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Gamification in Skills Management

Personal Profile Monitoring

José Carlos Marques Araújo

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Thesis Advisor:

Prof. Dr. Gabriel Pestana

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List of Acronyms

AAL	Active and Assisted Living
CV	Curriculum Vitae
DSR	Design Science Research
DSRM	Design Science Research Methodology
DSS	Decision Support system
EC	European Commission
EM	Extrinsic Motivation
ERD	Entity Relationship Diagram
EU	European Union
GPE	General Professional Experience
GUI	Graphical User Interface
HCM	Human Capital Management
HR	Human Resources
HRMS	Human Resource Management System
IA	Intelligent Agent
IM	Intrinsic motivation
IS	Information System
ISCED	International Standard Classification of Education
ITIL	Information Technology Infrastructure Library
NIESR	National Institute of Economic and Social Research
OECD	Organization for Economic Co-operation and Development
PC	Personal Computer
PMBOK	Project Management Body of Knowledge
R&D	Research and Development
SDM	Skills Development Module
SE	Self-esteem
SPE	Special Professional Experience
TM	Talent Management
UK	United Kingdom
UI	User Interface
UOD	Universe of Discourse
VAT	Virtual Assistance Tool

Abstract

Employees are the human capital which, to a great extent, contributes to the success and development of high-performance and sustainable organizations. In a work environment, there is a need to provide a tool for tracking and following-up on each employees' professional progress, while staying aligned with the organization's strategic and operational goals and objectives.

The research work within this Thesis aims to contribute to improve employees' self-awareness and auto-regulation; two predominant research areas are also studied and analyzed: Visual Analytics and Gamification. The Visual Analytics enables the specification of personalized dashboard interfaces with alerts and indicators to keep employees aware of their skills and to continuously monitor how to improve their expertise, promoting simultaneously behavioral change and adoption of good-practices. The study of Gamification techniques with Talent Management features enabled the design of new processes to engage, motivate, and retain highly productive employees, and to foster a competitive working environment, where employees are encouraged to be involved in new and rewarding activities, where knowledge and experience are recognized as a relevant asset. The Design Science Research was selected as the research methodology; the creation of new knowledge is therefore based on an iterative cycle addressing concepts such as design, analysis, reflection, and abstraction.

By collaborating in an international project ([Active@Work](#)), funded by the Active and Assisted Living Programme, the results followed a design thinking approach regarding the specification of the structure and behavior of the Skills Development Module, namely the identification of requirements and the design of an innovative info-structure of metadata to support the user experience. A set of mockups were designed based on the user role and main concerns. Such approach enabled the conceptualization of a solution to proactively assist the management and assessment of skills in a personalized and dynamic way. The outcomes of this Thesis aims to demonstrate the existing articulation between emerging research areas such as Visual Analytics and Gamification, expecting to represent conceptual gains in these two research fields.

Keywords: Visual Analytics, Skills Management, Self-Awareness, Semantic Context, Monitoring Events, Gamification

1. Introduction

This chapter provides an introduction to the research work performed within the scope of this Master's Thesis, outlining Gamification and Visual Analytics as the main research areas. The research challenge can be expressed as how to efficiently manage and monitor events using graphical interfaces such as personalized interactive Dashboards, enabling employees to access relevant information and simultaneously to promote self-awareness and auto-regulation. These self-awareness and auto-regulation behaviors are supported by the Skills Development Module (SDM). This module intends to encourage employees to upskill their competencies as well as their career progress, enriching in this way their Curriculum Vitae (CV), matching in a more proficient way the increasing demands of business needs in extremely competitive environments. The section also considers the formulation of the problem to which the work will cope and the main concepts to investigate. Innovative achievements were attained by showing that Gamification and Visual Analytics are correlated and complement each other, based on a methodological approach developed with the knowledge acquired through the study of Design Science Research Methodology (DSRM). Finally, it ends by describing the structure of the document.

1.1. Context

The current socio-economic situation in Europe was taken by the European governments as a reason to raise the retirement age, supported by some studies that have shown that working beyond the retirement age can be beneficial to the individual's physical and mental health (European Commission, 2015a). However, there is at least one challenging hurdle to capitalize on the benefit of employing older individuals in organizations; this is the lack of innovative paradigm-changing solutions. These solutions are meant to assist older individuals in staying active and efficient, especially in a context where the overall labor force is becoming older and less experienced. This is extremely important, since organizations recognize that older, yet experienced, employees are very valuable assets, and this cannot be neglected or even comparable to younger employees, which are less skilled and experienced. There is also a myth about older employees and an alleged inability to learn new skills. However, research shows learning is not an age-dependent factor (Charness & Czaja, 2006). Because ever-evolving technology affects the workplace, there is a need to support employees in acquiring new skills to remain proficient in an increasingly competitive working environment.

Thus, the existing solutions should provide appropriate skills management recommendations that tap into the specific motivations and needs of each employee, using Gamification techniques to challenge them for competitiveness, or by acquiring new skills/competencies or by investing in career progression as determinants to meet business demands.

The aim to create innovative paradigm-changing solutions and the opportunity to collaborate in the Active@Work project (<http://www.activeatwork.eu/>), an European Union (EU) funded R&D project with a duration of 30 months starting in December 2015, was strengthened with the interest on research predominant areas such as Visual Analytics, Gamification and Talent Management, combined with the challenge to design an innovative solution for the SDM.

1.2. Overview

The research work within this Thesis consists on the following requirements:

- Define an info-structure of metadata to support dynamic creation of indicators, taking into consideration the user profile and/or role/function, without any need of intervention from the IT department.
- Develop the SDM solution to maintain employees' self-conscious and informed about their assessment and the need for CV adjustments, to meet organizations skills & competencies demands.
- Autonomous management mechanism of CV in a standardized way (another SDM feature), enabling employees to have information on what are the most valued skills for the organization (through the training catalogue).

To accomplish such research the following three main domains were analyzed: Visual Analytics, Gamification and Talent Management. By applying Gamification techniques, such as instant feedback & (healthy) competitiveness for desired actions and indicators for merit, performance and reputation, the solution promotes employees' self-awareness, increasing their motivation to seek out new skills, eventually contributing to improve the CV. The solution also intends to develop, motivate, and retain productive, engaged employees, pointing in this way to goals related of Talent Management aspects, creating a good alignment to meet organizations

strategic and operational goals and objectives¹. Goals and objectives are often used interchangeably, but the main difference comes in their level of concreteness. Objectives are very concrete, whereas goals are less structured. The solution had to comply with multi-platform and mobility requirements (e.g., PC, tablets or smartphones), capable to interact with the end-user in a very seamless and personalized way. Usability requirements are therefore a major concern to dynamically adjust interaction and notifications in conformity to the end-user needs.

1.3. Objectives

The SDM intends to provide a contribution to the functionalities to be provided by the Virtual Assistant tool (VAT) that is a core component within the software architecture of the Active@work project. This integration intends to create a highly motivating and rewarding environment that makes it easy for employees to manage and develop their skills, promoting engagement and motivation to fit into organization needs and expectations. Within this context, the SDM addresses the following research areas: Visual Analytics, Gamification and Talent Management.

- **Visual Analytics**, this interactive technique of information visualization, enables enables the employee to get access, in real-time and based on metadata characterizing the user profile and/or role/function, to some relevant information through interactive dashboards. These dashboards provide employees a clear perception of their strengths and weaknesses, by means of indicators (e.g. CV Evaluation, ranking and CV composition) and events (alerts, warnings and recommendations) which are dynamically triggered by an Intelligent Agent (IA). Developing self-awareness helps the employees to have the opportunity to make changes in behavior and motivation aspects, which may be extremely important in case the employee's CV (i.e., perceived skills or expertise) start to lose relevance, in an increasing competitive working environment.
- **Gamification**, by adopting data-driven elements and techniques that game designers use to engage employees, reward and recognize individuals and keep people motivated to achieve - sometimes extremely - ambitious results, adding value to business and promoting loyalty. Organizations are continuously being challenged to effectively encourage employees to

¹ Cfr: [Talent Management](#), accessed on 13/02/2016

achieve basic business goals and develop working environments driven by healthy competitive practices. If serious gaming techniques become part of the Organizations' working culture, it will encourage employees to continuously seek to improve their CV. In such working environment, self-awareness can be seen as a way to "play" with alerts and recommendations triggered dynamically by an Intelligent Agent (IA), which motivates employees to constantly invest effort in auto-regulation to improve their performance (e.g., rank classification, career development, encourage ambition and self-achievement).

- **Talent Management**, by adopting processes designed to engage, motivate and retain highly productive employees, it is possible to combine Skills Management & monitoring related critical capabilities with information visualization techniques, helping organizations to maximize potential use of Talent Management technology. Through a training catalogue with specific skills offering, employees can search and manifest interest in some training(s) offers or seek for career options. In some cases, a workflow approval is required (e.g., training courses requiring a fee payment), these requests are sent to the employee supervisor for further approval/rejection.

1.4. Motivations

According to a research (Altmann, 2015) requested by the United Kingdom (UK) National Institute of Economic and Social Research (NIESR), if UK workers over 50 y/old were kept for just one more year in the workforce, an extra 1% of UK GDP - £18BN in 2014 – would be generated. In addition, by 2022 the UK will have 700,000 fewer people aged 16-49, but 3,7 million more people aged between 50 and state pension age (Ray Barrell, Kirby, & Orazgani, 2011). But this is not UK specific, according to the HR Consultancy company Mercer, it is expected that “by 2050, the number of people over 65 y/old will triple and the number of those over 80 will quadruple. Some countries will be more affected than others, but the labor force across the world will change: will be older and smaller”².

According to the 2015 Ageing Report (European Commission, 2015b), people aged 65+ will become a much larger share (rising from 18% to 28% of the population), and those aged 80+ (rising from 5% to 12%) will almost become as numerous as the young population in 2060, as illustrated in Figure 1. In Portugal, the projection is even higher, since people aged 65+ will

² Cfr: [AGEING WORKFORCE VIDEO: Introduction](#), accessed on 14/02/2016

rise from 20% to 35% of the population and those aged 80+ will become more numerous than the young population in 2060 (16% versus 11%).

	2013				2060			
	(0-14)	(15-64)	(65+)	(80+)	(0-14)	(15-64)	(65+)	(80+)
BE	17%	65%	18%	5%	17%	59%	24%	9%
BG	14%	67%	19%	4%	14%	54%	32%	12%
CZ	15%	68%	17%	4%	15%	56%	28%	12%
DK	17%	65%	18%	4%	16%	59%	25%	10%
DE	13%	66%	21%	6%	13%	55%	32%	13%
EE	16%	66%	18%	5%	15%	55%	30%	12%
IE	22%	66%	12%	3%	19%	60%	21%	10%
EL	15%	65%	20%	6%	13%	54%	33%	15%
ES	15%	67%	18%	6%	13%	57%	30%	15%
FR	19%	64%	18%	6%	17%	58%	25%	11%
HR	15%	67%	18%	4%	14%	57%	30%	11%
IT	14%	65%	21%	6%	13%	57%	30%	13%
CY	16%	70%	13%	3%	15%	58%	27%	9%
LV	15%	67%	19%	5%	16%	56%	28%	11%
LT	15%	67%	18%	5%	18%	56%	26%	11%
LU	17%	69%	14%	4%	17%	61%	22%	8%
HU	14%	68%	17%	4%	14%	56%	29%	12%
MT	14%	68%	18%	4%	15%	56%	29%	10%
NL	17%	66%	17%	4%	15%	57%	27%	11%
AT	14%	67%	18%	5%	14%	57%	29%	11%
PI	15%	70%	14%	4%	13%	54%	33%	12%
PT	15%	66%	20%	5%	11%	54%	35%	16%
RO	16%	68%	16%	4%	15%	56%	29%	12%
SI	15%	68%	17%	5%	15%	56%	29%	12%
SK	15%	71%	13%	3%	11%	53%	35%	13%
FI	16%	65%	19%	5%	16%	58%	26%	10%
SE	17%	64%	19%	5%	17%	58%	24%	9%
UK	18%	65%	17%	5%	17%	58%	25%	9%
NO	18%	66%	16%	4%	17%	60%	23%	8%
EU	16%	66%	18%	5%	15%	57%	28%	12%
EA	15%	66%	19%	6%	15%	57%	29%	12%

Figure 1. Decomposition of the population by age-groups (source: European Commission, 2015)

Because of these different trends among age groups, the demographic old-age dependency ratio (people aged 65 or above relative to those aged 15- 64) is projected to increase from 27.8% to 50.1% in the EU as a whole over the projection period (from 2013 to 2060), as illustrated in Figure 2. Demographic old-age dependency ratio ($65+/(15-64)$) (source: European Commission, 2015). In Portugal, people aged 65+ relative to those aged 15-64 is projected to increase from 29,8% to 63%, significantly above the average projected for the EU in 2060. This implies that the EU would move from having four working-age people for every person aged over 65 years to only two working-age persons.

The expectable impacts of these projections are especially relevant for this Thesis, for two main reasons:

- Foreseeable raise of the retirement age in the mid/long term;
- Greater demand/consciousness for active aging policies (organizations will need to keep their senior resources for a longer period time).

	Demographic dependency ratio (65+)						p.p. change 2013-2060
	2013	2020	2030	2040	2050	2060	
BE	27,1	29,7	34,7	37,2	37,9	39,9	12,9
BG	28,9	33,9	39,1	45,8	54,3	58,4	29,6
CZ	25,1	31,7	35,3	40,8	48,4	50,1	24,9
DK	27,9	31,6	36,9	40,7	39,4	41,8	13,9
DE	31,8	36,2	47,6	55,6	57,4	59,2	27,4
EE	27,5	32,8	39,8	45,5	51,7	54,5	26,9
IE	18,9	23,6	30,7	39,0	44,7	35,6	16,7
EL	31,2	34,6	41,6	53,8	63,7	60,8	29,7
ES	26,8	30,7	40,2	54,3	62,3	53,2	26,4
FR	27,9	33,0	39,4	44,1	43,7	42,9	14,9
HR	27,3	32,1	39,5	43,9	49,3	52,3	25,0
IT	32,8	35,1	41,3	50,2	52,9	53,0	20,3
CY	19,1	24,3	32,1	36,6	42,6	46,5	27,4
LV	28,3	32,5	42,2	47,8	50,7	50,3	22,0
LT	27,4	32,3	48,0	55,7	51,6	45,7	18,3
LU	20,3	21,7	25,8	29,3	31,7	35,6	15,2
HU	25,4	31,0	34,4	40,5	47,5	52,6	27,1
MT	25,8	33,2	40,5	40,9	45,0	50,9	25,1
NL	25,9	31,2	40,6	47,1	46,4	47,8	21,9
AT	27,0	29,5	37,9	44,4	46,8	50,5	23,5
PL	20,5	27,7	35,6	40,4	52,6	61,0	40,5
PT	29,8	34,7	43,6	55,7	64,3	63,9	34,0
RO	24,1	28,8	32,7	41,8	48,7	51,8	27,7
SI	25,4	32,2	41,0	47,7	54,1	52,5	27,2
SK	18,7	24,8	32,9	40,6	54,9	66,1	47,4
FI	29,6	36,1	41,5	41,1	42,0	45,1	15,5
SE	30,2	33,1	35,7	37,4	37,6	41,5	11,2
UK	26,6	29,6	35,2	39,1	40,7	42,8	16,1
NO	23,9	26,5	30,2	33,7	35,1	39,0	15,1
EU	27,8	32,1	39,4	46,1	49,5	50,1	22,3
EA	29,3	33,3	41,5	49,4	52,0	51,1	21,8

Figure 2. Demographic old-age dependency ratio (65+/(15-64)) (source: European Commission, 2015)

The 2015 Ageing Report also provides Labor Force projections, where it is mentioned that, due to pension reforms raising the statutory retirement age or the state pension age, the participation rates of men aged 55-65 in the labor market has increased in most countries since the turn of the century, as illustrated in Figure 3. In the EU, the participation rates of people of both sexes aged 55-65 in the labor market has increased from 45,1% (in 2005) to 54,3% (in 2013). In Portugal, for a longer comparison period (from 1990 to 2013), the participation rates of people of both sexes aged 55-65 in the labor market has increased from 47,6% (in 1990) to 54,1% (in 2013), which is in line with the EU average figures.

	Total							Men							Women						
	1985	1990	1995	2000	2005	2010	2013	1985	1990	1995	2000	2005	2010	2013	1985	1990	1995	2000	2005	2010	2013
BE	27.3	22.2	24.2	25.9	33.3	39.2	44.1	45.1	35.4	35.9	36.3	43.4	47.6	50.5	11.0	9.9	13.3	15.8	23.4	30.9	37.8
BG				25.1	38.0	47.9	54.1				39.9	49.9	55.7	59.9				12.5	27.8	41.3	49.0
CZ				38.1	46.9	49.7	54.8				54.5	62.1	62.5	66.1				23.3	32.9	38.0	44.2
DK	53.2	57.1	53.6	56.9	62.8	61.8	65.0	65.8	69.1	67.9	64.5	68.7	67.8	70.2	42.4	45.9	40.1	48.2	56.8	55.9	59.9
DE	39.5	42.4	42.8	42.9	52.1	62.5	67.4	58.8	58.3	54.5	52.5	61.2	70.8	74.4	24.3	27.5	31.3	33.4	43.2	54.5	60.7
EE				47.3	58.9	64.3	66.6				54.4	60.5	64.3	66.9				41.9	57.7	64.3	66.5
IE	45.8	42.6	43.0	46.3	53.1	55.0	57.4	73.6	66.5	65.0	64.6	67.7	65.3	67.8	18.9	18.9	21.0	27.7	38.2	44.6	47.1
EL	46.1	41.5	41.9	40.9	43.2	45.1	42.5	67.3	59.5	61.1	57.7	60.8	60.2	54.9	26.4	24.3	24.5	25.9	27.1	30.9	30.8
ES		40.1	36.6	40.8	45.9	50.8	54.1		62.3	55.0	60.3	63.2	63.9	63.7		19.6	19.6	22.5	29.6	38.5	45.1
FR	35.6	32.9	31.4	31.7	40.7	42.6	49.1	44.3	39.3	36.1	35.5	43.8	45.3	52.3	27.7	26.9	27.1	28.2	37.7	40.0	46.1
HR					35.1	40.5	40.7					47.2	53.4	49.7					24.9	29.1	32.2
IT	33.8	32.5	29.0	28.6	32.6	38.0	45.3	54.4	51.7	45.2	42.2	44.3	49.6	56.7	15.1	15.0	14.2	15.9	21.5	27.0	34.6
CY				51.2	52.4	59.1	56.6				69.5	73.2	74.3	71.2				33.6	32.8	44.3	42.3
LV				39.0	53.9	56.9	61.3				53.8	61.0	58.5	62.2				28.0	48.6	55.7	60.5
LT				45.6	52.8	56.5	60.1				59.0	63.8	62.6	65.2				35.4	44.5	51.7	56.1
LU	25.7	28.4	24.0	27.6	32.4	40.6	42.5	40.2	43.2	35.1	38.6	39.4	48.8	50.5	13.6	13.8	13.3	16.8	25.1	32.0	34.2
HU				22.6	34.3	37.3	41.7				34.3	42.3	43.1	50.2				13.2	27.7	32.4	34.8
MT				29.5	31.9	33.3	38.4				52.9	53.1	52.3	57.2				8.6	12.4	14.6	19.7
NL	30.3	30.9	29.9	38.6	48.1	55.9	64.1	49.2	45.8	41.4	50.8	59.5	67.3	75.3	13.2	16.8	18.6	26.4	36.5	44.5	52.9
AT		30.2		31.4	33.0	43.4	46.5		42.6	44.5	43.0	53.0	56.4			18.8	18.9	23.5	34.2	37.1	AT
PL				32.1	30.5	36.7	44.0				41.1	40.9	48.9	55.9				24.4	21.5	25.9	33.3
PT	47.6	47.4	53.0	53.8	54.0	54.1		65.9	61.9	64.5	62.4	61.8	62.4		31.5	34.5	42.9	46.1	47.0	46.6	
RO				52.5	40.4	42.5	43.1				58.4	48.4	52.7	54.0				47.5	33.5	33.5	33.5
SI				23.7	32.1	36.5	36.0				33.5	45.4	47.5	45.1				14.8	18.9	25.5	27.0
SK				24.6	35.0	45.1	49.5				41.0	55.1	59.7	59.5				11.1	18.1	32.3	40.4
FI			39.6	45.5	56.6	60.2	62.9		41.6	46.4	56.9	60.1	61.5			37.7	44.6	56.4	60.3	64.3	
SE			67.2	68.4	72.6	74.8	77.5		71.0	72.1	76.2	79.3	81.6			63.4	64.6	69.0	70.2	73.4	
UK	51.4	53.1	51.5	52.8	58.4	59.9	62.8	69.2	68.3	62.5	63.3	68.3	69.1	70.7	35.0	38.7	40.9	42.6	48.9	51.1	55.3
NO			63.2	66.2	66.5	69.6	72.0			70.6	72.7	72.1	73.5	75.9			56.0	59.7	60.9	65.5	67.9
EA				37.2	43.7	49.5	54.7				48.4	53.8	58.3	62.6				26.5	34.2	41.1	47.3
EU					45.1	49.7	54.3					55.2	58.9	62.7				35.7	41.0	46.5	EU

Figure 3. Historical participation rates: workers aged 55 to 64 (source: European Commission, 2015)

In addition to the aging and demographic challenges and how will this affect the labor force across the world, sustained by the projections from the 2015 Ageing Report illustrated above, it's equally important to evaluate the Education qualifications level, as well as the skills/competencies from these senior employees.

According to the “Educational attainment and labour-force status Indicators”, from the Organisation for Economic Co-operation and Development (OECD), regarding the labour force status and the educational attainment level published in “OECD Education at a Glance 2015”, (which includes data for 2000, 2005, 2010 and 2014), the lack of educational literacy in people of both genres aged 55-65, as illustrated in Figure 4, can be seen as an obstacle to the continued employability of an increasingly aging population. In this Figure the search criteria was the International Standard Classification of Education (ISCED) level “Upper Secondary” (i.e. immediately below higher education) education level (UNESCO, 1997).

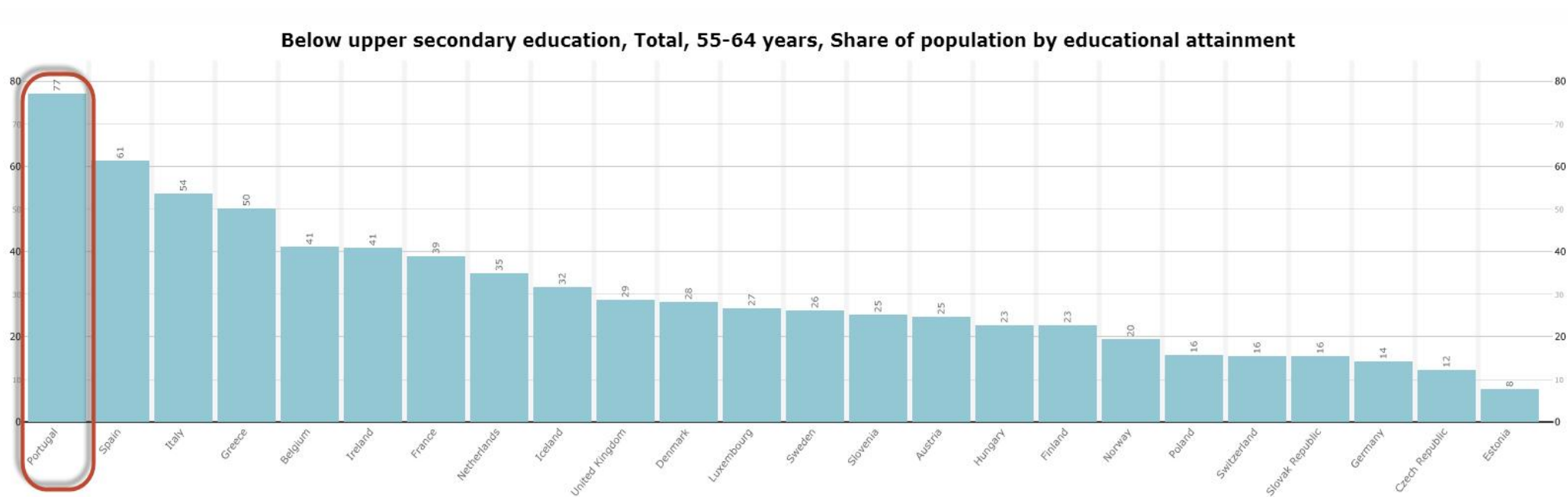


Figure 4. Share of population aged 55-64 years with education level below upper secondary (source: OECD, 2014)

The graph objectively shows that there are a few countries, such as Portugal, Spain, Italy and Greece, where $\geq 50\%$ of the population aged 55-64 has an education level below “Upper Secondary”. Portugal is illustrated as one of the countries with the most serious gap in the senior population with academic qualifications of higher education. From this graph it is possible to infer the relevance OECD report and consequently the relevance of having a tool such as the SDM to support adult senior to proficiently and proactively management their skills, encouraging and motivating them to continuously improve their skills or acquire new ones.

1.5. Design Science Research Methodology

Design science research (DSR) is a set of analytical techniques and perspectives for performing research in Information System (IS). DSR involves the creation of new knowledge through the design of novel and innovative artifacts. It also helps the analysis of such artifacts to improve and understand the behavior of aspects related to Information Systems (Kuechler & Vaishnavi, 2008). A designed artifact is an object with material and/or immaterial characteristics that is designed and created intentionally by one or more human beings, such as algorithms, human/computer interfaces, and system design methodologies or languages.

In the last century, natural sciences almost drove out ‘design’ from professional school curricula in all professions, with the exception of management, computer science and chemical engineering (Simon, 1996). To bring the design activity back to the an intellectual level, (Simon, 1996) makes a clear distinction between “natural science” and “science of the artificial” (design science), where design science is seen as knowledge in the form of constructs, techniques and methods for creating artifacts that satisfy given sets of functional requirements. DSR is the research that creates this type of missing knowledge using design, analysis, reflection, and abstraction.

The main goal of DSR is to develop knowledge that professionals can use to design solutions for their area of research/concern (i.e., a problem domain). This mission can be compared to the one of the ‘explanatory sciences’, like the natural sciences and sociology, which is to develop knowledge to describe, explain and predict (van Aken, 2005). Hevner states that the main purpose of DSR is to achieve knowledge and understanding of a problem domain by building and application of a designed artifact (A. R. Hevner, March, Park, & Ram, 2004).

Gamifying up skilling activities can be beneficial as it can better engage employees and result in better competencies. However, incorporating game-thinking in non-game contexts such as up skilling activities can be difficult because it requires an appropriate mix of science, interaction, and experience. DSR can help overcome this issue. Through a search process for determining an appropriate solution for a given problem domain, combined with an active participation of the end user in the specification and conceptual model validation, DSR allows multiple iterative cycles over which the solution is incrementally refined, addressing the objectives praised in this Thesis and resulting in a successful implementation. (Cheong, Cheong, & Filippou, 2013).

