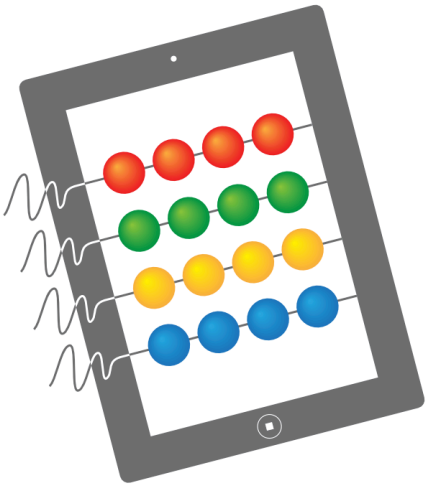
FP7 ICT STREP Project



LEARN PAD

Deliverable D5.4

KPI Ontology and Learners Assessment Mechanisms

http://www.learnpad.eu

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Abstract

Public Administrations need to ensure that their employees (civil servants) are able to learn fast how to correctly execute relevant business processes and hence meet their business goals on strategic and operational levels. Concerning the strategic business goals, they hence need to derive operational goals and learning goals, i.e. for each organisational goal, they need to answer the question: which competencies do civil servants need to acquire in order to help achieve that business goal?

Having identified the learning goals, Public Administrations – in order to take appropriate actions and implement suitable measures for learning – must be able to identify the gaps in civil servants' competencies, to track progress in closing them and to provide guidance and support to employees in the learning process. Tracking progress can be done e.g. via suitable (learning) KPIs.

This deliverable describes the design of a comprehensive solution to the above challenges: it outlines how we studied the example of the Titolo Unico process to understand typical goals and KPIs that were required to plan and track learning in a real workplace environment. Based on the insights from this domain analysis, we elaborate a meta-model, suited to model all relevant aspects of a learning scorecard – a tool that helps to model learning goals, connect them to organisational goals and define KPIs for assessing their achievement.

To illustrate the approach, we have created a learning scorecard with strategic, operational and learning goals and corresponding KPIs for the Titolo Unico process. We have taken care to keep the elements generic such that they will suit different business processes in different Public Administrations. Finally, we describe the design of a dashboard to visualise goal achievements.

In addition to these concepts, we also introduce methods for assessing learning outcomes, i.e. for measuring KPI values: we show how learners' achievements can be measured on the basis of traces from the collaborative workspace and simulation environment and we discuss the design of questionnaires that can be used to test civil servants' knowledge about certain relationships captured in domain and process models. A prototypical implementation of these methods has been performed.

Keyword list

Learning Assessment, Learning Goals, Key Performance Indicators, KPI Ontology, Learning Scorecard, Assessment Procedures, Questionnaires

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Glossary, acronyms & abbreviations

Item	Description
ArchiMEO	Enterprise Ontology developed by FHNW based on ArchiMate Standard and enhanced for Learn PAd
BP	Business Process
BPMN	Business Process Model and Notation
Browsing	Learning mode that allows navigating through models
CBR	Case Based Reasoning
FHNW	University of Applied Sciences and Arts Northwestern Switzerland
Learning Material	All entities not representing models but relevant for learning as books, tutorials, learning audio and video file but also browsing and simulation
Learning Objects	All models represented in the wiki are considered learning objects
MOP	Memory Organization Pocket
MR	Marche Region
OWL	Ontology Web Language
PA	Public Administration
SPARQL	SPARQL is a W3C recommendation defines the syntax and semantics of the SPARQL query language for RDF.
SPIN	SPIN is a W3C Member Submission that has become the de-facto industry standard to represent SPARQL rules and constraints
SUAP	Sportello Unico Attivitá Produttive
Titolo Unico	'Titolo unico' means in English standard request to start business activity; here used to name the business process considered
UC	Use Case
UML	Unified Modeling Language
W3C	World Wide Web Consortium

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1. Introduction

Deliverable D5.4 “KPI Ontology and Learners Assessment Mechanisms” includes both the KPI reference ontology, and the assessment methods for evaluating the learners. The former will be used in order to assess the learning progress and to guide the learner in the learning paths on the base of their knowledge. The latter defines learning evaluating artefacts to be submitted to the learners. Main part of the deliverable is software plus a report, documenting approach, method and results.

A snapshot of the software can be found at:

http://www.learnpad.eu/docs/lp-dashboard-D5_4.zip

and at:

http://www.learnpad.eu/docs/lp-ontology-recommender-D5_4.zip

1.1. KPI Ontology and Learners Assessment Mechanisms – Motivation

Learn PAd aims at supporting holistic learning solutions for the Public Administrations, providing collaborative workplace learning centred on Business Processes (BPs) and their context. Hence, assessment of learners is strongly related to learning goals, which in turn are related to the business goals of a PA. We already have the Business Motivation Model (BMM) in which strategic goals and their relation to vision, mission etc. are expressed. To assess the performance of a learner, strategic goals need to be broken down into operational business goals and learning goals contributing to them. Furthermore, Key Performance Indicators (KPI) for business goals and learning goals must be identified and suitable measurements defined. As in Learn PAd not only individual but also organisational learning is addressed, the performance of organisational units (e.g. SUAP office) has to be assessed, too. This means on the one hand that individual goal achievements are aggregated on the team level and on the other hand that we may formulate goals and KPIs that are meant to be solely or primarily evaluated on team level.

In terms of the relationships of operational and learning goals to business processes, we are assuming that the business goals of many PAs are related to business processes that involve dealing with applications and/or requests of citizens or companies. Hence, we have developed the KPI model and ontology having in mind a family of business processes that are similar to the SUAP process in the sense that they consist in responding to requests or applications of citizens or companies. In our model, several KPIs refer to the (quality of) result of completing instances of such business processes (e.g. identification of missing documents in application, keeping the timeline etc.). Such KPIs should be measured across several executions or simulations of that process. For an individual, they are measured only when that individual was involved in the process instance. The resulting dashboards will thus give an impression of how certain process-related goals are achieved across many executions of BP instances.

Among mechanisms used in Learn PAd for the assessment of specific operational and learning goals and the associated KPIs, we will also exploit natural language questionnaires that can be derived from the process models by applying model transformation techniques, guided by coverage criteria over the graph elements. The approach relies on an original research effort by CNR (Bertolino et al. 2011; Autili et al. 2016) that was originated in a different project and has been here adapted to the needs arising from the Learn PAd

context. The tool previously developed that we have used here to derive the questionnaires is available from:

http://labsedc.isti.cnr.it/tools/mothia

1.2. Methodology

As for the other deliverables developed in WP5, we followed the design science research methodology for information systems research (Hevner et al. 2004). Hence, the research design follows the stages in the design science research methodology: problem awareness, suggestion, development and evaluation. In the following paragraphs each stage is described.

1. Awareness of Problem – in this phase, we performed a detailed domain analysis to understand which KPIs are relevant for measuring learning performance in a workplace environment. Our analysis was done in close cooperation with representatives of Marche Region. In addition we considered the approach of a maturing score card, introduced in the MATURE project.
2. Suggestion – based on the findings in the problem awareness phase, we derive and describe the conceptual models that facilitate the implementation of a goal oriented learning at the workplace, namely
    1. KPIs relevant for measuring individual and organisational learning performance
    2. Enhancements of the KPI meta model (adapting the Knowledge Maturing Scorecard for learning)
    3. The KPI-Model based on the aforementioned meta model
    4. The dashboard for performance monitoring
    5. The concept for integrating the KPI-Model (aka Learning Maturing Scorecard) and dashboard in the Learn PAd system.

    Development – at this stage, we define the technical architecture for learning performance monitoring and its integration into the Learn PAd platform. A prototypical implementation has been done.

    Evaluation – the solution will be fully evaluated in D8.4. Due to the facts that full evaluation is planned for later date than delivery date of this deliverable and that comprehensive data about the use of the platform is needed to perform performance measuring, evaluation has been done only with respect to intermediary results. That is, all concepts developed in the suggestion phase were discussed in depth with Marche Region and approved before implemented.

1.3. Structure of the Deliverable

The deliverable is structured as follows: in Chapter 2, we discuss related research about measuring performance of workplace related learning. Chapter 3 presents the findings of the domain analysis (problem awareness), with a focus on elicited requirements. We describe our conceptual solution in Chapter 4 – comprising the meta models needed to model learning assessment and their relation to organisational goals, as well as proposed generic goals and KPIs and their measurement and presentation within a dashboard. Chapter 5 provides more detail about the measurement processes used to assess KPI values using questionnaires. The corresponding technical architecture is summarized in Chapter 6. Chapter 7 concludes and indicates directions for future research.

2. Related Work

In the following sections we provide findings from literature regarding KPIs for learning and ways of presenting them to the learners. Furthermore we investigated strategies and frameworks for the evaluation of learning focussing on approaches using questionnaires and KPIs.

As shown by (Wang et al. 2010) in many organizations, e-learning is not aligned with the organizational vision and mission. Focus is put on technical aspects neglecting motivation and assessment of the learners. The authors elaborate on embedding learning activities in the workplace to address corporate interests (organization), individual needs (learner), work performance (work), and social context (other learner) as depicted in Figure 1.

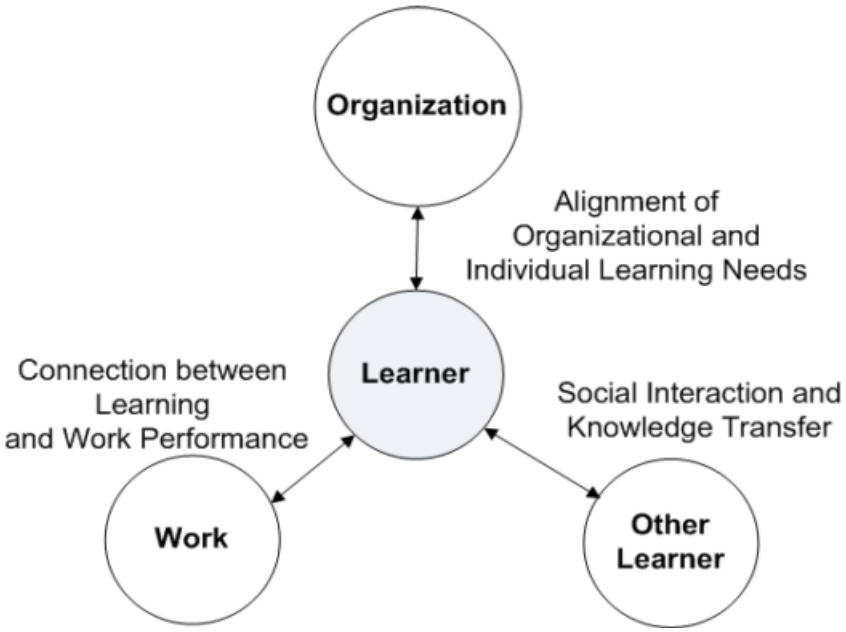

Figure 1: Learning in the Workplace (Wang et al. 2010, p 169)

Nikolova et al. (2014) did a comprehensive literature review and showed that most research done on measuring workplace learning is limited by its context dependence. The authors therefore present a multi-dimensional scale measuring the learning potential of the workplace applicable across various occupational settings. Furthermore, according to Nikolova et al. (2014) workplace learning has two main components: an interactional and a task-based one. However, contrary to our approach in Learn PAd, task-based is used in the notion of cognitive–behavioural but not in the sense of getting better in performing a (business process) activity. Hence, learning goals and measures remain unrelated to business goals and how learning can be measured with respect to meeting these goals.

In research done by (van Dam 2015) workplace goal orientation is investigated, distinguishing between learning, performance, and avoidance. That is, workplaces emphasizing learning goals are likely to provide opportunities for personal growth, like challenging job assignments and learning activities; workplaces emphasizing performance goals are likely to impose pressure on employees and show a high degree of comparison and competition; workplaces emphasizing avoidance goals are likely to focus on punishing errors (van Dam 2015). Also in this research goal orientation is not considered with respect

to supporting a learner in better reaching an organisation's business goals but with respect to its ability of supporting employees' personal development.

Workplace learning in a broader context of an organization like the political economy in which goods or services are sold, economic sectors and structure of production was researched by (Fuller & Unwin 2011). They investigated factors determining expansive and restrictive learning environments in an organisation and emphasize that "expansive environments do not separate personal and organizational goals, but see them as integrated within a symbiotic relationship" (Fuller & Unwin 2011, p 59). Unfortunately the authors didn't provide details on how this could or should be done. Although (Fuller & Unwin 2011) provide a comprehensive framework for capturing organisational factors which influence how people learn at work and how this learning can be valued, fostered or limited, they spare the 'measurement challenge' (quotation marks by the authors).

