" and "report project progress." This knowledge interests project stakeholders. In transferring this knowledge to stakeholders, the EPM is performing a bridging process, the sharing of internal knowledge, which was conceptualized previously in this study by Lopez and Esteves (2013). The output of the control category analysis is a KM support list that EPM can provide.

## 5.5 | Integration

Each category of SM4PM was evaluated with the intention of exploring the interaction between users and artifact (context knowledge) and analyzing its efficacy (category tool validation). In this evaluation, the perception of integration in the SM4PM instantiated framework was not clear.

The perception of the integrated use of EPM, SharePoint, and Lotus Notes is clear, as cited by I18: "I see integration very easily." I1, I6, and I15 corroborated with I18. Besides, the complete lack of knowledge about SharePoint is evidence of the perfect integration of the tool, as perceived in the words of I9: "I do not have information that the data I use is in Sharepoint." Another group of interviewees

(I1, I6, and I14) justified that the ease of exchange of the SM tool during the process of the First Wave Test gave the perception that the framework was integrated. I1 also affirmed that WhatsApp Web integrates with a personal computer, concluding that it can be integrated with other tools.

Conversely, some testimonies asserted that SM4PM framework does not have an integrated tool. In the view of I13, integration should be done by a unique tool: "I should have a project management tool that would do everything integrated. This would be an ideal world. This is an opportunity for a tool, an integrating tool. […] There must be human intervention to provide this integration. There is not a tool that does all this."

Despite this counterpoint, the acceptance of the framework was high. I9 commented that he "would not replace these tools with another." I8 agreed with I9: "From this framework, I would not stop using any tool, I would use everything." I6 highlighted: "It was a benefit for the insertion of social media." Perception of usefulness was evidenced by I15 as SM4PM has specific tools for specific activities. Interviewees I6, I1, and I15 also argued that remote access helps in updating the project information, which is useful. In this case, convenience increased the intention of use, in line with Yoon and Kim (2007). I1 declared in an interview segment that SM4PM tools are a place of interaction to be in touch with knowledge, praise, and other information instantly, confirming that it is a virtual shared space.

After analyzing the data from interviews, we conducted two FGs with those findings, affirming that it was not clear if integration was perceived by the users. Around 25% of the FG duration was dedicated to discussing the integration of the SM4PM instantiated, showing the uncertainty of the interviewees' perceptions. The first perceptions of the interviewees were that tools in the artifact were not integrated because they consider only physical integration. In FG2, I1 asserted that there was "integration by agreement with the project team," emphasizing agreement among the project team, opposing the first perceptions. FG2 concluded that there was a partial integration.

Instructions of what tool could be used to execute the activities of the First Wave Test were agreed upon previously, but they were not formalized, leading to the conclusion that it is necessary to write and to design a process that explains the use of the framework. Besides, it was necessary for one person to collect data from WhatsApp and post it in the PM social, inferring that it was necessary to involve people in the process. Finally, in both FGs, the participants reported that lessons learned are registered during the whole project lifecycle by situation report and minutes of meeting in the SM4PM instantiated.

When analyzed, data from all categories show relationships between PM and KM. Activities in PM use KM processes, in accordance with Ahern et al. (2014), who reconceptualized a project as a process of knowledge. KM support is the base for PM activities. As a practical example, in the PM activities debugging information or share issue and questions, individuals socialize the ideas in their minds with existing knowledge. Putting ideas in the SM is an act of externalization. This is an environment for knowledge creation, which happens in the whole project lifecycle. In this view, a project has the role of a knowledge process.

Another remarkable finding is related to the KM process, based on Alavi and Leidner (2001). In each SM4PM category, there is evidence that all the processes of KM (knowledge creation, knowledge transfer, knowledge store/retrieve, and knowledge application) take place inside each category, providing support that KM processes are independent of SM category. Figure 7 presents this evidence.

In agreement with Oun et al. (2016), PM has a strong association with KM. The merge of PM and KM activities resulted in the construction of Gasik's PKM in the "knowledge management execution" and "knowledge summarization" phases, which the SM4PM instantiation is based on. What highlights the "executing knowledge management" phase is PM activities within the KM process, which indicates that there is a mobilization of knowledge and its development. However, the "knowledge summarization" phase will occur throughout the project lifecycle, which is not in line with the chronological phases of Gasik's PKM.