1.6. Report Organization

This Thesis is structured as follow. The second chapter presents a literature review of the state-of-the-art regarding the three predominant research areas, it analyzes and discusses the information published about the Thesis subject. This chapter introduces the DSR, Visual Analytics Framework, Talent Management from the Skills perspective and Gamification. The third chapter focus on the research challenges, namely how it started, what was achieved and how it can be improved. It details how the research study was conducted, including the theoretical framework reference and assumptions. The forth chapter presents the expected results that support the proposed solution to the identified problem. Finally, the Thesis structure ends with the fifth chapter presenting the main conclusions and a reflection on the results obtained from the research work with some guidelines regarding future work.

2. State of the art

This chapter presents a literature review of the current state-of-the-art, which seeks to gather, analyze and discuss information published around the subjects covered within this Thesis. It provides a theoretical foundation to the research objectives and refers what has already been researched or published in topics similar to the one approached in this Thesis.

2.1. Revised Framework for Design Science Research Activities

Design can be thought of a mapping from function space - a functional requirement constituting a point in this multidimensional space - to attribute space, where an artifact satisfying the mapping constitutes a point in that space (Takeda, Veerkamp, Tomiyama, & Yoshikawa, 1990). Design Science is then knowledge in the form of constructs, techniques and methods for performing this mapping, models, theory - the know-how for creating artifacts that satisfy a given sets of functional requirements. DSR is research that creates this type of missing knowledge using design, analysis, reflection and abstraction.

There are many excellent models of the research process of DSR (A. Hevner, 2007; Kasanen, Lukka, & Siitonen, 1993; Kuechler & Vaishnavi, 2008; March & Smith, 1995; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) being reported in high impact journals. A comparison of research steps among those models is presented in Table 1. Based on this table, it can be argued that the core processes involved in DSR are:

- 1) Establishing **Awareness of Problem** – as highlighted in blue colour;
- 2) DSR (**Development of the Artifacts and Evaluation**) – as highlighted in green colour;
- 3) Theory building/**Conclusions** – as highlighted in purple colour.

Table 1. Comparison of DSR Steps According to Literature (source: adapted from Rocha, Formoso, Tzortzopoulos-Fazenda, Koskela, & Tezel, 2012)

(Note: 1. Establishing Awareness of Problem- blue colour; 2. Design Science Evaluation–green; 3. Theory Building-purple)

Lukka (2003)	March and Smith (1995)	Kasanen et al (1993)	Vaishnavi and Kuechler (2007)	Hevner (2007)
Find a practically relevant problem with potential for theoretical contribution		Find a problem with practical relevance and that also has research potential	Awareness of the problem	Problem and opportunities
Assess the likelihood for long-standing research collaboration with the target organisations				
Obtain an understanding of the problem from a practical and theoretical perspective		Obtain an understanding of the topic		
Innovate a solution idea and develop a solution that solves the problem at hand	Create things that serve human purposes	Innovate, namely construct a solution	Suggestion of a tentative design	Build, design artefacts and processes
			Further development of the tentative design and implementation	
Implement the solution and test how it works	Evaluate the performance of things in use	Demonstrate that the solution works	Evaluation of the design against previously defined criteria	Evaluate
Identify and analyse its theoretical contribution		Present its connection to theory and the research contribution	Conclusion	Additions to knowledge base
		Assess the scope of application of the solution		

This Thesis has chosen to work around the research process proposed by (Dasgupta, 1996; Purao, 2002; Takeda et al., 1990; V. Vaishnavi & Kuechler, 2004), Figure 6 provides a short overview of the loop schema, which is a well-known cycle to any researchers, who adopted or studied the DSR methodological approach. A general model that shows how knowledge is being generated and accumulated as in Figure 5 is also helpful in understanding the DSR process.

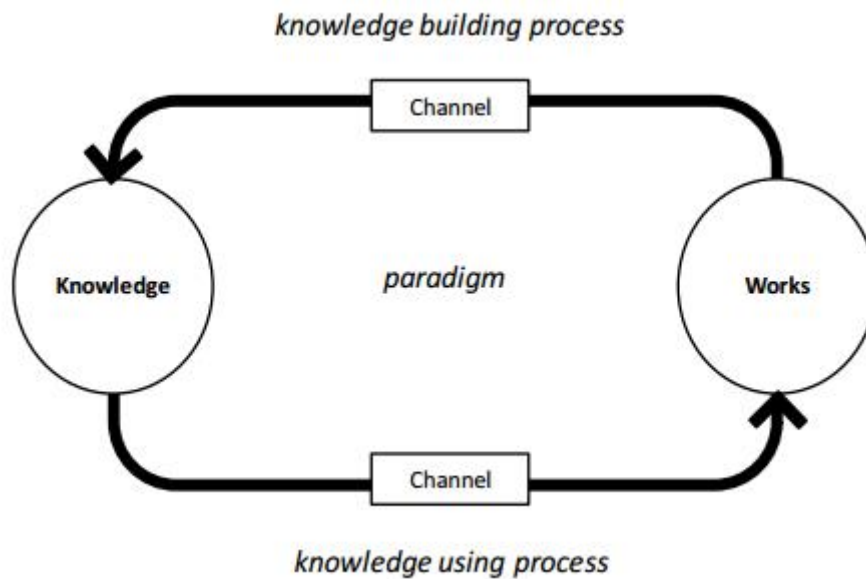


Figure 5. General Model for Generating and Accumulating Knowledge (source: Owen, 1997)

As presented by Qwen, “Knowledge is generated and accumulated through action. Doing something and judging the results is the general model. The process is shown as a cycle in which knowledge is used to create works, and works are evaluated to build knowledge” (Owen, 1997). Indeed, DSR will contribute to the production of new knowledge. In general, it's recommendable to produce a new product using state-of-practice application of techniques and available components. In most cases, product design efforts are preceded by many discussions, alignments and meetings to check out the risks, probability and evaluation of the design effort. The risks identified "we don't know how to do this yet" areas that are precisely the targets of DSR efforts (V. K. Vaishnavi & Kuechler, Jr., 2007).

A typical DSR workflow is summarized in Figure 6. It combines the approach from (Dasgupta, 1996; Puro, 2002; V. Vaishnavi & Kuechler, 2004), which focus on the DSR process model, with the approach from (Takeda et al., 1990), which focus on the Cognitive processes.

The DSR follows a user-centric approach. It starts with a survey about the project scope to achieve a preliminary awareness of the challenges related to the scope of the problem domain, identifying hypothesis to be tested and evaluated using information artifacts. An active participation of the end-user is required in testing and evaluating the identified artifacts on each process step, execution generates outcome which might contribute, after being analyzed, to generate findings to feed the knowledge about the research problem that is being studied, in a continuous cognitive improvement process. The analysis of the results might provide additional

inputs or contribute to redesign some services that will also be considered as a relevant information in achieving a better understanding about the problem domain, as well as the identification of stakeholders concerns and interests in the system. A description of the five process steps (Awareness of Problem, Suggestion, Development, Evaluation and Conclusion) are presented in Figure 6.

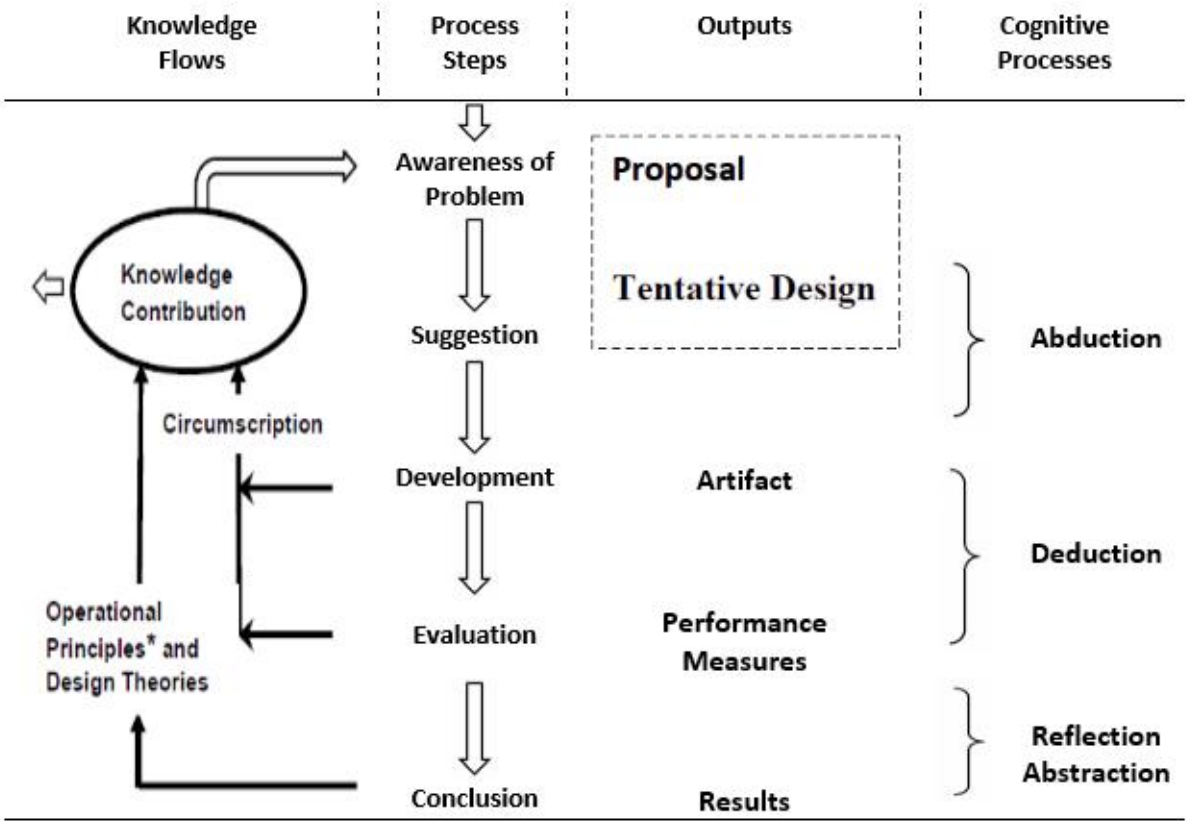


Figure 6. DSR Model & Cognitive Processes (adapted from: Dasgupta, 1996; Purao, 2002; Takeda et al., 1990; V. Vaishnavi & Kuechler, 2004)

* An operational principle can be defined as “any technique/frame/reference about a class of artifacts or its characteristics that facilitates creation, manipulation and modification of artifactual forms” (Dasgupta, 1996; Purao, 2002)

- Awareness of the Problem** - DSR is often referenced as "Improvement Research" and this designation emphasizes the problem-solving/performance-improving nature of the activity. All Design begins with Awareness of Problem, which is not only identified but also defined, leading to “more time defining the problem before deciding to build a tool” (Purao, 2002). In this Thesis, the context of ever-evolving technology affecting the workplace, increases the need to support employees in quickly learning new skills, by improving their self-

awareness and auto-regulation. In addition, and by collaborating in an international project (Active@Work), there is also a strong focus on promoting active aging measures in the workplace, at the same time that improves senior employees' life quality, due to the lack of innovative paradigm-changing solutions.

- **Suggestion** - The Suggestion phase follows immediately behind the proposal and it's intimately connected with it as the dotted line around Proposal and Tentative Design (the output of the Suggestion phase) indicates. This is an essential creative step wherein new functionality is envisioned based on a novel configuration of either existing or new and existing elements. "Suggestions for a problem solution are abductively drawn from the existing knowledge base for the problem area, which may or not be adequate for the problem identified, depending on possible knowledge gaps" (Peirce, 1931). An attempt is made at creatively solving the problem, based on the existing knowledge. The SDM addressed in this Thesis intends to provide a set of functionalities to create a highly motivating and rewarding environment that makes it easy for employees to manage/develop their skills, promoting engagement and motivation. To achieve it, the proposal is to explore two predominant research areas: Visual Analytics, Gamification and Talent Management.
- **Development** - The Tentative Design is further developed and implemented in this phase. The techniques for implementation will, of course, vary depending on the artifact to be created, such as algorithms, human/computer interfaces, and system design methodologies or languages. An expert system embodying assumptions about human cognition in emergent areas like the ones described in this Thesis: Gamification and Visual Analytics, will require innovation paradigm-changing solutions, in order to meet business needs. The implementation itself can be very straightforward and may not involve novelty, beyond the state-of-practice for the given artifact. The solution - a tentative design - is used to implement an artifact. Partially or fully successful implementations are then evaluated according to a functional specification during the Evaluation stage. The main objectives of this Thesis are outlined on events management/monitoring through Visual Analytics dynamic/personalized dashboard interfaces, where the generated artifacts corresponds to a set of mockups (see Chapter 3 for more details).
- **Evaluation** - Once constructed, the artifact is evaluated according to criteria that is frequently made explicit in the Proposal (Awareness of Problem phase). The evaluation phase contains an analytic sub-phase in which hypotheses are made about the behaviour of the artifact. The results acquired in the construction of the artifact are compiled, in order to

feedback another round of Suggestion (circumscription arrows of the Figure above). This leads to a new design, frequently preceded by new literature research in directions suggested by deviations. In this Thesis, the preliminary mockups were presented as a baseline for discussion with the Active@Work project team members, to check if it satisfies user needs and intended uses. The outcome of these discussions lead to another round of Suggestion, where proposed adjustments to the design were made based on deviations. Development, Evaluation and further Suggestion are frequently iteratively performed in the course of the research effort. The basis of the iteration, the flow from partial completion of the cycle back to the Awareness of Problem, is indicated by the Circumscription arrow. The Circumscription process is especially important to understanding design science research process because it generates understanding that could only be gained from the specific act of construction. Circumscription is a formal logical model method (McCarthy, 1980) that assumes that every fragment of knowledge is valid only in certain situations. Discovering that things don't work "according to theory" is part of the DSR learning process. This is part of the incomplete nature of any knowledge base and it contributes with valuable constraint knowledge to the understanding of the "always incomplete theories" that abductively motivated the original research.

- **Conclusion** - This phase is the end of a research cycle or of a specific research effort. The results of the effort are consolidated and the knowledge acquired in the effort is frequently categorized as either "firm" - facts or behaviour that have been learned and can be repeatably applied or as "loose ends" - anomalous behaviour that defies explanation and may well serve as the subject of further research. Depending on the type of knowledge contribution and the state of knowledge in the area of research, the expectations on the nature and depth of knowledge contribution outputs can vary. The creative cognitive processes of reflection and abstraction are used in the Conclusion phase to make knowledge contributions of principles and possibly design theories. At the conclusion of the research project, the overall contribution made by the research project to advance knowledge in the research area needs to be argued. In this Thesis, through the combination of Gamification techniques with Talent Management, new processes are designed to engage, motivate, and retain highly productive employees, fostering a competitive working environment, where dynamic/personalized Dashboards enables employees to monitor to access relevant information, promoting self-awareness & auto-regulation mechanisms.

The credibility of the research findings is an important aspect of any research work success and is influenced with the appropriate selection of research methodology. Research methodology is the overall approach to be used in the research work process from the theoretical foundations of the research object to the collection and analysis of the data. In this context, DSRM has been presented and justified as the research methodology adopted for this Thesis using design, analysis, reflection and abstraction for achieving a better understanding about the problem scope, environment and in the identification of stakeholders concerns and interests in the system. A typical DSR workflow, which combines the DSR process model-focus with the Cognitive process-focus can be defined in five process steps (Awareness of Problem, Suggestion, Development, Evaluation and Conclusion), the same approach was followed in the specification and development of the SDM in this Thesis.

2.2. Visual Analytics Framework

Visual analytics is an emerging research discipline that intends to ensure the best possible use of enormous loads of information in a wide variety of applications by combining typical methods of Business Intelligence with the visual perception and analysis capabilities of the human user.

The visual analytics is characterized through interaction between data, visualizations, models about the data, and the users in order to discover knowledge (D. A. Keim, Kohlhammer, Ellis, & Mansmann, 2010). Figure 7 illustrates an abstract overview of the different stages (represented through ovals) and their transitions (arrows) in the visual analytics process. The visual analytics process aims at tightly coupling automated analysis methods and interactive visual representations.

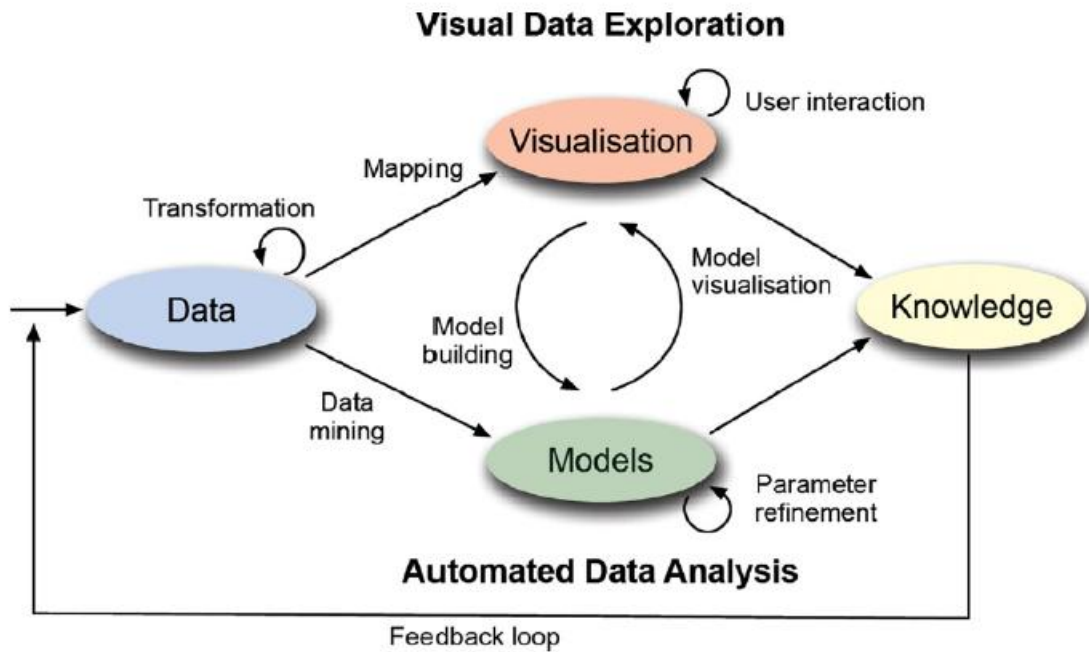


Figure 7. Visual Analytics process (source: Daniel A. Keim et al., 2010)

The guiding principle of the visual analytic framework is to visually explore the information based on “Overview first, zoom/filter, details on demand”, (Shneiderman, 1996) describes how data should be presented on screen. In this Thesis, information is perceived as basic (or source) data complemented with spatio-temporal context information characterizing the basic data, eventually with additional characterization aspects related to the user profile and/or role/function (generically defined as metadata). With massive datasets at hand, it is extremely difficult to get an overview visualization without losing relevant patterns, which makes filtering techniques useless, taking in consideration the little amount of information given to users to examine further.

In many application scenarios, heterogeneous data sources need to be integrated before visual or automatic analysis methods can be applied (e.g., data cleaning, normalisation, grouping, integration). Therefore, the first step is often to preprocess and transform the data to derive different representations for further exploration (as indicated by the Transformation arrow in Figure 7).

After transformation, the business analyst can choose between visual methods of analysis or the use of automated methods. If an automated analysis is applied first, the analyst has different data mining techniques to infer patterns from the original data model. Once a new model is created, the business analyst has to evaluate and refine the model, using visualization and exploitation of data techniques. The visualization component allows the interaction of the

analyst with the automated methods, to modify the settings or choosing other algorithms. The goal is to refine and assess the appropriateness of the knowledge generated when implementing the selected models.

Overall, this process intends to speed up the generation of knowledge, through the analysis of data according to its value and interest (semantic context), highlighting the most relevant aspects of data, while providing models of interaction which allows the user to get more details about data, in their process of search and understanding of data. The Visual Analytics framework includes a set of concepts, all essential for effective analysis (D. Keim et al., 2008), the ones considered as the most relevant for this Thesis are:

- **Visualization** – this is a core concept that can be classified as "Scientific Visualization" (Friendly, 2009) when it refers to abstract data visualization where there is the need to infer spatio-temporal context (e.g., numbers and alphanumeric data with timestamps and georeferenced data). A visual analytics approach, with spatio-temporal regions, to forecast hotspots is presented in (Maciejewski et al., 2011). A typical interactive spatio-temporal visualization system is also presented in BirdVis (Ferreira et al., 2011) with geographic data views to understand bird populations. The capability to interact with this information is extremely important and, as such, different approaches using automatic data analysis techniques such as clustering or size reduction have been studied.
- **Data Analysis (also known as Data Mining or Knowledge Discovery)** - the inclusion of the concept of data analysis in this paradigm is due to the need for automatic extraction of knowledge from raw data and streamline the entire Visual Analytics process. There are several approaches to the development of computational methods that automatically analyze and extract useful information. The supervised learning approach requires a data sample so that the solution can "learn" from there and use, for example, deterministic and probabilistic algorithms, decision trees and neural networks. The unsupervised approach requires no prior knowledge of information, meaning that data are automatically grouped based on similarity criteria. The clustering algorithms are an example of a technique used in this approach.
- **Data Management** - Efficient management of data from different sources of information constitutes an essential element of Visual Analytics paradigm. A primary condition for data processing and analysis is an integrated and consistent data basis (Han, Kamber, & Pei, 2011). With the advent of the Internet and the ease of getting a large amount of heterogeneous data, came also new challenges in this domain, particularly in developing

databases capable of storing and cataloging all types of received data (numeric, text, audio , video, semi-structured data, semantic representations, etc.). Some approaches using data fusion techniques have been used in order to automate this process (Naumann & Bleiholder, 2006). The use of data management techniques, based on intelligent methods of data analysis and visualization techniques, optimize the entire process of data acquisition and storage.

- **Data analysis Space-Time** - the Visual Analytics process should also consider the existence of spatial data (e.g., geographic measures, GPS data) and temporal data (information normally varies with time). Finding or establishing relationships between these two data types brings challenges (Andrienko et al., 2007) both in terms of the complexity of the scales as the level of uncertainty associated with the often incomplete information collection and acquired at different times.
- **Human Perception and Cognition** - this Visual Analytics element is associated with the human aspect in the analysis of the data. While perception is the ability of humans to interpret what surrounds it (i.e., the reported information), cognition is the ability to understand what the visualization means and make inferences based on prior apprenticeship. Effective Visual Analytics-based system should be provided with Dashboard type interfaces, to optimize human-machine interactions (Sears & Jacko, 2007).

The Visual Analytics process combines methods of visual and automated analysis through interactive visual interfaces (e.g., Interactive Dashboards), synergistically combined with database operations and computational processing. Dashboards are a particular type of Decision Support Systems (Arnott & Pervan, 2005) and can be defined as “a visual and interactive performance management tool that displays on a single screen the most relevant information to address individuals and/or organizational goals, allowing the user to identify, explore, and communicate problem areas that need corrective action” (Yigitbasioglu & Velcu, 2012).

With the increasing amount of information that is generated daily, users feel a constant need to monitor the business model dynamics. For this reason, tools with intuitive interfaces where the information is displayed according to different perspectives of different analysis and levels of granularity (e.g., strategic, tactical and operational). Thus, Dashboards may be used by different users such as front-line workers to monitor inventory, by middle managers to analyse lagging measures, and by executive managers to evaluate strategic performance against

objectives. In this Thesis, the approach to the concept of interactive and personalized Dashboards advocated in the SDM was designed to incorporate the following concepts:

- **Self-Awareness**, capacity of introspection and the ability to recognize where the employee currently is, in comparison with his peers, objectives and commitments. Through building self-awareness, the employee will have a clearer understanding of the areas of behaviour that he needs to manage more effectively. In this Thesis, this self-awareness culture, supported by the SDM, is promoted by addressing employees' needs to access relevant information, encouraging them to career development and progress, enriching their CV to match the increasing business needs of an extremely competitive employment environment.
- **Auto-Regulation**, compliance with goals and inference deviations from the objectives and commitments. In this area, the incorporation of progress monitoring techniques, combined with Gamification techniques, presents additional stimulus in overcoming the challenges. In this Thesis, the analysis of auto-regulation in collaborative environments brings incentives resulting from teamwork, mutual support and share of experiences, possibly complemented with mentoring actions by more experienced colleagues (e.g., senior employees) or upper rated in the ranking. The visibility and risk exposure triggered by events (e.g., certification is about to expire, employee interests in the current position or where the employee plans to move in the short / medium term) according to the user model (e.g., user profile and/or role/function) tend to monitor the adoption of desired behaviors and therefore an overall improvement of the results.
- **Data analytics**, science of examining raw data with the purpose of extracting knowledge from that information. In this Thesis, the analysis of raw data, according to its value and interest (context), is key to support the user's decision process. The SDM is a Decision Support System (DSS), intended to help decision makers (i.e. employees), by providing them all the relevant information, regarding the actions that must be performed. The timestamp data reported, together with the information representation of data (e.g., context and semantics) define the metadata info-structure of support to the data characterization/business model.

In this Thesis, the incorporation of Visual Analytics will explore the combination of typical methods of Business Intelligence with the visual perception and analysis capabilities of the human user, to ensure the best possible use of the increasing amount of information received. Thus, the SDM will make use of Visual Analytics concepts like Data Analysis (via metadata info-structure of support to the data characterization/business model) and Human Interaction

and Cognition (via Self-Awareness and Auto-Regulation). Through intuitive interactive/personalized Dashboards, most relevant information is displayed according to different perspectives of different analysis and levels of granularity, enabling it to be used by different users and allowing them to identify, explore, and communicate problem areas that need corrective action, in order to achieve one or several individual and/or organizational goals.

2.3. Talent Management from the Skills perspective

Talent management (TM) is the science of using strategic human resource planning to improve business value and to make it possible for companies and organizations to reach their goals. Everything done to recruit, retain, develop, reward, engage and make people perform forms a part of talent management as well as strategic workforce planning. A talent-management strategy needs to link to business strategy to make sense.

For supporting an organization's need to plan, attract, retain, develop, reward and engage talent, an integrated set of applications is required. Such applications include workforce planning, talent acquisition/onboarding, performance appraisal/assessment, goal management, learning management, competency management, and career development, among others. These functional components align with the key human capital management (HCM) processes of plan to source, acquire to onboard, perform to reward and assess to develop. A further boost to the TM market is offered with functionalities to improve workforce engagement and collaboration, as well as to provide greater analysis and even predictive insights to improve decision making around workforce actions.

According to “Critical Capabilities for Talent Management Suites” report (Gartner, 2015), “providers of TM solutions are aggressively adding new features to keep up with demand for workforce effectiveness in the digital workplace, but offerings still vary significantly”. For this reason, “HR leaders should focus on a product's critical capabilities when evaluating the evolving vendor landscape”.

Software Vendors rated as Leaders are not necessarily rated highest in specific use cases. This report is a product-focused evaluation and analyses TM according to seven critical capabilities (Recruiting, Onboarding, Performance and Goals, Learning Management, Compensation Management, Career and Succession, and Reporting and Analytics Tools) against four use cases (Attract and Retain Talent, Develop the Workforce, Pay for Performance, High-Volume Talent Management), to identify which ones most closely fits organizations potential use of TM technology.