2.1. Strategies and Frameworks for the Assessment of the Learners

In their research (El Faddouli et al. 2011) propose an approach for adaptive learning that is based on assessment and competency-based learning with the goal to individualize the learning path. In their approach (El Faddouli et al. 2011) enhanced previous work on formative assessment which allows for personalized learning. Assessment is done based on offered items (i.e. questions) presented to the learner. "The correctness of the answer to an item determines the selection of the next one taking into account the previous responses and performances recorded in the learner model" (El Faddouli et al. 2011, p. 265). For each assessed item the competency gap is identified, i.e. the gap between current level of performance and target level of performance in order to identify a suitable next learning activity. The assessment is done in several iterations considering not only the achieved results but also the learner's profile. The approach is designed according to standards, such as IMS-LD, IMS- QTI, IMS-LIP, IMS-LD and IMS RDCEO[1] (the latter two standards are considered in Learn PAd for competency and learning modelling). (El Faddouli et al. 2011) differentiate between static level (captured in a profile) and dynamic level of a learner (describing the learning progression). Within the Learn PAd project we follow a similar approach: the (more) static level is also captured in a learner's profile whereas the dynamic level is represented in the Learning Maturing Scorecard. As we regard learning as a collaborative process assessment of individuals is not enough: a learner's performance must be assessed within the context of a (learning) team performance. Hence, in Learn PAd we exceed the approach of (El Faddouli et al. 2011) as the scorecard not only show the learning performance of individuals but also from groups, i.e. organizational units. Furthermore we provide learning recommendation on individual

[1] IMS Global Learning Consortium Inc. IMS Global is legally organized as a non-profit member organization. It is a "community of education and technology leaders from around the world working together to advance progress towards putting in place an open architecture to support next generation digital learning". URL: https://www.imsglobal.org/learningdesign/ldv1p0/imsld_infov1p0.html (retrieved: 13.3.2016)

The purpose of assessment *for* learning is “to monitor the progress of the learner toward a desired goal, seeking to close the gap between a learner’s current status and the desired outcome” (Clark 2012, p 208). In his comprehensive contribution (Clark 2012) also shows, that assessment can be regarded *as* learning. A process in which learner and teacher “set learning goals, share learning intentions and success criteria, and evaluate their learning through dialogue and self and peer assessment” (Clark 2012, p 208). In the Learn PAd project we transferred this notion into workplace learning, supposing that learning goals are 1) aligned with business goals and 2) measured via KPIs related to those business goals which in turn support the strategic goals of an organization.

2.1.1. KPIs for Learning

(Wang et al. 2010) suggest to consider the alignment of individual and organizational learning needs, the connection between learning and work performance, and communication among individuals when designing workplace e-learning. They set up a set of key performance indicators (KPIs) with measures “focusing on the aspects of organizational and individual performance that are critical for the success of the organization” (Wang et al. 2010, p 167).

2.1.2. Questionnaires

Questionnaires with multiple choice questions are a very popular means of assessment and self-assessment in both traditional and electronic learning settings. The creation of such questionnaires is a time consuming task, especially when the number of items constituting a questionnaire is large. Some research on automatic generation of questionnaires for learning has been recently carried out. The proposed solutions deal with ontology-based question generation or Natural Language Processing (NLP) techniques. Specifically, the work in (Papasalouros et al. 2008) presents a tool that derives multiple choice questionnaires using the semantic web standard technology OWL (Ontology Web Language); the tool is independent of the domain. Other approaches such as (Aldabe et al. 2006) focus on NLP-based and efficient procedures for the construction of multiple-choice tests using data bank of morphologically and syntactically analysed sentences and question models defined in the XML language. Differently from the above approaches, the solution proposed in (Bertolino et al., 2011) can derive Natural Language questionnaires in automated way, starting from UML models such as *Class Diagram*, *Use Case Diagram* and *Activity Diagrams*.

2.2. Knowledge Maturing Scorecard

Within the MATURE project a Knowledge Maturing Scorecard was developed (Hrgovcic & Wilke 2012). The concept of knowledge maturing (Maier & Schmidt 2007; Schmidt et al. 2012) describes a process of learning on a collective level, where bottom-up initiatives of employees, leading to new ideas and knowledge, are encouraged, guided and taken up by organisations in order to foster knowledge development and innovation. The process consists of various phases, where knowledge reaches ever higher degrees of sophistication and organisational acceptance. It is the goal of most organisations to foster such maturing for exactly that knowledge that will make the company function in a more effective and efficient way. Indeed, (Hrgovcic & Wilke 2012) see knowledge maturing as a precondition for innovation.

To make the success of knowledge maturing – and hence also of organisational learning – visible and measurable, the knowledge maturing scorecard was introduced. It follows the principles of a Balanced Scorecard (Kaplan & Norton 1996), but replaces strategic goals with

knowledge maturing goals and key performance indicators with knowledge maturing indicators (KMI) and proposes some new perspectives.

In our work, we follow a similar approach – we extend the meta model behind a Balanced Scorecard with the concept of a learning goal and extended the properties of KPIs to be able to model assessment of learning, as well as its connection to an organisation's strategic goals (see Section 4.1). For this, we also used concepts from the Business Motivation Model, as described in the next section.

3. Domain Analysis

In order to determine business goals – on strategic and operational level – to identify the KPIs, their measurement and assessment, we conducted interviews and workshops with representatives of Marche Region. The results are described in the subsequent sections.

3.1. Strategic, Operational and Learning Goals

We identified three different types of goals relevant for workplace learning and performance measurement.

Strategic goals are modelled in the Business Motivation Model (cf. to D5.1, section 4.1.1). In Figure 2 we depict the BMM defined for the PA of Monti Azzurri.

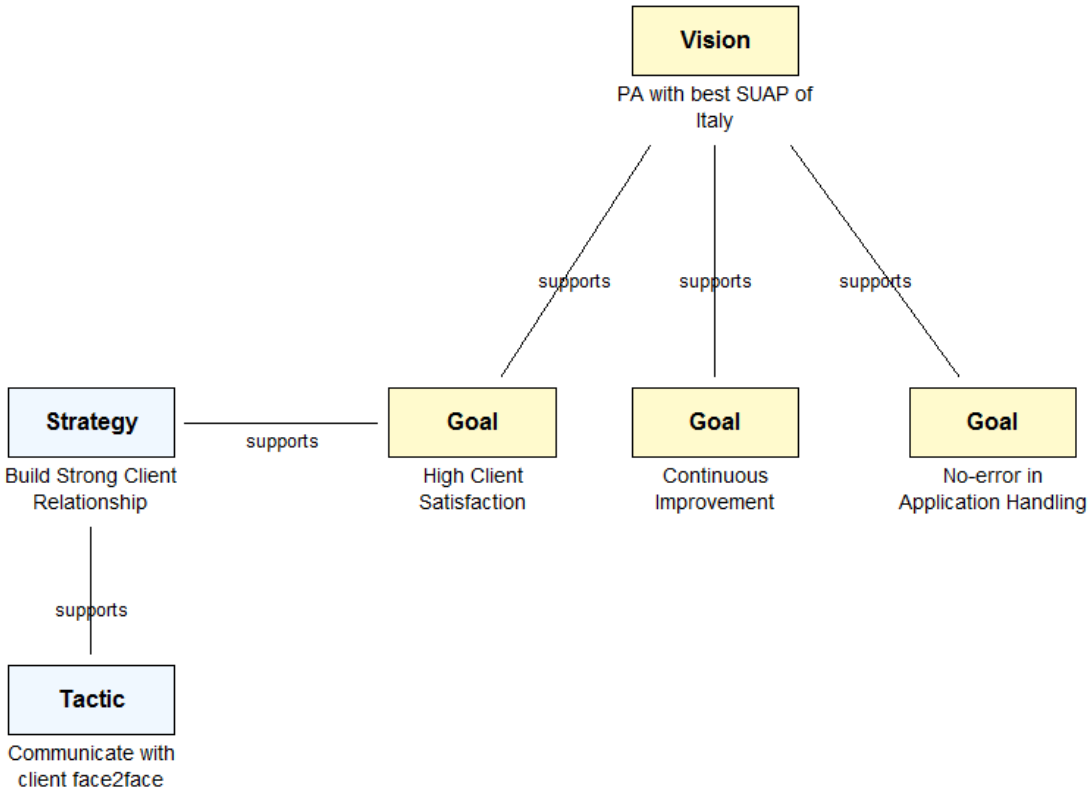

Figure 2: BMM for Monti Azzurri

Strategic goals are implemented by operational goals. Figure 3 shows a print screen of the operational goal “Timely delivery of Service” in the KPI-Model (depicted as orange circle) and its reference (property: *Referenced Motivation Element*) to the strategic goal “High Client Satisfaction” in the BMM (shown in Figure 2).

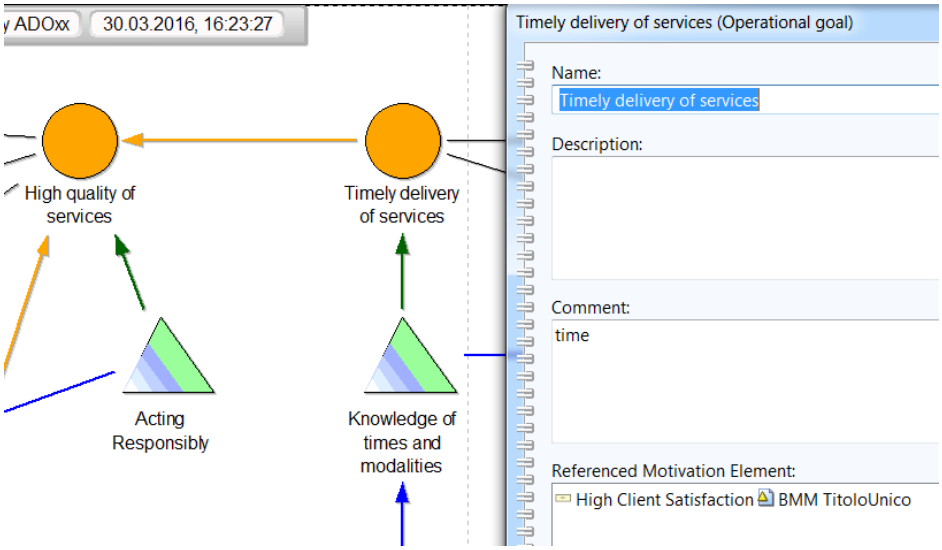

Figure 3: Reference from Operational Goal (KPI-Model) to Strategic Goal (BMM)

An operational goal may also support another operational goal; in Figure 3 it is the “Timely delivery of services” that supports the “High quality of services”. Learning goals (depicted as striped triangles) are considered to enable a business goal. Here it is the learning goal “Knowledge of times and modalities” that enables the operational business goal “Timely delivery of services”; the “Acting responsible” learning goal enables the “High quality of services” operational business goal.

Together with representatives of Marche Region, we identified, for each strategic goal, the operational goals that implement it. After this the learning goals that support one or more operational goal were determined. In a next step KPIs for both, operational goals and learning goals were determined along with its source and kind of measurement.

Table 1 gives an overview on the operational goals defined for the PA of Monti Azzurri; Table 2 lists the enabling learning goals. The tables show the goal, identification data for the KPI, a brief description of the KPI and the priority that representatives of Marche Region assigned.

Operational Goal	KPI No	KPI	priority
High quality of services	B1	no of complaints of clients about an employee (learner)	high
Intensive use of Learn PAd platform	B4	total no of valuable comments	high
Timely delivery of services	B6	identification of errors & missing docs in applications before learning compared to after learning	high
	B7	Keeping the timeline	high
Improvement of Business Models	B8	no of feedbacks to improve the models (not considered detections of errors)	medium-high
	B28	no of changes of models based on feedback	medium-high
Intensive use of Learn PAd platform	B9	no of feedback created from comments	medium-high
	B10	total no of Learn PAd platform users	medium-high
	B11	total no of simulations	medium-high
Competence Development	B12	percentage of staff meeting the competence requirements	low
Intensive use of Learn PAd platform	B13	total no of comments to additional pages	low
Short & effective setting-in period	B14	training costs per new employee	low
Competence Development	B15	Percentage of learners improving their EQF level	medium
High quality of services	B16	no of errors made dealing with an application after a first contact with the SUAP Office	medium
Improvement of Business Models	B17	no of models changed	medium
Improvement of PA service delivery	B18	No lawsuits after case closure	medium
Intensive use of Learn PAd platform	B19	no of feedback created from scratch	medium
	B20	total no of comments on learning objects	medium
	B21	no of comments	medium
	B22	total no of help requests	medium
Short & effective setting-in period	B23	decrease of time spend on similar cases	medium
High quality of services	B24	Single Point of Contact	medium-low

Intensive use of Learn PAd platform	B25	no of total wiki pages navigated per user	medium-low
	B26	no of additional pages	medium-low
	B27	total no of recommendations accepted by the learner	medium-low

Table 1: Operational Goals defined for PA Monti Azzurri

Table 2 lists the learning goals and their KPIs.

