Process-oriented knowledge management and learning in public administrations

Antonia Bertolino

CNR-ISTI,
Pisa, Italy
Email: antonia.bertolino@isti.cnr.it

Guglielmo De Angelis

CNR-IASI,
Roma, Italy
and
CNR-ISTI,
Pisa, Italy
Email: guglielmo.deangelis@iasi.cnr.it
*Corresponding author

Andrea Polini and Barbara Re

University of Camerino,
Camerino, Italy
Email: andrea.polini@unicam.it
Email: barbara.re@unicam.it

Andrea Sergiacomi

Regione Marche,
Ancona, Italy
Email: andrea.sergiacomi@regione.marche.it

Abstract: The capability to easily access and acquire knowledge is a key enabler for complex organisations that need to adapt to frequent changes of their operative contexts. These changes generally challenge workers that need to acquire new competences and skills. Such a situation is particularly evident in public administrations that nowadays are undergoing complex re-organisations in order to implement new regulations, and to deliver simplified services to both citizens and enterprises. This paper reports the insights gained in assessing the effectiveness of a novel knowledge management and learning approach, which was developed within a project financed by the European Commission. The approach, which is supported by a modular software platform, leverages enterprise related models to organise knowledge and make it available for learning purposes according to different paradigms. A validation, by means of a comparative study against more traditional learning paradigms currently in use within public administrations, is reported.

Keywords: business process; knowledge management; evaluation experience; e-learning platform; organisational change; workplace learning.

Reference to this paper should be made as follows: Bertolino, A., De Angelis, G., Polini, A., Re, B. and Sergiacomi, A. (xxxx) 'Process-oriented knowledge management and learning in public administrations', *Electronic Government, An Int. J.*, Vol. x, No. x, pp.xxx–xxx.

Biographical notes: Antonia Bertolino is the Research Director of the Italian National Research Council (CNR), in Pisa. Her research interests cover software and services validation, testing, and monitoring, and on these topics she worked in several national and European projects, including the EU Project Learn PAd and the ongoing H2020 ElasTest. She is currently serves as a senior associate editor for the *Elsevier Journal of Systems and Software*, and as an associate editor of the *ACM Transactions on Software Engineering and Methodology*, *Springer Empirical Software Engineering*, and *Wiley Journal of Software: Evolution and Process*. She has (co)authored over 180 papers in international journals and conferences.

Guglielmo De Angelis is a technologist and a researcher at the CNR-IASI. He received his PhD in Industrial and Information Engineering from the Scuola Superiore Sant'Anna of Pisa. His research area is software engineering, where he mainly focuses on model-driven engineering and on service oriented architectures. He served as a technical leader during the development of the EU Project Learn PAd.

Andrea Polini is an Associate Professor of Computer Science at the University of Camerino. She received her Laurea degree from the University of Pisa and her PhD from the Scuola Sant'Anna Superiore – Pisa. Her research activities mainly focus on software engineering, and in particular to quality assurance strategies for complex software systems. Her research has been strictly related to EU founded research projects. In particular she has been WP leader in the FP7 CHOReOS project and Project Scientific Leader for the FP7 Learn PAd project.

Barbara Re is an Assistant Professor of Computer Science at the University of Camerino. She received her PhD in Information Science and Complex System from the University of Camerino. Her research interests refer to the area of business process management from modelling to analysis. Particular attention is paid to to push the use of formal methods as methodological and automatic tools for the development of high-quality process-aware information system. She was involved in multidisciplinary research projects in the area of e-government in collaboration with national and international research institutes and companies.

Andrea Sergiacomi is a senior software analyst member of ICT Department in the Marche Region, responsible for integrated front-end public services, digital communication, intranet and internet web portals and mobile applications. She is also an expert of web accessibility with a focus on ISO specifications and W3C Web Accessibility initiatives. She is actually involved in the experimentation of disruptive technologies, such as deep learning, machine learning, IoT. She received her Degree in Economics from

the University of Ancona. She served as a project manager for several ICT projects at the Regione Marche; among the others: the Marche Digital Agenda initiative and some Horizon 2020 EU research projects. She is also member of numerous regional and national working groups with the aim to provide guidelines for digital transition and administrative simplification in the public administration.

1 Introduction

Complex organisations, such as public administrations (PAs), ground most of the efficacy of the offered services on their capability to efficiently react to changes of operative conditions. Various approaches and strategies can be adopted in order to respond to such changes, most of which possibly include modifications to some organisational assets (Liao and Wu, 2010): for instance, an evolution of functional perspectives, roughly how things are done, or of the organisation structure represented in the organisational chart, roughly who is in charge of doing what. In the latter case, implied modifications can in particular refer to the insertion of new operators as a result of recruiting procedures, the relocation of employees from one role to a different one, the introduction of new roles with corresponding relocation, or even more complex scenarios resulting from the combination of the above. Clearly, modifications to the organisational chart may have an high impact on the organisation performances and daily activities, and so they are generally taken when no other solutions are available. For instance, in a PA employees could be relocated from one office to another as consequence of a new law that modifies a service. On the other hand, the need to relocate people from one office to another could also be related to a peak in the requests received for a delivered service.

As said, the relocation of people can have profound impacts on the functioning of an organisation, and it generally requires an adaptation effort related to the acquisition of new knowledge and skills in order to fulfil the tasks foreseen by the new positioning. Furthermore it is often the case that the time-frame available for reaching full effectiveness after an adaptation is rather short, and service operativity cannot be stopped meanwhile. The above scenarios make it evident that traditional approaches to teaching and learning in complex organisations need to be complemented with innovative solutions that foster the codification, reuse and transfer of knowledge, in particular in a collaborative setting.

In many organisations the knowledge needed to support the delivery of services is represented using suitable modelling notations and considering different organisational perspectives, as recommended by enterprise architectural frameworks, such as the Zachman (1996) framework. Among the others, the business process (BP) view permits to represent the procedural knowledge needed to organise the different activities, and to fulfil the objectives related to the requested services. A BP consists of *a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs* (Davenport, 1993). The knowledge included in the representation of a BP is generally complemented by additional knowledge and information coming from other model kinds, possibly used to represent different

perspectives. For instance, information relevant to perform a given collaborative activity could be embedded in an organisational chart specifying whom to contact for what topic, or in a business motivation model specifying the reasoning behind activities.

The above considerations inspired us the vision to possibly exploit the codification of procedural knowledge in terms of BP models for supporting complex organisations in management, evolution and learning of know-how and task-related expertise. The intuition was to leverage BPs not only to structure the knowledge related to the performance of services, but also to facilitate the collaboration among people involved in the delivery of such services, so to make information sharing and collaborative learning easier and more effective.

In the last three years we have been working to implement this vision in the recently concluded European project Learn PAd. Its main objective was to develop an e-learning approach and its supporting platform that leverage the knowledge codified in BP models in order to foster and accelerate the learning of civil servants (CSs) from PAs who are newly hired or relocated to new tasks/offices.

The focus of this paper is not on the scientific and technical advances produced in Learn PAd, which can be found elsewhere, e.g., The Learn PAd Consortium (2015, 2016). Instead we provide a short introduction to the architecture and main functionalities of the Learn PAd e-learning platform in order to make the work self-contained, we refer to the cited papers and the other publications available from the project website[1] for further details. The goal of this work is to *present the methodology and the collected results in our experience of validating the BP oriented learning approach* developed in Learn PAd. Our aim was to investigate the potential of the newly proposed approach, assess whether it could be well received by workers in complex organisations, and identify areas for improvement. In particular, although we see the approach as potentially relevant for large organisations carrying out collaborative and complex BPs, in this paper we focus on the *opportunity to adopt a BP oriented learning approach within a PA*.