In this Thesis, from these seven critical capabilities presented in this report, the most relevant ones, from a Skills Management & monitoring perspective, are: Onboarding, Performance and Goals, Learning Management, Career and Succession and Reporting and Analytics Tools, which are described below.

- **Onboarding**, bridges the gap between candidates and employees. Involves form and task completion, integration to a core Human Resource Management System (HRMS) for hiring process management, integrated talent processes and support newcomers in their first working day - "Day 1". In this domain, what is addressed in this Thesis is that senior employees can take part on the Onboarding process. The reason for this is that the experience and the knowledge of the organization culture detained by senior employees are valuable assets to be shared with newcomers. Such approach would provide a relevant role for older employees to be involved in onboarding tasks of new employees, providing at the same time a strong message of recognition where their knowledge and experience are considered as important information to share.
- **Performance and Goals**, tools to align the workforce with organization and team strategic and operational goals and objectives, establish individual and team goals, evaluate performance, and provide periodic feedback. Performance appraisals, goal management, competency/skill assessments, development planning, and manager and peer feedback are common elements. In this Thesis, the Visual Analytics Dashboards are defined as a visual and interactive performance management tool that displays on a single screen, by means of indicators, the most relevant information needed to achieve one or several individual and/or organizational goals, allowing the user to identify, explore, and identify which areas require the user attention and action.
- **Learning Management**, includes tools to develop, offer and track learning, create/manage content, manage skills and competency development, and engage in multimodal learning (e.g., class, video, mobile, offline, social, and discussions). In this Thesis, it's described an interactive training environment (Training Catalogue), which enables the employee to enroll in the advised training offers, increasing their skills, abilities and the overall CV Evaluation, in order to stay aligned with the organization's strategic and operational goals and objectives.
- **Career and Succession**, how employees and organizations can together build career and succession plans, using employee/talent profiles, career plans/paths, visualization (e.g., org charting and n-box grids), talent pool management, succession planning, talent

review/assessment, and impact analysis. In this Thesis, the Visual Analytics Dashboards enables visibility and risk exposure triggered by events (e.g., certification is about to expire) and provides specific skills trainings and career options (e.g., employee interests in the current position or where the employee plans to move in the short / medium term) according to the user model (e.g., user profile and/or role/function), in order to increase employees' skills and abilities and carry out their responsibilities into the company.

- **Reporting and Analytics Tools**, this value is the average product satisfaction rating from customer reference feedback on the full range of reporting and analytic tools, including standard reports, ad hoc report tools, metrics dashboards, and embedded analytics in business application processes or predictive analytics. In this Thesis, through Visual Analytics Dashboard interfaces alert mechanisms and indicators, employees are enabled to perform a monitoring progress of their skills and performance, promoting an immediate behavioral change and adoption of best-practices.

This Critical Capabilities report analysis differentiates each vendor's solution based on the four most common use cases for TM, where the importance of specific functionality depends of the business context.

- **Attract and Retain Talent** - Organizations embracing a TM approach prioritize Recruiting/onboarding, performance/goals management, career/succession management and learning management over other criteria. In this use case, organizations focus on attracting, evaluating and selecting candidates for available openings, reinforcing their employment brand with a smooth and effective onboarding, and retaining top performers with a broad set of performance management, talent review and career development processes. Organizations embracing this use case tend to be growing within their market segments and/or expanding into other segments and geographies.

The SDM addressed in this Thesis follows a similar approach, it also intends to stimulate the user interest in improving his/her skills and to keep the user engaged, informed and motivated to keep using the SDM. The main goal is to help organizations to retain their most productive and talented employees. The combination of these functionalities with Gamification techniques like reputation and recognition induction, will foster a healthy competitiveness and create high-performance and sustainable organizations that meets their strategic and operational goals and objectives.

- **Develop the Workforce** - Organizations embracing a TM approach prioritize learning management, performance/goals management, and career/succession management over

other criteria. In this case, the focus is on improving and measuring the capabilities of the employee, not only for enhanced worker performance in current positions, but also to fit with other roles or even job opportunities. These organizations career promotions tend to be from inside (as opposed from outside recruitment), this is a typical recognition of the value of long-term workers as opposed to short-term workers who easily leave the organization in the first opportunity they find attractive. As a result, providing personalized learning plans and measure employees' learning effectiveness are top priorities.

Through the combination of Gamification and information visualization mechanisms and indicators, the SDM addressed in this Thesis intends to keep employees aware about their skills and performance and encourage them to upskill their competencies and invest on career progress. These new skills can be selected through dynamic events triggered by an IA and based on metadata from the user profile and/or role/function, or via a training catalogue which has an enormous and diverse skills offering, where employees can search and submit their skill(s) request(s). Based on the reported interests, career ambition or role needs, the system is able to provide recommendations regarding which soft and hard skills are more adjusted to the employee interests, in order to increase employees' skills and abilities and carry out their responsibilities into the company.

- **Pay for Performance** - Organizations embracing a TM approach prioritize performance/goals management, and compensation planning functionality, trying to strengthen the link between workforce pay and performance. In this use case, organizations focus on attempting to strengthen the link between perceived performance and the various forms of compensation (base pay, bonuses, incentives and equities, for example) paid to workers by deploying such processes as goals management, robust performance appraisal, and comprehensive compensation planning.

The use of gaming techniques (e.g., scoring, ranking) can motivate employees to constantly invest effort to improve their performance (e.g., rank classification, encourage ambition/self-achievement) and introduce reward mechanisms to promote behavior change by encouraging/challenging the user. These rewards should be allocated for compensation of progress and should focus on tying individual performance and compensation to business outcomes. In the context of the SDM, employees may not enjoy learning new competencies, yet they are motivated to continue doing so because of the possibility of something tangible (e.g., monetary compensation, promotion) at the end of the process.

- **High-Volume Talent Management** - Organizations embracing a TM approach are in high-volume/high-turnover industries and stress efficient recruiting/onboarding, performance/goals management and learning management over other criteria. In this use case, organizations tend to employ large numbers of workers (often hourly/low-level salaried) in substantively similar roles, and the focus is on maintaining headcount levels by hiring and deploying workers as quickly and efficiently as possible. A straightforward and effective assessment of the employee's ability to meet current job responsibilities is key, with a short-term learning focus on getting staff trained quickly and ready for immediate and next roles.

The SDM addressed in this Thesis intends to improve and strengthen employee skills. In order to provide adaptive and personalized learning plans and recommendations, it will be necessary the combination of immersive advanced learning capabilities in order to obtain highly personalized learning experiences. This is particularly true for key learning indicators and indicators about the employee skilled level. Machine learning techniques and algorithms can help improve the quality of the diagnostic information presented by TM, in order to provide recommendations more adjusted to the profile / role of each user.

The “Critical Capabilities for Talent Management Suites” report (Gartner, 2015), demonstrates that Critical Capabilities analysis differentiates the appropriateness of each vendor's solution based on the four most common use cases for TM. In this Thesis, the incorporation of TM will explore the combination of information visualization techniques with Skills Management & monitoring related critical capabilities like Onboarding, Performance and Goals, Learning Management, Career and Succession and Reporting and Analytics Tools against the most common use cases for TM like Attract and Retain Talent, Develop the Workforce, Pay for Performance and High-Volume Talent Management. Thus, the SDM addressed in this Thesis, by adopting processes designed to engage, motivate, and retain highly productive employees, intends to help organizations to maximize potential use of TM technology, creating a high-performance and sustainable working environment that meets their strategic and operational goals and objectives.

2.4. Gamification

Gamification is an emerging concept that started in 2010 and which still does not have a precise definition because its scope and applicability to new domains increases each year,

therefore a consensual definition has not yet been agreed on. One of the definitions that found widespread acceptance defines Gamification as the use of game-thinking and game mechanics in non-game contexts in order to engage users and solve problems (Huotari & Hamari, 2012).

Another relevant definition for Enterprise Gamification, as an empathy-based process of introducing, transforming and operating a service with affordances for gameful experiences to teach, engage, entertain, and measure to support players' overall value creation for indirectly supporting an entity's overall value creation (Herger, 2014).

In simple terms, it is a fun, outcome-based process of using “game” elements techniques that game designers use to engage employees, reward and recognize individuals and keep people motivated to achieve - sometimes extremely - ambitious results, adding value to business and promoting loyalty. Organizations continuously encourage employees to achieve business goals and are challenged to promote working environments driven by healthy competitive practices. Using gaming techniques (e.g. scoring, rewards, badges, etc.) can encourage employees to constantly invest effort to improve their performance (e.g. rank classification, career development, encourage ambition and self -achievement) and stay aligned with the organization's strategic and operational goals and objectives. This is seen as a powerful 21st century way of stoking the competitive nature of human beings — particularly millennials (i.e., a person reaching young adulthood around the year 2000) who have grown up in a digital world where gaming is often the rule not the exception (Senthil Rajamarthandan, 2015).

To properly leverage Gamification, organizations must first understand basic game mechanics that successfully engage employees. A company willing to explore and apply Gamification activities should start by identifying ways to encourage participants to achieve key goals — and those goals should be aligned with the organization's strategic and operational goals and objectives. Gamification can be adopted by organizations for internal (workforce) or external (customers and/or partners) initiatives. In this thesis, the focus will be on internal initiatives.

In the traditional feedback cycle, only at the end of the civil year employees receive feedback related to their global performance assessment, usually done by their hierarchical supervisor or management structure. By changing existing processes, organizations can achieve fast and meaningful/accurate feedback, accelerating employees' growth and learning. Unfortunately, in most organizations, short-term goals are unclear, particularly as the business environment evolves quickly, making change inevitable. Moreover, business rules often lack

transparency; rewards and recognition are rarely given to participants who consistently exceeds expectations across all dimensions throughout the year.

Organizations need to change their working mindset and establish small wins, with intermediate milestones and guidelines to master new skills, keeping employees motivated to continuously contribute to add value to business, meaning to be a valuable asset to the organization. To increase competitive advantage, the organization should adopt tools to enable employees to earn rewards and respect/recognition within their peer groups, as well as to monitoring their skills and compare each competency with the ones required by the organization or demanded by the peer group or even by relevant competitors. The key is to create competition in a scalable and automated way that can be used to drive repeatable results in a sustainable manner. Driving competition, cooperation, networking and knowledge-sharing among employees is critical to achieve short and long-term organization's strategic and operational goals and objectives.

Under this Thesis, motivation, challenges and competitiveness are seen as key elements for the construction of a successful organizational network, eager to interact with the tools to recognize their added value and above all to become promoters in using the SDM. This strategy is based on the principle that motivation is a key pillar to retain and attract employees. Building trust in relationships increases retention, engagement and rewarding of these employees, gradually creates a motivated community committed to success factors relevant to both the employee and the organization. In the literature it is possible to find two driving forces: intrinsic motivation related to inner strength (Mekler, Brühlmann, Tuch, & Opwis, 2015) and extrinsic motivation related to the surrounding context (i.e., with external factors).

- **Intrinsic motivation (IM)** drives behaviors that result in internal rewards, like enjoyment, positive feelings and happiness. With increasing IM, people have a genuine desire for the activity, leading to an increase of their self-esteem (SE), and therefore a greater propensity to complete tasks, predisposal to cooperate and eagerness to learn. As a consequence, significant improvements in the process of learning / using the SDM leads to a deeper understanding and the creation of fitness. In other words, greater willingness to look at the SDM as a personal tool set for themselves without third-party interference, addressing their concerns, needs and interests.
- **Extrinsic Motivation (EM)** involves doing something for its external rewards, like money or something tangible. The application of extrinsic motivational elements is suitable for specific situations, where people have resistance (or little interest) to the initial

implementation of a particular activity or adoption of a new technology (i.e. a typical behavior of resistance to change). In this scenario, the introduction of reward mechanisms can promote behavior change by encouraging / challenging the user. These rewards should be allocated for compensation of progress and should be directly linked to the performance of a specific behavior. In the context of the SDM, employees may not enjoy learning new competencies, yet they are motivated to continue doing so because of the possibility of something tangible (e.g., monetary compensation, promotion) at the end of the process.

Gamification uses an approach based on empathy (with origins in Interaction Design and DSR), introducing concepts built on observation of the experiences, needs and preferences of the users. It provides a search process for determining an appropriate solution for a given problem, for a number of iterative cycles over which the solution is incrementally refined, ultimately resulting in a successful implementation and improving the human-machine interface. In the scope of the SDM, the following Gamification techniques were analyzed and considered to be applied within the Active@Work project:

- **Merit & Leadership Board** - an emerging practice in the prospective organizations to assign leaderboards in different areas of knowledge. The presence in the top-performers board will be a diffusion mechanism of leadership and mastery of assigned functions and goals (over)achieved. The connection to an organizational networks represents a leverage to create competition through levels of excellence and will contribute to the enhancement of the CV.
- **Levels and Reputation (Scoring & Ranking)** - techniques that induce feelings of pride, professionalism and therefore of greater responsibility in the user-subscribed challenges. These techniques stimulate commitments in terms of engagement and involvement of the user in his career progress, to improve its ranking in order to match or exceed those with a rating better and therefore to a better position in the league table (i.e., ranking).
- **Competition** - this technique intends to stimulate behaviors of healthy competition, promoting group dynamics and therefore stimulate cooperation between employees or employees' groups. In a pragmatic approach, this technique is used to describe a situation in which success is measured in terms of results.
- **Points (Point System)** - common technique in loyalty systems, it intends to incorporate best practices to create tools of promoting and retaining talent, able to fidelize talents rewarding them with the chance to make use of the benefits associated with points earned in the SDM. In practice, it is a technique to motivate and encourage desired behaviors.

In this Thesis, the incorporation of Gamification will explore paradigms based on game theory and take advantage of technological advances to benefit employees and organizations. Thus, the SDM will make use of concepts like Merit Boards (via Assessments), Levels & Reputation (via Scoring & Ranking) for, through a Skills Management interface (see section 3.3.2 for more details) using data analysis techniques expressed in indicators (i.e. Dashboards type interfaces), provide information to the employee regarding their skills, recognition of their efforts, stimulating competition and motivation to improve their CV.

3. Skills Management Awareness Model

This chapter describes how the research challenges were conducted, including the research work related to theoretical frameworks and assumptions. The chapter also provides a description to the assessment of the suitability of the proposed method, reliability of the expected outcomes and validity of the model flexibility and applicability to other TM domains. The proposed solution for the problem identified in Chapter 1 is also presented.

3.1. The role of Active@Work in Skills Management

The theoretical framework associated to the research work that supports this Thesis aims to contribute to improve employees' self-awareness and auto-regulation, through the specification of the SDM, a software component that is part of the overall architecture of the Active@Work project (see chapter 4 for more details). In this Thesis, two predominant research areas are object of great interest: Visual Analytics and Gamification. The Visual Analytics provided the theoretical foundation to specify personalized dashboard interfaces with a set of indicators defined in an innovative way. Based on an info-structure, each indicator can be specified dynamically by the business user at run time without requiring the intervention of any programmer. Associated to each indicator a set of thresholds will trigger notifications whenever those thresholds are exceeded keeping the user aware whenever their intervention is required.

The incorporation of Gamification techniques like Merit Boards (via Assessments), Levels & Reputation (via Scoring & Ranking), Points (via CV Evaluation) and (healthy) competitiveness, through data analysis techniques expressed in indicators (i.e. Dashboards type interfaces), intends to take advantage of technological advances to promote employee's awareness regarding their skills, recognition of their efforts, stimulating competition and

motivation for auto-regulation, in order to keep the CV aligned with the expertise required or valorized by the organization, benefiting both parts.

Through the combination of Gamification techniques with Talent Management, processes designed to engage, motivate, and retain highly productive employees were adopted, to foster a sustainable and competitive working environment, where employees are encouraged to develop new skills or invest in career options. The SDM addressed in this Thesis provides a way to assist employees in keeping their CV aligned with what is required from the employer point-of-view as well as from an academic or professional perspective keeping the employee aware about recommendation to improve the skills level so that the CV assessment is kept at higher rates.

Within the scope of the Active@Work project, the management of employees skills is foreseen as a critical requirement in promoting a healthy but competitive and demanding work environment where each employee is encourage to continuously improve his/her knowledge and expertise. This effort is publically recognized by the organization through the adoption of a solution with the capabilities defined for the SDM. Such approach is particularly adjusted in the area of Consulting and IT Service Delivery (White-collar workers³) with a focus on promoting active aging initiatives in the workplace. By encouraging senior employees to share their valuable skills and expertise with less experienced employees or newcomers, the theoretical foundation is to keep them motivated, increasing at the same time team spirit. The Active@Work architecture consists on the following modules (see Chapter 4 for more details):

- A **Cognitive module**, this module is responsible to represent the conditions of the work environment providing a catalogue of services to assist the user in their daily work, avoiding critical clinical situations (i.e., surveillance of clinical parameters by periodically collecting data from wearable bio-sensors and by analyzing data related to the quality of the work space environment, data collected through environmental sensors), assuring in this way workers well-being at the work environment;
- A **Collaborative module**, to promote active participations and interactions between employees, sharing of experiences amongst senior and younger employees. Provide a collaborative environment to endorse innovative ideas as well as the establishment of mentoring services;

³ Cfr: [White-collar worker](#), accessed on 28/05/2016

- A **Skills Development module**, intends to provide support for the employees to engage in new and rewarding activities, where senior employee’s knowledge and expertise can be an important asset. The major goal of this module is to provide a user-friendly environment for employees to manage/develop their skills within the organization. This is the module addressed in this Thesis.

3.2. Workforce Skills Analysis

In the scope of the SDM, the Visual Analytics Framework provides a combination of automated analysis techniques with interactive techniques of information visualization. The objective aims to enhance comprehension of large data sets (i.e., Big Data) for analysis through interactive visual interfaces (i.e., Dynamic Dashboards). The incorporation of Gamification techniques will explore paradigms based on game theory and take advantage of technological advances to benefit employees. The objective aims to make use of techniques like Merit Boards (i.e., Assessments), Levels & Reputation (i.e., Scoring & Ranking) and Points (i.e., CV Evaluation) to provide relevant information to the employee regarding their skills through data analysis techniques expressed in indicators. The articulation of these scientific research areas intends to improve employees’ self-awareness and auto-regulation:

- **Self-Awareness**, the interactive/dynamic Dashboard interfaces are presented as a monitoring instrument, combined with key elements like motivation, challenges and healthy competitiveness, enabling the employee to continuously monitor his/her ranking in relation to his peers, objectives and commitments. Figure 8 provides an overview of the employees’ Personal Skills Dashboard – the section mapped with the A letter. This graphical interface presents the information structured into sections to streamline and enable the reading of the information in an eye-blink. For instance, the section mapped with the B letter, provides information related to indicators such as: the “CV evaluation”, “Assessment”, “Peers Average”, “Ranking” position and “Employee CV composition” (i.e., pie chart) are showed. A detailed explanation about these kind of indicators are presented in section 3.3.1. The section mapped with the C letter, provides information related to “My Messages” area, where alert display features with different levels of severity – Alerts, Warnings and Recommended. This kind of alerts are triggered via multichannel and are also presented in section “My Training History”, where the employee can check either the most recent training courses or the full list of trainings attended - the section mapped with the D letter.

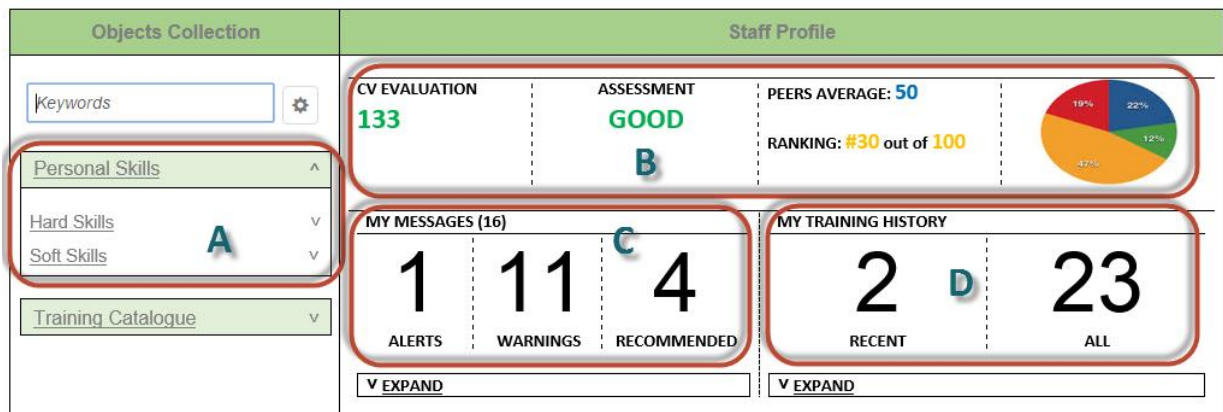


Figure 8. Mockup of the Personal Skills Dashboard layout

By accessing this relevant information, by means of alert mechanisms and indicators, the interface capabilities of the Personal Skills Dashboard enables employees to promote changes in their behavior, which may be extremely important in cases where the employee's CV may lose significant relevancy (e.g., acknowledged competencies versus required skills for the current position), in an increasing competitive working environment. The Skills Management interface (see section 3.3.2 for more details) enables the business user to configure the most relevant indicators, according to the organization's strategic and operational goals and objectives.

- **Auto-Regulation**, in the SDM, the Dashboard is also responsible for keeping the user constantly informed about events requiring his/her immediate attention. Figure 9 illustrates a structure of employees' competencies (Personal Skills) classification, grouped by Hard & Soft Skills categories, and sub grouped in parameters, which represents employee's skills – the section mapped with the A letter. Within the detail of each parameter, whenever applicable the user is informed about the risk of expiring some certification (i.e., professional expertise), through the Status field – the section mapped with the B letter. In response to such notification, the employee can trigger a workflow by activating the “Assign” option, one of the possible operations/status of the Action field, that allows to mitigate the risk associated to the Alert -- the section mapped with the C letter.

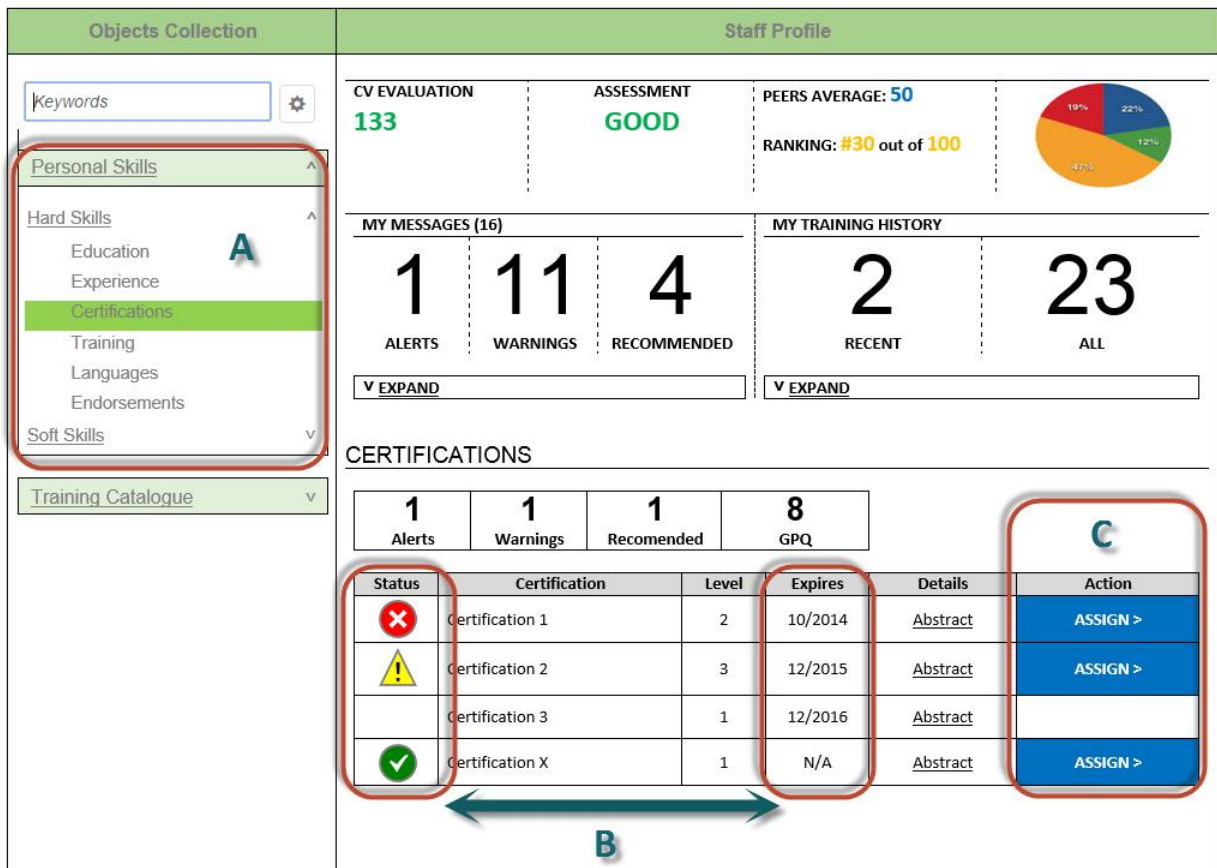


Figure 9. Mockup of the Personal Skills – Certification layout

As presented in Figure 9, the interface is composed by two sections: header and detail. In the header section, the employee can check the messages (alerts, warnings and recommendations) triggered by an IA, based on the information available in the detail section, where the employee can monitor the status (error, warning or recommendation) of each certification or expand the header to check for addition details. In addition, and whenever there is a Skill with status "Alert" or "Recommendation" (status "Warning" is optional) the button "ASSIGN" is shown/activated, enabling the user to trigger an action. In the mockup presented in Figure 9, by pushing the "ASSIGN" button, it will trigger a workflow that submits a request to renew a certification (in case of status "Alert"), or to get a certification (in case of status "Recommendation"). In some cases (normally when the subscription of the training action has a cost/payment fee), a workflow approval is required, these requests are sent to the employee supervisor for further approval/rejection.

Apart from the structure of employees' competencies (Personal Skills) classification, there is also a dynamic/personalized Training Catalogue Dashboard, enabling the employee to enroll in the advised training offers, in order to increase employees' skills and expertise, and

with this, to increase the corresponding overall CV Evaluation indicator. Figure 10 provides an overview of the employees' Training Catalogue Dashboard - the section mapped with the A letter. This graphical interface presents the information structured into sections to streamline and enable the reading of the information in an eye-blink. For instance, the section mapped with the B letter, provides information related to indicators such as: total number of trainees, total number of sessions and average score for the attended trainings. The section mapped with the C letter, provides information related to "My Skills Plan" area, where the employee can check, per Skill Type (e.g., Hard Skills) and Category (e.g., Certifications) and with different levels of relevance – Alerts, Assignments and Recommendations - the list of Training sessions already scheduled and assigned to his/her name (Alerts), the list of Training sessions approved by the business user (Assignments), or the list of Training sessions dynamically recommended by the SDM, based on the user profile and/or role/function.