Learning goal	KPI-No	**KPI**	**priority**
Acting Responsibly	L1	Acting autonomously on one's own responsibility	high
Familiarity with Learn PAd functionality	L2	global action per user	high
	L3	score per simulation and user	high
Knowledge about all processes a user is involved in	L4	No of processes known	high
	L5	No of correct answers per process	high
	L6	success rate of simulations	high
Knowledge of laws and regulations	L7	percentage of laws & regulations and how they are applied	high
Knowledge of relevant 3rd PA parties	L8	no of errors made inviting PA parties	high
Knowledge of sector specific regularity/irregularity of requests	L9	no of errors made determine irregularities	high
Knowledge of times and modalities	L11	no of errors made in setting time	high
Knowledge of valuable comments	L12	no of valuable comments per user	high
Knowledge of templates and documents	L13	percentage of templates and documents known applied correctly	medium-high
Familiarity with Learn PAd functionality	L14	no of simulations per user	medium
	L15	degree of completeness of simulation per user	medium
	L16	no of help requests per user	medium

	L17	score per user and session	medium
Knowledge of additional pages	L18	no of additional pages per user	medium
Knowledge of the application forms used for requests	L19	percentage of correctly used forms	medium
Knowledge of valuable comments	L20	no of comments per user	medium

Table 2: Learning Goals defined for PA Monti Azzurri

Also within the domain analysis we defined the attributes for modelling the KPIs that are: periodicity, unit, measurement and thresholds. It was also differentiated between KPIs for individuals (which can be aggregated on team level, e.g. for the organisational unit SUAP) and KPIs specific for teams (organisational units). The details of the KPIs and their measurements are listed in Section 4.3.

4. KPIs for Learn PAd

Drawing upon these business requirements we adapted the Knowledge Maturing Scorecard meta model to the Learning Scorecard meta model (aka KPI meta model) and also adapted the already existing dashboard provided by BOC[2] to reflect the specifics of the Learn PAd project.

4.1. Learn PAd Learning Scorecard Meta Model

For the Learn PAd KPI model we base on the Knowledge Maturing Scorecard developed in the MATURE project (Hrgovcic & Wilke 2012). However, to meet the specific requirements of the Learn PAd project we adapted the meta model as follows:

- We added the model element 'Learning Goal'
- We replaced the model element 'Strategic Goal' by a reference from the operational goal to the strategic goal modelled already in the BMM
- We added relations between model elements, namely
  - 'supports': an operational goal may support another operational goal
  - 'contributes to': a learning goal may contribute to another learning goal
  - 'enables': a learning goal may enable an operational goal
- We added new attributes to the KPI model element, namely
  - 'Periodicity', to indicate the time frame in which the measurement shall take place
  - 'Source', to indicate if the value for the KPI comes from the Learn PAd collaboration system, Learn PAd simulation, or is captured from an external system
  - 'Unit', to indicate the measure, for example percentage or number
  - 'Treshold green/yellow', to indicate how the KPI is represented in the dashboard
  - 'Treshold yellow/red', ditto
  - 'What performance is better', to determine if increasing or decreasing performance is better
  - 'Recommendation', to provide suggestions on how performance could be improved.

As for the other meta models we created the respective concepts in the Learn PAd ontology. Figure 4 shows the concepts of the Learn PAd Learning Scorecard Meta Model (aka KPI Meta Model).

[2] https://www.adoxx.org/live/web/learnpad-developer-space/cockpit_v01

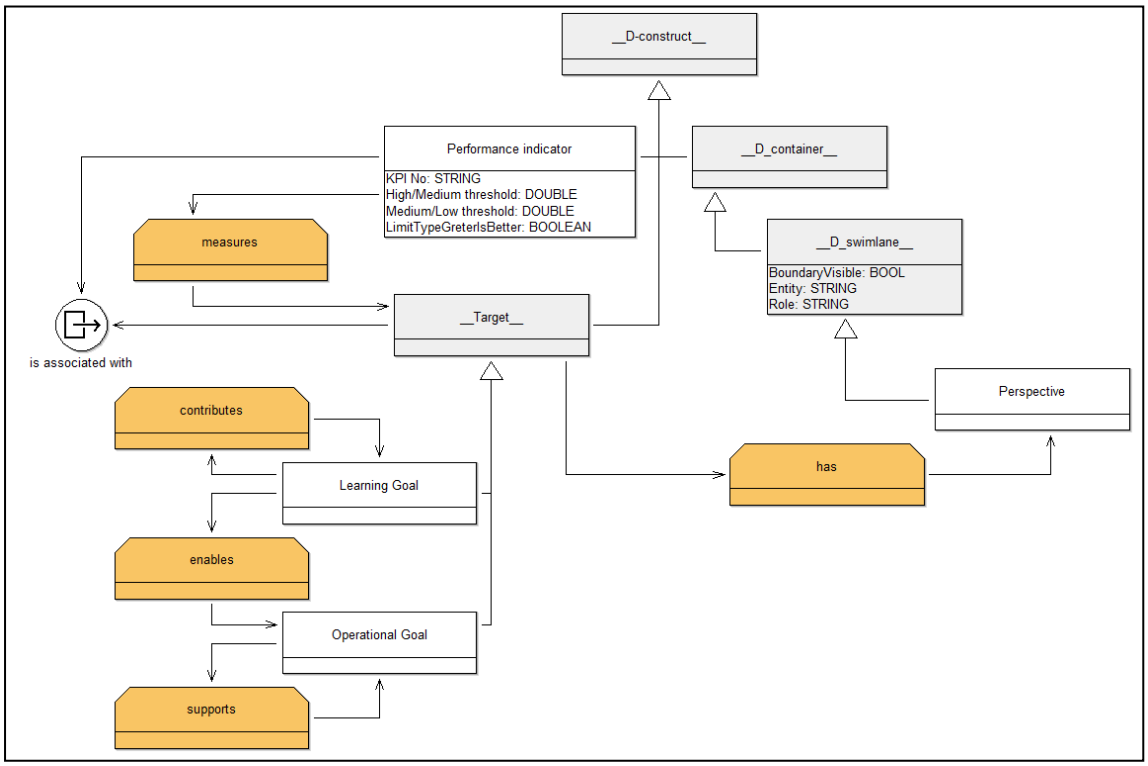

Figure 4: Core Concepts of Learn PAd Learning Scorecard Meta Model

4.1.1. Relations between models in the ontology

The KPI Meta Model has relationships to the Organisational Model and the Business Motivation Model (BMM). Figure 5 shows the relationships of KPI's, learning goals and operational goals to an associated business actor. Depending on the level of assessed KPI's the values will be associated to an individual (person) or an organisational unit.

Also shown in Figure 5 is the relationship to the strategic goal of the Business Motivation Model.

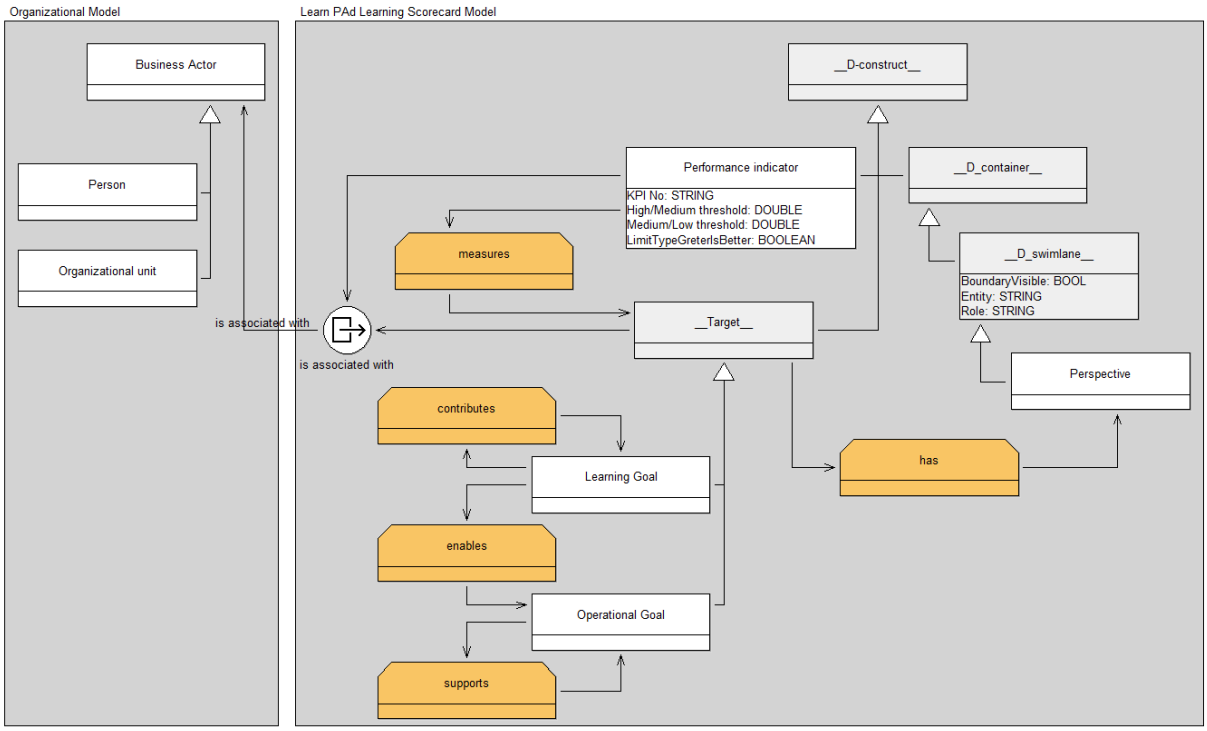

Figure 5: Relations Between Models

4.2. Learn PAd Learning Scorecard Model

Figure 6 depicts the Learning Scorecard Model (i.e. the KPI-Model) for the PA Monti Azzurri. The mode contains the four standard perspectives of a balanced scorecard: client, process, financial and learning organisation. The top-level perspective is chosen according to mission criticality: since the mission of a public administration is to support citizens (clients) - not to make profit - the client perspective is at the top. Goals of a lower perspective may support goals of a higher perspective, i.e. for instance goals from the process perspective may support goals in the client perspective in our example below. Therefore, the rest of perspectives is ordered in a way that reflects chains of cause and effects - where arrows representing them should be pointing upwards.

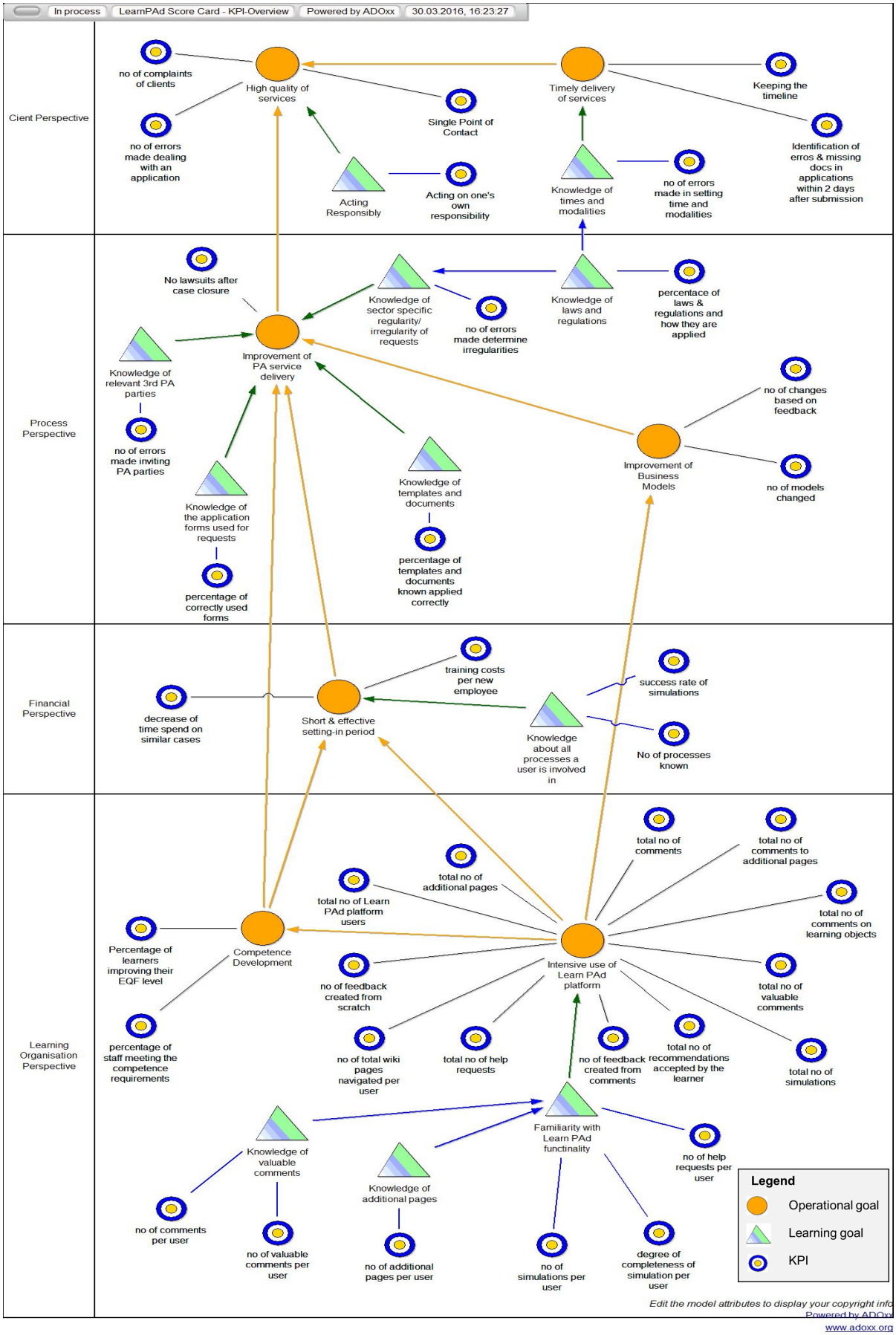

Figure 6: Learning Scorecard (aka KPI Model) for PA Monti Azzurri

Figure 7 and Figure 8 show a print screen of the attributes for the KPI model element 'Acting autonomously on one's own responsible' that measures the learning goal 'Acting Responsibly' which enables the operational goal 'High quality of services'.

