KPIs 4 Workplace Learning

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Abstract: Enterprises and Public Administrations alike need to ensure that newly hired employees are able to learn the ropes fast. Employers also need to support continuous workplace learning. Workplace learning should be strongly related to business goals and thus, learning goals should directly add to business goals. To measure achievement of both learning and business goals we propose augmented Key Performance Indicators (KPI). In our research we applied model driven engineering. Hence we developed a model for a Learning Scorecard comprising of business and learning goals and their KPIs represented in an ontology. KPI performance values and scores are calculated with formal rules based on the SPARQL Inferencing Notation. Results are presented in a dashboard on an individual level as well as on a team/group level. Requirements, goals and KPIs as well as performance measurement were defined in close cooperation with Marche Region, business partner in Learn PAd.

1. INTRODUCTION

Within the European funded project Learn PAd a model-based approach was developed that supports collaborative workplace learning. Workplace learning is considered strongly related to workplace performance, i.e. all learning should contribute to improve work results. In our research we investigate how learning can be (1) related to business goals, (2) how workplace learning can be measured and (3) how such an approach can be automated. In our approach, we determine learning goals that support the achievement of business goals and derive Key Performance Indicators (KPIs) to measure achievement of business and learning goals. Next, it is determined who – i.e. which organisational units and business roles – is supposed to meet the goals and which competencies are required from the roles.

This approach allows for deriving general learning goals for an employee, as well as personal learning goals derived from the gap between acquired competencies and the required competencies of a role. It also allows to assess an employee's workplace learning progress based on the measurement of the KPIs.

2. RELATED WORK

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).

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. According to Nikolova et al. (2014) workplace learning has two main components: an interactional and a task-based one. However, contrary to the approach pursued 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.

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.

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 and Unwin (2011). Although Fuller and 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 Learner Assessment Strategies

In their approach 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. 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. 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 a similar approach is pursued: the (more) static level is also captured in a learner's profile whereas the dynamic level is represented in the Learning 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 our approach we exceed the outcome of Faddouli et al. (2011) as not only learning performance of individuals but also from team/groups, i.e. organizational units is considered.

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, p 208) 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" (2012, p 208). In the Learn PAd project this notion is transferred 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.

Wang et al. (2011) 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" (2011, p 167).

2.2 Knowledge Maturing Scorecard

Within the MATURE project a Knowledge Maturing Scorecard was developed (Hrgovcic & Wilke 2012). Knowledge maturing (Schmidt et al. 2012) describes a process of learning on a collective level, which consists of various phases, where knowledge reaches ever higher degrees of sophistication and organisational acceptance. The Knowledge Maturing Scorecard 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.

Although the approach of using a (modified) Balanced Scorecard may be adequate to measure knowledge maturing, it does not model learning goals and their relations to business goals and hence does not allow for assessing learning with respect to improving business performance.

3. RESEARCH METHODOLOGY

For our work we followed the design science research methodology for information systems research (Hevner et al. 2004). Hence, the research design follows the following stages:

In the ‘Awareness of Problem’ phase we performed a detailed domain analysis to understand which goals and KPIs are relevant for measuring learning performance in a workplace environment. In the ‘Suggestion’ phase we derived and described the conceptual models that facilitate the implementation of goal oriented learning at the workplace.

In the ‘Development’ phase we defined and implemented the technical architecture for learning performance monitoring. All artefacts were iteratively developed in close cooperation with the business partner, a Public Administration, in the Learn PAd project.

The solution will be fully evaluated (‘Evaluation’ phase) within the upcoming final phase of the Learn PAd project.

4. ASSESSING WORKPLACE LEARNING

As our work is part of the Learn PAd project, workplace learning is investigated for the application domain of Public Administrations (PAs). PAs must perform complex processes in order to provide services to citizens and companies. Complexity stems from several issues: e.g. new or updated laws and regulations require creation or adaptation of services and processes and many activities must be performed collaboratively by different, possibly many, PA offices. To come to grips with his/her assignment is tedious for a beginner and public administrators are never done with learning how to carry out their tasks.