Therefore the validation experience that we report here is novel in two respects. On the one side, from a recent systematic survey of literature (Subramanian and Bertolino, 2017) we could conclude that there have been so far only few attempts to exploit the mature and powerful BP management methodology for e-learning purposes. Thus the Learn PAd approach represents an innovative technology and its potential has to be evaluated. On the other side, to the best of our knowledge no clear guidelines or instruments for the evaluation of acceptance and effectiveness of e-learning approaches in the PA are available. In addition according to Stoffregen et al. (2015) experiences reported in the literature are few and reported only at an high level of abstration.

Thus we were faced with the challenge of developing and applying a validation study for assessing a novel technology (BP oriented e-learning) applied to a sector with specific needs and challenges (the PA). The research question that we addressed can be expressed as: *How much is a BP oriented learning approach effective in relation to employees of a PA?* To answer this RQ we decided to use a comparative study to assess the new approach against a more traditional e-learning approach. We thus performed a comparative analysis based on a set of questionnaires submitted to two homogeneous groups of PA employees. The first group used a traditional learning style (that is to say an approach supported by the Moodle LMCS), while the second group used our newly introduced platform. Notably both groups had then to accomplish the same objectives.

In the remaining of the paper we focus on how we setup the assessment, and on

the obtained results. We are aware that an analysis based on a single study cannot provide a generally valid evidence on the usefulness of the approach. However we could already draw some preliminary conclusions on the possible effectiveness of the new process-oriented paradigm for knowledge management and learning, and these encourage us to further pursue this endeavour. Besides, we believe that the report of the study design by itself can provide a useful example and reference for future similar studies.

The following sections are structured as follows: in Section 2 we report about the user requirements gathering phase; in Section 3 we briefly describe the implemented Learn PAd platform (both its architecture and use cases) that is used in the validation; in Section 4 we present the setup of the empirical assessment; in Section 5 we show and discuss the results achieved; in Section 6 we survey related works, and finally in Section 7 we conclude summarising main insights and hinting at future work.

2 CSs' needs and expectations: how do CSs learn?

Before starting the design and development of the Learn PAd platform, we conducted an investigation aimed at eliciting the needs and the expectations from CSs, being them the targeted final users for our system. In this section we report about such preparatory study.

In Subsection 2.1 we present the relevant stakeholders in the considered learning scenario, and in Subsection 2.2 the applied methodology and the gathered results.

2.1 Learning stakeholders

From the available literature, and in particular from Weske (2010), we can say that in process-oriented organisations the actors could be usually classified according to three main categories:

- *BP-owners:* Their main objective is the definition of models that correctly represent the reality of the organisation. In other words, they define and manage the BPs conforming with the mission, the duties, and the activities that have to be followed.
- *BP-responsibles:* Their main objective is to drive the execution of specific BP instances as prescribed by the BP-owners. For instance they can directly take part to the enactment of a BP instance, but they can also coordinate the activities of several BP-operators.
- *BP-operators:* Their main objective is the execution of one or more tasks of a specific BP instance, during their daily-work related activities.

On the other hand, a model-based learning platform implies the three following categories of users.

- *Modelers:* This role refers to those users accessing the platform in order to produce models, according to prescribed meta-models, and describing different aspects of a process and/or of an organisation. The platform access point for these users could be represented by a specific modelling tool.

- *Content managers:* This role refers to those users that are interested in loading useful materials associated with the models and relevant official documentation into the learning platform.
- *Learners:* This role refers to all those users accessing the platform in order to learn different aspects of an organisation or of a process. Learners typically access the platform in order to learn how to operate in their daily-work by properly responding to the activation of process instances.

In our endeavour of developing a process-oriented e-learning platform, we can find a match between the two above categorisation of roles: *modelers* match with the *BP-owners*, as they provide the models driving the e-learning platform as official documentation. *learners* correspond to the *BP-operators*, as they would directly access the e-learning platform for executing the available functionalities. Finally, *content managers* reflect *BP-responsibles*, as they aim at increasing the competencies, and capabilities of the BP-operators related to the enactment of BPs.

Our survey specifically focused on CSs that would access the platform acting as either learners (i.e., BP-operators) or content managers (i.e., BP-responsibles). CSs acting as modelers were not considered in this survey as they relate with the platform as providers of knowledge rather than as consumers of it in order to learn something.

2.2 Applied methodology and results

The needs and the expectations of CSs in PAs have been elicited by means of focused questionnaires. The definition of such questionnaires is a critical task that may influence the insights that can be gained (Bradburn et al., 2004). This risk was mitigated by including both open and closed questions. Open questions permit to leave space to report unplanned aspects. However, they are much more difficult to analyse than closed ones. Also many open questions may require more time in filling the questionnaire, so eventually they could bring superficial answers. Considering such issues, a task force was setup among the Learn PAd partners to draw up a meaningful and effective layout for the questionnaire (Polini, 2015).

The task force produced two questionnaire layouts tailored to the two categories of CSs distinguished in Section 2. Specifically, one targeting those employees that have to perform activities during the BP enactment (i.e., either back or front office BP-operators), and the other one targeting the CSs that are responsible for process enactment, and for the achievement of process objectives (i.e., BP-responsibles). The task force considered the CSs in the second group as interested both in training other people, and in sharing their knowledge on the specified process.

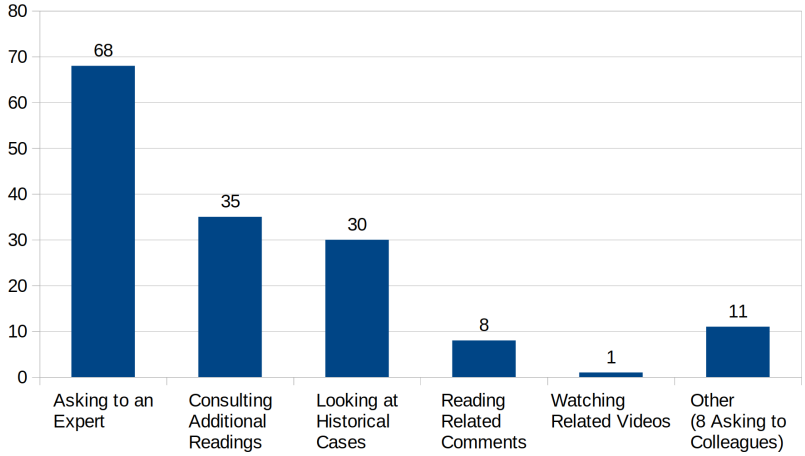
The two layouts shared a first block of demographic questions to profile the responding CS, and thus to hijack him/her to a second block that was profile-dependent.

The second block of questions targeting BP-operators aimed at clarifying the perceptions that CSs had of the process they are involved in, and their related learning needs. Among the others: how CSs are approaching issues arising in their daily-work, how to improve the way they solve problems (e.g., by structuring learning resources and their access), if/how they provide support to colleagues.

The second block of questions targeting the profile of BP-responsibles aimed instead at shaping their current practice in managing a group of CSs for the fruitful enactment

of the specific BP instance they are responsible of. For instance, the questions concerned the communication of goals and objectives within the group, and aimed at revealing if collaborative procedures were in place, and how they were perceived.

Figure 1 How CSs usually tackle a problem (see online version for colours)



Overall we collected answers from 101 CSs belonging to several PAs and involved in some process-oriented practice. Specifically, most of the interviewees (i.e., 86%) had an expertise of more than ten years, some of them (i.e., 14%) had a medium-term working experience, and only few classified themselves as junior. No novice was included in this interview. About the roles, we sampled 52 CSs involved in back/front office activities (i.e., BP-operators), while the remaining 49 employees had some responsibilities in a process (i.e., BP-responsibles).