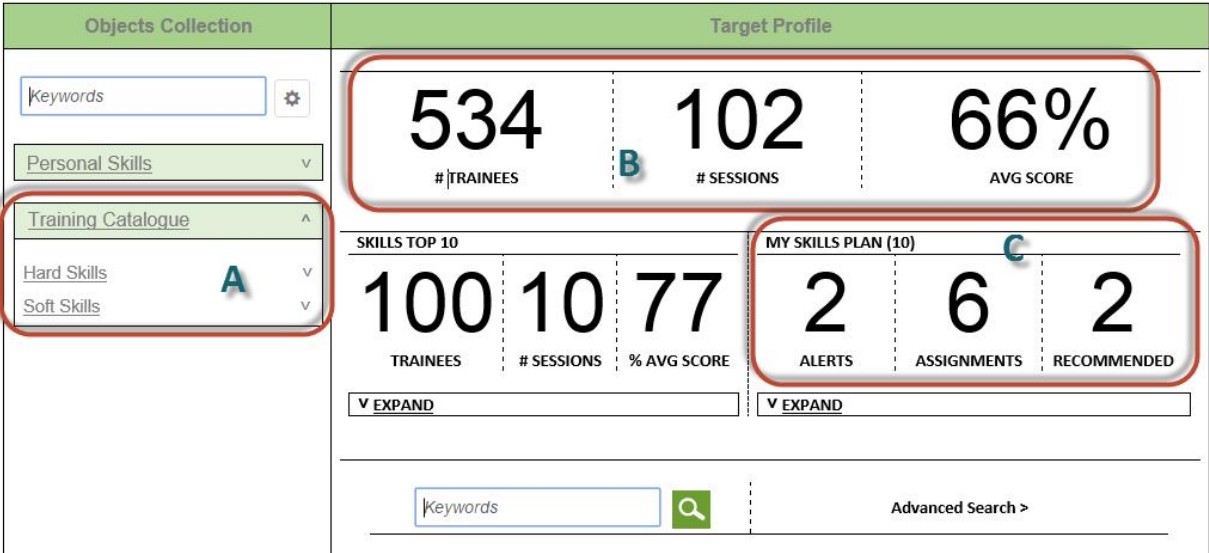


Figure 10. Mockup of the Training Catalogue Dashboard layout

The dynamic/personalized Training Catalogue Dashboard interfaces enables employees to access the information of the most requested training offers, and choose the skills training offers that most contributes for enriching their CV according to current business needs.

The specification of these two Dashboards required the definition of a metadata info-structure capable of integrating all the knowledge about User Models and respective archetypes (i.e., an original model or type after which other similar things are patterned; a prototype) information. Data analysis assumes a strategic dimension in the generation of multidimensional information according to the user profile and/or role/function. The value of metadata aims to

more efficiently classify and organize information, as well as to yield deeper insight into the actions taking place across the organization, providing more intelligence and higher quality information to fuel big data initiatives, automation, compliance, data sharing and collaboration.

3.3. Metadata Info-Structures

Metadata is "data that provides information about other data"⁴. While the metadata application is manifold covering a large variety of fields, there are specialised and well-accepted models to specify types of metadata. These can be distinguished between three distinct types: Descriptive, Structural and Administrative ("Understanding Metadata," 2004). Descriptive metadata describes a resource for purposes such as discovery and identification. It can include elements such as title, abstract, author and keywords. Structural metadata is used to characterize the structure of database objects such as tables, columns, keyword (from a business point of view) and indexes. Administrative metadata provides information to help manage a resource, such as when and how it was created, file type and other technical information.

The SDM addressed in this Thesis is aligned with a solution based on structural and descriptive metadata, which allows a business user to dynamically characterize the data structure of the objects used by the software components of the proposed solution (e.g., Personal Skills, Training Catalogue and the corresponding Dashboards), composed by indicators with different types of assessment. This approach provides a full flexibility, enabling business user to maintain the structure of attributes that characterize each of the parameters available on the system, in addition to complete flexibility in configuring the layout (i.e., dynamic specification of descriptive attributes) according to their information needs, without any intervention from the IT department.

3.3.1. Skills Metadata Management

The maintenance of the structure of attributes that characterize each of the parameters available on the system needs to be kept up-to-date and an appropriate approach for managing metadata needs to be set. In this Thesis the management of Metadata corresponds to an end-to-end process and governance framework for creating, controlling, enhancing, attributing, defining and managing a metadata schema, model or other structured aggregation system, either

⁴ Cfr: [Metadata](#), accessed on 07/05/2016

independently or within a repository and the associated supporting processes (often to enable the management of content).

In the SDM, the Personal Skills Dashboard illustrated in Figure 11 presents a set of indicators providing measurements related to skills monitoring from different perspectives, structured into sections to streamline and assist the reading of the information. For instance, the indicator “CV Evaluation” is represented in the section mapped with the A letter, the indicator “Assessment” is represented in the section mapped with the B letter and the indicators “Peers Average”, “Ranking” position and “CV composition” are represented in the section mapped with the C letter.



Figure 11. Mockup of the Personal Skills Dashboard Indicators layout

The values of each indicator are fed through Gamification techniques. For instance, the value 133 shown for the indicator “CV Evaluation”, expressed as CE for simplification, is obtained through a quantitative calculation of all the employee Hard & Soft Skills metrics, by a means of a formula defined by the business user. This means that, the more skills/competencies the employee has, the higher the “CE” indicator value will be. The complete expression of the CE formula is presented in Table 2.

Table 2. Curriculum Vitae Evaluation - CE (Description, Formula and Example)

Indicator	CV Evaluation (CE)
Description	Quantitative expression to determine the value of the CE indicator which is based on metrics related to Hard Skills and Soft Skills, taking in consideration the weight of each metric.
Formula	$CE = (2AQ + GPE + 2SPE + GPQ + 2SPQ + LQ + EQ + 2CQ) / ND$, where: <ul style="list-style-type: none"> • AQ: Academic Qualifications metric; • GPE: General Professional Experience metric; • SPE: Specific Professional Experience metric; • GPQ: General Professional Qualification metric; • SPQ: Specific Professional Qualification metric; • LQ: Language Qualification metric; • EQ: Endorsements Qualification metric; • CQ: Competencies Qualification metric; • ND: Number of Dimensions (optional).
Example	<p>Hard Skills for a specific Employee which the following expertise</p> <p>AQ: Degree in Management → Weight: 12</p> <p>SPE: 10 Years' Experience in Project Manager → Weight: 16</p> <p>GPQ: Certification in PMP (> 60 hours) → Weight: 5</p> <p>LQ: English (Level 3) → Weight: 8</p> <p>EQ: Scrum (70 Endorsements - Level 4) → Weight: 5</p> <p>Soft Skills for a specific Employee which the following expertise</p> <p>CQ: Teamwork (Very Good) → Weight: 10</p> <p>SPQ: Lead as Example (Training course) → Weight: 8</p> <p>CE: $(2 \times 12 + 2 \times 16 + 5 + 2 \times 8 + 8 + 5 + 2 \times 10) / NM = 110$</p> <p>ND: Not applicable (N/A)</p> <p>If the PMP Certification expires, the system attributes 0 to the GPQ metric, which will cause the employee CE indicator to decrease to 105</p>

The expression to determine the value of each indicator is defined dynamically according to each Organization specific business rules, meaning that the weight of each metric can vary, which influences the formula and the corresponding result. Each indicator is

characterized by a set of metadata, namely: an Indicator type (e.g., Cost, Benefit, On Target), a set of thresholds to define distinct severity levels and dynamically triggers alert notifications, whenever the corresponding values exceed the defined range for each predefined threshold. A detailed list of the indicators defined within the scope of this thesis are described in Annex D.

In the SDM, an example of the maintenance of the structure of attributes that characterize each of the parameters which represents employees' skills is illustrated in Figure 12. The section mapped with the A letter, presents the structure of employees' competencies (Personal Skills), grouped by two main categories (Hard & Soft Skills) and subdivided in Parameters (e.g., Education). The section mapped with the B letter, represents the information associated to the characterization of the parameter "Education" that was assigned to the category Hard Skills. The description of the selected parameter "Education" is accomplished based on a set of attributes, which are managed dynamically using the interface of the Skills Management (see section 3.3.2 for more details). In this case, the value of the Academic Qualifications (AQ) metric is determined based on the information listed on each row, meaning that depending on the number of academic qualifications detained by a specific employee, the higher the value of the AQ metric. This kind of correlation corresponds to a predefined formula that is defined using the Skills Management interface. The current value of the AQ is represented in Figure 12 with the C letter.

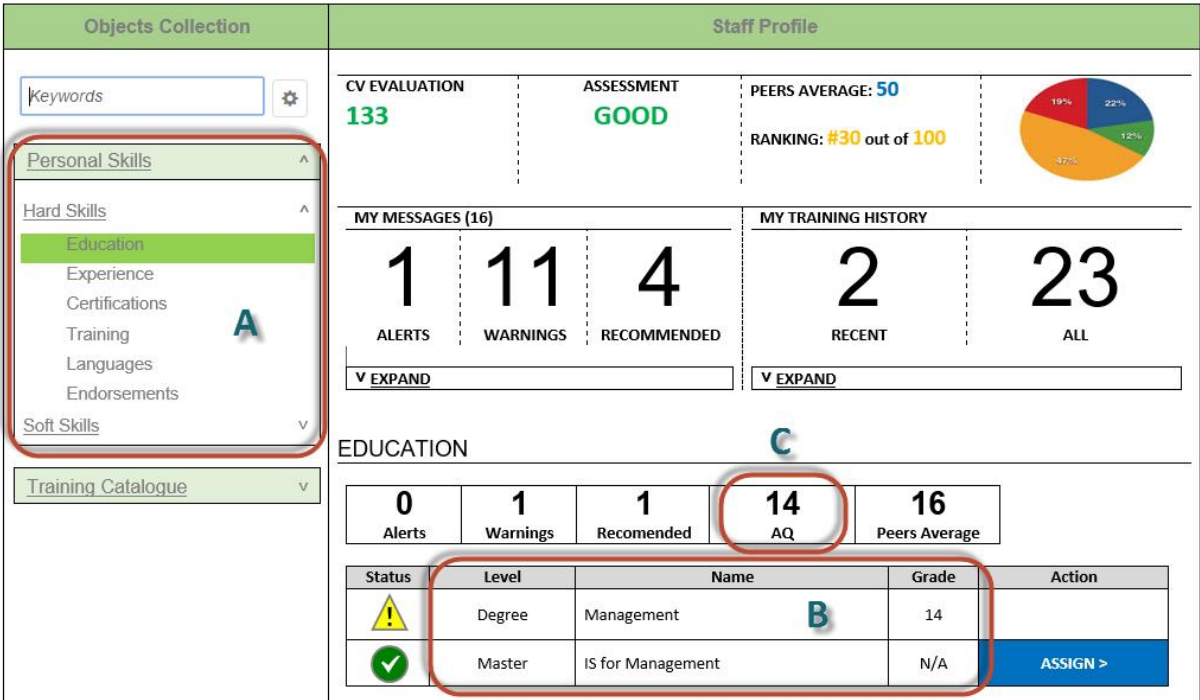


Figure 12. Mockup of the Personal Skills – Education layout

As an example the formula to determine the value of the metric “AQ” in Figure 12 is presented in Table 3. The quantitative calculation of the AQ metric is determined based on the type of academic qualification. The more academic qualifications the employee has, the higher the “AQ” metric value will be. The benefit of the proposed contribution derives from the fact that the expression can change at any time to map any additional academic degree or qualification not initially considered.

Table 3. Academic Qualifications - AQ (Factor, Weight and Description)

Factor	Weight	Description
$AQ = S + D + M + P$		<i>S: Upper Secondary education level</i> <i>D: Degree education level</i> <i>M: Master education level</i> <i>P: PhD education level</i>
AQ: Academic Qualifications	6	Upper secondary education
	12	Degree in area not related to information technology
	16	Degree in computer science area
	2	Master's degree
	2	PhD

The calculation of each metric should be done according to each Organization specific business rules, meaning that the weight each of the “AQ” metric parameters can vary, impacting the value of the “AQ” metric. All Metrics (factors, weights and descriptions) are described in Annex D.

3.3.2. Mockups configuration of Metadata

It is important to note that within this Thesis the approach was to complement, whenever feasible, the description of the metadata info-structure with the presentation of a preliminary mockup to streamline the management of the metadata characterizing the information presented in the Personal Dashboard. The mockup technique is introduced in this phase as a visual information blueprint, facilitating the communication between the end-user and the programmers, with the mediation of the system analyst.

When pitching a design to the team, presentation is always crucial. Mockups are not the final product, they are only a visual schema of the graphical layout of a specific application (i.e., Graphical User Interface – GUI). This means that mockups are a powerful way to keep the design of the solution (i.e., graphical specification of functional and non-functional

requirements) within the project boundaries. In this way, it is possible to graphically express the metadata info-structure in an early stage of the project.

The Skills Management corresponds to a software component of the SDM and it aims to provide a graphical interface to streamline the management of the metadata associated to the informational artefacts presented in the Personal Dashboard, namely, characterization of the indicators, characterization of the metrics, characterization of any descriptive attribute or even defining lists of predefined values. The Skills Management interface implements a Metadata Framework to assist business users in dynamically managing the data structures for both the Personal Skills Dashboard and Training Catalogue Dashboards. As presented in Figure 13 the interface is composed by four main components, correlated with each other: Lists, Parameters, Metrics and Indicators, displayed through a tab menu. These four tabs have a logical precedence that needs to be followed to create, for instance, a standard description to the possible values of a specific attribute to be used as a relevant determinant to the formula of a metric that is used by a specific indicator.

Whenever the business user needs to create a new parameter (e.g., Education), for the category “Hard Skills” under the employees’ competencies (Personal Skills), the user should start by selecting the “Lists” tab. The “Lists” tab enables the business user to define a list of values which can be assigned, if required, to the attributes presented as headlines for the (Skills) Parameter selected in the “Personal Skills/Training Catalogue” menu. When a new “List” is created, the business user should define a name (e.g. List of AQs – Academic Qualifications) and select the type of the field in the “List Type” cell. The user should also define if the List should be active or not by selecting the “Active” option. The list of values created should be assigned to a “Parameter” attribute whenever the business user needs to restrict the input to the domain of values expressed by the selected list. For more details about the creation of a list of values see Annex A.

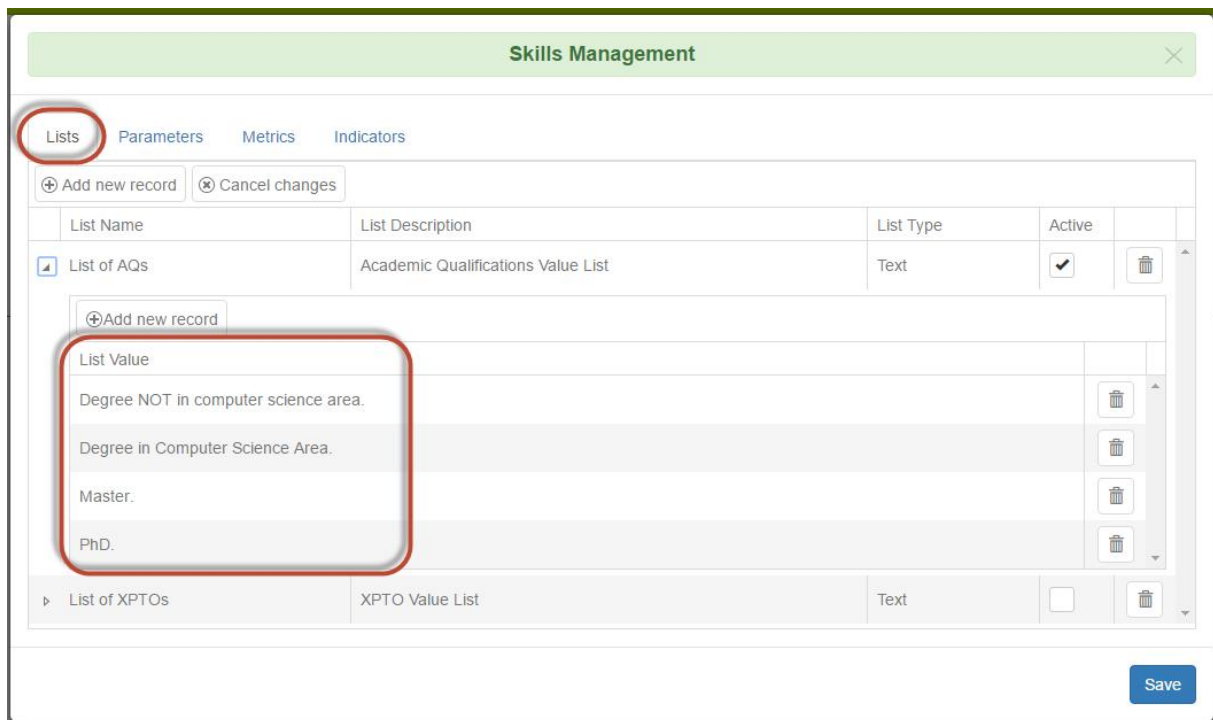


Figure 13. Skills Management – Metadata configuration interface

The “Parameters” tab provides a way to dynamically define the set of metadata that represents the data structure of a skills parameter, enabling the business user to define the attributes of the (Skills) Parameter selected in the “Personal Skills/Training Catalogue” menu. For the new parameter to be created (i.e., Education), the business user starts by filling the “Skills Parameter” and the “Tooltip” (i.e., message which appears when a cursor is positioned over an element in a GUI) cells with “Education”. Then, the business user has to classify it as “Personal Skills” in the “Parameter Group” cell and as “Hard Skills” in the “Skills Group” cell. The “Parameters” UI is illustrated in the Figure 14 below.

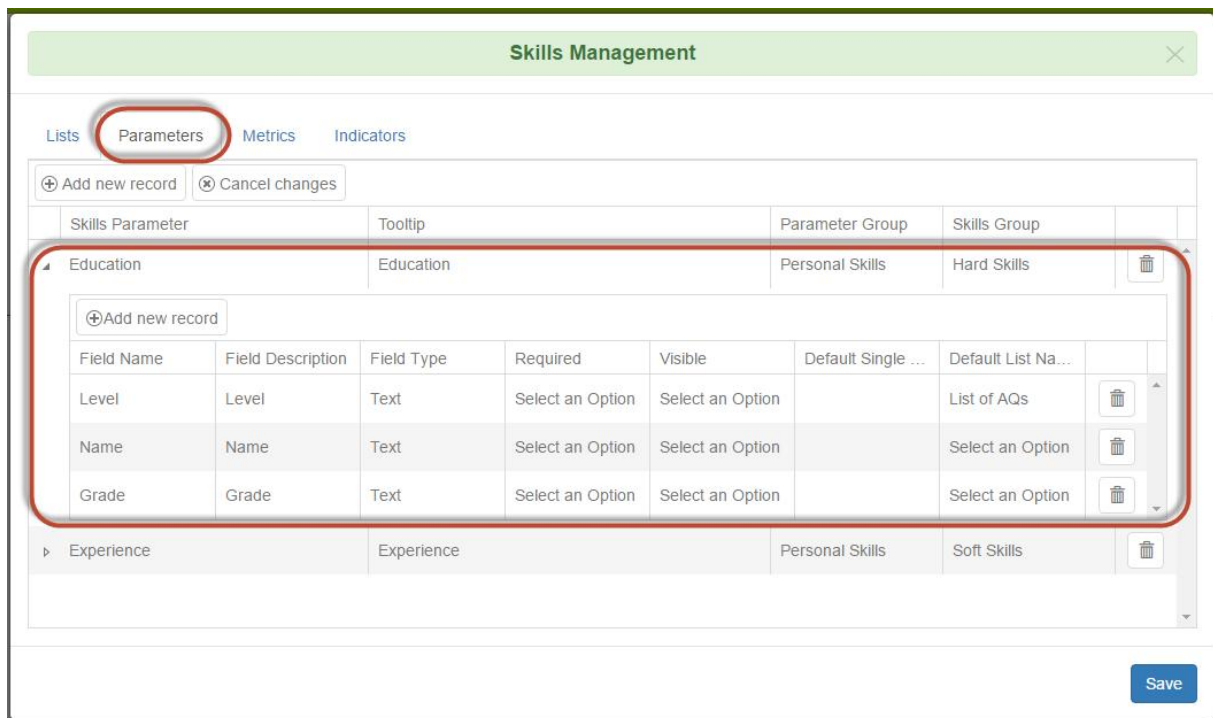


Figure 14. Metadata Configuration - Parameters

When the business user presses the “Expand” icon, the configuration of the metadata available enables the business user to configure the name of the attributes to be presented as headlines in the Workspace area. In addition to the name of the attributes, the configuration of the metadata available allows the business user to specify a “Field Description” and select the type of the field in the “Field Type” cell. The business user should also specify if the field is “Mandatory/Optional” in the “Required” cell and the “Yes/No” option in the “Visible” cell. In case the “Mandatory” option is selected in the “Required” cell, the “Visible” cell should automatically be filled with “Yes”, due to the dependency between both fields. Finally, the business user should decide to define if the field should have a default single value, by filling the “Default Single” cell or it should have a default list of values, by selecting the required “List Name” in the “Default List Name” cell. In the figure above, the list of values illustrated in Figure 13 (i.e., List of AQs) is assigned to the “Level” attribute. In this way, it is possible to restrict the list of values that the attribute “Level” can assume. Any of the attributes created should be assigned to a “Metric” whenever the business user needs to create a set of rules (i.e., formula) and the corresponding values (i.e., weight) for such attribute. For more details about “Parameters” check Annex A.

The “Metrics” tab, provides a way to dynamically define the set of metadata that characterize the structure of a Metric. It enables the business user to dynamically define a new

metric and define the corresponding expression (i.e., formula) that will determine the value of the newly created metric. For each Metric, one or several rules (and the corresponding values, i.e., weights), can be created. For the new “Skills Parameter” created (i.e., Education), the business user starts by filling the “Metric Name” and the “Metric Description” cells. The assigned skill parameter “Education” shall be used as a category of the selected ”Metric” and the cell “Field Name” can only be activated once a valid option is selected for this cell, due to the dependency between both fields. This means that the list of values to be presented in the “Field Name” cell are dependent on the selected “Skills Parameter”. Finally, the cell “List Name” can only be activated once an option is selected in the “Field Name” cell, due to the dependency between both fields. In case the “Field Name” selected is already assigned to a “List Name”, the “List Name” cell is automatically filled with the “List” assigned (i.e., List of AQs). Otherwise, the business user should decide to define if the metric should have a default list of values, by selecting the required “List Name”. The “Metrics” UI is illustrated in the Figure 15 below.

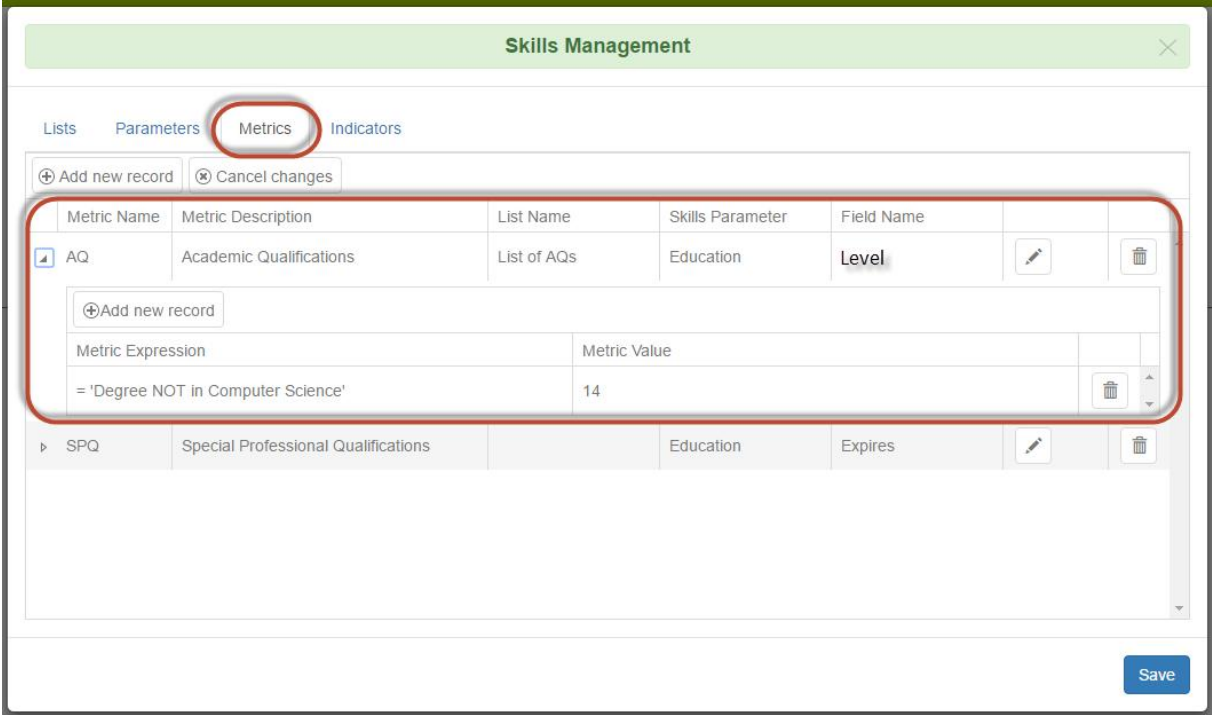


Figure 15. Metadata Configuration - Metrics

When the business user presses the “Expand” icon, the configuration of the metadata available enables the business user to specify a “Metric Expression” and a “Metric Value”, as illustrated above. In case the “List Name” cell is filled, the “List Name” values of the selected “List Name” are automatically assigned to the “Metric Expression” cell and the business user

can dynamically use them to define the “Metric Expression”. After defining the “Metric Expression” (i.e., formula), the business user shall define the corresponding “Metric Value” (i.e., weight) to be considered. Any of the metrics created can be dynamically included in the expression defined by the business user to determine the value of each indicator, according to each Organization specific business rules. In this expression, the weight of each metric can vary, which influences the formula and the corresponding result. For more details about “Metrics” check Annex A.

The “Indicators” tab, which defines the set of metadata that represents the data structure of an Indicator, enables the business user to manage the list of indicators to be presented, for the new parameter created (i.e., Education) in the “Personal Skills” Dashboard. When a new “Indicator” is created (e.g. Curriculum Evaluation – CE), the business user starts by filling the “Indicator Name” and the “Indicator Description” cells. Then, the business user should classify it as “Personal Skills” in the “Dashboard Group” cell and select the “Yes” value of the “Visible” cell, so that this Indicator is shown at the corresponding Dashboard. Finally, in the “Indicator Type” cell, the business user should select between one of the fixed/hardcoded values: “Cost/Benefit/On Target” (e.g. Benefit) and create/edit the formula in the “Indicator Expression” cell. The “Indicators” UI is illustrated in the Figure 16 below.