In the following we will focus on how learning goals are determined and learning progress is measured.

4.1 Goals and KPIs

We followed a top-down approach starting from strategic business goals, which are supported by operational business goals, which are supported by learning goals. For operational and learning goals we then identified the KPIs and how to measure them. Since in Learn PAd we pursue a model-driven approach we consider three model kinds relevant for our approach: the Business Motivation Model (BMM) (OMG 2014), the Learning Scorecard Model and the Organisational Model. In the Learning Scorecard Model operational business goals and learning goals and their KPIs are modelled. Business goals are related to one or more motivation element(s) of BMM (e.g. (strategic) goal, objective, and target). Furthermore, for each organisational unit and role, the operational und learning goals to be achieved are determined.

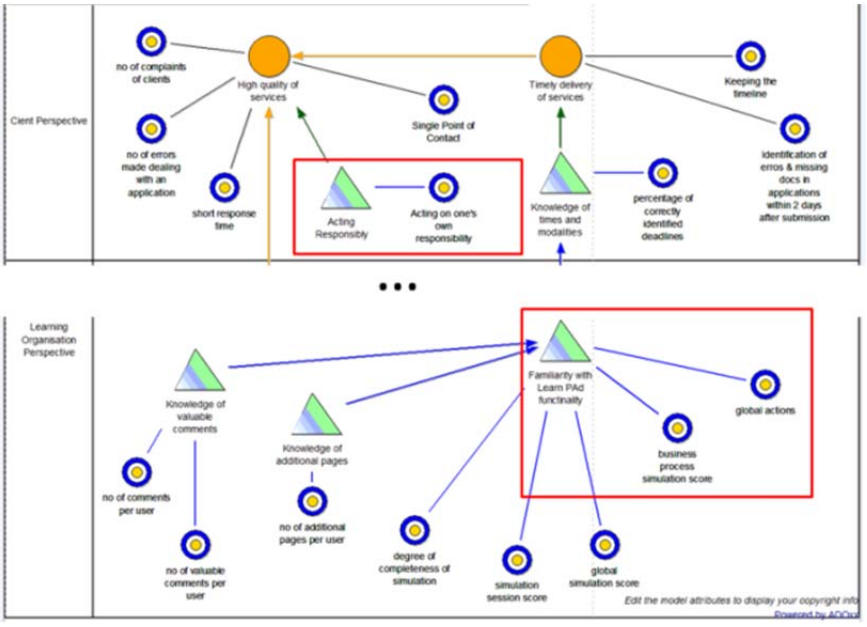

Figure 1: Parts of Learning Scorecard

4.1.1 Learning Scorecard

Like the Balanced Scorecard (Kaplan & Norton 1996), our Learning Scorecard considers four perspectives: Client, Process, Financial and Learning Organisation. Perspectives may contain business goals and their relation to strategic goals (modelled in the BMM) and a new type of goal – the learning goal, which supports one or more business goals.

We created an organisation-specific model together with business representatives of a PA and extended the properties of KPIs to be able to model assessment of learning. Figure 1 depicts a part of the Learning Scorecard showing business and learning goals and their KPIs for the Client and Process Perspective.

Operational business goals are represented by orange circles (their relation to strategic goals is not visible in the figure); arrows indicate how one goal may support another one. Learning goals supporting the business goals are represented by striped triangles, for example 'Acting Responsibly' supports 'High quality of services'. In addition a learning goal can also support another learning goal as depicted in the lower part of the figure. KPIs are represented by targets, e.g. 'no of complaints of clients' is a KPI for the business goal 'High quality of service'. The red rectangles in Figure 1 indicate the goals and KPIs detailed in Table 1.

It was also differentiated between KPIs for individuals (which can be aggregated on team level) and KPIs specific for teams (organisational units, which again can be aggregated on department level and so forth). Therefore we assign business and learning goals to roles and organisational units. For our chosen scenario, 7 business goals measured by 27 KPIs and 12 learning goals measured by 18 KPIs were determined overall.