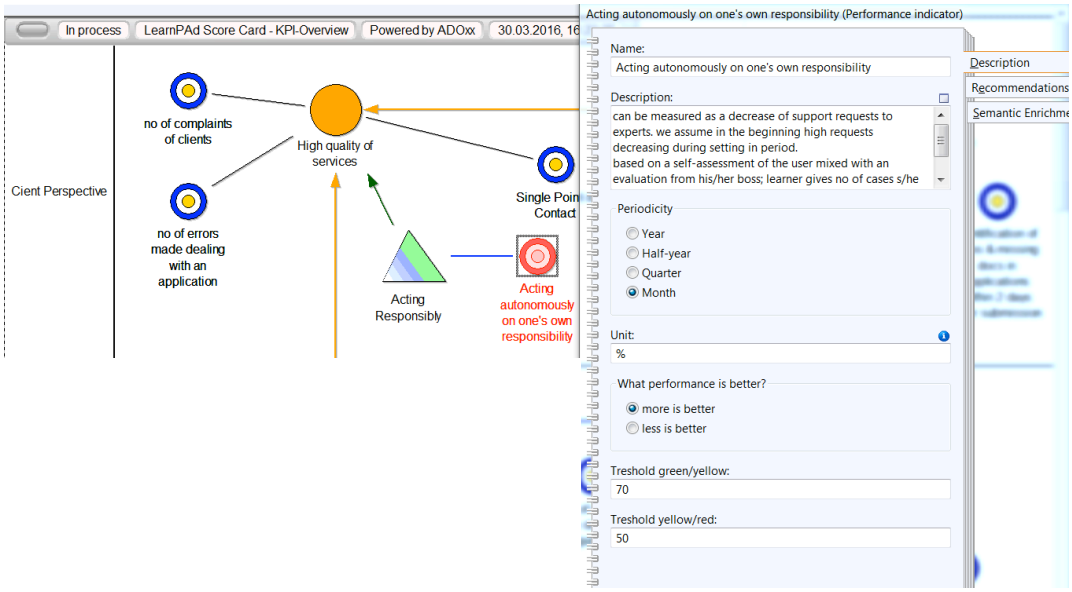

Figure 7: Attributes of the KPI Model Element (part 1)

In Figure 8 the learning recommendation is depicted that will be given to a learner if the threshold is orange or red.

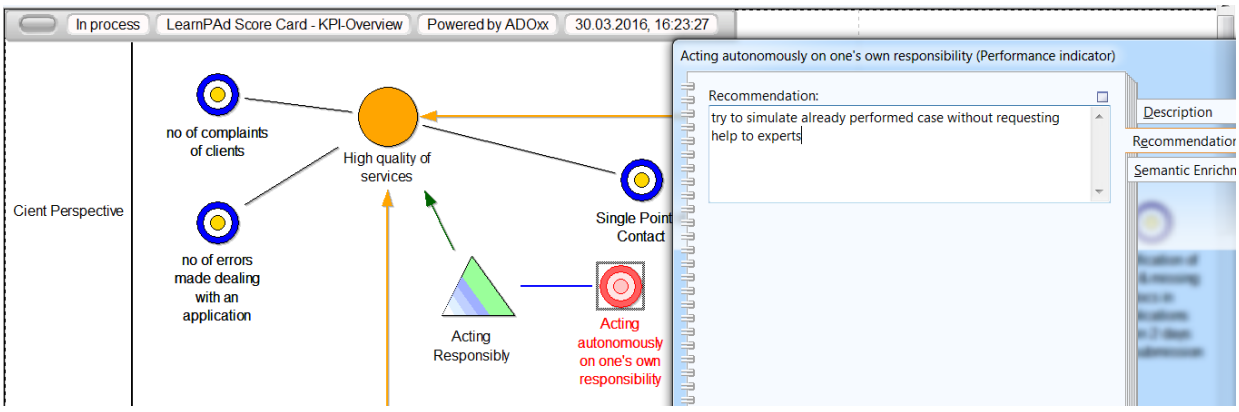

Figure 8: Attributes of the KPI Model Element (part 2)

For the sake of completeness the BMM of Monti Azzurri is shown in Figure 9 as the operational goals of the KPI model have references to the strategic goals modelled in the BMM.

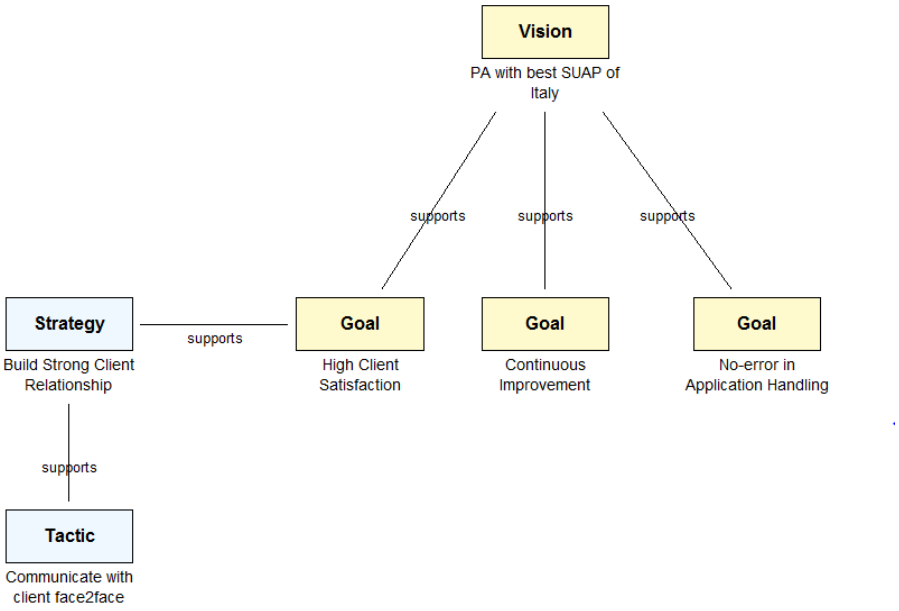

Figure 9: BMM of Monti Azzurri

4.3. Measurement of KPIs

For the Learn PAd prototype we focussed on KPIs with priority high and medium-high. Find below an excerpt of the definitions. Measurement of KPIs was determined in a workshop with representatives of Marche Region.

In the tables below the third column contains information about how KPIs could be measured. There are three broad categories of measurement that we rely on:

- **Evaluation of Learn PAd logs:** many KPIs refer to the way the Learn Pad system is used. In particular, these KPIs assess on the one hand whether learners extend and contribute their knowledge by using the browsing and knowledge sharing functionalities of the collaborative workspace. On the other hand, some KPIs assess to what degree learners reach learning goals in simulations (e.g. KPI L3, see Section 2.2 of Deliverable D6.2). The corresponding information can be easily derived from the logs of the Learn PAd platform (collaborative workspace and simulation environment, see Section 3 of Deliverable D6.2).
- **Questionnaires:** to assess achievement of learning goals, learners can test their knowledge by using the automatically generated questionnaires (e.g. for KPIs L4 and L5) as described in Section 5. The results of taking questionnaires are stored and accessible for KPI calculation.
- **Self-assessment:** for several KPIs, relevant information resides outside of the reach of the Learn PAd system (e.g. the customer questionnaire in KPI B1, see the first row of the table below). In many cases, the information might not be readily available in electronic form at all, e.g. because it partially depends on subjective assessment of a human (see e.g. KPI L1). In such cases, we assume that learners will discuss the assessment of the KPI e.g. as part of regular performance reviews and that the value will then be stored in some place where the Learn PAd dashboard can access it (e.g. a spreadsheet).

KPI No	KPI	how to measure (examples)	green	orange	red	unit	period
B1	no of complaints of clients about an employee (learner)	questionnaire of customer satisfaction about an employee (learner)	<=20%	> 20% <=40%	>40%	%	30 days
B4	total no of valuable comments	total no of valuable comments of members of OU related to all comments provided by members of OU	>=70%	>=50% <70%	< 50%	%	30 days
B6	identification of erros & missing docs in applications before learning compared to after learning	self-assessment: it stated the reduction of time that is achieved in handling a case after learning	>=20%	<20 %	0	%	30 days
B7	Keeping the timeline	self-assessment: give the percentage of cases a learner couldn't be handle in time	>80%	<=80% -60%	<60%	%	30 days
B8	no of feedbacks to improve the models (not considered detections of errors)	if feedback concerns an error it is not counted; only feedback recommending changes/improvements are to be considered	>= 4	<4 >0	0	#	1 year
B28	no of changes of models based on feedback	model changes based on feedback	>1	1	0	#	
B9	no of feedback created from comments	when a feedback is created it should be stated whether it is based on a comment	>=10%	<10% - 0	0	%	1 year
B10	total no of Learn PAd platform users	no of registered users related to users using Learn PAd platform	>=75 %	<75% - >=50%	< 50	%	30 days
B11	total no of simulations	no of simulations performed entirely (from start to end) related to the no of simulations started but abandoned	>=75%	<75% - >=50%	< 50	%	30 days

Table 3: KPIs for Operational Goals with Priority High and Medium-high

The following table depicts the KPIs for learning goals and their attributes.

KPI-No	KPI	how to measure (examples)	green	orange	red	unit	period
L1	Acting autonomously on one's own responsibility	based on a self-assessment of the user mixed with an evaluation from his/her boss; learner gives no of cases s/he performed and no of cases in which s/he requested help	>=70%	>=50% <70%	< 50%	%	30 days
L2	global action per user	number of "interactions" with Learn PAd platform in 30 days (i.e. no of comments + no of additional pages + no of pages **navigated**)	>=12	>=5 <12	<5	#	3 months
L3	score per simulation and user as defined in D6.2	absolute session score	>=70%	>=50% < 70%	<50%	%	3 months
		relative_bp_score / absolute_ bp_score	>=70%	>=50% < 70%	<50%		
		relative_global_score / absolute_ global_score	>=70%	>=50% < 70%	<50%		
		bp_coverage	>=70%	>=50% <70%	< 50%		
L4	No of processes known	self-assessment: no of procceses a learner knows related to the total no of processes a learner is involved in (e.g. a learner is involved in 5 processes and knows 3)	>=70%	>=50% <70%	< 50%	%	30 days
L5	No of correct answers per process	no of questions the learner answers correctly with respect to the total number of questions related to a process	>=70%	>=50% <70%	< 50%	%	30 days
L6	success rate of simulations	number of successfully performed simulations related to the total no of performed simulations	>=70%	>=50% <70%	< 50%	%	30 days
L7	percentace of laws & regulations and how they are applied	for a certain process/task all relevant laws and guidelines are to be identified	>=70%	>=50% <70%	< 50%	%	30 days

L8	no of errors made inviting PA parties	for an application/case all involved parties should be identified	>=70%	>=50% <70%	< 50%	%	30 days
L9	no of errors made determine irregularities	in one application all errors should be identified	>=70%	>=50% <70%	< 50%	%	30 days
L11	no of errors made in setting time	in a task the right deadlines are to be set	>=70%	>=50% <70%	< 50%	%	30 days
L12	no of valuable comments per user	Valuable can mean that: it has a big number of replies AND it is stated by a teacher/expert in charge OR the no of comments on which feedback/patch is based	>= 1	>=1 comments without rating	0	#	30 days
L13	percentage of templates and documents known applied correctly	for a certain process (e.g. SCIA) and for a certain case an entrepreneur must use a particular form and has to provide specific documents	>=70%	>=50% <70%	< 50%	%	30 days

Table 4: KPIs for Learning Goals with Priority High and Medium-high

Details of the KPI calculations are defined in Section 6.3.