In order to validate the technical instrument (artifact), we explored the user's perception of the three TAM dimensions by each category and for the whole framework. In communication category, ease of use, usefulness, and convenience were strongly perceived using WhatsApp. Lotus Notes received few comments, possibly because WhatsApp is a novelty in the process and it demands more commentaries. In dissemination category, PM social did not get good overall feedback. Although it was perceived as useful and convenient, most of the interviewees found it difficult to use. This criticism is justified by lack of training and lack of a strategy for dissemination. The result of the low perception of the dimension ease of use leads to a low engagement in the use of PM social as described in Yoon and Kim (2007). Repository category received the fewest contributions in this study because it is physically integrated with EPM and its uses are transparent (cannot be perceived as being used). Control category was well perceived in convenience as this tool can be used in any place, at any time.

Despite all the contributions and results per category, these were not reflected in the SM4PM instantiated integration. After the First Wave Test, results of the SM4PM instantiated artifact validation and stakeholder's assessment indicate that the artifact should be refined. The maturation of the artifact is foreseen in the DSR approach.

The current study suggests applying a macroknowledge lifecycle proposed in Gasik (2011) as a first step in improvement, meaning that the process should be designed for formal application with the intention of clarifying the framework and engaging the usability. In the refined artifact, indicating how the SM are integrated was recommended. As a solution, the integration of WhatsApp by a process that explains how and in which situations is to be used is recommended.

PM social is integrated with a link to the PMO website, in line with what was proposed by Ikemoto (2017), who affirms that tool integration can be done by links. The refinement of SM4PM is represented in Figure 8. In the center of the framework refined by the researcher, integration is now represented by a three-dimensional cycle, making an analogy of layers of integration. The low layer represents physical integration. EPM and PM social belong to this layer. EPM has a physical integration with SharePoint and Lotus Notes tools.

In addition, PM social has a physical integration with Lotus Notes. But neither EPM nor PM social has this deep interaction between them. One of the design's changes integrates EPM and PM social by connecting dissemination and control category with a link in the PM social blog, addressing an e-mail to the person responsible at PMO or to the PMO's web page. This link is represented in the SM4PM with a chain that joins both EPM and PM social.

In the central circle, integration, an icon with the shape of a human head with gears inside was added, representing that in the high level of integration, it can be done by process and people. The same shape and icon of central circle integration were applied to WhatsApp tool, in the communication category. These changes represent that WhatsApp is integrated by process and people.

The refined framework was presented to two CFGs to validate the treatment. I13 exposed the participant's impression: "a simple way to integrate, by link." The researcher requested that the CFG should speak about their understanding of the project lifecycle in the SM4PM instantiated refined framework. After some reflection, CFG participants confirmed that the whole flux of the SM4PM happens during the whole project lifecycle. Regarding the theoretical validation of the refined SM4PM, considering ease of use, usefulness, and convenience, I13 *liked*, supported by I5 and I6. Convenience had some commentary about the regulation in the use of WhatsApp and restriction of the use of EPM. Despite this, the CFG agreed that SM4PM is convenient.

Asked about the understanding of the project lifecycle in the SM4PM, the group agreed that "categories will fit into every stage of the project lifecycle," as affirmed by I15. Likewise, the group recognizes that knowledge processes happen during the whole project lifecycle.

Crucial discussion arose when the researcher gave the CFG the chance to enhance the instantiated SM4PM's refined design. I15 suggested exchanging repository category with control category because visually the proximity of control category and PM social should make more sense of the link. On the other hand, I18 proposed exchanging the circle composed of the categories with the circle

| *Category /SM* | *Macro-knowledge phase* | *Macro-knowledge process* | *Micro-knowlege* | *PM activities* | *KM support* |
|---|---|---|---|---|---|
| *Communication WhatsApp* | Knowledge management execution | Knowledge mobilization | Knowledge creation | Debbuging information, promote team interaction, share issue and questions, give feedback, integration the project team, follow-up project activities | Socialization, externalization, promote knowledge creation |
| | | | Knowledge transfer | Report facts, give feedback, share issue and questions, follow-up project activities | Promote knowledge sharing, share tacit knowledge |
| | | Knowledge development | Knowledge application | - | |
| | Knowledge summarization | | Knowledge store/retrieve | Register conversation, register image | Repository of knowledge |
| *Communi- cation Lotus Notes* | Knowledge management Execution | Knowledge mobilization | Knowledge creation | - | - |
| | | | Knowledge transfer | Task designation, schedule meeting | Knowledge sharing |
| | | Knowledge development | Knowledge application | - | Storage/retrieve knowledge |
| | Knowledge summarization | | Knowledge store/retrieve | - | - |
| *Dissemination PM Social (Blog)* | Knowledge management Execution | Knowledge mobilization | Knowledge creation | Interaction between team members | Externalization, provide a virtual shared space |
| | | | Knowledge transfer | Register the project information, update project information, register lessons | Provide knowledge transfer, provide a virtual shared |