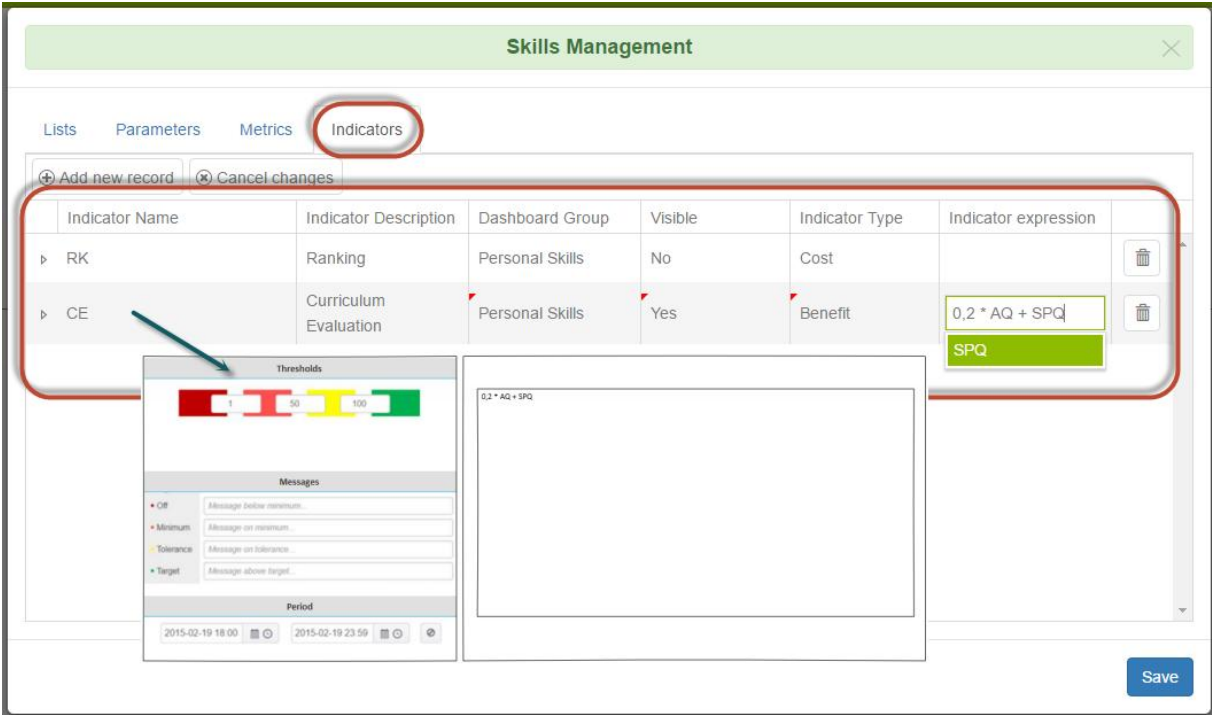


Figure 16. Metadata Configuration - Indicators

When the business user presses the “Expand” icon, the configuration of the metadata available enables the business user to define the values from the corresponding fields of the “Thresholds” and “Messages” sections, as well as to set the “Period of validity” of the Indicator and create/edit the formula in the “Indicator Expression” cell, as illustrated above. For more details about “Indicators” check Annex A.

The SDM was designed based on the implementation of some Gamification techniques (e.g., Merit Boards, Reputation, Points and Competition) to encourage and motivate users to modify their behaviour and adopt best practices. For achieving it, it is important to create attractive and user-friendly applications that foster people to take the measurements that organizations need. In this Thesis, DSR was adopted because it follows a user-centric approach that encourages the use of the mockups technique for an active interaction with the different stakeholders in the validation of non-functional requirements. This approach streamlines communication and promotes a more expeditiously contributions collection, leading to an iterative process of continuous improvement. The purpose here is to learn from the stakeholder’s feedback and if necessary iterate back to prior stages to improve the mockups. Voting in the team or ideally with the end-users can select the best drafts, which shall be taken as a basis for the final solution development. This approach was followed in the Active@Work project, where the users analyzed the mockups online and provide feedback/improvement recommendations and the project developers contributed with questions which helped to improve the level of usability and clearness of the SDM GUI.

The use of conceptual domain models is an important part of this process as they define the Universe of Discourse (UoD) and facilitates the proper semantic integration of the information within a domain.

3.3.3.Domain model

A domain model is a conceptual model containing the concepts of importance to a certain domain (i.e., business context) as well as the relationships between these concepts. It represents the ‘things’ that exist or events that transpire in the business environment. The domain model is a high level logical view of information requirements and structure. The domain model is at a high level of abstraction and should not be confused with database models or schemas, which will be at a much greater level of detail. The domain model is not concerned with the way in which data or information is physically held or processed. It may include concepts and data which are not currently implemented or stored exactly as modelled. This

means that the domain model can include other data that may reside in a variety of physical databases or file systems under the control of distinct software modules. As such, it represents information that will be shared across the research project and which is necessary for the development team to carry on normal operations, monitor performance and make operational decisions.

The Skills Management Metadata Framework domain model presented in Figure 17 was designed using the UML Notation. The classes prefixed with the letter “**M**” correspond to Technical/Structural metadata classes and are used to store and manage metadata. The letter “**M**” type classes represent the list of Tabs described in section 3.3.2 (i.e., Lists, Parameters, Metrics and Indicators) and are used to store the list of attributes that describe the values recorded in classes prefixed with the letter “**V**” (to be described later in this section). Each one of these letter “**M**” type classes are divided in two subtypes:

- **MxxxH**, used to identify header-related metadata;
- **MxxxL**, used to identify lines-related metadata;

When the business user needs to create a new parameter (e.g., Education), for the category “Hard Skills” under the employees’ competencies (Personal Skills), it should start by creating a “List”. Whenever a new “List” is created, one new entry is created in the “**MListH**” class (with the header information, e.g., List Name) and as many entries in the “**MListL**” class as the number of values defined (e.g., List AQ is composed by 4 values, means 4 entries in the **MListL** class). The list of values created should be assigned to a “Parameter” attribute whenever the business user needs to restrict the input to the domain of values expressed by the selected list.

The next step is to create the (skills) parameter (i.e., Education) by using the “Parameters” tab. Whenever a new “Parameter” is created, one new entry is created in the “**MParameterH**” class (with the header information, e.g., Tooltip) and as many entries in the “**MParameterL**” class as the number of attributes defined (e.g., assuming that the Education parameter is composed by 3 attributes, means 3 entries in the **MParameterL**). In addition, a new class (e.g., **VSS_Education**) is automatically generated with the attributes defined for the Parameter created. The classes prefixed with the letter “**V**” correspond to Descriptive metadata classes and are used to store and manage Skills-Management related data. Each one of these prefixed letter “**V**” type classes are divided in two subtypes:

- **VSSxxx**, used to identify Staff Skills (SS)-related data;
- **VTCxxx**, used to identify Training Catalogue (TC)-related data.

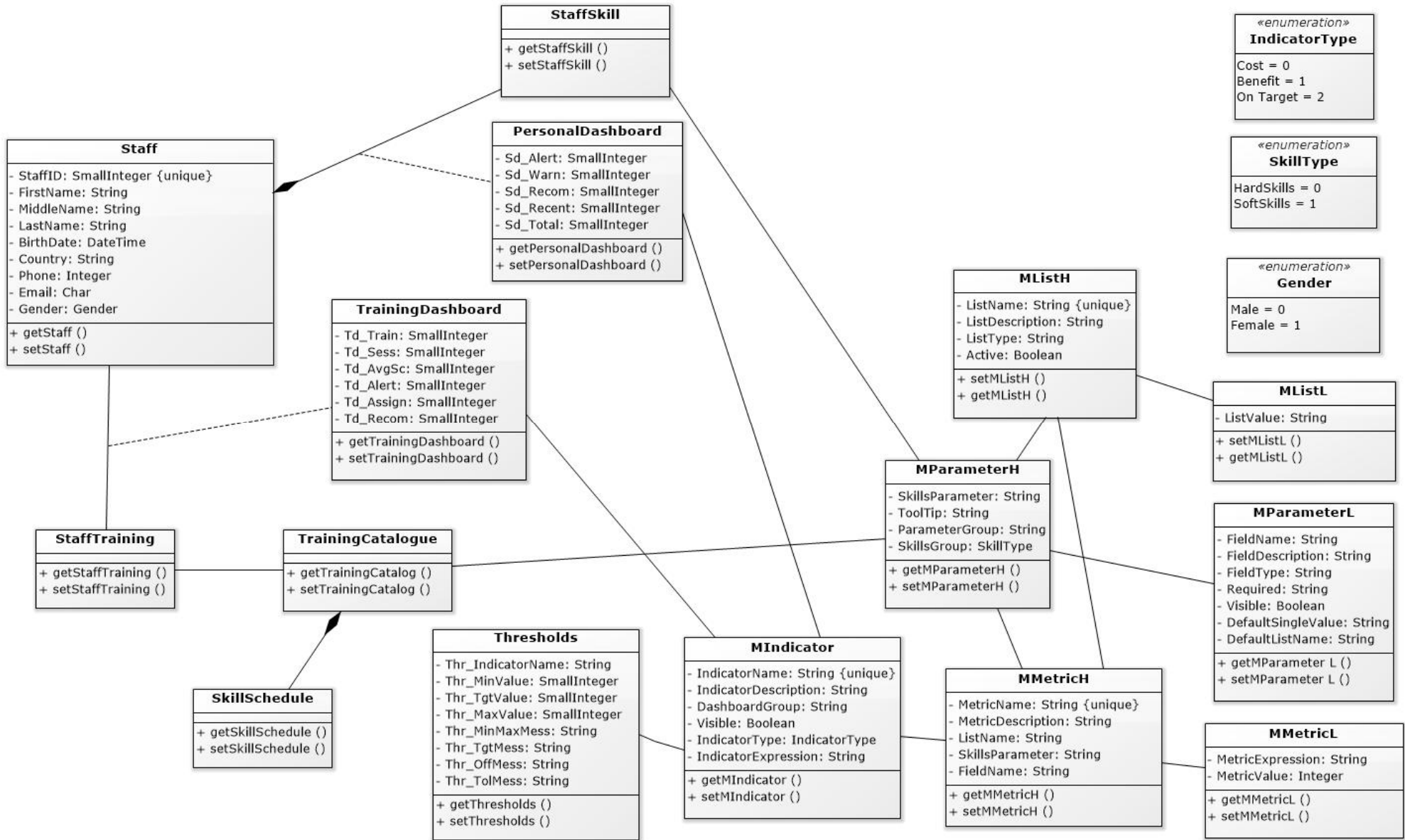


Figure 17. Skills Management domain model using the UML Notation (with Mxxx type classes)

For each prefixed letter “**V**” type classes, there are two fixed attributes: Status and Action, which are automatically created and have pre-defined values:

- **Status**, Empty, Error , Warning and Recommendation;
- **Action**, Empty, Assign, Open, In Analysis, Approved, Rejected and Scheduled.

These two attributes are mandatory, in order to evaluate the status of the employees’ skill parameter and trigger an Action, whenever a specific skills becomes invalid (e.g., expired certification).

The Skills Management Metadata Framework domain model, using the UML Notation (with classes prefixed with the “**M**” & “**V**” letters), is illustrated in the Figure 18 below. The business user can dynamically adjust the metadata characterization of the elements (e.g., add/remove attributes) from the prefixed letter “**V**” type classes generated, as required and accordingly in the “**MParameterL**” class.

In case the business user wants to dynamically assign a metric to each attribute of the new parameter created (i.e., Education), it should use the “Metric” tab. Whenever a new “Metric” is created, one new entry is created in the “**MMetricH**” class (with the header information, e.g., Metric Name) and as many entries in the “**MMetricL**” class as the number of combinations of “Expressions” (i.e., formula) and “Values” (i.e., weight) defined (e.g., List of AQs selected is composed by 4 values, means 4 entries in the **MMetricL** class).

Any of the metrics created can be dynamically included in the expression defined by the business user to create an indicator for the new parameter (i.e., Education) in the “Personal Skills” Dashboard. Whenever a new “Indicator” is created (e.g. Curriculum Evaluation – CE), one new entry is created in the “**MIndicator**” class (with the Indicator information, e.g., Indicator Name) and in the “**Thresholds**” class (with the Thresholds information, depending on the Indicator type selected, e.g., Cost/Benefit/On Target). For more details about the SDM Domain Model check Annex E.

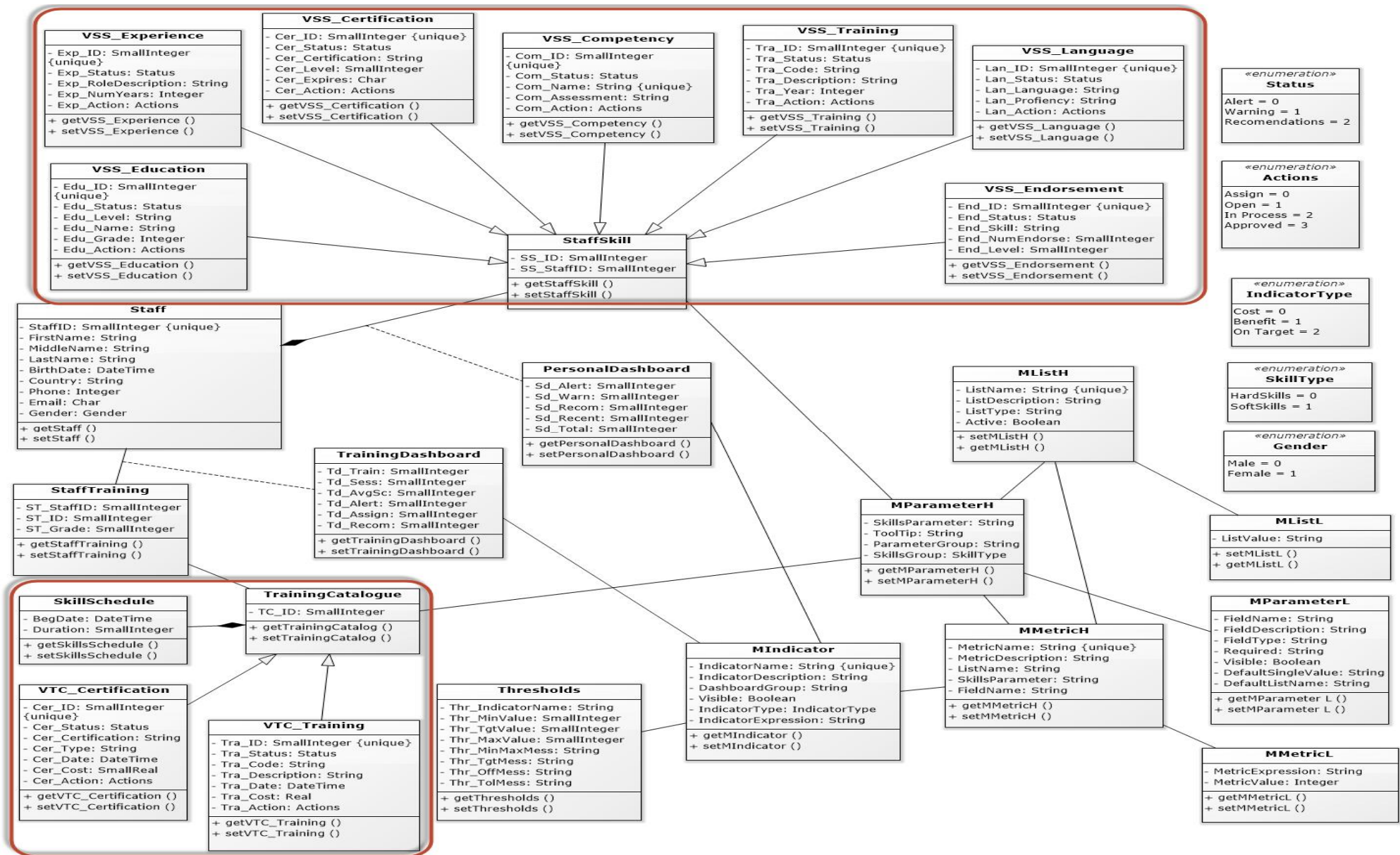


Figure 18. Skills Management domain model using the UML Notation (with Mxxx and Vxxx type Classes)

The domain model addresses the following goals:

- Provide a conceptual framework of the things in the problem space;
- Capture the most important concepts (business object) in the context of the business;
- Foundation for use case/workflow modelling;
- Helps to focus on semantics and provides a glossary of terms – noun based.

The domain model approach is to identify concepts pertinent to the domain that need to be modelled in software. The concepts include the data involved in the business and rules the business uses in relation to that data. A domain model generally uses the vocabulary of the business domain so that a representation of the model can be used to communicate with non-technical stakeholders in describing requirements, processes, rules or other things, that need to be understood in the same way.

4. Results

This chapter outlines how the specified domain model and specification of the SDM were applied to the case study held by the research Active@Work project, presenting simultaneously the project main goals and web site form more information related to the research challenges addressed within this AAL project. An assessment of the achievements accomplished within this thesis are also provided, taking into account the role and contribution within the Active@Work project as well as the accomplishment of the research hypothesis formulated in Chapter 1. The Chapter ends by presenting some conclusions related to the results, emphasizing the theoretical and practical consequences.

4.1. Skills Development module

The expected results of the Skills Development Module include:

Through Visual Analytics dynamic/personalized dashboard interfaces alert mechanisms and indicators, promoting employees' self-awareness of their skills, overall curriculum evaluation and enabling comparison with his/her peers. It also reflects the employees' resume organization relevance in the short/medium term, by providing recommendations about how the employee should progress in his/her training or knowledge based on skills, role/function and a global classification in comparison to the average skills for the career option the employee wants to apply to, to stay aligned with the organization's strategic and operational goals and objectives. In terms of profile management, employees can also take great advantage from the Intelligent Agent (IA) help, namely through data collection from social network websites (e.g., LinkedIn).

Through a Business Rule Manager (this advantage comes from the collaboration with the Active@Work R&D project and it benefits the skills development module, although it is not in the scope of this Thesis), by delivering a rule engine, enabling the dynamic configuration of business rules, applicable to the CV valorization.

Through Gamification techniques exploring paradigms based on game theory and taking advantage of technological advances, to benefit employees and organizations. Organizations are continuously being challenged to effectively encourage employees to achieve basic business goals and develop working environments driven by healthy competitive practices. If serious gaming techniques become part of the Organizations' working culture, it will encourage employees to continuously seek to improve their CV. In such working environment, self-awareness can be seen as a way to "play" with alerts and recommendations triggered dynamically by an Intelligent Agent (IA), which motivates employees to constantly invest effort in auto-regulation to improve their performance (e.g., rank classification, career development, encourage ambition and self-achievement).

Through the combination of Gamification techniques with Talent Management, adopting processes to engage, motivate, and retain highly productive employees, it is possible to combine Skills Management & monitoring related critical capabilities with information visualization techniques, helping organizations to maximize potential use of Talent Management technology. Through a training catalogue with specific skills offering, employees can search and manifest interest in some training(s) offers or seek for career options, and carry out their responsibilities into the Organization.

Motivation, challenges and competitiveness are seen as key elements for the construction of a successful organizational network. These processes, combined with information visualization techniques, keep employees aware about skills and performance related information, such as:

- Current score and ranking position;
- Classification of types of training activities;
- List of training actions taken, including certification and expiration date (a professional certification can expire after a predefined period);
- List of trainings actions and certifications recommended based on the employee profile and/or role/function within the company - in this case there may be a set of training sessions or mandatory professional certifications (e.g., PMBOK, ITIL, etc.);
- Warnings in advance if the score is to be decreased in any way (due for instance to a certification that will expire or if a professional training actions with more than five years will no longer be considered relevant).

4.2. Case Study – Active@Work

Active@Work is an EU project, funded by the AAL Programme and co-funded by the EC, with the main goal to provide a web-based solution to assist senior employees, in particular those close to retirement age, in order to perform their job efficiently without risking their health condition. The Active@Work focus is an integrated approach to manage the negative impacts of aging both physiologically and psychologically, while taking the advantage of senior employees' valuable experiences. Senior employees who are close to their retirement age are concern with realizing some changes in their psychological and physiological systems. Most of the time these changes are not easy to realize from outside and even the person himself ignores these signs and changes. The fact that it is not easy to accept these changes would be the reason of this ignorance. Thus, Active@Work as an assistant system has the goal to help the senior employees who are going through this phase of life to spontaneously do their daily duties at work and deal with psychological and physiological demands of normal aging.

The main scientific challenges for Active@Work are the management and extraction of useful information from vast amounts of environmental and physiological data, the development of a customized system to influence behavioral change, and developing a solution applicable in differing working environment. In order to meet these challenges, Active@Work will investigate: (i) how best to provide the dynamic accurate measurement and data transfer of useful information about end-user, (ii) how best to use physiological and environmental data to improve the senior employees well-being and influence end-users to modify their behavior, (iii) how to arrive at the best business model to convert a promising technology into a useful and cost-effective product, and (iv) how to demonstrate and validate the new methodologies on two case studies in Spain and Belgium.

The Active@Work project intends to follow the next generation design architecture, by creating a platform, or more precisely a modular architecture. Creating appropriate modular architectures is, in nowadays, key to support new kinds of business strategies. The modular architecture is a two-part definition:

- Decomposition of the overall functionalities of a product into a set of component parts;
- Specification of the interface between the components, in order to interact together in the product as a system.

The Modular architecture of the Active@Work project, with a high-level view of the project components (i.e modules) is illustrated in Figure 19. The expected results of this contribution are described in this Thesis, by defining the specification of the structure and behavior of the SDM.

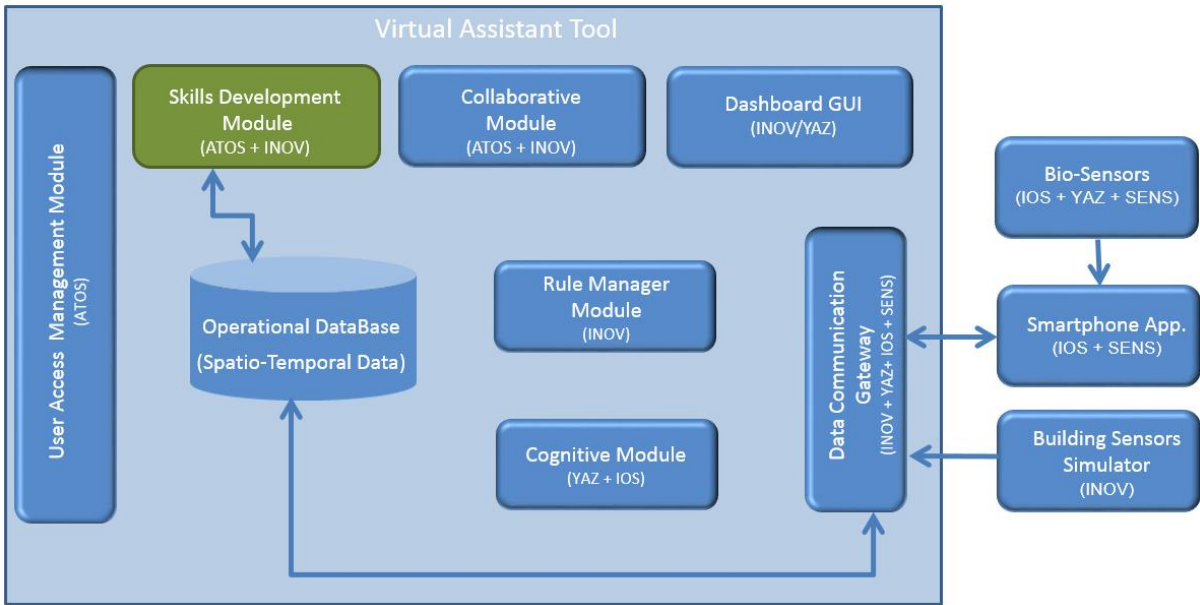


Figure 19. Virtual Assistant Tool Architecture

The SDM addressed in this Thesis intends to provide a solution able to create a highly motivating and rewarding environment that makes it easy for employees to manage/develop their skills, promoting engagement and motivation to fit into organization needs and expectations. This solution is composed by two main components: Personal Skills, Training Catalogue and the corresponding Dashboards. Each one of these components is described in Table 4 below.

Table 4. List of components identified for the SDM

Component	Personal Skills
Sections (Dashboard)	<ul style="list-style-type: none"> • Overall, where relevant information indicators like employee CV evaluation (overall calculation), assessment and Employee CV composition (each pie chart slice represents a different Skills Parameter), ranking position and Peers average can be seen; • My Messages, where notifications like Alerts, Messages and Recommendations can be checked; • My Training History, where the most recent training courses or the full list of trainings attended can be checked.

Categories	<ul style="list-style-type: none"> • Hard Skills, composed by the parameters: Education, Experience, Certifications, Training, Language and Endorsements; • Soft Skills, composed by the parameters: Competencies and Training.
Component	Training Catalogue
Sections (Dashboard)	<ul style="list-style-type: none"> • Overall, where relevant information indicators like total number of trainees, total number of training sessions and total number of sessions average score can be seen; • Skills Top 10, where total number of trainees, total number of sessions promoted and total number of skills top10 sessions average score can be checked; • My Skills Plan, where notifications like Alerts, Messages and Recommendations regarding each employee skills plan can be checked
Categories	<ul style="list-style-type: none"> • Hard Skills, the parameters shown may vary, depending on each employees needs and interests • Soft Skills, the parameters shown may vary, depending on each employees needs and interests

More detailed information regarding the four components described above can be seen in Chapter 4.3.

4.2.1. List of actors and roles participating in the specified scenarios

From the analyses of the scenarios, in this section are described the different kinds of users (i.e., Actors) and roles that have been identified for the SDM. Each one of these actors are described in Table 5.

Table 5. List of actors identified for the SDM

Actor(s)	Employee (junior/senior)
Role	Trainee - Someone who is the consumer/receiver of the content in order to improve a skill or learn new things or solve a task related to a problem in the working environment
Actor(s)	Employee (junior/senior), manager, external stakeholder who has the relevant knowledge
Role	Producer of the content - Someone who can create a content (learning material, course) based on a request
Actor(s)	Employee (junior/senior), manager (operational, health, environment, supervisor, moderator)
Role	Requestor of the content - Someone who request for a new content or changing an existing content when he/she sees an opportunity or a need for that
Actor(s)	Manager
Role	Administrator/Moderator - Someone who is responsible for managing the accounts (governing data access), organizing the knowledge structure and reviewing and publishing the content

4.2.2. Generic scenarios

In this section are described the generic business scenarios of usage of the SDM. The scenarios have been defined through different refinement phases. Each scenario is expressed in natural language, describing a specific interaction between a user (actor) and the system. While each scenario covers one specific goal, they are strictly related each other as they share the same devices and data. Each one of these scenarios are described in Table 6.