4.4. KPI Dashboard

The calculated KPI's of individual (learners) as well as the figures on organisational levels are shown in a dashboard.

In Figure 10 an example of the learner's individual dashboard with calculated KPI scores is shown. The user can drill down from the aggregated levels like the perspectives to the leaves, the KPI's.

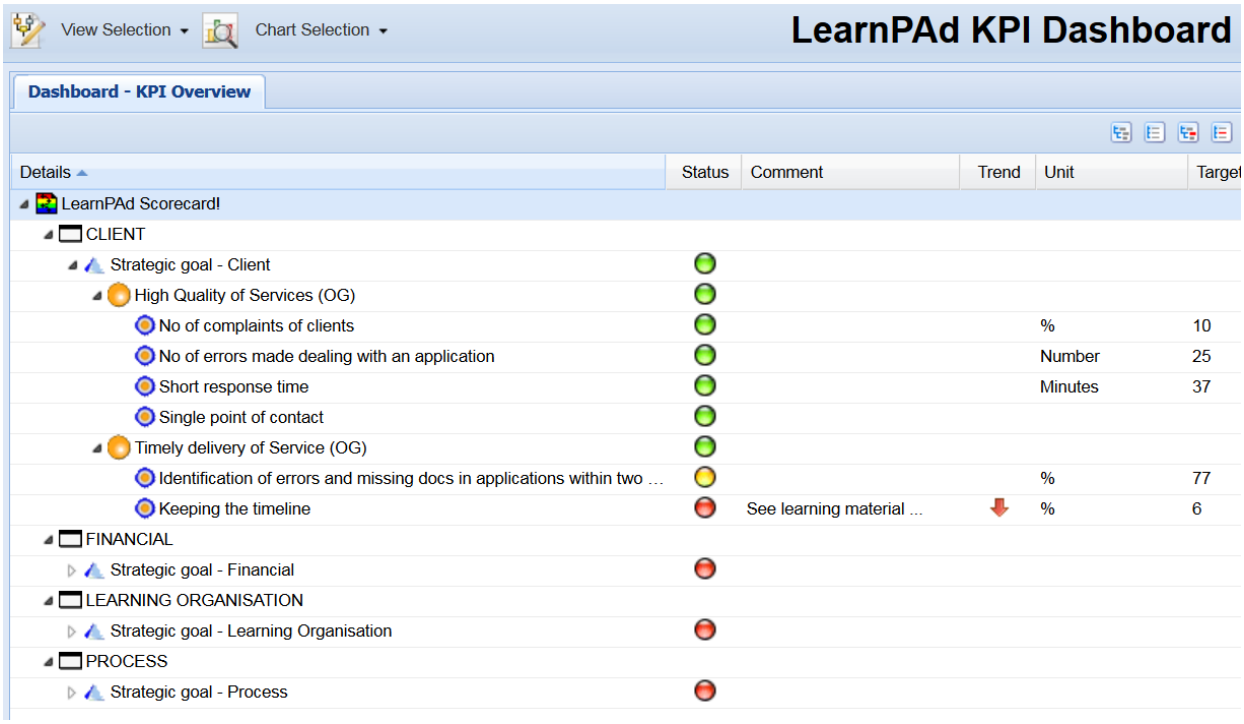

Figure 10: Learners Individual Dashboard Example

5. Assessment through Questionnaires

5.1. Questionnaires Generation

The methodology we adopt for the generation of the questionnaires is inspired by early work in (Bertolino et al. 2011), later refined in (Autili et al. 2016). In these cited works, the approach aimed at facilitating the mutual comprehension between the modelling experts and domain experts during the model validation phase. Here, we use the same approach with a different aim: the target of the validation in Learn PAd is the learner's knowledge with respect to the Learn PAd models.

Model-driven engineering (MDE) approaches allow for automated models transformation as well as formal logic representation of the input model and the application of inference rules to check for the satisfiability of desired properties. Applying MDE techniques it is thus possible to automatically derive from the Learn PAd models a set of customizable questionnaires expressed in natural language as well as the associated correct answers. Using these questionnaires and the associated correct answers, it is possible to interview the learners and assess their acquired competence and skill with respect to the learning concepts expressed in the models.

Precisely, starting from a domain model we automatically generate a configurable list of simple questions expressed in natural language, spanning over all the model elements. The questions just require a Yes/No answer and also consider the case in which the learner is not able to answer. The idea is to automatically generate for each element of the model and interaction between model elements, a set of questions able to assess the learner knowledge about them. Moreover, for each generated question it is possible to derive the corresponding correct answer, by applying semantics inference on the model. The derived answer can be compared with the learner's answer to assess the learner knowledge about the modelled learning concepts.

The questions generated fall into three categories: a Deduction is inferred from true predicates on the input domain model, a Distractor from false predicates, a Hypothesis from predicates obtained through the domain ontology.

The main components of the tool performing questionnaires generation are:

i) *KnowledgeBaseGenerator* converts the input domain model into the internal representation, describing the domain entities and their relations as facts;

ii) *InferenceEngine* loads such facts and the set of rules representing the semantics of the input modelling language;

iii) *QuestionnaireGenerator* loads the configurations (expressed in term of patterns and criteria) that drive the queries to the *InferenceEngine* and drives the creation of the questionnaires;

iv) *NLAnalyzer* aids the creation of NL questions by querying a domain ontology. It can either enrich and refine the text of a question, or try to infer entities and relationships that are not in the input model.

v) To reduce the number of questions, or even to focus only on specific areas of the domain model, a configurable *Filters* component can be used. A filtering policy can be a sub-part selection of the input domain model, a random selection of questions, a word-based selection of questions or model elements, or a combination of them (other filtering can be devised); finally,

vi) *EmittersContainer* component deals with the output format of the questionnaire.

5.2. Questionnarie-based KPI Assessment

Multiple-choice questionnaires are used for the assessment of several learning and operational goals and the associated KPI as defined in Section 3.1.

Specifically, referring to the operational goal “Competence Development” and the associated KPI B15 – *Percentage of learners improving their EQF level* – of Table 1, the cardinality of learners who are able to provide a correct answer to a high number of questions represents a measure of learners able to improve their EQF level. Referring to the learning goal “Knowledge about all processes a user is involved in” of Table 2, questionnaires can be used to measure the KPI L5 - *No of correct answers per process*. By using such questionnaires we intend to assess which processes the learner knows. In particular, we consider that the learner knows a specific learning process in which he/she is involved if the percentage of correct answers to the questions related to that process is higher than a given threshold.

6. Technical Architecture and Implementation

The technical architecture describes the implementation of the Learn PAd Scorecard and the dashboard and their integration in the Learn PAd system.

Figure 11 depicts the process from modelling the KPI's to the final dashboard with the graphical representation of the assessed and calculated figures.

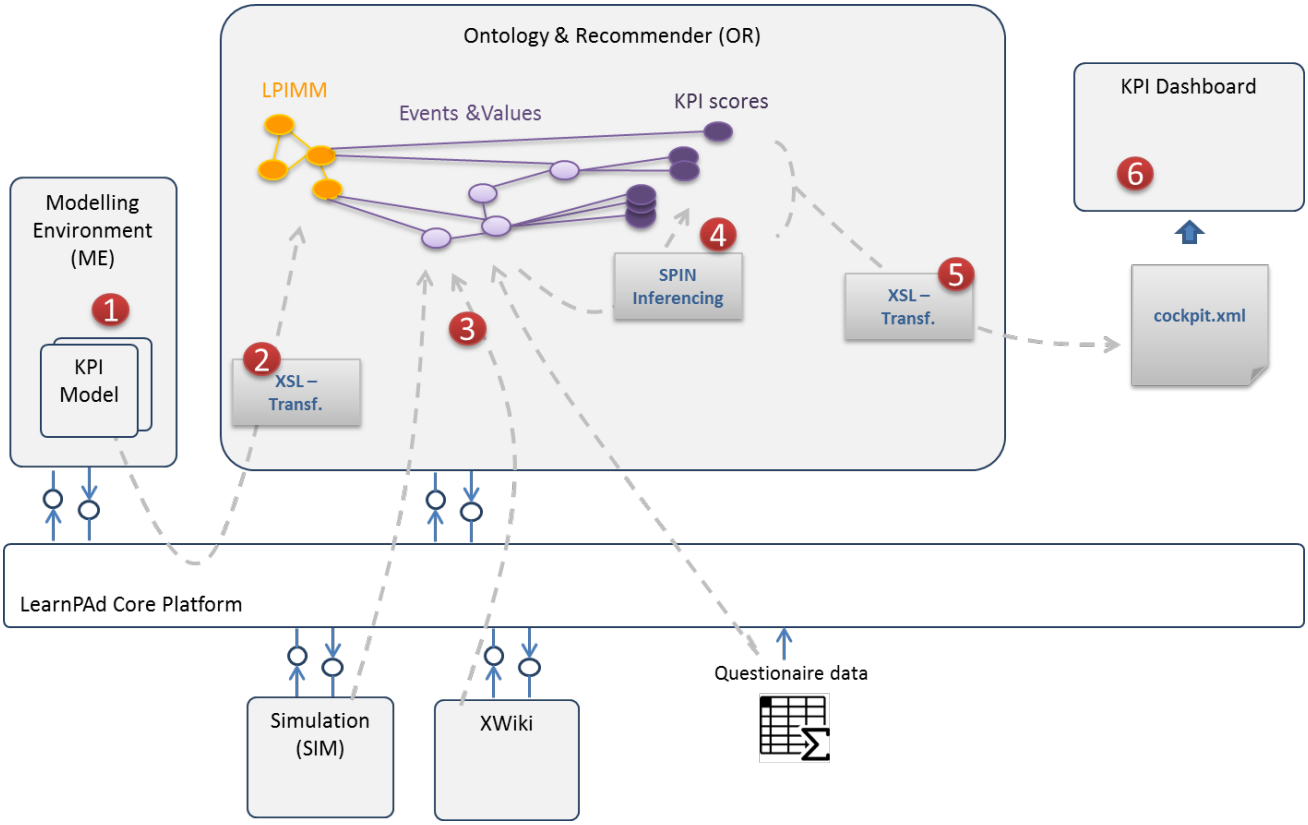

Figure 11: KPI Workflow

1. The process to assess KPI's starts with modelling the KPI's in the modelling environment.
2. The KPI models will be transformed with XSLT into instances of the platform independent KPI model (specific model of LPIMM).
3. In this step KPI relevant data and events from different sources will be collected continuously during the usage of the systems by learners.
4. With inferencing rules (SPIN rules) the score for the individual and the aggregated KPI's are calculated
5. With XSLT the ontology with inferred KPI's values is transformed into the target format required by the dashboard component.
6. KPI's can be shown for individuals (learners) and on a aggregated levels like the organisational units or the company

The details covering this workflow are described in the following sections.

6.1. Sources for KPI relevant data

The main data providers for the KPI calculations are the Learn PAd components *XWiki* and *Simulation* (for simulation KPIs, see also Deliverable D6.3 (Learn PAd Project Team, 2016)). Data from forms or evaluations outside the system will be integrated via data files based on Excel or CSV. An adapter for such external data reads and creates instances of the concrete KPI model classes as shown in Figure 12. This asserted data serve as a base for the KPI score (traffic light mapping) calculations.

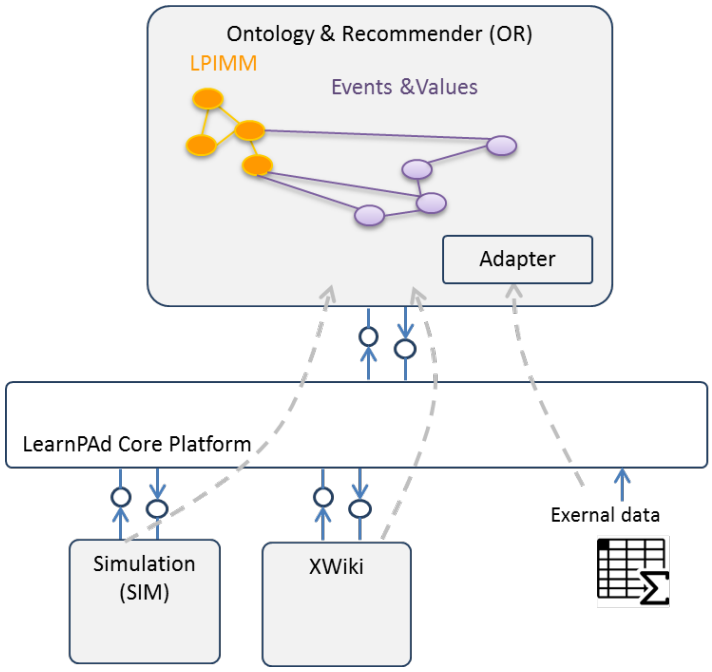

Figure 12: KPI Values Provider Integration

Runtime data

Some KPI's relay on data gathered during runtime from the components of the Learn PAd platform. These data respectively events are stored in the ontology base as well.