**FIGURE 7** Relation between PM activities and KM processes supported by SM. Source: Authors

| Category /SM | Macro-knowledge phase | Macro-knowledge process | Micro-knowlege | PM activities | KM support |
|---|---|---|---|---|---|
| | | | | learned, access project asset, report project information | space, provide bridging, provide knowledge sharing, share tacit knowlege |
| | | Knowledge development | Knowledge application | - | Provide a virtual shared space |
| | Knowledge summarization | | Knowledge store/retrieve | Register the project information, register lessons learned, access project asset | Provide a virtual shared space, apply knowledge |
| *Repository Sharepoint* | Knowledge management Execution | Knowledge mobilization | Knowledge creation | - | - |
| | | | Knowledge transfer | Recover project life cycle, recover lessons learned, construct project history | Provide knowledge transfer |
| | | Knowledge development | Knowledge application | - | Recover project knowledge, store project knowledge |
| | Knowledge summarization | | Knowledge store/retrieve | Store the project documents, recover project life cycle, upload and download documents, register lessons learned, recover lessons learned, construct project history | - |
| *Control EPM* | Knowledge management Execution | Knowledge mobilization | Knowledge creation | Construct critical path, perform project protocol | Combination |
| | | | Knowledge transfer | Allocate human resource, planning, cost control, perform project protocol, control activities, update project information, report project progress, time control | Provide knowledge transfer, bridging, provide knowledge sharing |
| | | Knowledge development | Knowledge application | Planning, cost control, time control, control activities | Sharepoint |
| | Knowledge summarization | | Knowledge store/retrieve | Sharepoint | Combination |

**FIGURE 7** (Continued)

containing the symbol of integrator. This suggestion was incorporated in Figure 8, making the understanding of the integrator that integrates SM categories clearer to the CFG participants.

Figure 8 illustrates the SM4PM instantiated, refined by the researcher and redesigned after the results of the CFG. The redesigned framework, with human ideas (ideological environment)

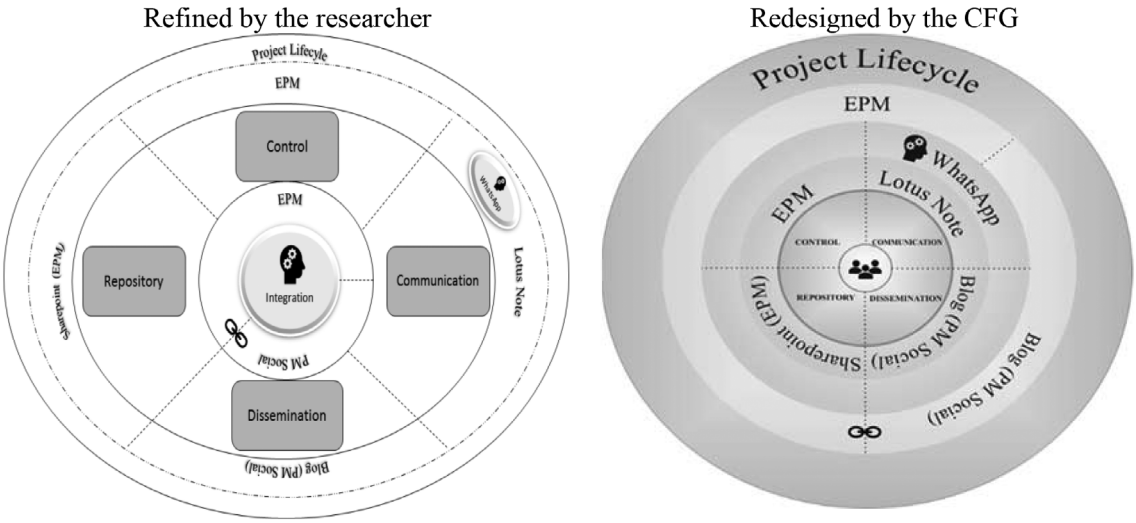


**FIGURE 8** SM4PM refined by the researcher and redesigned by the confirmatory focus group. Source: Authors

represented by people in the center of the figure, is permeated by the PM activities (categories) that use SM tools in an integrated way (technological environment), inside project lifecycle.