As detailed in Polini (2015), we asked the CSs to consider the three top-most common problems they faced in their daily-work related activities. For each one, they were asked to explain how the problem is usually tackled. One goal of this analysis was to survey a comprehensive record of the efforts made by the CSs in solving a problem, regardless of the specific context, so in the end all the answers have been grouped into a unique collection without taking into account which problem each answer referred to. The results are reported in Figure 1: they confirm the intuition that consulting experts, checking additional information and looking at similar past cases are perceived as the most valuable means for solving issues. Thus, a collaborative e-learning platform for PAs should also reflect and support such an attitude. However, CSs also remarked that often it is difficult to identify the resources containing relevant hints for the solution of a problem.

A wide subset of the interviewees (i.e., 40%) thinks that the major benefit from an e-learning platform is that it saves the time of moving to a physical classroom. Almost half of the answers reports that an e-learning platform could foster the collaboration among the learners (i.e., 18%), it could provide support during the actual work (i.e., 22%), or it could help with the simulation of actual daily-work scenarios (i.e., 10%). Even though the simulation appears as a secondary feature for e-learning frameworks, interestingly we revealed a divergence of opinions among the respondents: while only

few BP-responsibles consider it useful (i.e., 4%), the percentage among the BP-operators rises to almost the 15%.

The collaborative creation/editing of documents is the second most required feature for an e-learning platform (i.e., 28%). The majority of the interviewees (i.e., 36%) considers the possibility to exchange opinions the most desirable feature, mostly like a platform for social networking. In addition, the interviewees recognised that contributing to a collaborative platform could save time in the long run (i.e., 36%), and could also contribute to increase their level of expertise (i.e., 32%). However, while the possibility to exchange opinions has been rated as highly desired, we also found that the availability of such a feature by itself is not enough in order to encourage/motivate contributors.

3 A platform for process-oriented learning

The result of the analysis described in Section 2 influenced the process-based learning approach envisioned by the EU FP7 Learn PAd project (The Learn PAd Consortium, 2016, 2015). More specifically, the requirements elicited during the development of the project (De Angelis et al., 2016a) were validated and redefined in order to actually meet the needs and expectations from CSs, as revealed by means of the above described survey.

This section introduces the Learn PAd platform that was employed in the validation activities described in Section 5. Specifically, Subsection 3.1 describes the high level architecture of the platform, while Subsection 3.2 reports about its main usage scenarios in relation to process-oriented learning.

3.1 Architecture

The Learn PAd architecture was conceived as a modular system where components could be plugged-in as needed. This provides flexibility to future adopters and developers that can configure the system in relation to their actual learning needs, and in dependence to different organisational contexts.

The system has been structured taking inspiration from the *black-board* architectural style (Garlan and Shaw, 1994), in which data shared by the different components are stored in a centralised repository, and are made accessible to all the other components via suitable RESTful interfaces.

In this setting, components provide actual functionalities while the *black-board infrastructure* is a communication backbone that orchestrates a pool of functionalities and that notifies components about relevant events/changes.

A minimal set of components enables the usage scenarios for process-oriented learning reported in Subsection 3.2. Among the others: the modelling environment to represent both the domain, and the procedures in place in the specific PA; the collaborative workspace referred by CSs for acquiring and complementing the information from the models; the model quality verification and the content analysis to validate the learning artefacts before their actual publication. Verification components implement the verification strategies studied in Corradini et al. (2018b), with reference to model structural properties, and reported in Corradini et al. (2018a) in relation to understandability of process models; the ontology recommender enabling the context-sensitive identification of experts, learning objects and material; the simulation

framework where learners can interactively execute a BPs in either single-user or multi-user sessions.

3.2 Main usage scenarios

In the following we report the most relevant use cases concerning knowledge modelling, and workplace learning when carried on by means of the Learn PAd platform. All these scenarios refer to modelling artefacts for structuring learning activities, and enabling the supported learning paradigms.

- *Knowledge modelling and management:* Enterprise contents are organised according to a set of models (De Angelis et al., 2016b) (e.g., BP models, organisational models, competency models, organisational goals, learning goals). The organisational knowledge is represented in such models by notation experts (i.e., the *modelers*) who are usually supported by knowledge experts of the PA. Bottom-up feedback from learners can be retrieved and possibly included in subsequent model releases.
- *Informative learning:* CSs explore both business related and organisational knowledge by browsing the synthesised contents. Specifically by navigating a BP it is possible to browse the organisational models of the PA, the documentation related to the given BP or business unit, or the contents provided by colleagues or experts. Using BPs as main learning artefacts helps CSs to critically consider the current way of working, and to detect possible error prone activities.
- *Collaborative learning:* Colleagues that are exposed to new regulations can cooperate by elaborating notes and learning-objects, or making suggestions for model improvements. Model-related suggestions can enable the codification and management of additional knowledge, which may lead to an evolution of the PA organisation. In other words, this use case may result in a bottom-up organisational learning.
- *Performative learning:* CSs can interact and cooperate to serve simulated cases requested by citizens in the past. The possibility to simulate BPs on real-world examples, enable collective reflections on how different CSs would have managed the selected case.
- *Assisted learning:* it relates to the possibility to introduce tutoring mechanisms to help the CSs in selecting the learning material, or in engaging in learning activities. Automated and context dependent recommendations drive the learner proposing contents and material in dependence of specific characteristics (e.g., based on competencies, goals or personal preferences).

4 Modelling processes and knowledge

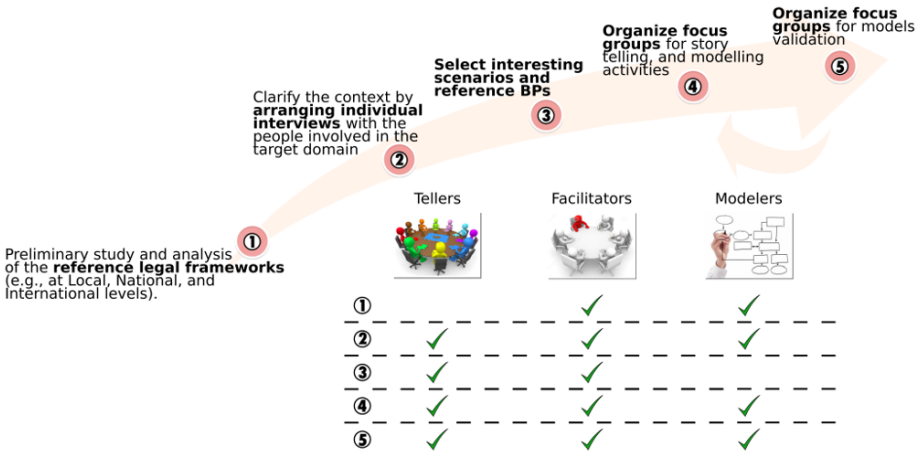
The Learn PAd project adopted a model-driven approach (Schmidt, 2006), thanks to which a deployed and ready-to-use instance of the platform can be obtained in a completely automated way. Models representing the reality of interest can then be pushed inside the Learn PAd Core Platform with a REST-style invocation. This step also

enacts the automatic synthesis of the contents conforming to the represented knowledge. Interested readers can find more details in De Angelis et al. (2016b), Re (2015) and De Angelis and Simard (2016). During the setup phase we prepared the demonstrator of the Learn PAd platform to be used for the validation. For such a purpose a version of the Learn PAd platform was deployed on the servers provided by Marche Region.[2]

The proposed process-oriented approach presupposes that the adopting organisation represents its procedural knowledge using BP models. We acknowledge that for those organisations where this is not already the case, as it could be for many PAs, an effort should be invested in deriving such models, and before the platform can be introduced. Indeed this is what we did for the chosen demonstrator, as the related BP models were not available. In this section we report about our experience in eliciting and building such models, as this could be a useful case for PAs willing to adopt the Learn PAd platform.