The following list of data to be collected was derived from the list of defined individual and operational KPI's and will be considered in the prototype implementation.

Data for individual KPI's:

- Learn PAd collaboration platform (global action per user (comments, additional pages + pages visited), no of valuable comments per user.
- For simulation (session start/end, score, laws and regulations identification rate, no of errors made inviting PA parties, no of errors made determine irregularities

Data for operational KPI's:

- no of complaints of clients about an employee
- percentage of cases a learner couldn't be handle in time
- no of simulations performed entirely
- no of comments created by a user

6.2. Ontological extensions for KPI related entities and values

The transformation from models of the modelling environment to LPIMM instances in the ontology was extended to support new the KPI related model elements. Figure 13 shows examples of transformed KPI's as instances (model layer M1).

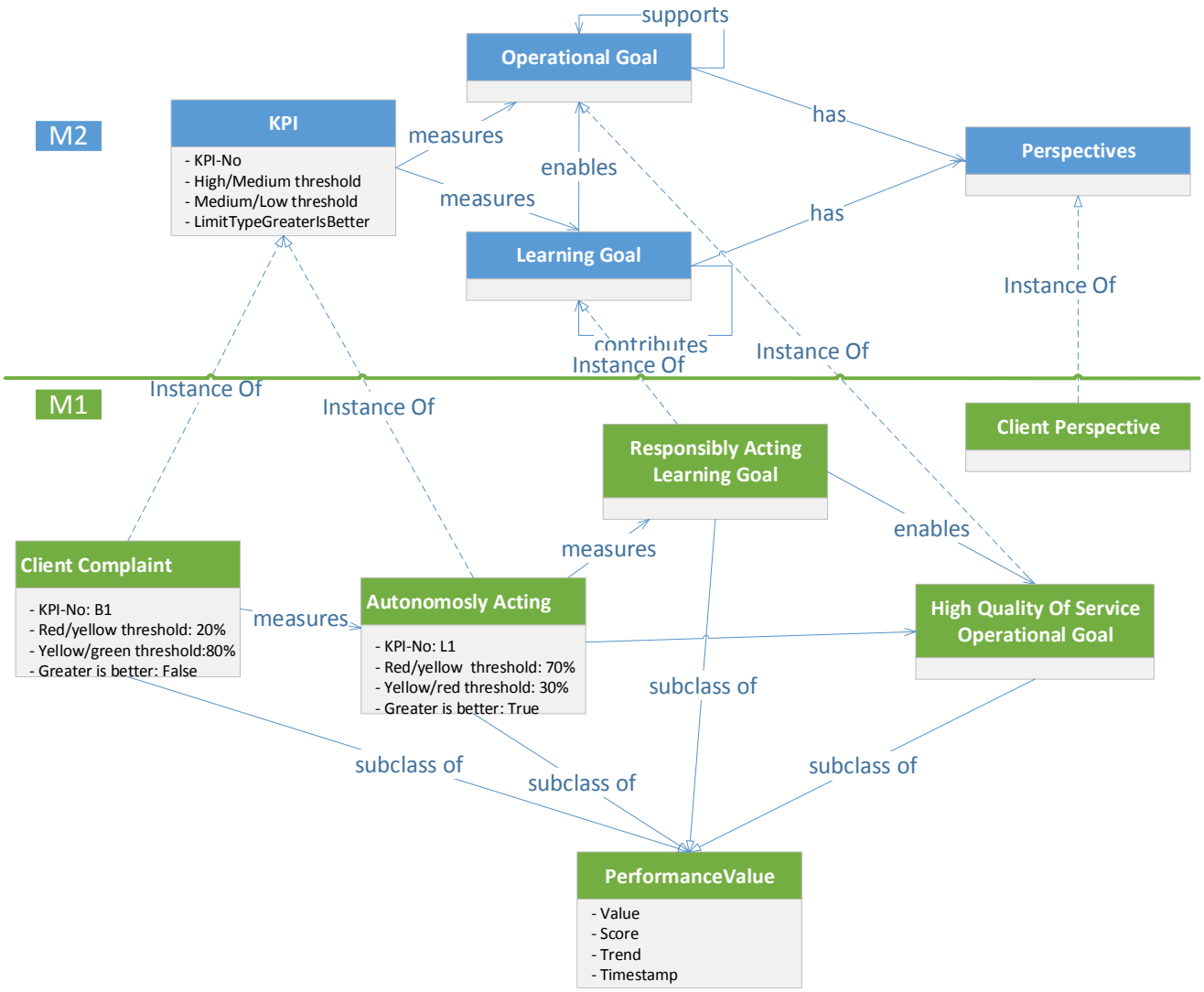

Figure 13: Instances of the KPI Meta Model (LPIMM)

The KPI relevant data collected from different sources is also stored in the ontology base. Therefore the KPI model instances are again modelled as instances and classes at the same time. This allows adding collected data as instances of KPI instances. For this multilevel approach we follow again (Fanesi 2015) and (Fanesi et al. 2015).

Figure 14 shows examples of asserted KPI values (model layer M0).

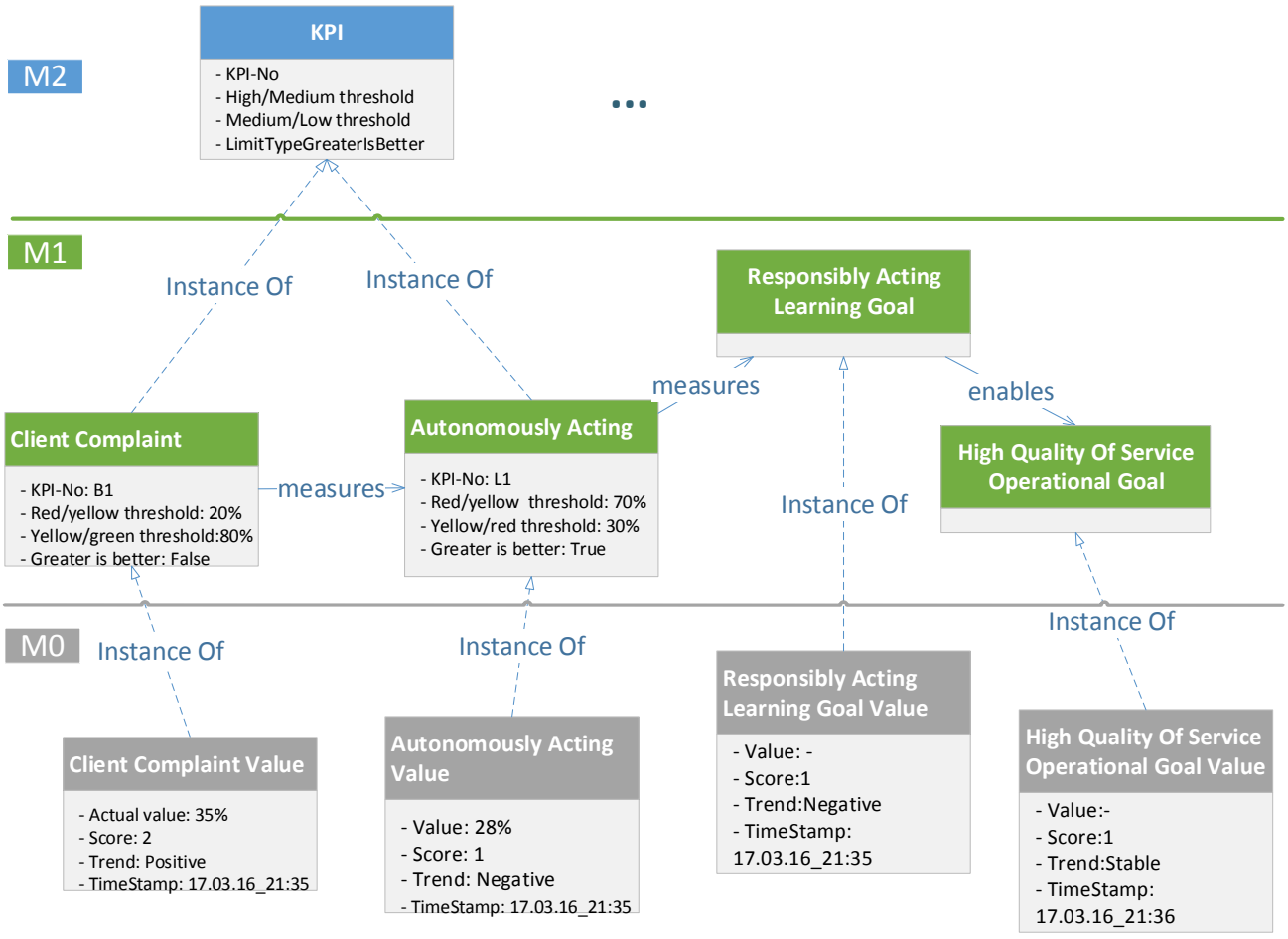

Figure 14: KPI Data Values as Instances of KPI Classes Instances

6.3. Calculation of KPIs

The KPIs and aggregated goal property's for the dashboard are stored in the ontology. Therefore the class *PerformanceValue* as depicted in Figure 13 has been introduced. Formal rules based on SPIN[3] calculate KPI's based on the definitions from the KPI models

[3] http://spinrdf.org/

and aggregated scores for a higher level. The details are specified in Section 6.3.1. The calculated respectively inferred values are asserted as instances on level *M0* as depicted in Figure 14.

6.3.1. Calculation rules

Several rules are applied to calculate and assert the KPI performance value instances with the property's *value, score, trend, timestamp and assigned business actor*. The rules are executed iterative (depending on their level) and incremental (run as long some new instances can be inferred).

Level #1 Rules

As a first step, these rules calculate a KPI value based on the collected data from platform activities like the simulation activities or platform usage (comments, pages added etc.). Selected examples with the formal rules to calculate the value are depicted in Table 5.

Table 5: Formal KPI Value Calculation Rules

KPI:	Goal type:	Rule:

Global action per user on platform	Learning goal	CONSTRUCT {
		?valueInstance a ?this .
		?valueInstance nco:performanceValueHasActualValue ?totalCount .
		}
		WHERE {
		{
		SELECT ?user ((SUM(?count)) AS ?totalCount)
		WHERE {
		{
		{
		SELECT ?user ((COUNT(?comment)) AS ?count)
		WHERE {
		?comment a xwiki:Comment .
		?comment xwiki:commentAddedByUser ?user .
		}
		GROUP BY ?user
		} .
		}
		UNION
		{
		{
		SELECT ?user ((COUNT(?pageCreated)) AS ?count)
		WHERE {
		?pageCreated a xwiki:Page .
		?pageCreated xwiki:pageHasCreator ?user .
		}
		GROUP BY ?user
		} .
		}
		UNION
		{
		{
		SELECT ?user ((COUNT(?pageVisited)) AS ?count)
		WHERE {
		?pageVisited a xwiki:PageVisit .
		?pageVisited xwiki:pageVisitedByUser ?user .
		}

		GROUP BY ?user } . } . } GROUP BY ?user } . BIND (spif:buildUniqueURI() AS ?valueInstance) . }

Score per simulation and user	Learning goal	CONSTRUCT {
		?valueInstance a ?this .
		?valueInstance nco:performanceValueHasActualValue ?bestSimulationScore .
		}
		WHERE {
		{
		SELECT ?user ((MAX(?simulationScore)) AS ? bestSimulationScore)
		WHERE {
		?simulation a D54_Design:Simulation .
		?simulation D54_Design:simulationWasPerformedByUser ?user .
		?simulation D54_Design:simulationScore ?simScore .
		}
		GROUP BY ?user
		} .
		BIND (spif:buildUniqueURI() AS ?valueInstance) .
		}

Success rate of simulations	Learning goal	CONSTRUCT {
		?valueInstance a ?this .
		?valueInstance nco:performanceValueHasActualValue ?bestSimulationSuccessRate .
		}
		WHERE {
		{
		SELECT ?user ((MAX(?simulationSuccessRate)) AS ? bestSimulationSuccessRate)
		WHERE {
		?simulation a D54_Design:Simulation .
		?simulation D54_Design:simulationWasPerformedByUser ?user .
		?simulation D54_Design:simulationSuccessRate ?simulationSuccessRate.
		}
		GROUP BY ?user
		} .
		BIND(spif:buildUniqueURI() AS ?valueInstance) .
		}

Total no of simulations	Operational goal	CONSTRUCT {
		?valueInstance a ?this .
		?valueInstance nco:performanceValueHasActualValue ?totalNumberOfSimulations .
		}
		WHERE {
		{
		SELECT ?user ((COUNT(?simulation)) AS ? totalNumberOfSimulations)
		WHERE {
		?simulation a D54_Design:Simulation .
		?simulation D54_Design:simulationWasPerformedByUser ?user .
		}
		GROUP BY ?user
		} .
		BIND(spif:buildUniqueURI() AS ?valueInstance) .
		}

No of comments	Operational goal	CONSTRUCT {
		?valueInstance a ?this .
		?valueInstance nco:performanceValueHasActualValue ?totalNumberOfComments.
		}
		WHERE {
		{
		SELECT ?user ((COUNT(?comment)) AS ?totalNumberOfComments)
		WHERE {
		?comment a xwiki:Comment .