## 6 | THEORETICAL AND PRACTICAL CONTRIBUTIONS

It was crucial to apply a prescriptive framework in a classical use (PM) in an existing problem (collect and register lessons learned) to find a new role for this framework: managing knowledge. The findings brought four types of contributions to the KM and PM fields.

The first is the contribution for methodology. The application of the DSR approach was enlarged with the addition of Wieringa's (2014) context investigation in this study, permitting DSR to explore social science. The second contribution is the confirmation of an extant theory. Ikemoto (2017) designed SM4PM and validated it theoretically. Applying it in this study confirmed that this artifact improves PM. The third contribution is a view to a new application. Results show that a unique framework of integrated use of SM can support both PM and KM. This new application was based on two literature reviews that report SM use in both managements (KM and PM) and the Blomquist et al. (2010) study that asserts existing convergence of PM and KM. Revealing knowledge is the fourth contribution. Findings show the use of WhatsApp as an extension of the human mind and social behavior. The study also unveils the smartphone as an extension of the human body. Another new item of knowledge presented was the possibility to collect tacit knowledge through a technological artifact.

Regarding practical contributions, DSR provides an experience that joins theoretical foundation to develop an artifact and apply it in the real word. This gives the opportunity to enrich the existing theories whose practical applications solve a class of problems: KM in PM during the whole project lifecycle with a unique artifact. Findings show that the integrated use of SM engaged user collaboration. The technological support provided structure and an environment for updating, developing, and reinforcing the support to KM and PM. The combined use of SM4PM for KM and PM requires less investment and therefore tends to be efficient. As SM4PM helps practitioners disseminate KM and PM best practices, it can be considered an asset to the organization.

The structure of SM4PM is a visual protocol that regulates and explains how SM are integrated and what the purpose of using this framework is. Doing so, its use promotes collective knowledge engagement, reducing the activities of the project manager in maintaining an equalization of individual knowledge.

The generalization of the use of SM4PM suggests its application in diverse types of projects in public security organizations. Both simple and complex projects need to use PKM as an information system or as an integrated SM. Distinctions are made by the power of the SM tool, the quantity of SM to be used, and how SM would be integrated. The use of SM4PM is outstanding in diverse management areas. Finally, this study empirically applied "theory to practice" by instantiating a technical instrument based on the "theory of doing well" and applied "theory from practice" to refine this technical instrument.

## 7 | FINAL REMARKS

This research showed the instantiation and the evaluation of the SM4PM as a tool of PKM in a New Organizational Survey Project in the PMESP. The results allow us to answer the research question: *How well does KPM work with integrated use of PM tools?* The originality of the solution lies in the fact that the results confirm that SM support both PM and KM. It was evidenced when the researcher crossed PM activities with the microknowledge process presented in Figure 7. Each category of SM4PM supported the whole microknowledge process that is inserted in macroknowledge phase. Although the microknowledge process is the same in all categories,

the same microknowledge process is related to different PM activities. However, its role does not change. For each set of PM activities, there was an associated microknowledge and macroknowledge process.

Integration was done with a hybrid solution. The technical solution was achieved with the use of SM (EPM and PM social), and the practical solution with a link and people. The assessment of the context resulted in the refinement of the artifact and SM4PM was validated by the TAM model. SM4PM offers a solution to a class of problems: managing important knowledge during the whole project lifecycle, which has the ability to upload documents, images, and whose content can be easily stored, recovered, and disseminated.

The main limitation of the research is related to the small project team and the data collection done only in one phase of the project. The limited number that composes the project team could make the study biased. However, the high number of experienced users in PM can reduce the impact of this limitation. The findings of the current study are promising and should be explored in the assessment during the whole project lifecycle, which requires clarification.

Several other questions remain to be addressed. Attention should be paid to human relationships with SM as an extension of human faculty and social behavior. Further investigation is needed to verify the proposition that SM are an extension of the human mind and the smartphone is an extension of the human body. In the same line, this present study found evidence of the transferring of tacit knowledge by SM narrating the user's experience with an image. More empirical studies will be needed to verify how this phenomenon occurs and its impact on PM and KM. Other research opportunities should be explored to confirm the depth of the integration of the SM. Theoretically, there was a validation of the integration of SM, but this suggests a longitudinal study because there was no previous comparison. Besides that, the findings showed that all processes of KM run in each SM4PM category, encouraging more studies to verify to what extent each knowledge process runs.

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