Table 6. List of Generic Scenarios

Goal	Management of skill alignment with individuals goals
Description	The skill development module provides the employee a single point to report his/her professional curriculum vitae (CV), which includes the presentation of data related to the employee assessment and ranking within the organization. This kind of dynamic dashboard intends to help the employee too improve and manage his professional profile/expertise. Based on the

	<p>reported interests, career ambition or role needs, the system is able to provide recommendations regarding which soft and hard skills are more adjusted to the employee interests. Possibility to configure the system to inform when a specific training course is offered within the company training catalogue or apply to a scholarship to enroll into a new academic course/degree. Enable older adults to change their area of interest within the organization by providing information about the new expertise they need to acquire to carry out new roles. The approach is to empower senior employees to continue managing their occupation in their working environment, help all employees to be aware about their position within the organization assessment, raise their operational and cognitive skills or to acquire new ones</p> <p>Target Group: All employees and the corresponding supervisor</p>
Intervention	<p>The system will implement a workflow to request the supervisor the acceptance of the employee enrolment in a set of certification or training actions. This workflow is triggered when the employee acknowledges the system training (or certification) recommendations or selects a new training course available in the training catalogue. Based on the reported information and on the selection of the intended training action, the Skills Manager will handle the administrative procedure to enroll the employee in the training actions requiring approval from the supervisor. After completing the process of obtaining authorization to enroll in the requested training actions, the next step is to proceed with the enrolment of the student in the corresponding training actions in order to monitor the achievement/assessment of the employee in each training action. If no approval is required and no inconsistency is detected, the Skills Manager automatically handles the enrolment of the employee.</p>
Goal	Skills manager to assist employees in organizing their training agenda
Description	<p>The employee will have the possibility to semantically search for specific training courses or specify what kind of new role or functions (s)he is about to attend or is willing to obtain. The employee can also configure a set of preferences on topics or types of training actions. This information is registered by the system. The Skills Manager (a software component acting</p>

	<p>as an intelligent agent) based on those preferences will perform a pre-validation of the reported information and alert for inconsistencies or provide some recommendations. If any inconsistency is detected (e.g., constraints due to precedence between some of the selected training actions) the Skills Manager will alert the user about those constraints and provide, whenever possible, alternative solutions. If no inconsistency is detected, the Skills Manager activates the authorization procedure to the employee supervisor. The decision is communicated to the employee and for all approved situations, the employee is asked to enroll in one of the available class's schedule. The attendance of the employee to each enrolled class is stored in the system and if the employee fails to attend the classes, a notification is generated</p> <p>Target Group: All employees and the corresponding supervisor</p>
Intervention	<p>The system will assist the employee in choosing the set of training action that best suit the valorization of the employee career within the organization. To accomplish such goals the employee has to provide information about what role (s)he willing to attend, or aims to attend in the medium term. The Skills Manager will act proactively reminding the employee about the start dates of the training actions and by providing statistical data regarding the number of enrolments, total number of employees who already concluded the training action, including information about the average assessment in each of the selected training actions.</p>
Goal	Motivate and inform the employee about his classification
Description	<p>The employee personal dashboard provides a layout with a summary of the classification and assessment of the employee. This information includes statistical data about the current ranking position and assessment. Information related to the expertise and competencies more valorized by the organization or more aligned with the current role of the employee are also provided. The Skills Manager will monitor the information and provide recommendation regarding improvements and/or alert the employee about which skills need to be improved or upgraded.</p>

	<p>The system also mitigates the risk of losing a professional certification. The system will act preventively by warning the employee about the need to renew a certification or by alerting when it is time for the employee to enroll into a new certification level.</p> <p>Target Group: All employees</p>
Intervention	<p>Improve and strengthen employee skills to progress in their career or improve their classification in the organization ranking. In order to provide adaptive and personalized learning plans and recommendations, it will be necessary the combination of immersive advanced learning capabilities (set of metadata characterizing the employee professional and literacy profile) in order to obtain highly personalized learning experiences. This is particularly true for key learning indicators and indicators about the employee skilled level in addition to indicators describing how employees are performing in the training courses.</p>

4.3. Case Study – Conceptual Framework to the Mockups Design

It is also important to note that within this Thesis the approach was to complement, whenever feasible, the description of the scenario with the presentation of a preliminary mockup to express non-functional requirements regarding the system UI. The mockup technique is introduced in this phase as a visual information blueprint, facilitating the communication between all team members.

When pitching a design to the team, presentation is always crucial. Mockups are not the final product, they are only a visual schema of the system UI. This means that mockups are a powerful way to keep the design of the solution (i.e., graphical specification of requirements) within the project boundaries - scope and objectives. In this way, it is possible to graphically express functional and non-functional requirements in an early stage of the project execution, reducing the risk of misinterpretations as well as the effort in describing requirements in a way that is understood by everyone in the same way.

The SDM addressed in this Thesis intends to provide four main components able to assist employees managing their skills, promoting engagement and motivation to fit into organization's strategic and operational goals and rapidly changing needs: Personal Skills, Training Catalogue and the corresponding Dashboards.

- The Personal Skills and Personal Skills Dashboard were designed based on information visualization techniques, to create a graphical interactive environment addressing the employee concerns and to assist his/her decision making process regarding the information provided by each parameter reported in the Personal Skill component. The information presented to the employee is related to his/her current skills assessment, curriculum evaluation and ranking position, as well as to monitor its progression and alignment with the organization needs, through an IA triggering events (alerts, warnings and recommendations). This intends to promote employees' self-awareness. By having a better understanding of themselves, this empowers employees to make changes and to build on their areas of strength as well as identify areas where they would like to make improvements. Self-awareness is often a first step to goal setting⁵, in order to be aligned with the organization needs. A mockup of this dashboard can be seen in Annex C, Figure 28.
- The Training Catalogue and Training Catalogue Dashboard were also designed based on information visualization techniques, enabling a graphical interactive training environment to support employees to learn new skills quickly and engage in new activities, in an increasing competitive working environment. In nowadays, to have high performance and sustainable organizations, that meets its strategic and operational goals and objectives, it's key to implement Talent Management programs, which are design to attract, develop, motivate, and retain productive and engaged employees. This can be achieved through an IA triggering events (alerts, assignments and recommendations) to create a dynamic Skills Plan, to ensure access to the employees with the skills, knowledge, and behaviors essential for the achievement of the organizations strategic objectives and/or demands. A mockup of this dashboard can be seen in Annex C, Figure 30.

5. Conclusions and Future Challenges

This chapter presents a reflection on the results obtained from the research work developed, where the achieved contributions should be explained, assessing the contributions to the proposed objectives. It is fundamental to create a summary of the demonstration presented in the development (i.e., previous sections) leading to a conclusion about this research thesis accuracy and relevance, according to the addressed point of view.

⁵ Cfr: [Self Awareness](#), accessed on 13/02/2016

It should also be dedicated a part of this section to explain a possible future research work, based on/following this research work.

5.1. Conclusions

This Thesis was undertaken based on the landscape of skills management that reveals existing problems regarding the need to promote employees' self-awareness and auto-regulation, increasing their motivation and challenging them to acquiring new skills/competencies or investing in career progression, supported by the SDM as an innovative way to stay aligned with the organization's strategic and operational goals and objectives.

The research methodology selected was the DSR, where the existing process has been adapted for a better establishment of awareness towards the problems, through a survey about the project scope to achieve a preliminary awareness of the challenges related to the scope of the research problem. The Identified hypothesis to be tested and evaluated using information artifacts contributed to deliver a better quality of research findings in the particular context of the research. DSR process facilitates the development of conceptual solutions, in contrast to the mainstream case where embodied solutions are developed.

The overall aim of this Thesis was expected to be addressed through exploring two predominant research areas: Visual Analytics and Gamification. Through Visual Analytics personalized/interactive dashboard interfaces alert mechanisms and indicators to keep employees aware of their skills and performance, promoting behavioral change and adoption of best-practices. This strategy is based on the principle that motivation is a key pillar to retain and attract employees. The ratio of intrinsic and extrinsic motivations driving forces was adopted in this Thesis as a truly innovative approach from the perspective of self-awareness and auto-regulation. Through the combination of Gamification techniques with Talent Management, new processes are adopted to engage, motivate, and retain highly productive employees. By fostering a competitive working environment, employees are encouraged to engage in new and rewarding activities. Building trust in relationships increases retention, engagement and rewarding of these employees, gradually creates a motivated community committed to success factors relevant to both the employee and the organization.

By collaborating in an international project (Active@Work) funded by the AAL Programme and co-funded by the EC, this research study contribution is described through the SDM as a particular type of DSS. This research study aimed to demonstrate the existing articulation between

emerging research areas such as Visual Analytics and Gamification, expecting to represent conceptual gains in the field.

5.2. Future Challenges

The conceptual solutions are recommended to be used as guidance in developing new practical solutions in the future. A future area of research, based on the outcome of this Thesis, could be an IA solution, a software component which uses machine learning techniques and algorithms, improving the quality of the diagnostic information presented. This concept is based on automated learning, which means that machines (i.e., IA) can learn from the available data and has various algorithms. These algorithms are organized into taxonomies and semantic contexts in order to address results desired/expectable. The most common types of algorithms include Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Reinforcement Learning, Transduction and Learning to Learn.

Through algorithms that can learn and make predictions based on the generated knowledge from the available data, together with metadata info-structure defined for the SDM, the Intelligent Agent solution aims to contribute for the employees' awareness of the risk associated to CV evaluation, through:

- Support automatic employees' notifications;
- Monitor the achievement/assessment of the employee in each training action;
- Pre-validate the reported information (list of training actions selected by the user);
- Alert for inconsistencies (constrains due to precedence between some of the selected training actions).

A final future research activity is to get SDM more widely known to the research communities. The researcher intends to write and publish a paper, expecting that will help more discussion or critique made on these kind of innovative paradigm-changing solutions.

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Annex A – Skills Management Metadata Framework

The Skills Management Metadata Framework enables the business user flexibility to choose between different components: Lists, Parameters, Metrics and Indicators, through a tab menu. When the business user presses the tab “Lists”, the UI illustrated in the Figure 20 below should be shown. When a new “List” is created, the business user should specify a “List Description”, select the type of the field in the “List Type” cell and should define if the List should be active or not in the “Active” cell. The values of the “List Type” field are fixed/hardcoded. The “Lists” tab enables the business user to define a list of values which can be assigned, if required, to the attributes presented as headlines for the (Skills) Parameter selected in the “Personal Skills/Training Catalogue” menu.

The screenshot displays the 'Skills Management' application interface. At the top, there is a green header bar with the text 'Skills Management' and a close button. Below the header, there is a tab menu with four tabs: 'Lists', 'Parameters', 'Metrics', and 'Indicators'. The 'Lists' tab is currently selected and highlighted with a red circle. Below the tab menu, there are two buttons: 'Add new record' and 'Cancel changes'. The main area contains a table with the following columns: 'List Name', 'List Description', 'List Type', 'Active', and a delete icon. The table has two rows: 'List of AQs' and 'List of XPTOs'. The 'List of AQs' row is expanded, showing a modal window for editing. The modal window has a 'List Value' field with a red border, containing the following text: 'Degree NOT in computer science area.', 'Degree in Computer Science Area.', 'Master.', and 'PhD.'. The 'List of XPTOs' row is collapsed. At the bottom right of the interface, there is a 'Save' button.

List Name	List Description	List Type	Active	
List of AQs	Academic Qualifications Value List	Text	<input checked="" type="checkbox"/>	
+ Add new record				
List Value				
Degree NOT in computer science area.				
Degree in Computer Science Area.				
Master.				
PhD.				
List of XPTOs	XPTO Value List	Text	<input type="checkbox"/>	

Figure 20. Metadata Configuration - Lists

When the business user presses the tab “Parameters”, the UI illustrated in the Figure 21 below should be shown. When a new “Parameter” is created, the business user starts by filling the “Skills Parameter” cell with the name of the Parameter and the “Tooltip” (e.g. message which appears when a cursor is positioned over an element in a GUI) cells with the message that wants to be shown. Then, the business user has to classify it as “Personal Skills/Training Catalogue” in the “Parameter Group” cell and as “Hard/Soft Skills” in the “Skills Group” cell. The values of both “Parameter Group” and “Skills Group” fields are fixed/hardcoded.

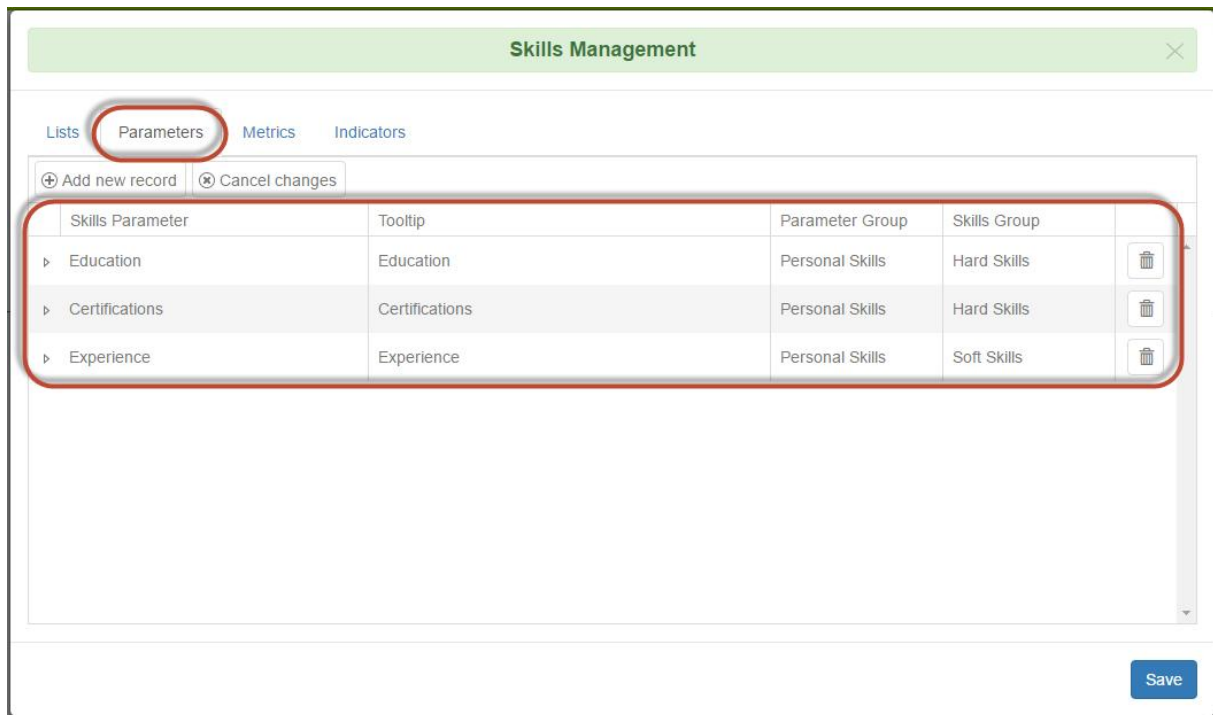


Figure 21. Metadata Configuration – Parameters

When the business user presses the “Expand” icon, the configuration of the metadata available enables the business user to configure the name of the attributes to be presented as headlines in the Workspace area, as illustrated in the Figure 22 below. In addition to the name of the attributes, the configuration of the metadata available allows the business user to specify a “Field Description” and select the type of the field in the “Field Type” cell. The business user should also specify if the field is “Mandatory/Optional” in the “Required” cell and the “Yes/No” option in the “Visible” cell. In case the “Mandatory” option is selected in the “Required” cell, the “Visible” cell should automatically be filled with “Yes”, due to the dependency between both. Finally, the business user should decide to define if the field should have a default single value, by filling the “Default Single” cell or it should have a default list of values, by selecting the required “List Name”, created in the “Lists” tab, in the “Default List Name”. Both fields shall not be filled.

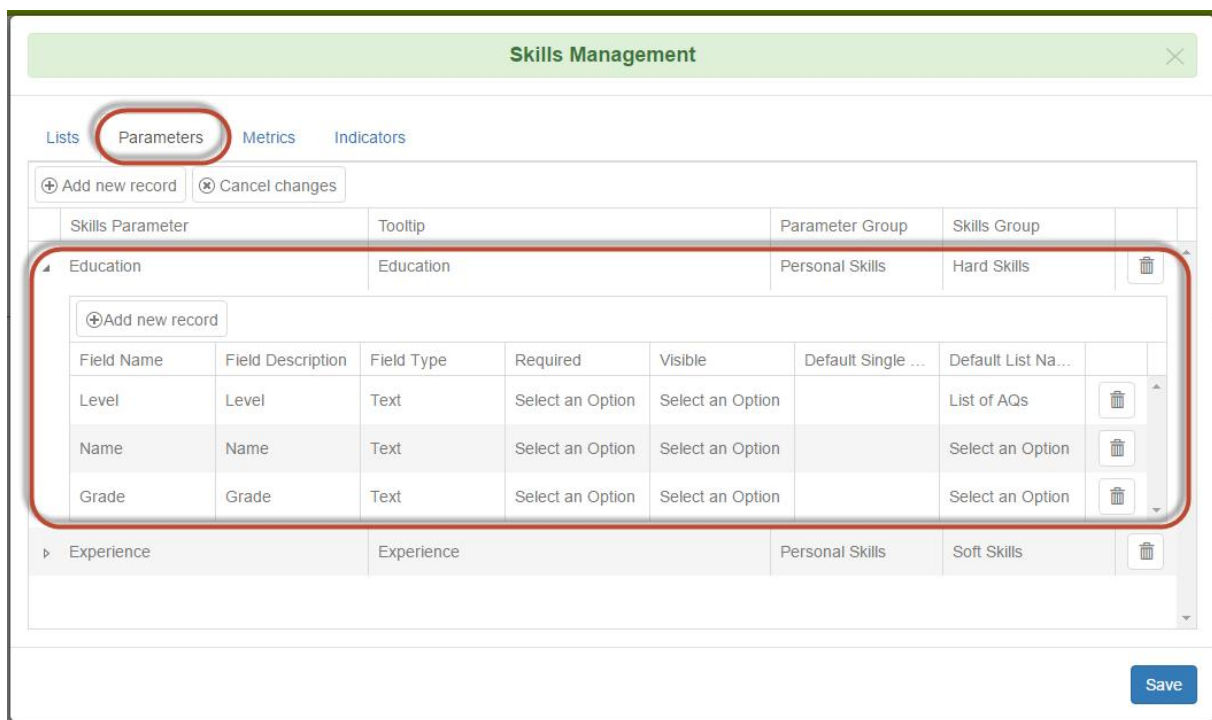


Figure 22. Metadata Configuration – Parameters Expanded

When the business user presses the tab “Metrics”, the UI illustrated in the Figure 23 below should be shown. When a new “Metric” is created, the business user starts by filling the “Metric Name” and the “Metric Description” cells. Then, the business user should assign it to one of the skills parameters listed in the “Skills Parameter” cell. This means that the assigned skill parameter shall be used as a category of the selected ”Metric”. The cell “Field Name” can only be activated once an option is selected in the “Skills Parameter” cell, due to the dependency between both fields. This means that the list of values to be presented in the “Field Name” cell are dependent on the selected “Skills Parameter”. Finally, the cell “List Name” can only be activated once an option is selected in the “Field Name” cell, due to the dependency between both fields. In case the “Field Name” selected is already assigned to a “List Name”, the “List Name” cell is automatically filled with the “List” assigned (e.g., List of AQs). Otherwise, the business user should decide to define if the metric should have a default list of values, by selecting the required “List Name”.

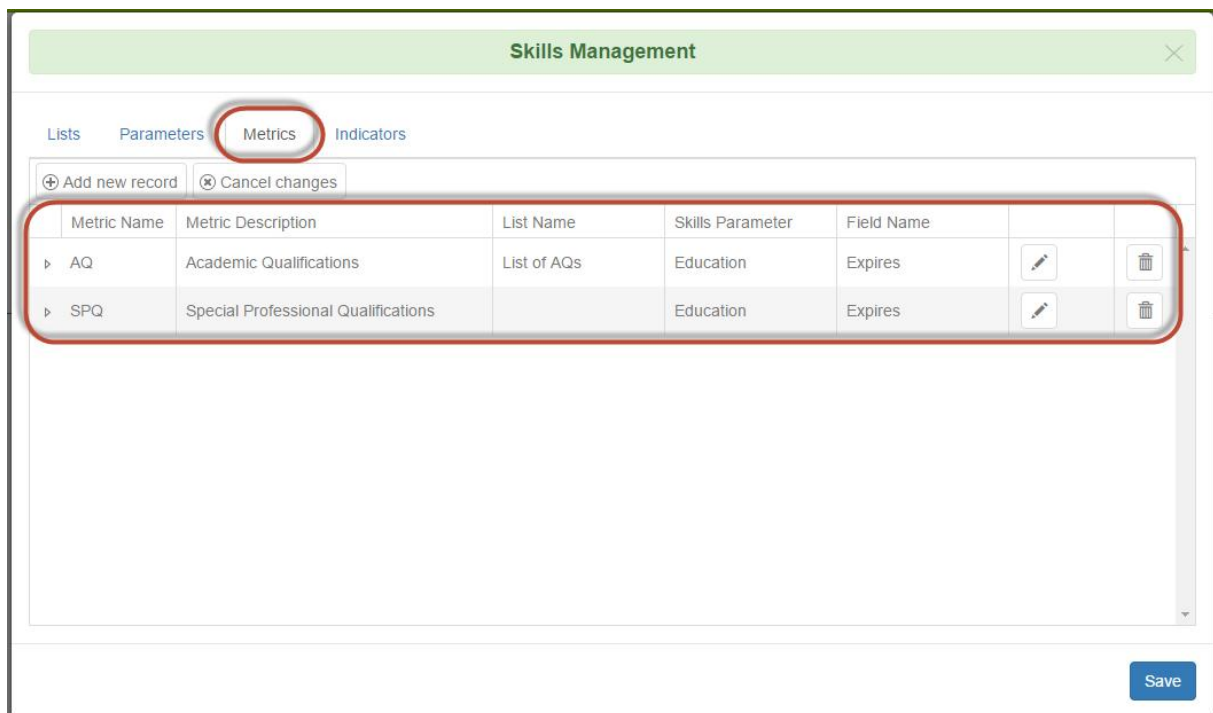


Figure 23. Metadata Configuration – Metrics

When the business user presses the “Expand” icon, the configuration of the metadata available enables the business user to specify a “Metric Expression” and a “Metric Value”, as illustrated in the Figure 24 below. In case the “List Name” cell is filled, the “List Name” values of the selected “List Name” are automatically assigned to the “Metric Expression” cell and the business user can dynamically use them to define the “Metric Expression”. After defining the “Metric Expression” (i.e., formula), the business user shall define the corresponding “Metric Value” (i.e., weight) to be considered.

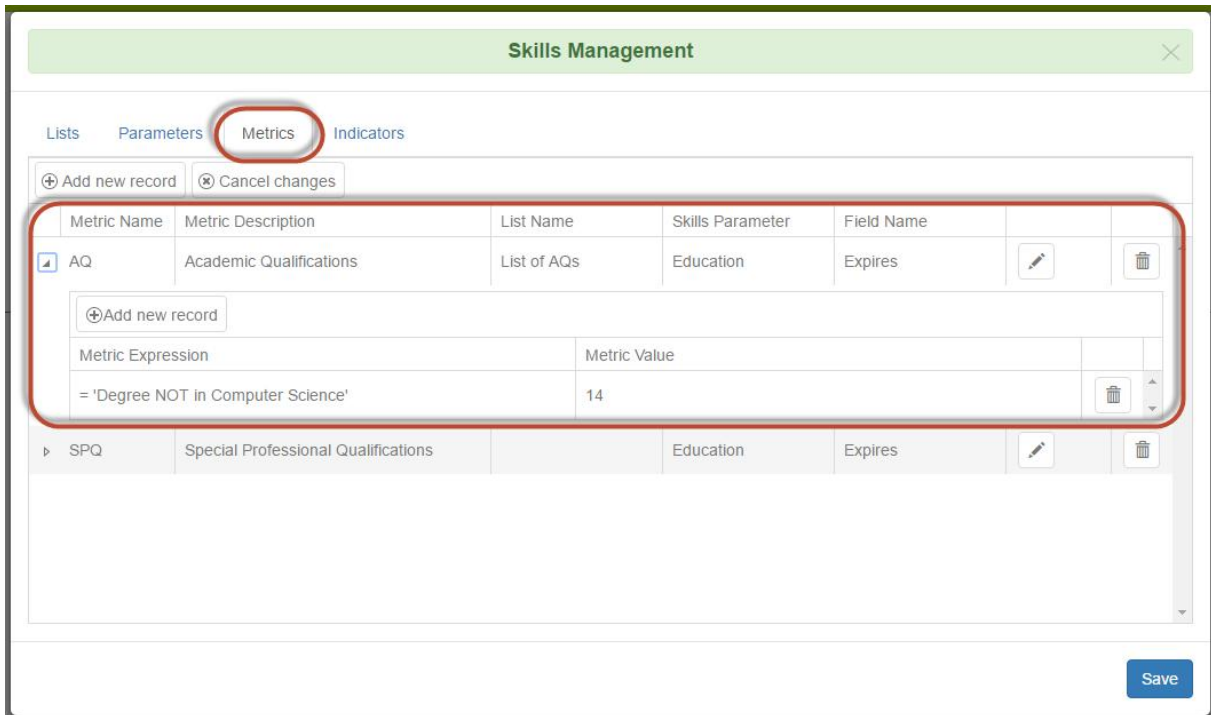


Figure 24. Metadata Configuration – Metrics Expanded

When the business user presses the tab “Indicators”, the UI illustrated in the Figure 25 below should be shown. When a new “Indicator” is created, the business user should classify it as “Personal Skills/Training Catalogue” in the “Dashboard Group” cell. The values of the “Dashboard Group” are fixed/hardcoded. In addition, if the value of the “Visible” cell is set to “Yes”, this Indicator is shown at the corresponding Dashboard. Finally, in the “Indicator Type” cell, the business user should select one of the fixed/hardcoded values: “Cost/Benefit/On Target” and the “Indicator Expression” cell enables the business user to create/edit the formula related to the selected indicators.