The chosen demonstrator is a real-world PA process that refers to a complex inter-organisational workplace, named 'Sportello Unico Attivit a Produttive' (SUAP). The SUAP includes as a 'one stop shop' the whole set of activities that the Italian PAs have to put in place to allow entrepreneurs to establish a new company. An application is completed through one single contact point constituted, at national level, by the SUAP system.[3] Following such an application, the SUAP workplace involves several PAs carrying out complex inter-organisational interactions.

Figure 2 The modelling process enabling a shared understanding between CSs and modelers (see online version for colours)



The methodology we followed to derive the models was initially based on the storytelling approach (Santoro et al., 2010). This is an elicitation strategy based on collaborative activities. Similarly to Maiden et al. (2014), the involved stakeholders describe their daily routine using natural language, reporting critical activities and providing possible improvements. The objective is to capture the knowledge from their stories. During storytelling meetings, people play different roles, such as:

- *Tellers* are the main performers of the work, and they tell the stories. They have domain knowledge about functional and behavioural aspects of the BP. Usually, tellers are not modelling expert.
- *Facilitators* mediate the practice of telling stories. They have professional experience in the application domain, and they can abstract the stories reported by tellers having a broader view on the topic.
- *Modelers* are experts of modelling notations. They develop the models of the BPs, and of other knowledge considering the abstractions derived by the facilitators.

  Note that in Section 2 we used the term modelers to identify a category of users in a model-based learning platform. Indeed, even though in different contexts, in both cases we are identifying to the same group of people, i.e., the modelling experts who are in charge to derive the models used in the platform.

The stories are transformed into models through several iterations. In various meetings different tellers can report different stories according to their visions and experience, and they can also interact with each other. Then the modelers and the facilitators collaborate to extract relevant information from the stories. The output of this phase is a collection of BPs, activities, rules, roles, documents, data, etc. Finally, the models are designed by the Modelers while the Facilitators can help establishing links among the elements.

In our case, two of the co-authors played the role of modelers since they are researchers with background in BP modelling and software engineering. Tellers were employees of the SUAP offices with practical experience (i.e., from the Senigallia Municipality[4] and the 'Monti Azzurri' Consortium[5] which are PAs implementing the SUAP regulations on behalf Marche Region). The facilitator was a delegate from Marche Region with background on SUAP, and related enabling software technologies. During the discussion, as soon as a new element emerged it was considered by the team according to its impact in terms of learning. In addition, a control group composed by the same Modelers, from the above group, but different tellers and facilitators was setup to validate the modelled artefacts.

5 Case study and validation

As we anticipated in the introductory section, the study aimed at answering the following research question: *How much is a BP oriented approach effective in relation to learning for employees of the PA?*

Clearly to provide a definitive answer to such a RQ a long-term observation of the approach in use would be needed. In the short-term, preliminary evidences on the effectiveness of the approach can be obtained through the feedback collected from a period of controlled usage of the platform. Such short-term validation is useful to better focus project activities, and to assess the applicability, acceptance and impact of the proposed solution in real working contexts.

Precisely, the proposed process-oriented learning approach was evaluated by considering the competences acquired by the CSs on the SUAP case study. This was done through two complementary instruments: a self-assessment evaluation on the acquired competences in the scope covered by the learning experience (i.e.,

SUAP-related activities), and a test constituted by multiple-choice questions related to the delivered training materials.

In the following we provide details on the setting up of the validation experience (Subsection 5.1), the validation results (Subsection 5.2), and the threats to validity (Subsection 5.3).

5.1 Experience setup

The validation involved a number of CSs that used the Learn PAd platform, and a matching control group that used the Marlene e-learning platform. Marlene[6] is the standard platform already in use at Marche Region for e-learning courses. The platform is based on the widely used Moodle system.

The main instrument to collect data from the experience was questionnaires. More precisely, we defined two questionnaires: the *ex-ante* one to be filled by the CSs before starting the validation, and the *ex-post* one to be filled after the validation.

5.1.1 Ex-ante questionnaire

The ex-ante questionnaire included a set of questions covering personal details of the respondents. These data were needed:

1 to classify and aggregate CSs according to relevant characteristics, including work-related experience and qualifications

2 to homogeneously distribute CSs between the Learn PAd group and the Marlene one.

The ex-ante questionnaire aimed also at getting a self-assessment of their level of expertise from each CS. Five main skill levels were identified as relevant in the evaluation of the Learn PAd approach. In particular they are:

- Skill 1 – Front-office activities, information, communication and management of the external relations with the citizens. They are needed for the tasks related to the preparation of work, and to provide information to the SUAP requester.
- Skill 2 – Assessing the administrative and procedural regularity of a request, through checking its completeness, and formal correctness. It is needed for the tasks related to the admissibility of a SUAP application.
- Skill 3 – Management and coordination of specific administrative procedures. It is needed for the tasks involving other PAs, for instance, to solicit the third parties in case of a delay or of a non-compliance.
- Skill 4 – Checking the consistency of provided data and documentation with respect to the business to be activated. It is needed for the tasks related to checking and monitoring the correctness of the acquired documentation in all the process phases, and also to issue an expert opinion on the admissibility of a SUAP authorisation.

- Skill 5 – Drawing up formal documents (e.g., decrees, reports, and letters). It is needed for the tasks related to the SUAP audit which focus on the capability to write and organise administrative documents in a proper manner.

For each skill we asked CSs to make a self-assessment selecting a mark from 1 (lowest) to 8 (highest), making explicit reference to the standard levels defined into the European qualifications framework (EQF).[7]

5.1.2 Ex-post questionnaire

The ex-post questionnaire asked each CS to repeat the same self-assessment related to the EQF at the end of the training activities. The intent was to verify the potential impact of using the learning platform into the learner's self-confidence.

The ex-post questionnaire also included a test of 15 multiple-choice questions related to SUAP notions that should have been acquired during the training session. Such questions were formulated by considering: the directives provided by Italian regulations in relation to learning in PAs; the recommendations from the literature about adult learning; other requirements dependent from the specific case study. The details of the analysis are available in Sergiacomi (2016). In relation to the specific skills/knowledge under scrutiny the resulting questions have been grouped into four homogeneous clusters, as described in the following:

- Group A is composed by four theoretical questions aimed at verifying a successful *learning of content delivered through images and related descriptions*.
- Group B is composed by three questions on the conference of service reform recently introduced by an Italian law[8] aimed at verifying a successful *learning of content delivered by supplementary material*.
- Group C is composed by five questions related to BPs aimed at verifying a successful *learning of content delivered through BP modelling and the logic of the procedural flows tracing a mental path, and the moving among the different tasks*.
- Group D is composed by three questions about practical cases aimed at verifying a successful *learning of content delivered through simulations or hands-on practice on real and concrete use cases*.

Finally, the ex-post questionnaire also asked the CSs opinions, from 1 (low) to 5 (high), related to the usability of the learning platform. The objective in this case was not to directly measure the usability of the Learn PAd platform, which is a research prototype certainly receptive of many improvements. Instead these questions were aimed at understanding the potential difference in usability between Learn PAd and Marlene, which is a mature platform in use for many years now.

5.1.3 Validation into practice

At the beginning of August 2016 we invited via email more than 90 CSs involved in the provisioning of the SUAP services, to join the validation activities. Among them, 72 CSs accepted to participate. Involved CSs had no knowledge of the two learning platforms before starting the validation.