		?comment xwiki:commentAddedByUser ?user . } GROUP BY ?user } . BIND(spif:buildUniqueURI() AS ?valueInstance) . }

The values from the Excel based assessments provide directly a KPI value and do not have to be calculated.

Level #2 Rules

For each KPI a rule calculates the score that represents a traffic light in the dashboard (1=red, 2=yellow, 3=green). The rule considers the thresholds defined in the modelled KPI's. and is a generic rule applied for all KPI performance value instance:

```
CONSTRUCT {
   ?kpiValue nco:performanceValueHasScore ?sore .
}
WHERE {
   {
      SELECT ?kpiValue ?actualValue ?score
      WHERE {
         ?kpi (rdfs:subClassOf)* kpi:KPI .
         ?kpiValue a ?kpi .
         ?kpiValue nco:performanceValueHasActualValue ?actualValue .
         ?kpi kpi:highMediumThreshold ?highMediumThreshold .
         ?kpi kpi:mediumLowThreshold ?mediumLowThreshold .
         ?kpiValue kpi:KPIhasLimitTypeGreaterIsBetter ?greaterIsBetter .
         BIND (IF(?greaterIsBetter, IF((?actualValue >= ?highMediumThreshold), 3, IF((?actualValue
>= ?mediumLowThreshold), 2, 1)), IF((?actualValue <= ?mediumLowThreshold), 3, IF((?actualValue
<= ?highMediumThreshold), 2, 1))) AS ?score) .
      }
   } .

}
```

Level #3 Rules

This rule infers the performance properties on a higher aggregation level, like goals and perspectives. The minimum function is applied, means if at least one KPI is red, then the higher aggregation level goes also on red. The following rule shows the selection of the minimum score:

```
CONSTRUCT {
   ?valueInstance a ?this .
   ?valueInstance nco:performanceValueHasScore ?minScore .
}
WHERE {
   {
      SELECT ?businessActor ((MIN(?score)) AS ?minScore)
      WHERE {
         ?kpiElement (rdfs:subClassOf)* kpi:KPI .
         ?kpiElementValue a kpi:KPI .
         ?kpiElementValue nco:performanceValueHasScore ?score .
      }
      GROUP BY ?businessActor
   } .
   BIND (spif:buildUniqueURI() AS ?valueInstance) .
}
```

All the inferred values will finally be exported to dashboard files, one for individual user on the platform and one for each organisational unit.

6.4. Learning Recommendations in the Wiki

The relationship between learning goals, learning material and calculated KPI performance scores for individuals enables new recommendations to be provided. On the one hand, this includes recommendations for individual learners, suggesting learning material or activities to improve a bad performance score (red traffic light) of a KPI. An example of such a recommendation is shown in Figure 15.

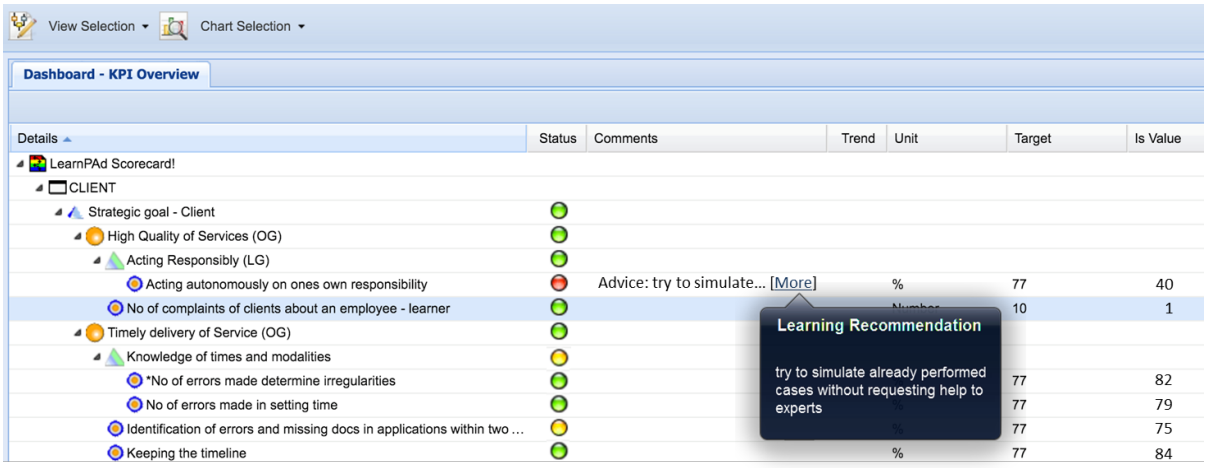

Figure 15: Example of a Learning Recommendation

On the other hand, recommendations can also be made for entire organisational units like the SUAP office or the whole public administrations. They may refer to organisational activities recommended for improving a bad KPI value.

In both cases, the advice that is given in the dashboard is modelled in advance (when designing the goals and KPIs), see Figure 8, i.e. a simple rule will fetch and display the advice when the KPI value is off-target.

6.5. Integration in Learn PAd system (APIs)

The REST API with methods exposed to the core platform is extended to receive events and data relevant for the KPI calculations. The Table 6 lists these interfaces to support the selected KPI's. Some interfaces were already implemented in earlier deliverables and the data has just to be stored in the ontology base.

Table 6: Learn PAd System Interfaces for KPI Data

KPI served:	Interface method:	Comments:
Global action per user on platform	***resourceNotification****(String modelSetId, String resourceId, ResourceType resourceType, String referringToResourceId, String[] modelArtifactIds, String userId, Long timestamp, ActionType actionType)*	*resourceType = [PAGE | COMMENT | ATTACHEMENT | FEEDBACK]* *resourceId = the id of the resource (ex. the page id or the comment id)* *referringToResourceId = the resource id this resource is reffering to (ex. the page id a comment is referring to) (optional)* *modelArtifactIds=[list of model object id's linked to the resource (ex. the page)] (optional)* Logs all actions ("visited", "added", "modified", "deleted") related to a resource (ex. a XWiki page, a comment etc.) The "Visit" action is expected for pages the user has navigated to.
Score per simulation and user Success rate of simulations Total no of simulations	***simulationInstanceNotification*** *(String modelSetId, String modelId, SimulationActionType action, String simulationId, SimulationData data)*	Same method as delivered with D5.3 but with session score provided at the end of a simulation (*action="SIMULATION_END", score=[long value]*)
No of comments	***resourceNotification****(String modelSetId, ...*	Counts comments logged in the ontology with the same method as the KPI "Global action per user on platform"

All other KPI values are imported via an Excel -adapter reading and storing the values in the ontology for individuals as well as for organisational units.

The XWiki Meta Model ontology modifications and extension to collect and store the user activities data are depicted in Figure 16.

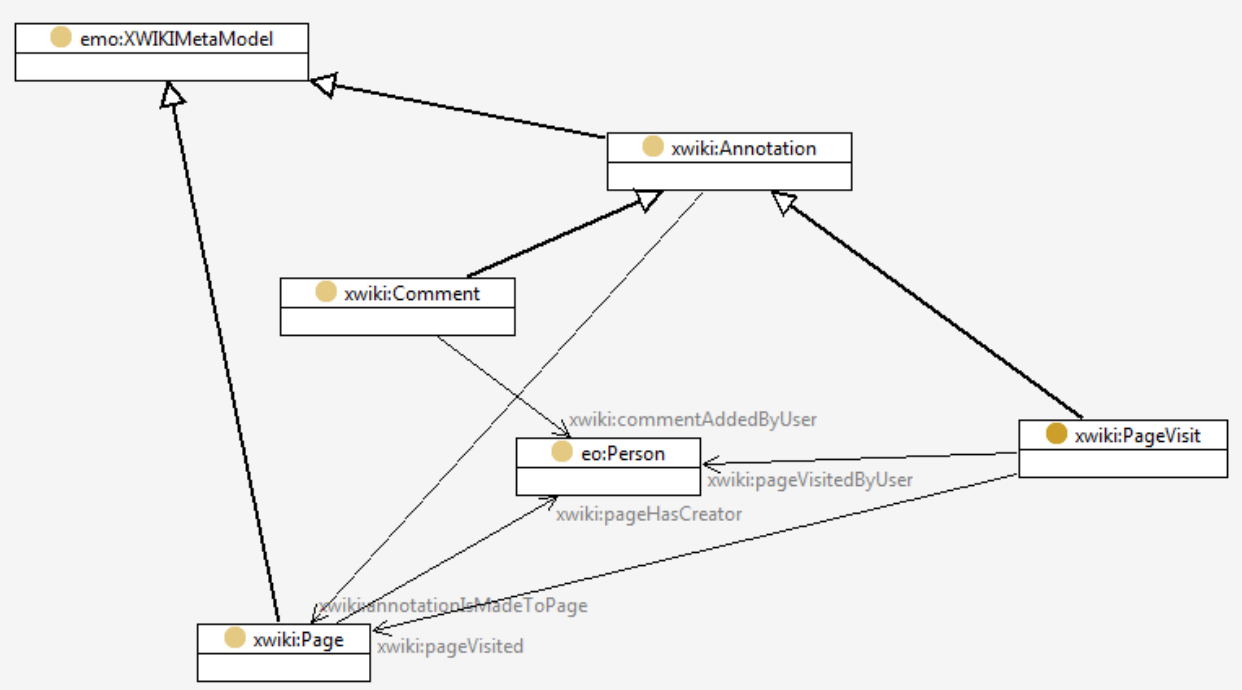

Figure 16: XWiki Model Extension for KPI Relevant Data

For the simulation data a subclass *Simulation* of the *Application* class as depicted in Figure 17 was created. When a new simulation starts, an instance of the class is created using the provided simulation session id to create a unique URI. At the end of a simulation session the score and the indication of a successful simulation are asserted to the instance.

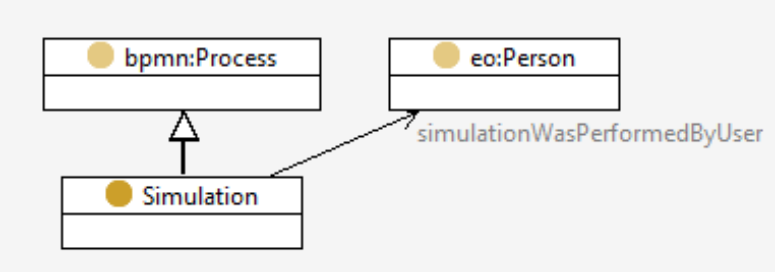

Figure 17: Process Model Ontology Extension for Simulation Data

6.6. Description of Questionnaire-based Assessment Procedure

The questionnaire manager component supports the generation of questionnaires from Learn PAd models; also it provides the functionality for the Learn PAd platform to retrieve and publish a questionnaire.

The current implementation of questionnaires generation takes as input three types of models: UML Activity Diagram, UML Class Diagram and UML Use Case Diagram. For this we rely on model-to-model transformation to translate Learn PAd models into activity diagrams, class diagrams and use case diagrams. Currently, this model-to-model transformation is not fully integrated in the Learn PAd platform.

Starting from UML Activity Diagram, UML Class Diagram and UML Use Case Diagram models, the questionnaire manager generates a set of questionnaires, each one containing a variable number of NL questions.

Moreover, by applying *semantics inference* on the domain model, the correct answer for each question that can be Yes, or No, is derived.

Finally, it is possible to tune the questionnaires on specific portions of the model and regulate the number of derived questions.

By using such questions it is possible to interview the learner and validate his/her domain knowledge, identifying some lacks in his/her knowledge about the Learn PAd models, if the actual answer differs from the expected one. In this sense, the aim is to exploit the information in the Learn PAd models to gather insights on the learner's competences and skills and identify which are the processes the learner needs to study more.

More precisely, for each question, the learner is provided with a multiple-choice-answer based on four possible, and exclusive, items: (1) Yes, (2) No, (3) "I'm not an expert of this specific subject" (NE), and (4) "I'm an expert of the subject but I'm not sure what to answer" (in brief, DK for don't know).