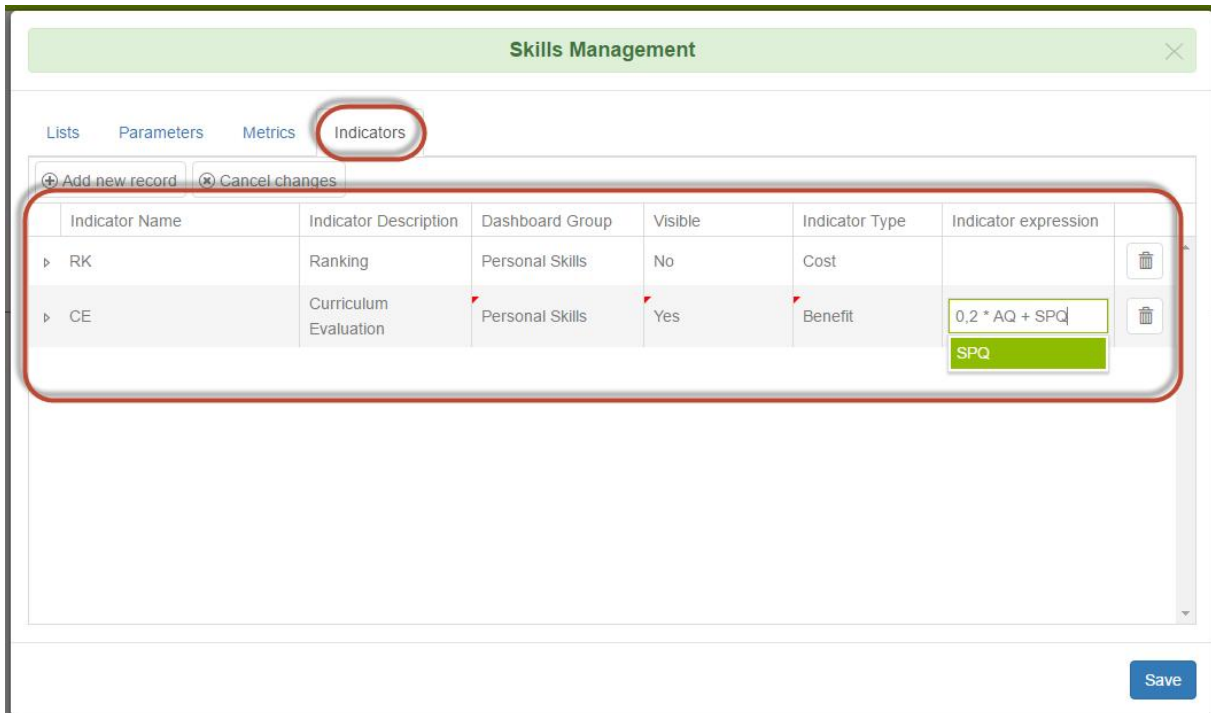


Figure 25. Metadata Configuration – Indicators

When the business user presses the “Expand” icon, a popup window similar to the Figure 26 mockup below should be opened for the selected indicator name (i.e. editing the selected row), which enables the business user to define the values from the corresponding fields of the “Thresholds” and “Messages” sections, as well as to set the “Period” of validity of the Indicator and create/edit the formula in the “Indicator Expression” cell.

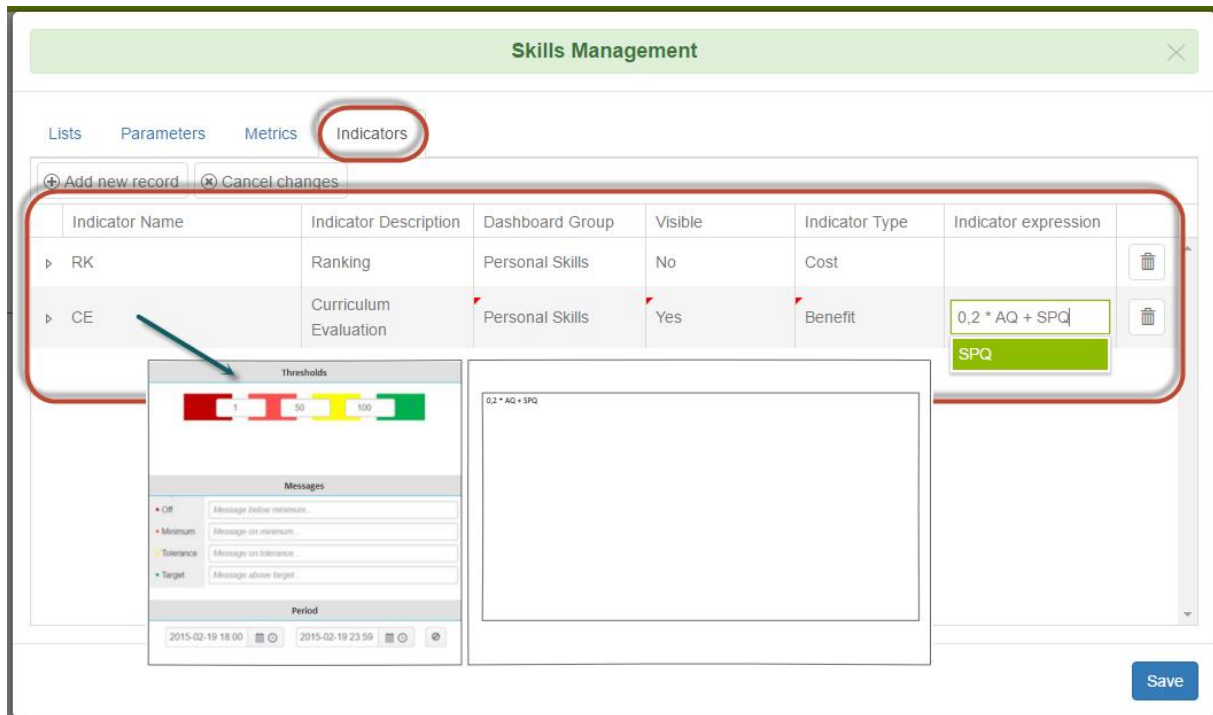


Figure 26. Metadata Configuration – Indicator Expanded

Depending on the “Indicator Type” selected: “Cost/Benefit/On Target”, different kinds of screens will be presented, as illustrated in the Figure 27 below. All “Indicator Types” screens are similar in terms of the scale presented at the “Thresholds” section, with relevance to the “Cost” and “Benefit”, which are antagonistic in terms of color order. In the “On Target” screen there is one additional field “Target Tolerance”, where the business user can define the tolerance value (i.e., deviation from the defined target value). In the “Messages” section, the fields presented vary, depending on the “Indicator Type” selected. Finally, the “Period” section is equal for all the different “Indicator Type” screens and enables the business user to set the “Thresholds” period of validity, by defining the “Start” and “End” dates and/or “Activate/Deactivate” it.



Figure 27. Metadata Configuration – Types of Thresholds

Annex B – Skills Development Module Requirements

Table 7 presents the contributions for the D2.3-1 document (Consolidated_requirements_pre-evaluation_and_scenarios) of the SDM.

Table 7. Requirements assigned to the SDM

# Req.	Title & Description	Priority
SD-FR-01	Provide information concerning the employee CV	H
	The Skills Module shall provide information concerning the employee CV (Curriculum Vitæ) – this includes the list of all training actions already taken, counting academic and professional certifications.	
SD-FR-02	Dashboard with information regarding the employee classification	H
	<p>The employee dashboard will provide a set of statistical data used to classify the employee performance perceived within the organization. This classification includes the following qualifiers:</p> <ul style="list-style-type: none"> • Assessment, a qualitative classification based on a global analysis of the employee CV; • Curriculum evaluation, a quantitative calculation based on a global analysis of the employee Hard Skills and Soft Skills; • Peers Assessment, a quantitative calculation based on a global analysis of the employee CV, divided by the total of employees; • Ranking position, a relative position based on the classification obtained by the other employees. This classification is very dynamic therefore it can change over time. 	
SD-FR-03	Determine the CV Evaluation indicator	H
	<p>The system shall compute the Curriculum Evaluation (CE) according to the following formula:</p> $(2AQ + GPE + 2SPE + GPQ + 2SPQ + LQ + EQ + 2CQ) / ND, \text{ where:}$ <ul style="list-style-type: none"> • AQ: Academic Qualifications; • GPE: General Professional Experience; 	

	<ul style="list-style-type: none"> • SPE: Specific Professional Experience; • GPQ: General Professional Qualification; • SPQ: Specific Professional Qualification; • LQ: Language Qualification; • EQ: Endorsements Qualification; • CQ: Competencies Qualification; • ND: Number of Dimensions (optional) 	
SD-FR-04	Determine the Peers Average indicator	H
	<p>The system shall compute the Peers Average (PA) according to the following formula:</p> <p><i>Total of CE / Number of employees</i></p>	
SD-FR-05	Determine the Assessment indicator	H
	<p>The system shall compute the Assessment according to the following formula:</p> <p><i>ROUND(Curriculum Evaluation (CE) * 100 / MAX(CE))</i></p> <p>And display qualitative information based on the following criteria:</p> <ul style="list-style-type: none"> • BELOW AVERAGE (<=50%) • AVERAGE (>50% and <=60%) • GOOD (>60% and <=80%) • VERY GOOD (>80% and <=95%) • TOP TALENT (>95% and <=100%) 	
SD-FR-06	Determine the Ranking indicator	H
	The system shall compute the Ranking according to the Curriculum Evaluation (CE), against to the total number of employees, using the RANK function	
SD-FR-07	Determine the CV Composition indicator	H
	The system shall compute the CV composition (i.e., pie chart) according to the following formula:	

	<p>$SM * 100 / SUM(SM)$, where:</p> <ul style="list-style-type: none"> • SM: Skill Parameter Metric • SUM(SM): SUM of Employees' Skill Parameter Metrics 	
SD-FR-08	<p>The dashboard shall include a section with the Employee alert messages</p> <p>The Skills Module shall alert the user when his/her score is in risk. The lead-time to trigger the alert is a configurable parameter. This feature aims at preventing situations related, for instance, to a certification that will expire or when a training actions is to be outdated (e.g., more than five years). Three type of alert messages shall be implemented:</p> <ul style="list-style-type: none"> • Alerts, a quantitative calculation based on the total number of alert messages from the Employee's Hard & Soft skills; • Warnings, a quantitative calculation based on the total number of warning messages from the Employee's Hard & Soft skills; • Recommendations, a quantitative calculation based on the total number of recommendation messages from the Employee's Hard & Soft skills. <p>The dashboard shall compute/provide the total number of alert messages according to the following formula:</p> <p><i>Total of Alerts + Total of Warnings + Total of Recommendations</i></p>	H
SD-FR-09	<p>Calculation of the Alerts parameter</p> <p>The system shall compute the # Alerts according to the following formula:</p> <p><i>(Total of Hard Skills Alerts + Total of Soft Skills Alerts)</i></p>	H
SD-FR-10	<p>Calculation of the Warnings parameter</p> <p>The system shall compute the total number of Warning according to the following formula:</p> <p><i>(Total of Hard Skills Warnings + Total of Soft Skills Warnings)</i></p>	H
	Calculation of the Recommendations parameter	H

SD-FR-11	The system shall compute the total number of Recommendations according to the following formula: <i>(Total of Hard + Soft Skills Recommendations)</i>	
SD-FR-12	Messages semantic search by messages type	H
	The system shall provide a tool to filter the list of alert messages using a semantic search. This search can be narrowed by applying a filter to the type of alert messages (i.e., Alerts, Warnings and Recommendations).	
SD-FR-13	The dashboard shall include a section with the Employee training history	H
	The employee dashboard shall provide a set of statistical data used to quantify the employee training perceived within the organization. Two types of training messages shall be implemented: <ul style="list-style-type: none"> • Recent, a quantitative calculation based on the total number of Hard & Soft Skills trainings attended by the Employee recently (e.g., last month). • All, a quantitative calculation based on the total number of Hard & Soft Skills trainings attended by the Employee. 	
SD-FR-14	The employee expertise will be segmented into hard and soft skills	H
	The system shall provide a way to classify the employee expertise into two major groups (soft and hard) skills. Each of these two groups can then be detailed into more granular classifier elements. For each group the alert message structure is defined based on the following two types: <ul style="list-style-type: none"> • Hard Skills: <ul style="list-style-type: none"> ○ Hard Skills Messages; ○ Hard Skills Curriculum Evaluation (HSCE). • Soft Skills: <ul style="list-style-type: none"> ○ Soft Skills Messages; ○ Soft Skills Curriculum Evaluation (SSCE). 	
	Calculation of the Hard Skills Messages parameter	H

SD-FR-15	The system shall compute the total number of Messages according to the following formula: <i>(Total of Alerts + Total of Warnings + Total of Rec of Hard/Soft Skills)</i>	
SD-FR-16	Calculation of the HSCE parameter	H
	The system shall compute the HSCE according to the following formula: <i>(AQ from Education + GPE+SPE from Experience + GPQ from Certifications + SPQ from Training + LQ from Languages + SEQ from Skills & Endorsements)</i>	
SD-FR-17	Calculation of the Soft Skills Messages parameter	H
	The system shall compute the total number of Messages according to the following formula: <i>(Total of Alerts + Total of Warnings + Total of Recommendations of Competencies and Training)</i>	
SD-FR-18	Calculation of the SSCE parameter	H
	The system shall compute the SSCE according to the following formula: <i>(CQ from Competencies + SPQ from Training)</i>	
SD-FR-19	Dashboard with information regarding the employee enrolment and adherence to the list of training actions.	H
	The Skills Module shall provide a dashboard with information related to the employee enrolment and adherence to the list of training action promoted within the organization (i.e., training catalogue). Three types of indicators shall provide the following information: <ul style="list-style-type: none"> • # Trainees, total number of employee who concluded at least one training action in the last three months; • # Total sessions; • # Average Score; • # Total Hard Skills assigned; 	

	<ul style="list-style-type: none"> • # Total Soft Skills assigned; • # Total Training Required. 	
SD-FR-20	<p>Implement a Skills Manager intelligent software agent</p> <p>The system will provide a software component that will act as an intelligent agent, providing recommendations about which training packages best suits the user professional profile, role in the organization or reported interests. These recommendations are presented to the employee to motivate his progress and skill improvement, with a high probability to increase his/her score.</p> <p>This intelligent agent will also handle the administrative procedure to enroll the employee in training actions requiring approval from the supervisor and monitor the achievement/assessment of the employee in each training action. This intelligent agent will perform the following roles:</p> <p>Provide recommendation about alternative training actions or training packages;</p> <ul style="list-style-type: none"> • Enroll the employee in a training class; • Present proposals for CV improvements, based on the training offers available in the training catalogue; • Alert (in useful time) the employee for expiration dates for some certifications; • Alert (in useful time) the employee for training action with more than five years. 	H

Annex C – Skills Development Module Mockups

The Personal Dashboard enables the employee to monitor some relevant information regarding his/her skills, as well as to check his/her progression and alignment with the organization needs, through events (alerts, warnings and recommendations) to fill the “My Messages” personal area. Figure 28 illustrates a mockup of the Staff Profile Dashboard, where besides the Curriculum Vitae (CV) evaluation, skills assessment and ranking position, the employee can also monitor his/her messages (alerts, warnings and recommendations) triggered by an IA, as well as the training historical and Personal Skills composition.

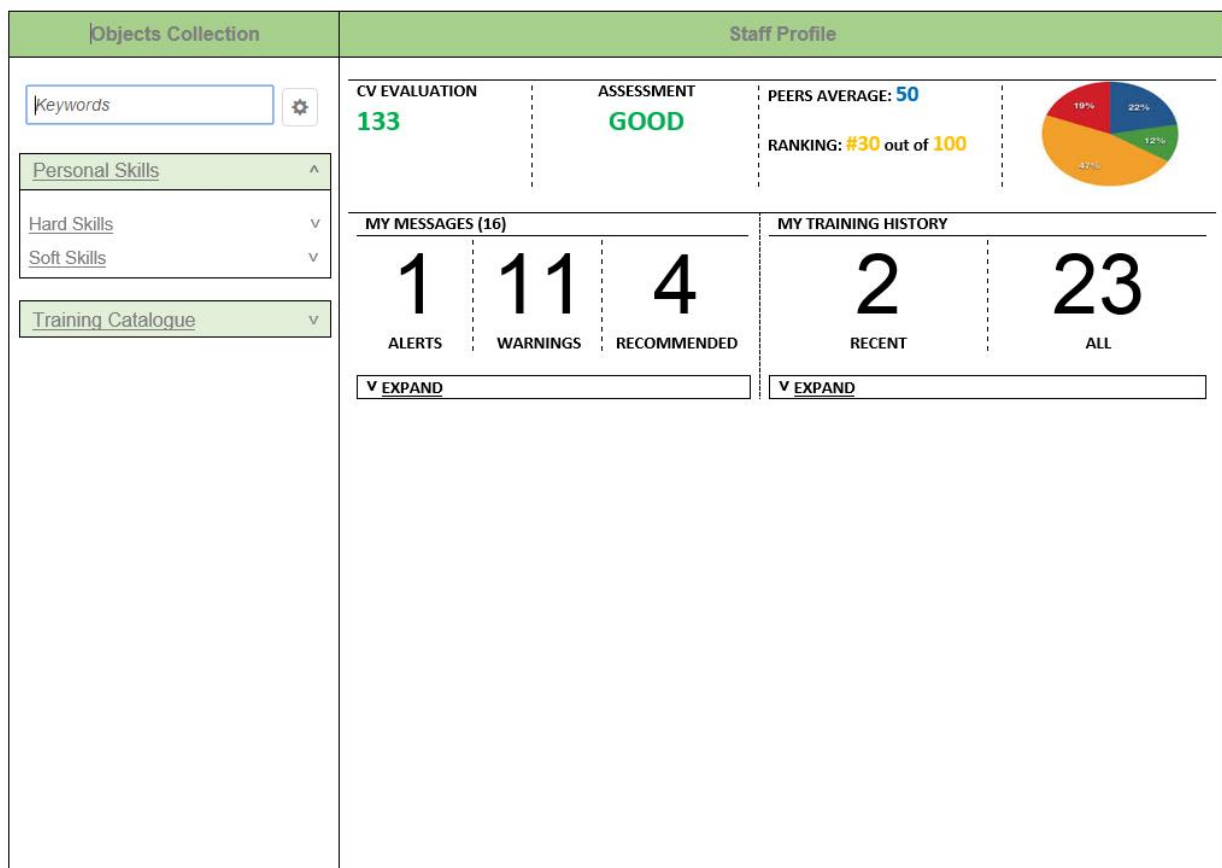


Figure 28. Mockup of the Staff Profile Dashboard layout

The Personal Dashboard enables the employee flexibility to choose between different Hard and Soft Skills options, through a tree map menu. Figure 29 illustrates a mockup of the Personal Skills Experience, which is composed by two sections: header and detail. In the header section, the employee can check the messages (alerts, warnings and recommendations) triggered by an IA, as well as the sum of the “General Professional Experience (GPE)” and “Special Professional Experience (SPE)” figures, which are both calculated with formulas related with roles time experience. In the detail section, the employee can monitor the status (error, warning or recommendation) of each role, check the details and trigger an action – if applicable.

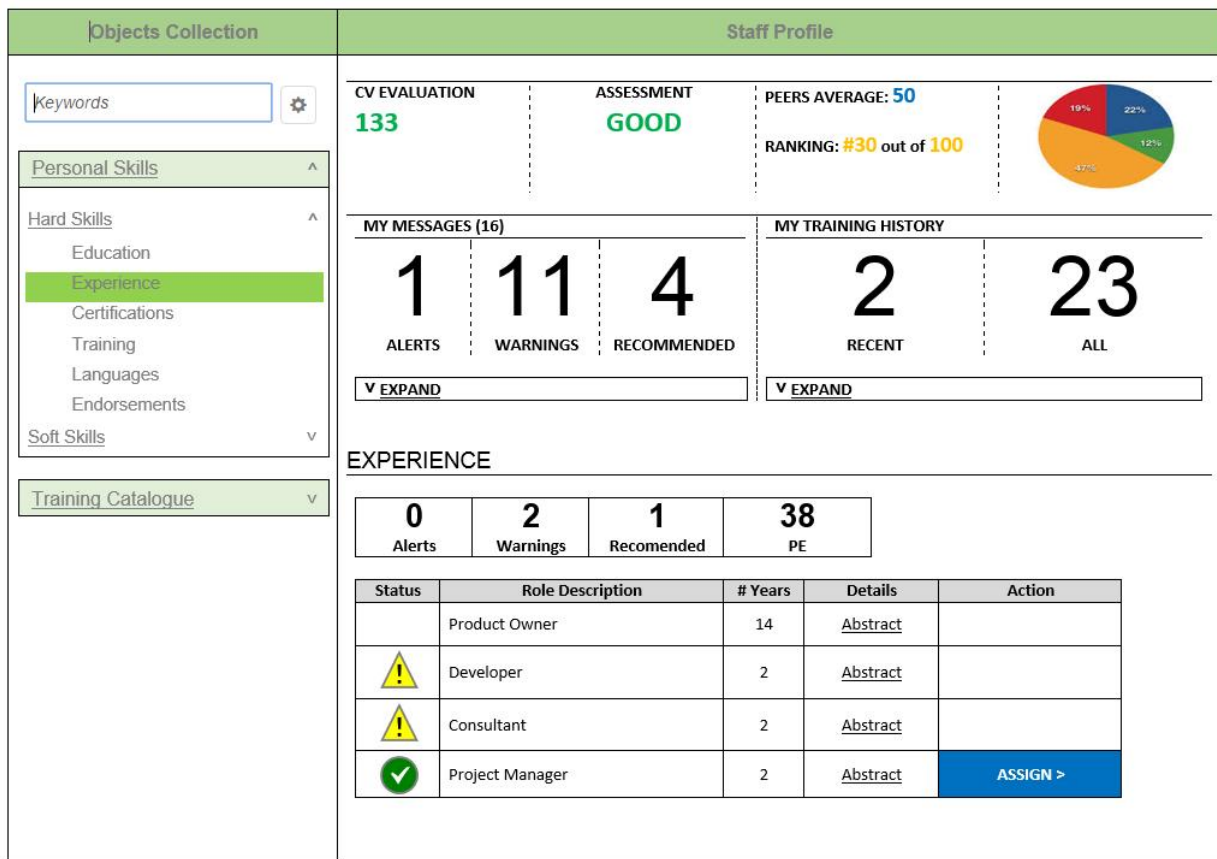


Figure 29. Mockup of the Staff Profile – Staff Experience Skills layout

The Training Catalogue enables the employee to monitor some relevant information regarding overall training sessions, as well as to provide an interactive training environment to support his/her progression and alignment with the organization needs, through events (alerts, assignments and recommendations) to fill the “My Skills Plan” area. Figure 30 illustrates a mockup of the Target Profile Dashboard, where besides the overall training and the “Skills Top10” figures, the employee can also monitor his/her Skills Plan (alerts, assignments and recommendations) triggered by an IA. The employees can also perform a keyword(s) semantic or advanced search.

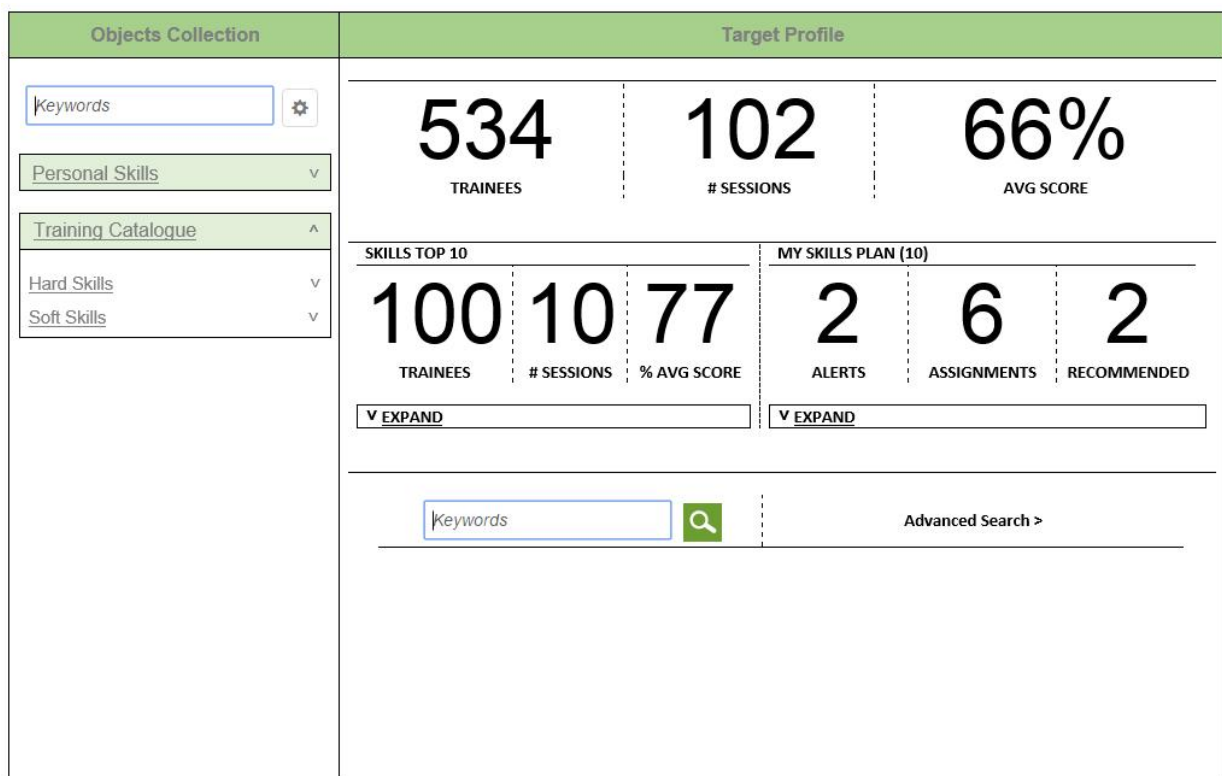


Figure 30. Mockup of the Target Profile Dashboard layout

The Training Catalogue enables the employee flexibility to choose between semantic or advanced search options. Figure 31 illustrates a mockup of the search results – grouped by Hard/Soft Skills, enabling the employee to expand/collapse any node from the tree map menu.