At the beginning of September the ex-ante questionnaire was provided to all the 72 CSs. This gave us the possibility to collect their profiles, professional experiences, competences and expertise measured according to the EQF levels. Afterwards they got access to the learning platforms for a two weeks trial period (from 15 August 2016 till 26 August 2016). After the two weeks trial among those 72 CSs who accepted to contribute, only 61 returned the ex-post questionnaire (31 – Learn PAd and 30 – Marlene). The data were anonymised, aggregated and processed to provide a clearer picture of the evaluation results, as explained in the following.

5.2 Experience results and discussion

Here we first illustrate the CSs profiles and then we report the results obtained from the ex-ante and ex-post questionnaires. Specifically, in the rest of this section we highlight in italics the main conclusions that provide an answer to our research question.

5.2.1 CSs involved in the validation

The 72 responding CSs were divided in two groups. In particular, 36 CSs to validate the Learn PAd platform and 36 CSs to validate the Marlene platform. The two groups were formed as balanced as possible, with respect to gender, age, level of education, years of experience in PA, and in particular years of experience in SUAP related services.

Table 1 CSs profile

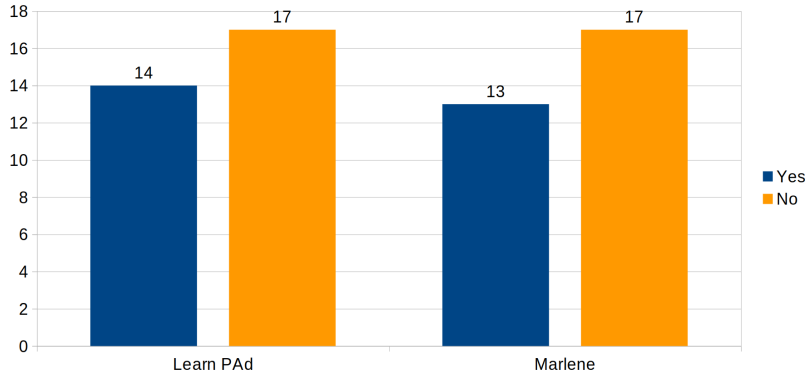
	Learn PAd	*Marlene*
# civil servants	Involved: 31	Involved: 30
Gender	Males: 17	Males: 18
	Females: 14	Females: 12
Age	Average: 43.61	Average: 44.40
Education	University: 23	University: 23
	High school: 8	High school: 7
PA experience	Average: 14.81	Average: 13.27
SUAP experience	Novices: 20	Novices: 15
	Intermediate: 7	Intermediate: 7
	Expert: 4	Expert: 8

In Table 1 we report the final distribution for the 61 CSs who completed the questionnaires. Notably, related to the SUAP experience, the two groups were composed as follow. In Learn PAd 64% of novice (with less than one year of work practice), around 23% of intermediate professionals, and almost 13% of expert (with more than five years of work practice). In Marlene 50% of novice, around 23% of intermediate professionals, and almost 26% of expert. More in detail the number of novice CSs using Learn PAd is higher than the ones in Marlene, and the number of intermediate is the same, while the number of expert ones is higher in Marlene than in Learn PAd.

5.2.2 Learning effectiveness

At the end of the learning session, we measured the difference in relation to the self-assessment step. In Figure 3, we graphically represent the outcome of such assessment: among the Learn PAd sample, 14 CSs out of 31 (45%) had improved their EQF self-assessment in one or more skills, while within the Marlene group 13 CSs out of 30 (43%) reported such an improvement. So, the improvement for Learn PAd users was a little higher.

Figure 3 CSs declaring improvements in using learning platforms (ex-post) (see online version for colours)



With reference to the five skills described in Subsection 5.1, the overall perceived improvement in each competence is reported in Table 2. It is calculated as a percentage considering the difference between the values resulting in the ex-post assessment minus the values resulting from the ex-ante assessment; the standard deviation was also calculated to understand the distribution consistency.

Table 2 Perceived skills improvements (ex-post vs. ex-ante)

Skills	*Learn PAd*		*Marlene*		*Delta*
	%	*Std. dev.*	*%*	*Std. dev.*	
Skill 1	+9%	0.57	+2%	0.25	+7%
Skill 2	+9%	0.63	+5%	0.37	+4%
Skill 3	+15%	0.70	+6%	0.50	+9%
Skill 4	+12%	0.79	+4%	0.34	+8%
Skill 5	+6%	0.47	+6%	0.48	-

Considering the column 'Delta' we can observe that for almost all the skills Learn PAd performed better than Marlene. Data also show that the percentage of improvement varies across the five different skills, so we consider each independently. Notably, the highest incremental percentage for the Learn PAd CSs is the 15% on skill 3 – "Management and coordination of specific administrative procedures", which is the most relevant skill when working with the coordination of the activities within the SUAP. *This was a competence acquired by means of the* ***browsing mode*** *of the Learn PAd*

platform that results to be quite effective rather than the standard learning approach proposed in Marlene (i.e., the 'informative learning' usage scenario described in Subsection 3.2). We also observe a relevant improvement using the Learn PAd platform in skill 4 – "Checking the congruence and pertinence of data and documentation submitted in an instance, considering the merits with respect to the business to be activated" (12% of improvement in the Learn PAd sample instead of the 4% within Marlene). *These are competences acquired using the Learn PAd case-based activity, performed in* ***simulation mode****, where CSs were asked to read a submitted application form to check it and determine how to proceed* (i.e., the 'performative learning' usage scenario described in Subsection 3.2). The task required the capability of applying the theory to a particular concrete case taken from the real world, synthesising and evaluating the main elements, and trying to solve it. An improvement in skill 2 has been also observed – "Assessing the administrative and procedural regularity of a request, through checking its completeness and formal correctness" (9% of improvement in the Learn PAd sample instead of the 5% within Marlene). *As skill 4 just described, this is a further skill acquired through the* ***simulation mode*** *supported by the Learn PAd platform*. Finally, less relevant is the impact on the improvements related to skill 1 – "Front-office activities, information, communication and management of external relationships" (9% of improvement in the Learn PAd sample instead of the 2% within Marlene) and to skill 5 – 'verification of data and documentation consistency' (6% among the Learn PAd sample instead of the 6% within Marlene). *These two skills do not exhibit particular difference between the two platforms, indeed they are referred to base functionalities shared by both Learn PAd and Marlene platform.*

The results of the test with 15 multiple choice questions included in the ex-post questionnaire were evaluated according to the standard procedures in use at Marche Region (precisely in the Regional School of Education – http://www.scuola.regione.marche.it/). In that context, a test is considered as successfully passed when at least 70% of the answers are correct.

Table 3 shows the collected data for both Learn PAd and Marlene. The rows in the table report the results both by assuming each single group of questions as a separate test (i.e., each group is passed by correctly answering more than 70% of its questions), and by considering all 15 questions aggregated as a unique test. In the case of Learn PAd, 15 CSs out of 31 (almost the 48% of the involved CSs) have correctly passed the evaluation if considered as a whole (see last row of Table 3). In the case of Marlene, instead, 16 CSs out of 30 (53% of the involved CSs) passed the whole evaluation. Considering the learning perspective we observe that the sets of users in Learn PAd, and in Marlene had a similar result related to the questionnaire, even if the group in Marlene seems to perform a little better. This might have been influenced by the fact (see Table 1) that the number of experts in Learn PAd (i.e., 4) is lower than in Marlene (i.e., 8) while the number of novices is higher (i.e., 20 vs. 15).