4.1.2 Measurement of KPIs

To measure KPIs we consider three types of sources: external data, user activity log, and simulation.

External data: for several KPIs, relevant information resides outside of the reach of the Learn PAd system (e.g. stored in PA's legacy systems). 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 (e.g. KPI 'Acting autonomously on one's own responsibility'). 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 a commonly used spreadsheet.

User activity log: many KPIs refer to the way the Learn PAd system is used for workplace learning. In particular, these KPIs assess whether learners extend and contribute their knowledge by using functionalities of the system and whether they contribute to process improvements through feedbacks.

Simulation: Some KPIs assess to what degree learners reach learning goals in simulations within the Learn PAd simulation environment.

The calculated KPI values of individual learners as well as the figures on organisational levels are

Table 1: Examples of Goals, KPIs and their Attributes

Goal	KPI	Measurement	Lights / Threshold	Unit	Period
Business goal: High quality of services	no of complaints of clients (about an employee / learner)	Self-assessment: interpretation of customer feedback	Green: <=20% Orange: >20% <=40% Red: >40%	%	30 days
Learning goal: Familiarity with Learn PAd functionality	global action per user	Log: number of interactions with Learn PAd platform in 30 days (i.e. no of comments + no of additional pages + no of pages navigated)	Green: >=12 Orange: >=5 <12 Red: <5	#	3 months
	business process simulation score	Simulation: ratio of achieved business process score to the maximum of business process score	Green: >=70% Orange: >=50% <70% Red: <50%	%	30 days