These learner's answers can be collected and used with different purposes: i) Answers Y and N constitute the basic choices and can be used to assess if the learner knows the concepts expressed in the model; ii) Option (3) has been introduced because, especially for large models, the learner could not be knowledgeable of all features. This kind of answer could reveal potential flaws into a PA organization, such as for instance SUAP, when most of people involved into such organization declare to be not expert on the topics and processes of that organization; iii) finally, option (4) is quite useful for dealing with questions whose formulation can be confusing and has been introduced to provide a self-assessment of the questionnaires generation tool. For any question on which the learner declares him (her) self as an expert and not able to express an opinion at the same time, it is likely that the generated question is not able to express the concepts expressed by the model elements that originated the question. The tool might have in fact generated a confusing question

In the following sections we present the questionnaires generated from the Learn PAd models of SUAP demonstrator.

6.6.1. Questionnaires generation from Business Process model

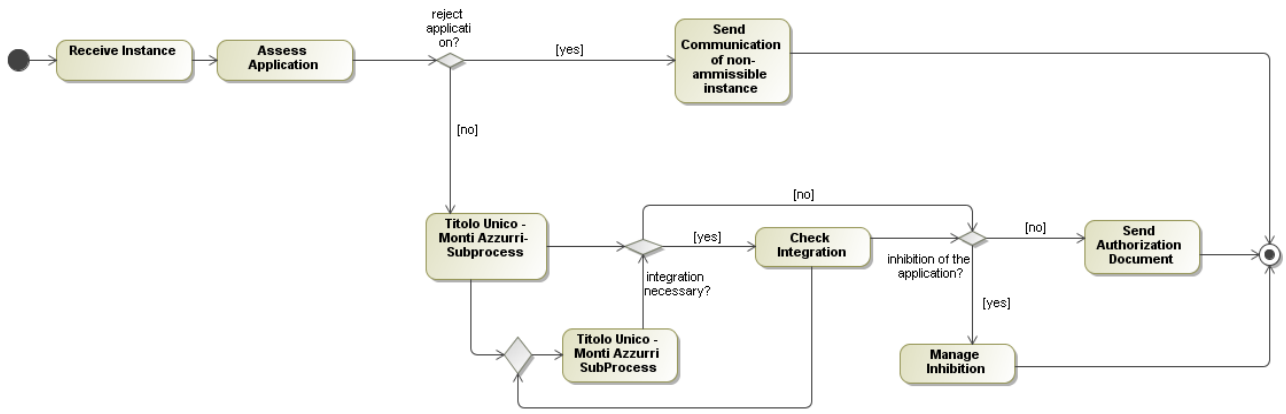

Figure 18: SUAP Titolo Unico Model

The questionnaires generated from the Business Process model aim mainly to assess the learner's knowledge about the different activities of the business process, their execution order and the actions involved in the execution of the process and its sub-processes.

The model of Figure 18 is the activity diagram derived from the Business Process model of SUAP Titolo Unico (see D8.3)[4]. It shows the activities that the SUAP office has to put in place in order to permit entrepreneurs to set up new companies or generally to organize business activities. Starting from this model, the questionnaire manager generated 14 questionnaires, each one containing a variable number of NL questions, for an overall amount of 1200 questions. The objective of these questionnaires is to assess the learner's knowledge about the different activities of the SUAP office and the relations existing among them.

The questionnaires generated from the model of Figure 18 can be divided into 3 main groups as in the following:

Group1: These questionnaires aim to assess the learner knowledge about the correct execution order of the activities of SUAP office. Examples of questions included in these questionnaires are:

*Is **Send Communication of non-ammissible instance** always the next action to be executed after the action **Assess Application**?*

oYes oNo oNot expert o Expert, but not sure what to answer

*Is the action **Manage Inhibition** always executed after the action **Titolo Unico - Monti Azzurri SubProcess**?*

oYes oNo oNot expert o Expert, but not sure what to answer

*Could the action **Receive Instance** be executed before the action **Send Communication of non-ammissible instance**?*

oYes oNo oNot expert o Expert, but not sure what to answer

*Is **Titolo Unico -Monti Azzurri-Subprocess** always the previous action executed before the action **Check Integration**?*

oYes oNo oNot expert o Expert, but not sure what to answer

*Could **Receive Instance** be the previous action executed before the action **Send Authorization Document**?*

oYes oNo oNot expert o Expert, but not sure what to answer

*Can **Send Authorization Document** be the next action to be executed after the action **Receive Instance**?*

[4] available at https://www.adoxx.org/live/documents/180103/441008/TitoloUnicoModelSet.adl/e31a7f40-41e0-47f2-a87c-103e79777309

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Is the action **Check Integration** always executed before the action **Manage Inhibition**?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Can the action **Receive Instance** be executed after the action **Manage Inhibition**?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

Group 2: These questionnaires assess the learner knowledge about the SUAP office activities that are involved in a loop, those that are alternative, those always executed and those concurrently executed. Examples of questions included in these questionnaires are:

*Can the action **Manage Inhibition** be executed as an alternative to the action **Titolo Unico - Monti Azzurri SubProcess**?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Is there a loop involving the action **Titolo Unico - Monti Azzurri SubProcess**?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Is the action **Send Authorization Document** always executed?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Can the action **Manage Inhibition** be executed concurrently to the action **Titolo Unico - Monti Azzurri SubProcess**?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

Group3: These questionnaires assess the learner knowledge about the SUAP office paths to be executed. An example of questions included in such questionnaire is:

*Can the path from decision **integration necessary?** to the action **Check Integration** be taken if the condition **"yes"** holds?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

6.6.2. Questionnaire generation from Organizational model

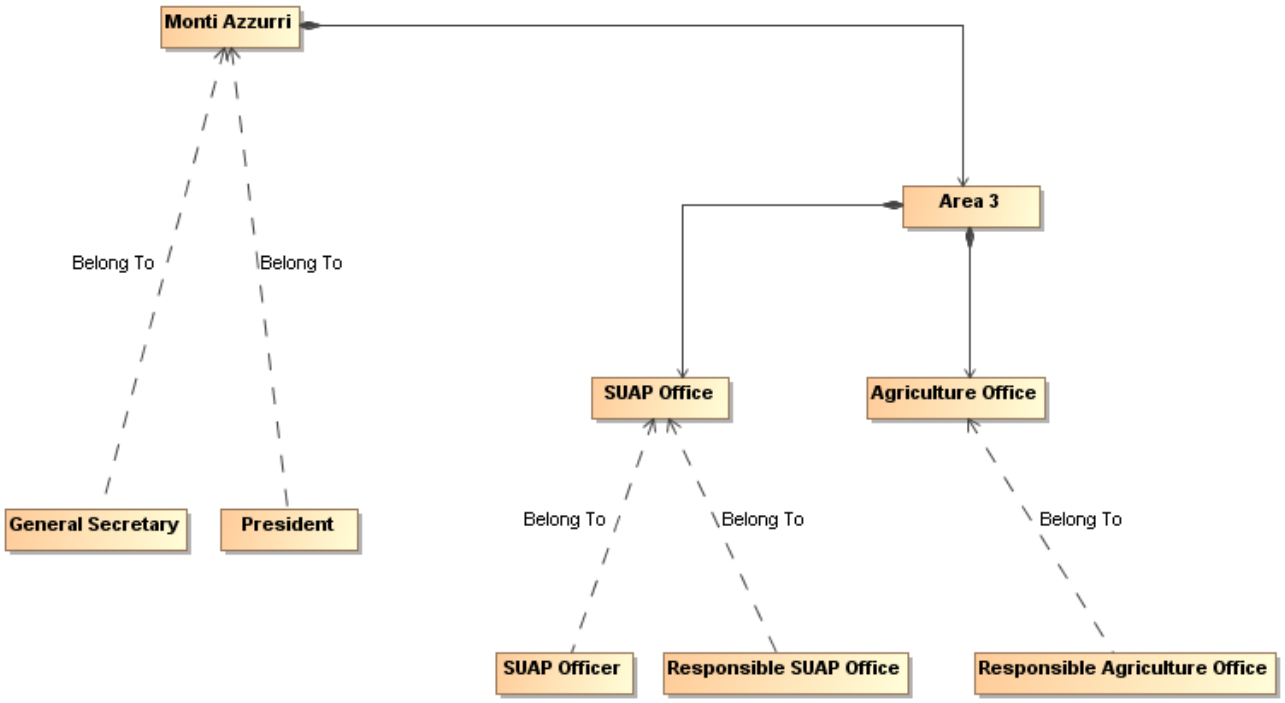

Figure 19: Monti Azzurri Organizational Model

The questionnaires generated from organizational models aim to assess the learner's knowledge about the business hierarchy and relationships among the organizational units. These relationships may include dependencies, communications, duties and resource allocations.

The model of Figure 19 is the class diagram derived from the Azzurri Organizational Model of SUAP demonstrator (see D8.3)[5]. It shows the organization of Monti Azzurri consortium of municipalities, offering the SUAP office. Starting from this model, the questionnaire manager generated 11 questionnaires, each one containing a variable number of NL questions, for an overall amount of 300 questions. The objective of these questionnaires is to assess the learner's knowledge about the allocation of responsibilities for different functions inside the Monti Azzurri Organization.

The generated questionnaires from the model of Figure 19 can be divided into 2 main groups as in the following:

Group 1: These questionnaires want to assess the learner knowledge about the relations and hierarchical dependencies among the different roles and responsibilities defined in the Monti Azzurri Organization. Examples of questions included in these questionnaires are:

[5] available at

https://www.adoxx.org/live/documents/180103/441008/TitoloUnicoModelSet.adl/e31a7f40-41e0-47f2-a87c-103e79777309

*Does **SUAP Officer** depend from **General Secretary**?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Can the relation from **Area 3** to **Agriculture Office** exist?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Can a relation from **Monti Azzurri** to an unlimited number of **Area 3** exist?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

*Does **Responsible SUAP Office** depend from **SUAP Office**?*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

Group2: These questionnaires want to assess the learner knowledge about the hierarchy of roles and activities, defined in the Monti Azzurri Organization, and their cardinality. An example of questions included in these questionnaires is:

*If I create an instance of **Area 3**, then it:*

*is associated with exactly one [**Agriculture Office**, **SUAP Office**];*

*is the target of exactly one association from [**Monti Azzurri**];*

*is possibly associated with exactly one [**Agriculture Office**, **SUAP Office**];*

*is possibly the target of exactly one association from [**Monti Azzurri**];*

○Yes ○No ○Not expert ○ Expert, but not sure what to answer

6.6.3. Preliminary assessment

A preliminary evaluation exercise has been performed inside the Learn PAd consortium aiming at validating the ability of the questionnaires in helping to assess the learner's knowledge about the Learn PAd models. All the questionnaires generated from the models of Figure 18 and Figure 19 can be found at:

http://www.learnpad.eu/docs/lp-questionnaires-D5_4.zip.

A set of 30 questions spanning over all the areas of concern in the domain model was randomly selected from them and used to interview several members of the consortium. The number of questions was fixed to 30 so to keep the estimated time for filling in the questionnaire under one hour. This preliminary experiment provided a first evidence of questionnaires effectiveness to catch the real knowledge of learners. Preliminary results were collected inside the consortium, and are under analysis to understand questionnaires suitability and areas for improvement. However, the results are anecdotal and under study, so we cannot yet draw any meaningful conclusion. A more extensive validation of questionnaires and their usage for KPI assessment is planned for future work.

7. Conclusions & Future Research Directions

This deliverable has reported a series of conceptual and technical advances, designed to support public administrations in planning and tracking the learning progress of civil servants. This includes the design of a new meta-model for learning scorecards – allowing organisations to connect learning goals to organisational goals and to model certain special aspects of learning KPIs, including e.g. learning recommendations to help learners when they fail to reach KPI target values. Furthermore, an exemplary and at the same time generic learning scorecard has been derived from a domain analysis – including strategic goals, learning goals and KPIs typical for business processes across public administrations. Finally, several methods for the assessment of learning outcomes and goal achievement have been described, including evaluation of system log files and application of questionnaires generated automatically from models. A prototypical implementation has been performed and corresponding technical details have been described. This prototype implementation is made available on the Learn PAd github project including the ontology files that build together the Learn PAd domain ontology[6] and cover the enterprise upper ontology files, the Learn PAd specific domain files and the KPI models with rules.

A promising direction for future research could be to investigate the possibility for automatic identification of learning recommendations: based on data from past learning achievements and selection of activities / learning materials, suitable recommendations could be mined from the data automatically.

Another path for future studies could be the more in-depth assessment of how generic the learning scorecard is, i.e. in how far it can be applied or needs adaptation in the contexts of other business processes and/or public administrations.

[6] https://github.com/LearnPAd/learnpad/tree/master/lp-ontology-recommender/src/main/resources/ontology

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