We then performed a statistical test to assess the null hypothesis that the difference between the number of correct answers for the two groups follows a symmetric distribution around zero, i.e., the null hypothesis is that the median values are statistically equivalent. Since our data could not be assumed to be normally distributed, we adopted a non-parametric statistical hypothesis test, the Wilcoxon signed-rank (Wilcoxon, 1945). With a resulting p-value of 0.5604, the null hypothesis could not be rejected, i.e., the median values observed are statistically equivalent. We repeated the test for the four groups of questions and the results were similar, i.e., the medians are

statistically equivalent. This means that the measures relative to the learning assessment are equivalent between the two samples. We see this as an encouraging result for the Learn PAd platform, as it is still in a prototypical stage, while the Marlene platform is a fully functional and actually used system.

Table 3 Profit results for each cluster of questions (ex-post)

Examination	*Learn PAd civil servants successfully passed (i.e., more than 70% of correct answers)*		*Marlene civil servants successfully passed (i.e., more than 70% of correct answers)*	
	Total #	*%*	*Total #*	*%*
Group A	9	29%	12	40%
Group B	18	58%	20	67%
Group C	12	39%	12	37%
Group D	9	29%	12	33%
As-A-Whole	15	48%	16	53%

We further examined these results looking for possible correlations with some of the factors that we collected. We supposed that CSs age, or already acquired experience in PA and SUAP might impact the learning results, and performed two correlation tests: Pearson and Kendall tau. Even if they are similar, we also considered Kendall tau since it does not require a normal distribution of the variables. The results are reported in Table 4.

Table 4 Factors impacting on right answers (ex-post)

	Pearson index		*Kendall index*	
	Learn PAd	*Marlene*	*Learn PAd*	*Marlene*
Age	-	-	0.403	0.282
PA experience	0.577	0.360	-	-
SUAP experience	0.563	0.467	0.469	0.520

With the Pearson index we noticed a limited correlation, more evident for the Learn PAd, with respect to the years of working experience within a PA and SUAP. *This means that, in the Learn PAd approach centred on work processes, learning is easier and more immediate for those who are more familiar with these processes.*

Considering Kendall tau correlation we use the Guilford (1942) scale, in which correlations with absolute value less than 0.4 are described as *low*, 0.4 to 0.7 as *moderate*, 0.7 to 0.9 as *high*, and over 0.9 as *very high*. We observed some interesting results for both platforms. The age of CSs has a low correlation with the number of right answers. The experience on SUAP has a moderate correlation with the number of correct answers. Based on such outcome, and noticing that within the Learn PAd sample a larger part of subjects declared to be novices in terms of SUAP expertise, we made a further analysis by computing the correlation between SUAP and the number of correct answers after removing those CSs who declared less than 1 years of SUAP experience. The correlation coefficient improved for both Marlene from 0.520 to 0.695 and Learn PAd from 0.469 to 0.595. *This seems to suggest that,* ***independently from the***

***platform used**, learning effectiveness improves when some previous knowledge exists, which might be supported by the need to have some background knowledge due to the high complexity of SUAP regulations.*

Finally, we also performed a Kendall tau correlation analysis between the experience with SUAP, and the individual's self-assessment (ex-post EQF levels declared). We observed a negative correlation for both platforms with correlation coefficients of –0.336554 and –0.05058633 for Marlene and Learn PAd, respectively. *This result is consistent with the expectation: individuals who are less experienced with SUAP will probably notice a greater improvement after using the platform, than those who are already experienced.*

5.2.3 Learn PAd platform usability

The overall assessment of this aspect revealed that *the two platforms do not present statistically significant variations in terms of usability*. The interpretation of this outcome provides us with greater confidence in the value of observed results, i.e., we were re-assured that the potential difference in usability did not affect the assessment of effectiveness.

5.2.4 Overall free-text feedbacks on Learn PAd

At the end of the evaluation we also prompted the involved CSs for free text feedback. Strengths and weaknesses were collected considering the Learn PAd platform.

Concerning the positive feedback, 20 CSs underlined the goodness of BP browsing functionality, including comments that the platform is simple to use, is logically and intuitively organised, and it provides a fast and flexible way to navigate through the workflow. They also noted that the process models and related content were accurate, well structured, clearly explained and easy to understand. In addition, ten CSs appreciated the simulation mode and its exercises based on real cases; eight CSs praised the social interaction features based on comments, the chat and the other forms of contribution, and underlined the importance of contributing with structured texts via the wiki environment. Finally, two CSs noticed the advantage of dynamic recommendation of new contents based on semantics; two CSs appreciated the homogeneous and responsive visual identity; and one CS generally appreciated the new way of learning.

Concerning the negative feedback, 19 CSs complained about an initial feeling of disconcert, uncertainty, displacement, un-clarity. They reported that the platform was difficult to explore since there was not a predefined orienting path to follow or explaining the progression. There were too many unknown available links and features, introduced in incomplete way and through a not so intuitive interface. One CS also remarked that just learning to use the platform itself is hardly time consuming. Moreover, ten learners wrote that simulation did not seem to work well or was not well explained or even that it was little effective in stimulating real problem solving attitudes; and two learners believed that the Learn PAd platform is not suitable for beginners as the course, and even the profit questionnaire required as a prerequisite a previously acquired knowledge. Finally, two CSs commented that the recommender provided a poor content support.

Summing up, it is not easy to deduce clear recommendations from the free-text feedback related to the Learn PAd platform. Nevertheless, we can say that some effort is

required to mitigate the differences between a process-oriented course and the traditional one. Once this initial gap is removed, the CSs found that the adoption of the Learn PAd platform simplified the way of accessing/retrieving information and knowledge. We also noticed that experienced people is more willing to collaborate and to do so by exploiting the features for socialisation, sharing, and contributing.

5.3 Threats to validity

In the following we briefly discuss some of the threats to validity that could affect our results. Specifically, we identified threats to *construct*, *external*, and *internal* validity.

5.3.1 Threats to construct validity

This category concerns the appropriateness of measures used for capturing the dependent variables. In other words, it refers to assumptions or decisions that have been considered during the definition and the setup of the experience and that may potentially impact the final results. Among the others, the numbers and the kind of questions that have been selected for both the ex-ante and ex-post questionnaires discussed in Subsection 5.1. Specifically, the set of skills adopted in the ex-ante questionnaires impact on the classification of the CSs. We adopted such classification in collaboration with personnel of Regional School of Education at Marche Region, since our intention was to reflect the various competencies related to the implementation of services by PAs. Also, in the second part of the ex-post questionnaires, the number of multiple-choice questions (i.e., 15) was decided in order to limit its overall duration to less than one hour. In our opinion a longer questionnaire might have negative impact on the quality of the answers, if not even on its completion. In the same category, we also include the duration of the learning platform validation that lasted for two weeks. We are aware that such a time-frame may result a bit tight for an assessment of learning, but it was the best we were able to afford considering the time and effort constraints. Nevertheless, it is important to remark that this threat might likely have produced a negative impact on Learn PAd, since the CSs had not much time to get familiar with the learning approach proposed by the new platform.

5.3.2 Threats to external validity

This category refers to the extent to which the results of our study can be generalised. In other words, which aspects could prevent getting similar results in different settings. First of all the validation involved a limited number of CSs. Even though the results are statistically relevant, a larger group of users should be involved. Also, the validation involved just one case study. Even if it was a quite complex scenario taken from a real world PA, having just one case study could limit the general validity of the results. To address these threats more studies are needed.