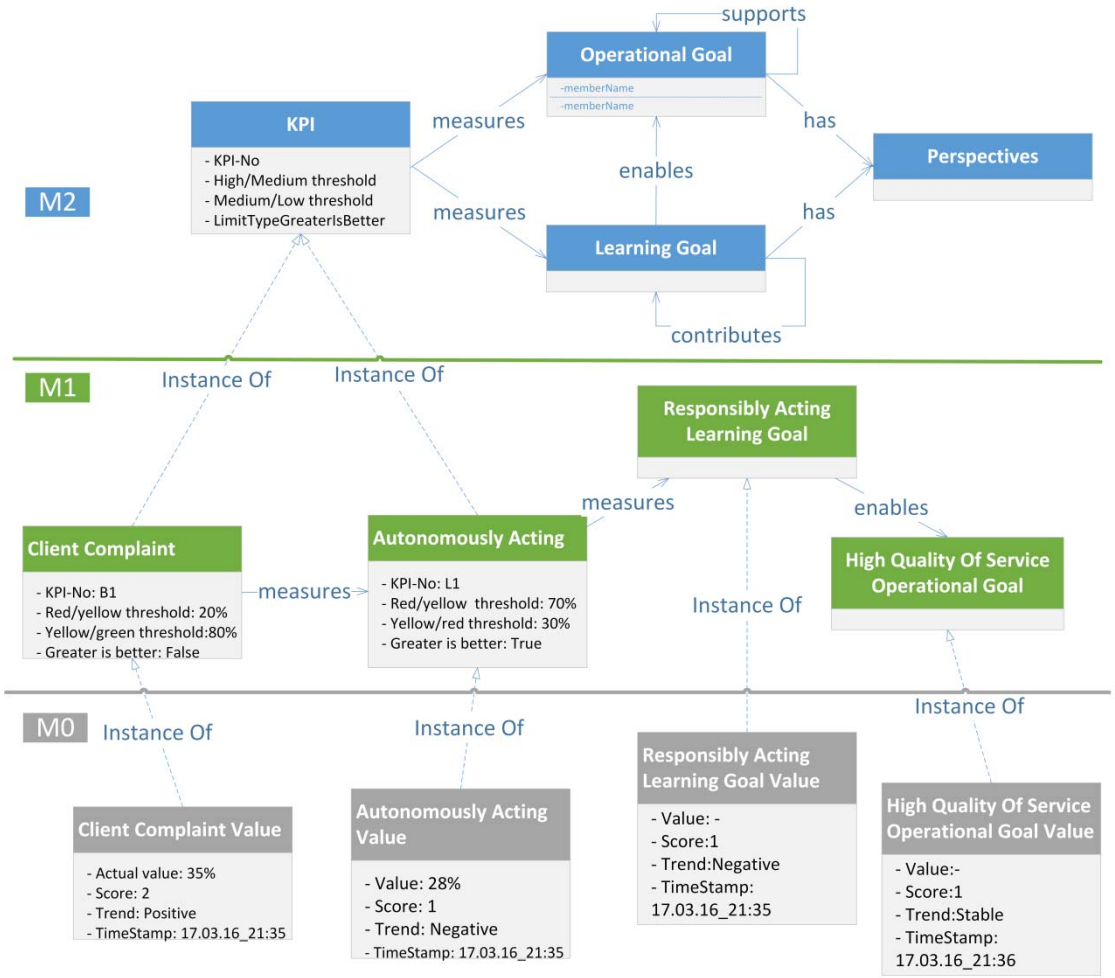

Figure 2: KPI model and instance layers

shown in a dashboard. In Figure 4 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 KPIs. On the left hand side of the figure the entities of the Learning Scorecard are provided in a hierarchical structure, starting from the perspectives followed by the business goals, the learning goals und their KPIs. Performance is depicted in form of lights, followed by information about trend, unit, target and current value. In case of severe underperforming (red light) recommendations for improvement are provided.

With this approach we provide a set of meta models that allow for explicitly defining learning goals and their relations to business goals and use well-established methods (aka KPIs) for assessing workplace learning. Details of the KPI calculations and implementation of the dashboard are provided in the following sections.

4.2 Ontological Representation

Figure 2 shows how models and instances of the learning scorecard are being represented in the web ontology language OWL (OWL Working Group 2012): KPI concepts are modelled in the meta model layer M2. Examples of domain specific instances of KPIs are depicted in layer M1.

The KPI value and score calculation during system runtime is based on gathered runtime data, the background knowledge provided by the domain ontology and on data from other integrated systems – shown as instances of KPIs in layer M0.

Here, we face the problem of a missing support of multilevel modelling by the ontology description

standards, like OWL. We have an instance of an instance problem if we add KPI value instances with calculated scores to our ontology, where the KPIs and other model instances are in turn instances of the meta model concepts of the highest layer. Following Fanesi (2015) and Fanesi et al. (2015) who have shown an approach how to overcome that problem and still keep it decidable by reasoners, the KPI model instances are modelled as instances and classes at the same time.

KPI values are calculated on an individual level, i.e. for each employee, and on an org unit level.

4.3 Implementation (EMS)

The concrete KPIs are modelled by knowledge engineers in an extended standard modelling environment. For this project the Meta Modelling Platform AdoXX is used. For further analysis and calculations, the exported models from the modelling environment are transformed with XSLT into instances of the ontology (step 2 in Figure 3). The KPI calculation is based on data gathered during runtime of the Learn PAd system (see Section 4.1.2).

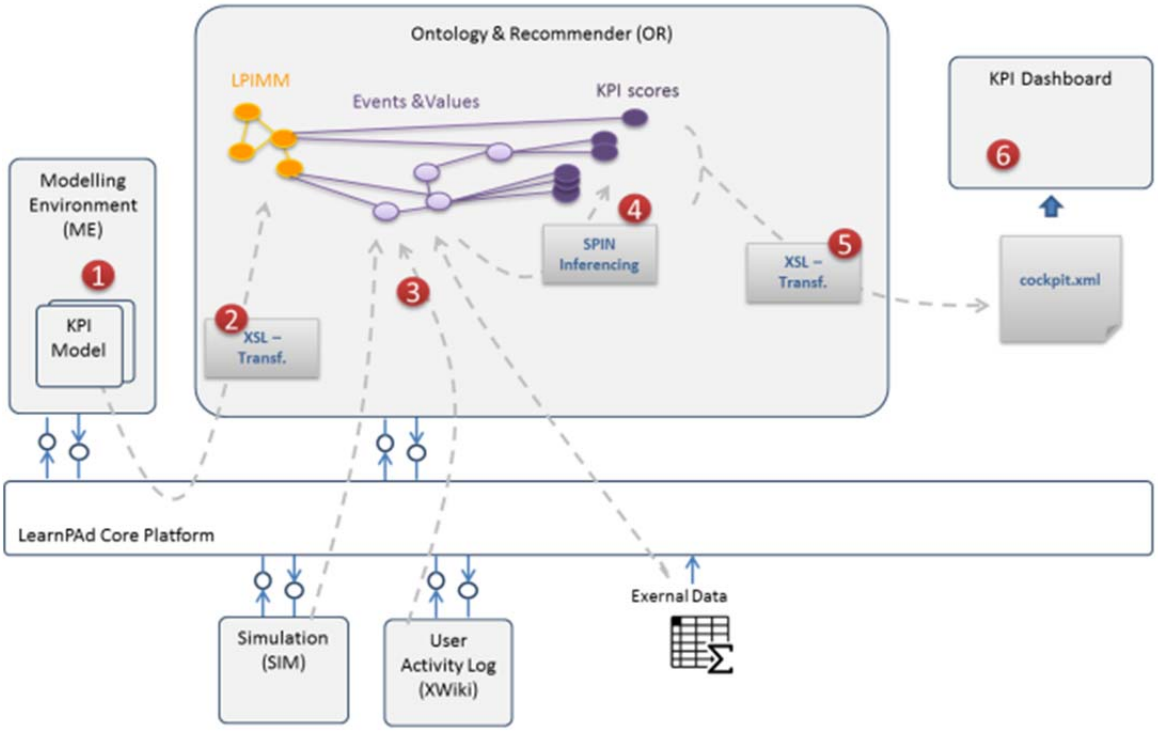

Figure 3: KPI system components

The KPI performance values and scores are calculated with formal rules based on the SPARQL Inferencing Notation (SPIN) (W3C n.d.). SPARQL (Prud'hommeaux & Seaborne 2008) is the query language for RDF based models, and therefore for our ontology, and has been standardized by the World Wide Web Consortium (W3C). The inferencing engine used is provided as open source implementation by TopBraid (TopQuadrant n.d.)

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 iteratively (depending on their level) and incrementally (run as long as new instances can be inferred). This means that the rules consider inferred values of the previous iteration. Another advantage of SPIN rules is their representation in the RDF format which allows assigning and storing them directly in the ontology.

Level #1 rules

The first level rules consider collected runtime data stored in the ontology repository. For instance the KPI "Global actions per user" considers all activities on a user on the Learn PAd platform, like the feedbacks for improvements, comments, attachments etc. a user has provided during the usage of the learning platform. The rule applied for this KPI counts simply all logged activities of a user.

The values from the external data sources provide directly a KPI value and do not have to be calculated.

Level #2 rule
In a second step the KPI value score is calculated based on the previously calculated and inferred actual KPI values and the loaded KPI values. The score can be 1, 2 or 3 and represents a traffic light in the dashboard (1=red, 2=yellow, 3=green). The rule considers the thresholds defined in the modelled KPIs and is a generic rule applied for all KPI performance value instances:

Level #3 rule
This rule infers the performance properties on a higher aggregation level, like the organisational units. The minimum function is applied, means if at least one KPI of a sub unit or an employee assigned to the units is red, then the organisational units KPI score goes also on red.
All the inferred values will finally be exported to the dashboard files. 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 the dashboard with such a recommendation is shown in Figure 4.