5.3.3 Threats to internal validity

This category refers to the extent to which the results obtained are function of the systematic observation/manipulation of the variables in the study. In other words, it

relates to the causal relations between the specific setting of the experiment and the results observed. As reported in Table 1, the final composition of the validation group (working on Learn PAd) exposed different levels of SUAP experience if compared with the control group (working on Marlene). Possibly such a difference may have an impact on the validity of conclusions. We explicitly report all such data in the experiment description. Besides, parts of both the ex-ante and ex-post questionnaires exploited answers based on self-assessment and in addition part of the ex-post questionnaire included free-text feedback. All these collected answers were inherently subjective and this may influence the validity of conclusions. However, usage of subjective feedback is common in learning evaluation (Strijbos, 2011; Fessl et al., 2017).

6 Related work

The convergence of knowledge management and e-learning has been widely discussed in literature in general (Sicilia et al., 2006; Chatti et al., 2012; Jia et al., 2011), and also specifically with respect to PAs (Savvas and Bassiliades, 2009; Kim and Lee, 2006). Chatti et al. (2012), critically analyse the role of both knowledge management and e-learning systems, their relations, and their deficiencies. Among the others the interestingly note that the two areas mostly evolve following two independent paths: at a conceptual level and at a technological one. Then the authors propose a theoretical framework aiming at bridging those complementary needs that the two domains expose. Even though our research started from another perspective and from different background, Learn PAd partially supports the views discussed in Chatti et al. (2012). Indeed Learn PAd conceives learning as a continuous process, in which the main learning materials are directly synthesised from knowledge artefacts. Artefacts model the organisation, its resources, and its process. Also, Learn PAd foresees the explicit representation at the *knowledge layer* of the competencies, the objectives (e.g., business motivation, learning goals), and the key performance indicators for both users and organisational units referred by the *e-learning layer*. Finally, the Learn PAd feedbacks system (see Subsection 3.2) supports reflection mechanism from the operative learning environment to the knowledge modelling infrastructure; such a feature can enable organisational learning and evolution.

Another class of related work concerns those e-learning solutions adopting process-oriented notations instead of the traditional content-oriented approaches. We refer to Subramanian and Bertolino (2017) for a systematic survey about this literature.

About e-learning solutions for workplace learning, in Jia et al. (2011) the authors remark the common issue of approaching their design/adoption from the technological perspective, while almost ignoring organisational or pedagogical ones. In addition, the authors recognise that most of the literature on e-learning targets educational approaches (e.g., learning at school), and tends to ignore the special characteristics and requirements of workplace learning. On the one hand, Learn PAd only partially refers to pedagogical aspects. For example, it supports different learning styles, and the explicit definition of learning goals (e.g., measured by means Key Performance Indicators on EQF-like scales). However we admit that there is room for improvement on this perspective. On the other hand, we already argued that Learn PAd is strongly based on organisational and motivational models; moreover, it also promotes learning by documenting practical

tasks, linking expert/responsible, and supporting simulation of past real-work situations. In conclusion, the Learn PAd platform targets workplace learning in a native way.

Stoffregen et al. (2015), survey the potential barriers towards the adoption of open e-learning systems D'Antoni (2009) in the public sector, distinguishing among contextual, social and technical barriers. It is out of the scope of this paper to report a detailed comparison between the proposed e-learning approach and the findings from Stoffregen et al. (2015); nevertheless the relation with some barriers are discussed in the following. One barrier to workplace learning is lack of time; in fact employees have a high workload, so they face difficulties to conduct learning sessions scheduled during working time. Learn PAd was mainly conceived as an on-line and collaborative platform accessible by CSs during daily-work activities. Even if we do not exclude the possibility to setup off-line courses based on our approach, Learn PAd considers learning and working strongly intertwined (learning while doing). Thus, Learn PAd mitigates this barrier with scenarios such as 'informative learning', or 'collaborative learning' (see Subsection 3.2) that can be enacted while the CSs are working and they look on-the-fly for support about some specific issue. With respect to the barriers: lack of personnel due to turnover, and lack of regulatory policy framework, Section 1 include them among the main goals motivating our research. Finally, Learn PAd also mitigates some technical barriers discussed in Stoffregen et al. (2015) and De Angelis et al. (2018) thanks to the sustainability of the technological artefacts. The proposed prototype released by the EU project relies on open-source software projects with quite active and mature communities (i.e., XWiki – https://www.xwiki.org, ATL and Acceleo – https://eclipse.org/modeling/, Activiti – https://www.activiti.org/). Where possible, standard notations have been adopted in order to model knowledge and processes (e.g., BPMN), and where no standard notation was available, on-purpose specifications (i.e., meta-models) were released according to open modelling frameworks and notations (e.g., ECore – https://eclipse.org/modeling/ , ADOxx – https://www.adoxx.org/). Interoperability issues were also mitigated by providing open APIs to the platform according to the REST-style paradigm.

7 Conclusions and future work

Mastering knowledge management and learning approaches is increasingly vrecognised as a necessary asset for enabling a complex organisation to react to frequent changes of operative conditions (e.g., reorganisation, new customer requests, new services, ...). In addition, the convergence of novel strategies in both these fields is strictly related to the need for an increased agility that more and more challenges complex organisations, in both the private and the public sectors.

With particular respect to the public sector, many European National Governments challenge PAs to evolve their role as effective service providers (European Commission – Directorate-General for Communications Networks, Content and Technology, 2013). Beyond specific solutions, shared objectives are the efficiency and the consistency of service delivered across the national territory, whereas shared strategies leverage a deep knowledge of the organisations, and also of the processes, the administrative procedures and the services the PAs must provide. Thus in PAs it is quite frequent that new laws and regulations ask for the introduction of new services or the modification of already

available ones. This in turn could require the relocation of workers to different offices or responsibilities.

This paper reports on an experience aimed at evaluating the effectiveness of a novel approach to knowledge management and learning for employees of the PA. In particular the approach has been conceived so to leverage enterprise-related models: among the others, process-oriented procedural knowledge, organisational knowledge, competency models, organisational goals, and learning goals. The proposed approach is supported by a software platform developed within the context of the EU project Learn PAd. In this paper, it has been assessed on a real working context to derive initial answers to our research question. The experience has been carried out considering a comparative analysis between the newly introduced approach and a traditional one.

The validation involved around sixties CSs that were split in two groups. People in the two groups were asked to acquire new knowledge using different learning strategies. In particular the control group was exposed to learning using the strategy already in use at their organisation. A second group instead was exposed to learning using the novel strategy and related platform. Participants were asked to provide answers to two different questionnaires. The first one was filled before the experiment started and was needed in order to have an homogeneous distribution of CSs between the two groups. The second questionnaire was answered after usage of the platform and aimed at assessing the effect of the exposition to the two platforms in relation to learning.

The experience results we got are encouraging. Overall we could conclude that no significant difference was observed, notwithstanding the fact that the novel strategy was mediated by a software platform still under development, while the traditional strategy could take profit of a stable and more standard platform. Moreover, if we considered the different expertise in the two groups, the results for our approach would be more positive. The CSs that took part to the study by using Learn PAd released several positive comments, and several suggestions for improvement as well. In conclusion, we interpreted both the scores and the free-text feedback as a positive answer to the research question addressed by the paper.

There are clearly some remaining open questions also in relation to the inherent uncertainty that such kinds of experiment convey. We listed some threats to validity aspects that will certainly need to be considered in planning our future work. In particular we intend to further experiment the platform in real working contexts, and we also intend to foster the creation of an open source community around the platform code available on GitHub.

Acknowledgements

This research has been partially funded by the European Project FP7 STREP 619583: Learn PAd. The authors wish to thank the partners of the Learn PAd Consortium for the collaboration during the experience reported in the paper, and in particular Alessia Balducci and Laura Giorgio from Regione Marche, and Breno Miranda from CNR-ISTI.

References

Bradburn, N.M., Sudman, S. and Wansink, B. (2004) *Asking Questions: The Definitive Guide to Questionnaire Design – For Market Research, Political Polls, and Social and Health Questionnaires*, Revised ed., April, Jossey-Bass, San Francisco, California, USA.

Chatti, M.A., Schroeder, U. and Jarke, M. (2012) 'LaaN: convergence of knowledge management and technology-enhanced learning', *IEEE Transactions on Learning Technologies*, April, Vol. 5, No. 2, pp.177–189.

Corradini, F., Ferrari, A., Fornari, F., Gnesi, S., Polini, A., Re, B. and Spagnolo, G.O. (2018a) 'A guidelines framework for understandable BPMN models', *Data Knowl. Eng.*, Vol. 113, No. 1, pp.129–154.

Corradini, F., Fornari, F., Polini, A., Re, B. and Tiezzi, F. (2018b) 'A formal approach to modeling and verification of business process collaborations', *Sci. Comput. Program.*, Vol. 166, No. 1, pp.35–70.

D'Antoni, S. (2009) 'Open educational resources: reviewing initiatives and issues', *Open Learning: The Journal of Open, Distance and e-Learning*, Vol. 24, No. 1, pp.3–10.

Davenport, T.H. (1993) *Process Innovation: Reengineering Work Through Information Technology*, Harvard Business School Press, Boston, MA, USA.

De Angelis, G. and Simard, J. (2016) *Core Platform Implementation – Second Version*, No. Del. D2.4, The Learn PAd Consortium.

De Angelis, G., Ferrari, A., Gnesi, S. and Polini, A. (2016a) 'Collaborative requirements elicitation in a european research project', in *Proc. of the 31st Annual ACM Symposium on Applied Computing*, ACM, Pisa, Italy, pp.1282–1289.

De Angelis, G., Pierantonio, A., Polini, A., Re, B., Thönssen, B. and Woitsch, R. (2016b) *Modeling for Learning in Public Administrations – The Learn PAd Approach*, pp.575–594, Springer International Publishing, Cham.

De Angelis, G., Ferrari, A., Gnesi, S. and Polini, A. (2018) 'Requirements elicitation and refinement in collaborative research projects', *Journal of Software: Evolution and Process*, Vol. 30, No. 12.

European Commission – Directorate-General for Communications Networks, Content and Technology (2013) *A Vision for Public Services*.

Fessl, A., Wesiak, G., Rivera-Pelayo, V., Feyertag, S. and Pammer, V. (2017) 'In-app reflection guidance: Lessons learned across four field trials at the workplace', *IEEE Transactions on Learning Technologies*, Vol. 10, No. 4, pp.488–501.

Garlan, D. and Shaw, M. (1994) *An Introduction to Software Architecture*, Tech. Rep. CMU-CS-94-166, Carnegie Mellon University, January.

Guilford, J.P. (1942) *Fundamental Statistics in Psychology and Education*, McGraw-Hill, New York, USA.

Jia, H., Wang, M., Ran, W., Yang, S.J., Liao, J. and Chiu, D.K. (2011) 'Design of a performance-oriented workplace e-learning system using ontology', *Expert Systems with Applications*, Vol. 38, No. 4, pp.3372–3382.

Kim, S. and Lee, H. (2006) 'The impact of organizational context and information technology on employee knowledge-sharing capabilities', *Public Administration Review*, Vol. 66, No. 3, pp.370–385.

Liao, S-H. and Wu, C-C. (2010) 'System perspective of knowledge management, organizational learning, and organizational innovation', *Expert Systems with Applications*, Vol. 37, No. 2, pp.1096–1103.

Maiden, N.A.M., Lockerbie, J., Zachos, K., Bertolino, A., De Angelis, G. and Lonetti, F. (2014) 'A requirements-led approach for specifying qos-aware service choreographies: an experience report', in *Proc. of Int. Working Conference on Requirements Engineering: Foundation for Software Quality (REFSQ)*, *LNCS*, Springer, Vol. 8396, pp.239–253.

Polini, A. (2015) *User Perspective and Project Evaluation Strategies*, No. Del. D8.1-Addendum, The Learn PAd Consortium.

Re, B. (2015) *Demonstrators Populated Learning Platform*, No. Del. D8.3, The Learn PAd Consortium.

Santoro, F.M., Borges, M.R. and Pino, J.A. (2010) 'Acquiring knowledge on business processes from stakeholders' stories', *Advanced Engineering Informatics*, Vol. 24, No. 2, pp.138–148.

Savvas, I. and Bassiliades, N. (2009) 'A process-oriented ontology-based knowledge management system for facilitating operational procedures in public administration', *Expert Systems with Applications*, Vol. 36, No. 3, pp.4467–4478.

Schmidt, D.C. (2006) 'Guest editor's introduction: model-driven engineering', *IEEE Computer*, Vol. 39, No. 2, pp.25–31.

Sergiacomi, A. (2016) *Demonstrators Assessment*, No. Del. D8.4, The Learn PAd Consortium.

Sicilia, M-Á., Lytras, M., Rodríguez, E. and García-Barriocanal, E. (2006) 'Integrating descriptions of knowledge management learning activities into large ontological structures: a case study', *Data & Knowledge Engineering*, Vol. 57, No. 2, pp.111–121.

Stoffregen, J., Pawlowski, J.M. and Pirkkalainen, H. (2015) 'A barrier framework for open e-learning in public administrations', *Computers in Human Behavior, Computing for Human Learning, Behaviour and Collaboration in the Social and Mobile Networks Era*, Vol. 51, pp.674–684.

Strijbos, J.W. (2011) 'Assessment of (computer-supported) collaborative learning', *Transactions on Learning Technologies*, January, Vol. 4, No. 1, pp.59–73.

Subramanian, V. and Bertolino, A. (2017) *A Systematic Mapping Study on Business Process-oriented E-learning*, Tech. Rep., CNR–ISTI, July [online] http://cnr.isti/2017-TR-010 (Accessed 5 April 2018).

The Learn PAd Consortium (2015) *The Learn PAd Solution to Process Oriented Learning*, Tech. Rep., The Learn PAd Consortium [online] http://www.learnpad.eu/docs/whitepaper4business (Accessed 5 April 2018).

The Learn PAd Consortium (2016) *The Learn PAd Platform for Process Oriented Learning*, Tech. Rep., The Learn PAd Consortium [online] http://www.learnpad.eu/docs/whitepaper4technology (Accessed 5 April 2018).

Weske, M. (2010) *Business Process Management: Concepts, Languages, Architectures*, Springer Publishing Company, Incorporated, Berlin Heidelberg, Germany.

Wilcoxon, F. (1945) 'Individual comparisons by ranking methods', *Biometrics Bulletin*, December, Vol. 1, No. 6, pp.80–83.

Zachman, J.A. (1996) *Concepts of the Framework for Enterprise Architecture*, Technical report, Zachman International, Los Angels, CA.

Notes

1 http://www.learnpad.eu/.

2 This is the version at Month 30 of the project that was made available from http://learnpad.regione.marche.it:8080/xwiki, whereas the official development repository of Learn PAd on GitHub is at https://github.com/LearnPAd/learnpad.

3 http://www.impresainungiorno.gov.it.

4 http://www.comune.senigallia.an.it/.

5 http://www.montiazzurri.it/.

6 Marlene is available on-line at the following link http://marlenescuola.regione.marche.it/moodle/.

7 https://ec.europa.eu/ploteus/en/content/descriptors-page.

8 Decree DLgs No. 127 30/06/2016.