4.4 Application Example

Let us suppose that a PA in a region in Italy hires a new employee – Gianni – as a SUAP officer. With his boss Sarah, he determines the business goals assigned to and the competencies required for this role. The gap between the required competencies of the role and Gianni's actually acquired competencies determines his individual learning goals. Gianni and Sarah review Gianni's learning goals and corresponding KPIs and define how they could be met in what timeframe. Sarah also explains the goals of the organisational unit to show how Gianni's performance contributes to the team performance. In the following Gianni's performance is monitored and he can consult the dashboard (see Figure 4) at any time to check on his improvements. His boss Sarah can do the same for the whole team as well as for the individual members of her team.

4.5 Pre-Evaluation

Since the KPI related models were developed in the last phase of the Learn PAd project which ends in November 2016, full evaluation will be performed within the next weeks with at least 30 PA officers. So far, evaluation has been done for intermediary results. Thus, all artefacts were cooperatively developed and constantly assessed by the business partner in the Learn PAd project.

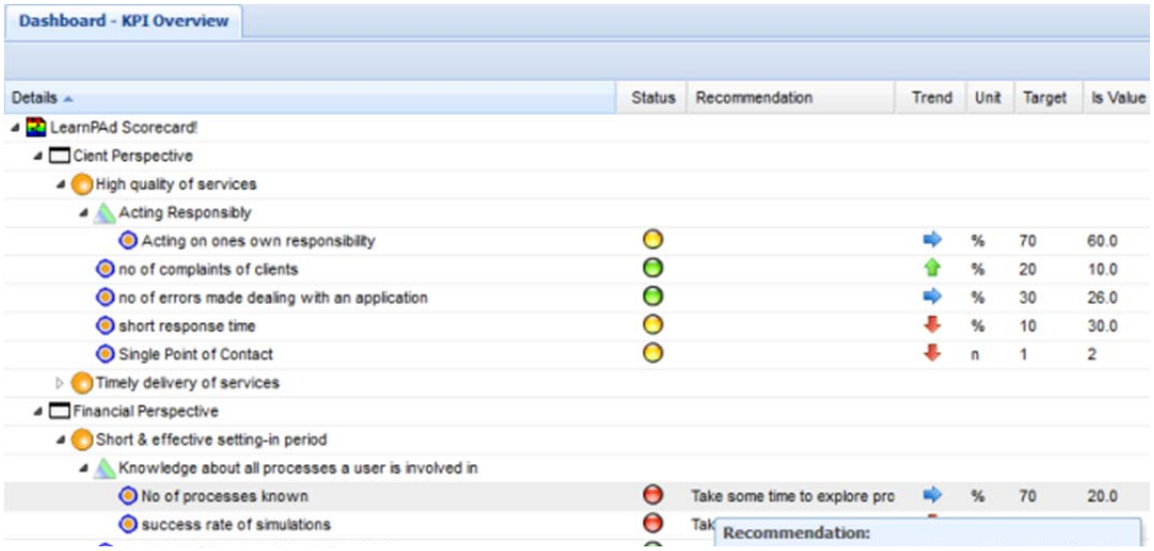

Figure 4: KPI dashboard with learning recommendation

Therefore we conducted interviews and workshops with the business representatives and they confirmed the utility and correctness of every artefact (requirements, design and implementation of goals, KPIs and relations amongst entities as well as sources for, content of and representation of the dashboard).

5. CONCLUSION

Our approach for goal-oriented workplace learning based on KPIs provides a series of conceptual and technical advances, designed to support organisations in planning and tracking the learning progress of employees. With our approach, we are able to explicitly relate workplace learning to business goals, to measure learning with regards to meeting business goals and to automate assessment and display of learning progress. 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 across public administrations. Finally, several methods for the assessment of learning outcomes and goal achievement have been described. A prototypical implementation has been performed and corresponding technical details have been described. The prototype implementation is made available on the Learn PAd github project including the ontology files that build together the Learn PAd domain ontology and cover the enterprise upper ontology files, the Learn PAd specific domain files and the KPI models with rules.

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W3C, SPIN SPARQL Inferencing Notation.

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