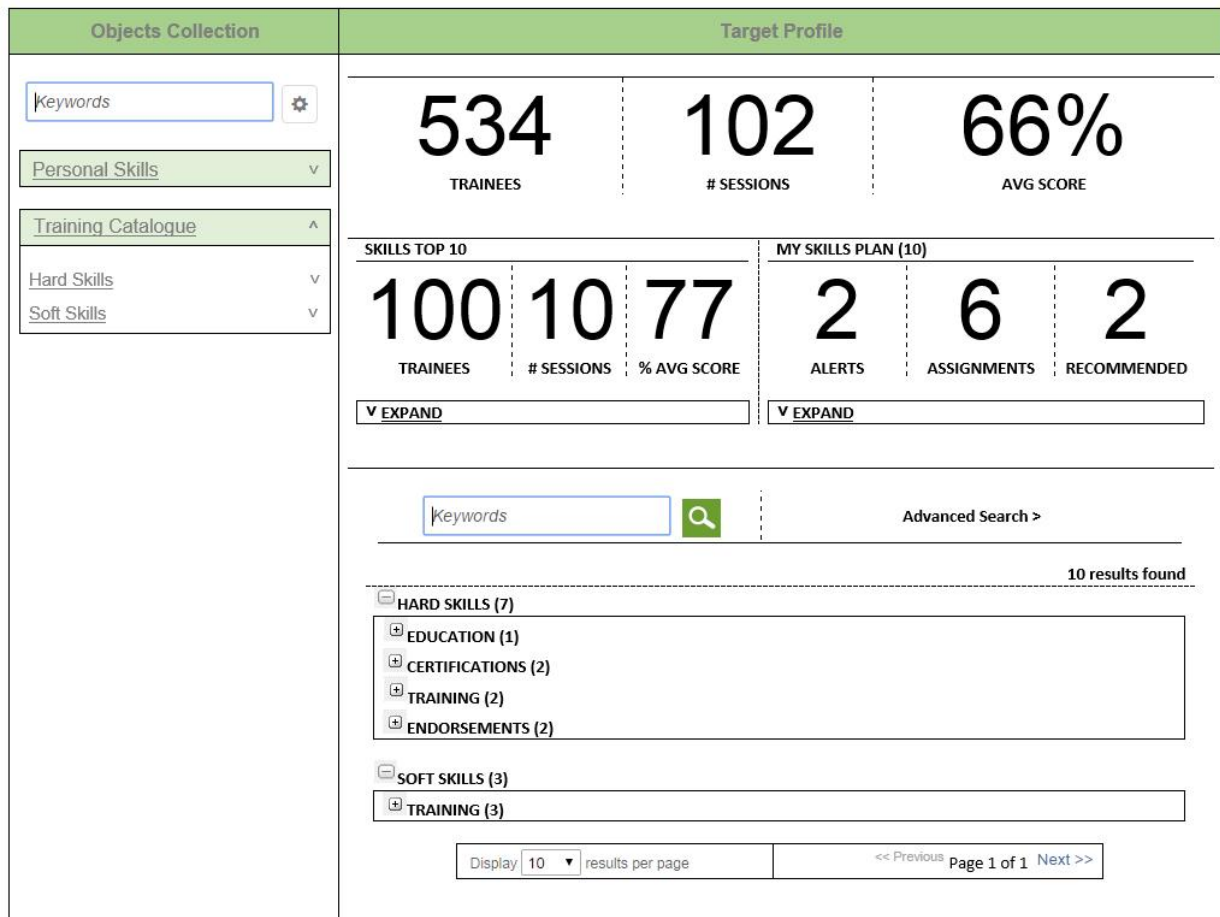


Figure 31. Mockup of the Target Profile – Search Results layout

Annex D – Skills Development Module Indicators & Metrics

Table 8 presents the Description, Formula and an Example of the Curriculum Vitae Evaluation (CE). The CE indicator represents the overall quantitative calculation of all the employee Hard & Soft Skills metrics.

Table 8. Curriculum Vitae Evaluation - CE (Description, Formula and Example)

Indicator	CV Evaluation (CE)
Description	Quantitative expression to determine the value of the CE indicator which is based on metrics related to Hard Skills and Soft Skills, taking in consideration the weight of each metric
Formula	$CE = (2AQ + GPE + 2SPE + GPQ + 2SPQ + LQ + EQ + 2CQ) / ND$, where: <ul style="list-style-type: none"> • AQ: Academic Qualifications metric; • GPE: General Professional Experience metric; • SPE: Specific Professional Experience metric; • GPQ: General Professional Qualification metric; • SPQ: Specific Professional Qualification metric; • LQ: Language Qualification metric; • EQ: Endorsements Qualification metric; • CQ: Competencies Qualification metric; • ND: Number of Dimensions (optional).
Example	<p>Hard Skills for a specific Employee which the following expertise</p> <p>AQ: Degree in Management → Weight: 12</p> <p>SPE: 10 Years' Experience in Project Manager → Weight: 16</p> <p>GPQ: Certification in PMP (> 60 hours) → Weight: 5</p> <p>LQ: English (Level 3) → Weight: 8</p> <p>EQ: Scrum (70 Endorsements - Level 4) → Weight: 5</p> <p>Soft Skills for a specific Employee which the following expertise</p> <p>CQ: Teamwork (Very Good) → Weight: 10</p> <p>SPQ: Lead as Example (Training course) → Weight: 8</p> <p>CE: $(2 \times 12 + 2 \times 16 + 5 + 2 \times 8 + 8 + 5 + 2 \times 10) / NM = 110$</p> <p>ND: Not applicable (N/A)</p>

	If the PMP Certification expires, the system attributes 0 to the GPQ metric, which will cause the specific employee CE indicator to decrease to 105
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Table 9 presents the Description, Formula and an Example of the Peers Average (PA) indicator. The PA indicator represents the quantitative calculation of the sum of all employees' CE, divided by the total of employees.

Table 9. Peer Average - PA (Description, Formula and Example)

Indicator	Peers Average (PA)
Description	Employees CV Evaluation Average according to the total of employees
Formula	$PA = \text{SUM}(CE) / \text{COUNT}(EMP)$, where: SUM(CE) : SUM of Employees' CE; COUNT(EMP) : Total number of Employees
Example	SUM(CE) : 1000 COUNT(EMP) : 100 PA = 100 Thus, if a specific Employee CE = 110 , then is higher than his peers average

Table 10 presents the Description, Formula and an Example of the Assessment (AS) indicator. The AS indicator represents the qualitative information of the employee' CE, based on specific criteria defined by the Organization.

Table 10. Assessment - AS (Description, Formula and Example)

Indicator	Assessment (AS)
Description	Employee overall qualitative Assessment according to the CV Evaluation
Formula	$AS = \text{ROUND}((CE * 100) / \text{MAX}(CE))$, where: <ul style="list-style-type: none"> • MAX(CE): CE maximum value And based on the following criteria: <ul style="list-style-type: none"> • BELOW AVERAGE (<=50%) • AVERAGE (>50% and <=60%) • GOOD (>60% and <=80%)

	<ul style="list-style-type: none"> • VERY GOOD (>80% and <=95%) • TOP TALENT (>95% and <=100%)
Example	<p>For a specific Employee with CE = 110 and assuming that MAX(CE) is 190</p> <p>$AS = \text{ROUND}((110 * 100) / 190) = \mathbf{58\%}$</p> <p>Thus, the specific Employee overall assessment is AVERAGE</p>

Table 11 presents the Description, Formula and an Example of the Ranking (RK) indicator. The PA indicator represents the quantitative calculation of the employee rank position, in comparison with his peers.

Table 11. Ranking - RK (Description, Formula and Example)

Indicator	Ranking (RK)
Description	Employee Ranking according to the total of employees
Formula	RANK function(EmployeeCE,Employee1:N)
Example	<p>For a specific Employee with CE = 110 and assuming that the Organization has the following employees/CE:</p> <p>Employee1: 50, Employee2: 60, Employee3: 70, Employee4: 80, Employee5: 90, Employee6: 100, Employee7: 120, Employee8: 130 and Employee9: 190</p> <p>$\text{RANK}(110, \text{Employee1:N}) = \mathbf{\text{Ranking 7 of 10}}$</p>

Table 12 presents the Description, Formula and an Example of the CV Composition (CC) indicator. The CC indicator represents the quantitative calculation of the percentage of each of the employee skills/competencies, in comparison with the sum of all his Hard & Soft Skills metrics.

Table 12. CV Composition - CC (Description, Formula and Example)

Indicator	CV Composition (CC)
Description	CV Composition is displayed in a pie chart, where each one of the pie chart slices (with different colours) represents graphically the weight of each one of the different Skills Parameters. The Personal Dashboard pie chart displays a percentage value, determined by the metric value of each one of the different Skills Parameters (e.g., Education, Experience).

Formula	$CC = SM * 100 / SUM(SM)$, where: <ul style="list-style-type: none"> • SM: Skill Parameter Metric • SUM(SM): SUM of Employees' Skill Parameter Metrics
Example	<p>For a specific Employee with CE = 110 and the SUM of the metrics values for each of the parameters for Hard & Soft Skills = 64, the Personal Dashboard will present a pie chart with the following slices percentages:</p> <p>Hard Skills (71,9%)</p> <p>AQ: 12 → $(12 * 100) / 64 = 18,8\%$ (Education)</p> <p>SPE: 16 → $(16 * 100) / 64 = 25\%$ (Experience)</p> <p>GPQ: 5 → $(5 * 100) / 64 = 7,8\%$ (Certifications)</p> <p>LQ: 8 → $(8 * 100) / 64 = 12,5\%$ (Languages)</p> <p>EQ: 5 → $(5 * 100) / 64 = 7,8\%$ (Endorsements)</p> <p>Soft Skills (28,1%)</p> <p>CQ: 10 → $(10 * 100) / 64 = 15,6\%$ (Competencies)</p> <p>SPQ: 8 → $(8 * 100) / 64 = 12,5\%$ (Trainings)</p>

Table 13 presents the Factor, Weights and the corresponding descriptions of the Academic Qualifications (AQ) metric. The AQ metric represent the Education parameter and is assigned to the category Hard Skills.

Table 13. Academic Qualifications - AQ (Factor, Weight and Description)

Factor	Weight	Description
$AQ = S + D + M + P$		<i>S: Upper Secondary education level</i> <i>D: Degree education level</i> <i>M: Master education level</i> <i>P: PhD education level</i>
AQ: Academic Qualifications	6	Upper secondary education
	12	Degree in area not related to information technology
	16	Degree in computer science area
	2	Master's degree
	2	PhD

Table 14 presents the Factor, Weights and the corresponding descriptions of the General Professional Experience (GPE) metric, which is subdivided in Exercise of Public Functions in Jobs,

careers, classes or functions (EPF) and Exercise of management positions, coordination and/or supervision (EMP). The GPE and Specific Professional Experience (SPE) metrics represents the Experience parameter and are assigned to the category Hard Skills.

Table 14. General Professional Experience - GPE (Factor, Weight and Description)

Factor	Weight	Description
GPE = (EPF + EMP) / 2		<i>EPF - Exercise of Public Functions in jobs, careers, classes or functions</i>
GPE: General Professional Experience	16	≤ 10 years
	18	> 10 years and ≤ 15 years
	20	> 15 years
		<i>EMP - Exercise of management positions, coordination and/or supervision</i>
	14	≤ 3 years
	18	> 3 years and ≤ 9 years
	20	> 9 years

Table 15 presents the Factor, Weights and the corresponding descriptions of the Specific Professional Experience (SPE) metric. The SPE and GPE metrics represents the Experience parameter and are assigned to the category Hard Skills.

Table 15. Specific Professional Experience – SPE (Factor, Weight and Description)

Factor	Weight	Description
SPE: Specific Professional Experience		
	10	Up to 1 year
	12	> 1 year and ≤ 3 years
	14	> 3 years and ≤ 6 years
	16	> 6 years and ≤ 15 years
20	> 15 years	

Table 16 presents the Factor, Weights and the corresponding descriptions of the General Professional Qualification (GPQ) metric. The GPQ metric represents the Certifications parameter and is assigned to the category Hard Skills.

Table 16. General Professional Qualification - GPQ (Factor, Weight and Description)

Factor	Weight	Description
GPQ: General Professional Qualification		<i>With special interest (last 5 years)</i>
	1	≤ 12 hours
	2	> 12 hours and ≤ 30 hours
	4	> 30 hours and ≤ 60 hours
	5	> 60 hours
	10	Post-graduation

Table 17 presents the Factor, Weights and the corresponding descriptions of the Specific Professional Qualification (SPQ) metric, which is subdivided in Specific Qualifications for Public Functions (SQPF) and Specific Qualifications for other Functions (SQO). The SPQ metric represents the Trainings parameter and is assigned to both categories Hard and Soft Skills.

Table 17. Specific Professional Qualification - SPQ (Factor, Weight and Description)

Factor	Weight	Description
$SPQ = (SQPF + SQO) / 2$		<i>Specific Qualifications for Public Functions</i>
SPQ: Specific Professional Qualification	12	Advanced course in public management
	14	Training programme in public management
	20	Senior management in public administration
		<i>Specific Qualifications for other Functions</i>
	8	Training course
	10	Advanced course
	12	Training programme
	16	Seminar for top management

Table 18 presents the Factor, Weights and the corresponding descriptions of the Language Qualification (LQ) metric. The LQ metric represents the Language parameter and is assigned to the category Hard Skills.

Table 18. Language Qualification - LQ (Factor, Weight and Description)

Factor	Weight	Description
LQ: Language Qualification		<i>Language levels (to be defined)</i>
	2	Level 1
	4	Level 2
	8	Level 3
	16	Level 4

Table 19 presents the Factor, Weights and the corresponding descriptions of the Endorsements Qualification (EQ) metric. The EQ metric represents the Endorsements parameter and is assigned to the category Hard Skills.

Table 19. Endorsements Qualification - EQ (Factor, Weight and Description)

Factor	Weight	Description
EQ: Endorsements Qualification		<i>Endorsement levels (proposal)</i>
	1	Level 1: > 1 and <= 20
	2	Level 2: > 20 and <= 40
	3	Level 3: > 40 and <= 60
	5	Level 4: > 60 and <= 80
	7	Level 5: > 80 and <= 100
	10	Level 6: > 100

Table 20 presents the Factor, Weights and the corresponding descriptions of the Competencies Qualification (CQ) metric. The CQ metric represents the Competencies parameter and is assigned to the category Soft Skills.

Table 20. Competencies Qualification - CQ (Factor, Weight and Description)

Factor	Weight	Description
CQ: Competencies Qualification		<i>Assessment levels (proposal)</i>
	0	Below Average
	5	Average
	10	Good
	15	Very Good
	30	Top Talent

Annex E – Skills Development Module Domain Model

Domain Model Classes	Description															
<p>Class Staff</p>	<ul style="list-style-type: none"> Corresponds to the class which records "Personal Data" in the Virtual Assistant Tool (VAT). It's through this class that there is a link between the staff in the SDM and the clinical profile of this staff in VAT (i.e., in the Database Entity Relationship Diagram – ERD – it should be the same table). Just as an example, and in order to reinforce that it's the same table in the database ERD, the same attributes from the interface "Personal Data" in the VAT (i.e., FirstName, MiddleName, LastName, BirthDate, Country, Phone and Gender) were placed in the domain model. <div data-bbox="772 981 1216 1357" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <pre> Staff - StaffID: SmallInteger {unique} - FirstName: String - MiddleName: String - LastName: String - BirthDate: DateTime - Country: String - Phone: Integer - Email: Char - Gender: Gender + getStaff () + setStaff () </pre> </div>															
<p>Association Class PersonalDashboard</p>	<ul style="list-style-type: none"> List of fixed attributes: <ul style="list-style-type: none"> Sd_Alert, Sd_Warn, Sd_Recom, Sd_Recent, Sd_Total <div data-bbox="839 1547 1145 1809" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <pre> PersonalDashboard - Sd_Alert: SmallInteger - Sd_Warn: SmallInteger - Sd_Recom: SmallInteger - Sd_Recent: SmallInteger - Sd_Total: SmallInteger + getPersonalDashboard () + setPersonalDashboard () </pre> </div> <div data-bbox="560 1832 1430 1989" style="margin: 10px auto; text-align: center;"> <table border="1" style="border-collapse: collapse; width: 100%;"> <tr> <td colspan="3" style="padding: 2px;">MY MESSAGES (16)</td> <td colspan="2" style="padding: 2px;">MY TRAINING HISTORY</td> </tr> <tr> <td style="font-size: 2em; padding: 5px;">1</td> <td style="font-size: 2em; padding: 5px;">11</td> <td style="font-size: 2em; padding: 5px;">4</td> <td style="font-size: 2em; padding: 5px;">2</td> <td style="font-size: 2em; padding: 5px;">23</td> </tr> <tr> <td style="font-size: 0.8em; padding: 2px;">ALERTS</td> <td style="font-size: 0.8em; padding: 2px;">WARNINGS</td> <td style="font-size: 0.8em; padding: 2px;">RECOMMENDED</td> <td style="font-size: 0.8em; padding: 2px;">RECENT</td> <td style="font-size: 0.8em; padding: 2px;">ALL</td> </tr> </table> </div>	MY MESSAGES (16)			MY TRAINING HISTORY		1	11	4	2	23	ALERTS	WARNINGS	RECOMMENDED	RECENT	ALL
MY MESSAGES (16)			MY TRAINING HISTORY													
1	11	4	2	23												
ALERTS	WARNINGS	RECOMMENDED	RECENT	ALL												

- List of variable attributes:
 - Correspond to the indicators defined in the MIndicator class, assigned to the "Personal Dashboard" group (e.g., CV Evaluation, Assessment, Peers Average, Ranking, ...).



- Whenever a new record is created in the MIndicator class (i.e., a new indicator):
 - The business user must indicate to which Dashboard this indicator will be associated to (i.e., PersonalDashboard);
 - Assuming that a new record is created in MIndicator for PersonalDashboard, when the business user clicks the "Save" button, the system automatically creates in the PersonalDashboard class a new record with the same name that was created in the MIndicator class. The objective of this record in the PersonalDashboard class is to keep the skill measured values for this indicator for each employee contained in the Staff class.

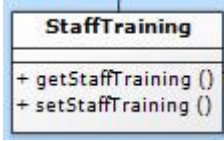
**Association Class
TrainingDashboard**

- List of fixed attributes:
 - Td_Train, Td_Sess, Td_AvgSc, Td_Alert, Td_Assign, Td_Recom.



- List of variable attributes:

	<ul style="list-style-type: none"> ○ No correspondence so far, since no indicators were defined in the MIndicator class, assigned to the “Training Catalogue” group. Once any indicators are created in the MIndicator class, assigned to the “Training Catalogue” group, they can be presented in the TrainingDashboard. ● Whenever a new record is created in the MIndicator class (i.e., a new indicator): <ul style="list-style-type: none"> ○ The business user must indicate to which Dashboard this indicator will be associated to (i.e., TrainingDashboard); ○ In class TrainingDashboard, the fixed indicator Assignments value is increased whenever the user selects a training activity available in the catalogue - TrainingCatalogue class (i.e., click the "Assign" button, or expressed interest in attending the training session).
Class StaffSkill	<ul style="list-style-type: none"> ● This class is used for the relationship of the classes that characterizes the skills that the employee (staff) has, that is, relates to the following classes: <ul style="list-style-type: none"> ○ Staff ID (class Staff); ○ ID of the records in the MParameterH class, assigned to the “Personal Skills” group, in the SDM Interface; ○ ID of the records from the VSSxxx classes (dynamically generated based on records contained in the the MParameterH class). ● As long as no record is created in the MParameter class, the StaffSkill class is empty, as illustrated in Figure 32. ● Whenever a new record is created in the MParameter class (i.e., a new skill): <ul style="list-style-type: none"> ○ The business user must indicate to which Parameter group (i.e., skill group) this parameter will be associated to (i.e., Personal Skills).
Class StaffTraining	<ul style="list-style-type: none"> ● This class is used to identify which training activities were selected by the employee from the list of options available in the Training Catalogue ● Each employee (staff) can, at any moment, select certain training activities from the list of options available in the catalogue. This leads to new records creation, since it relates the following classes: <ul style="list-style-type: none"> ○ Staff ID (class Staff);

	<ul style="list-style-type: none"> ○ ID of the records in the TrainingCatalogue class, which were selected by the employee (i.e., training activities marked as “Assigned”); ○ Grade in the training activity. <div style="text-align: center;">  <pre> classDiagram class StaffTraining { + getStaffTraining () + setStaffTraining () } </pre> </div>
<p>Class TrainingCatalogue</p>	<ul style="list-style-type: none"> • This class characterizes the catalogue of available training activities • Performs the relationship of the classes that characterizes the training offers available in the Training Catalogue, that is, relates the following classes: <ul style="list-style-type: none"> ○ ID of the records in the MParameterH class, assigned to the “Training Catalogue” group, in the SDM Interface; ○ ID of the records from the VTCxxx classes (dynamically generated based on records contained in the the MParameterH class). The VTCxxx classes are specializations of training offers from the Training Catalogue. • As long as no record is created in the MParameter class, the TrainingCatalogue class is empty, as illustrated in Figure 32. • Whenever a new record is created in the MParameter class (i.e., a new training activity): <ul style="list-style-type: none"> ○ The business user must indicate to which Parameter group (i.e., skill group) this parameter will be associated to (i.e., Training Catalog).

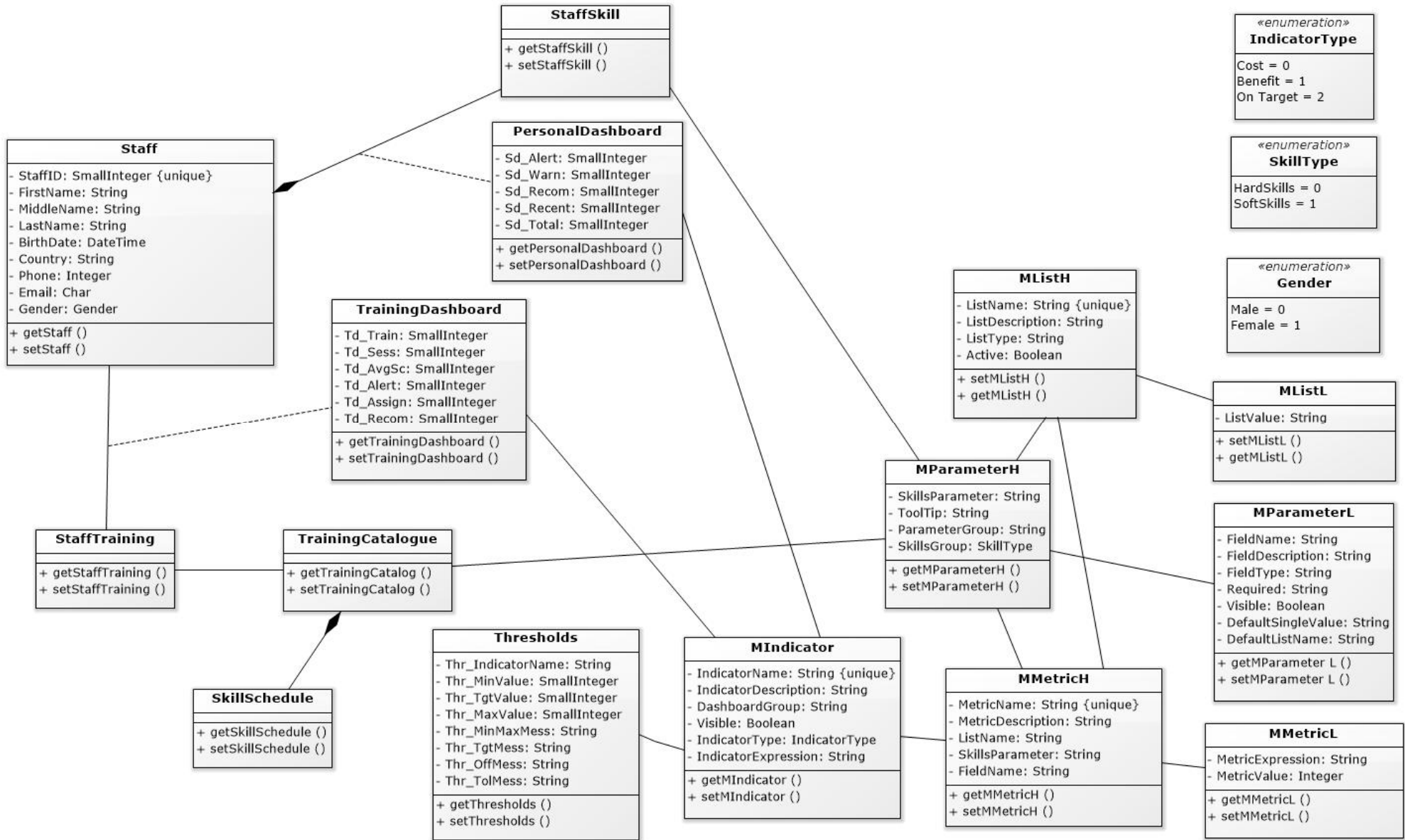


Figure 32. Skills Management domain model – Phase I

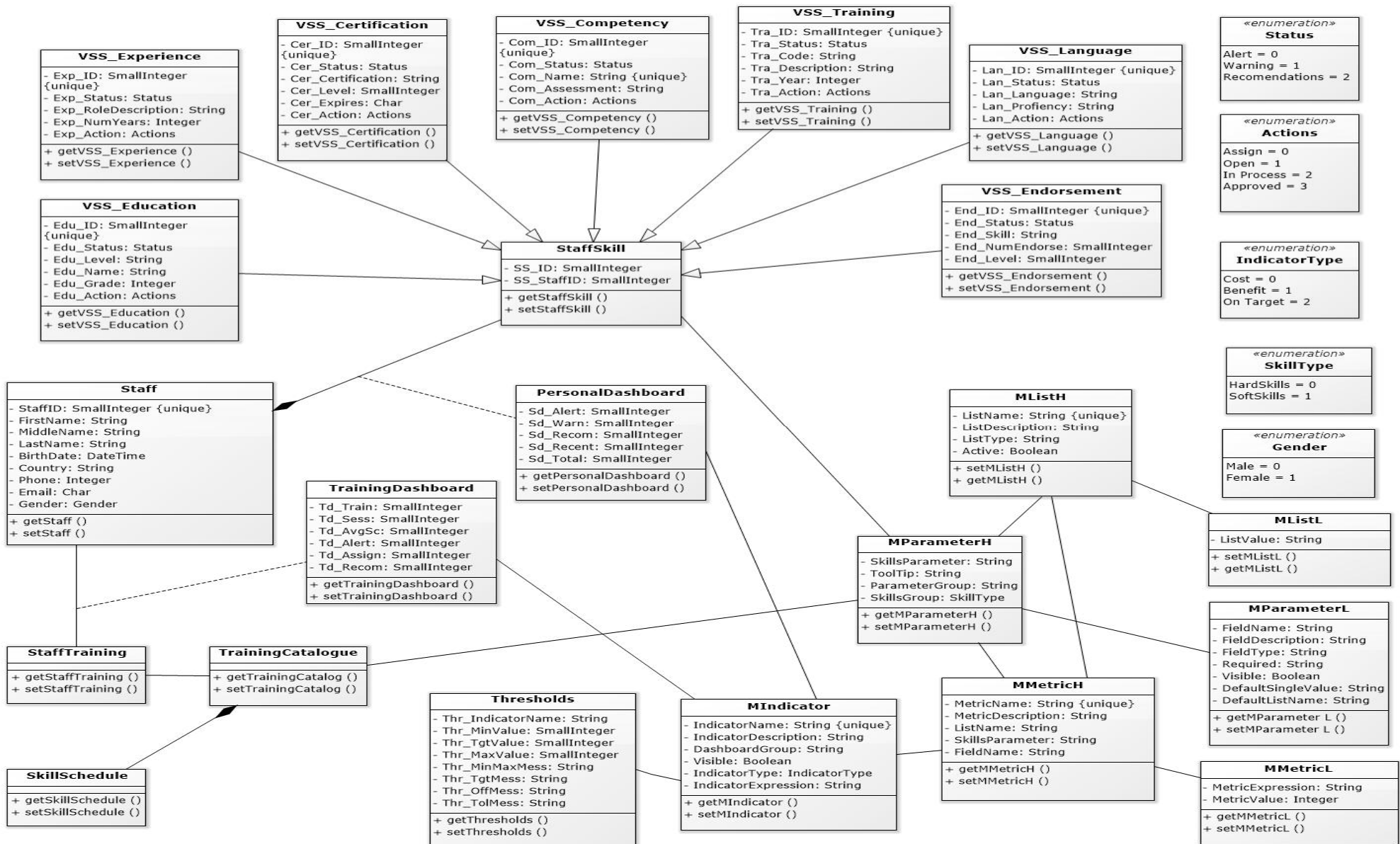


Figure 33. Skills Management domain model – Phase II

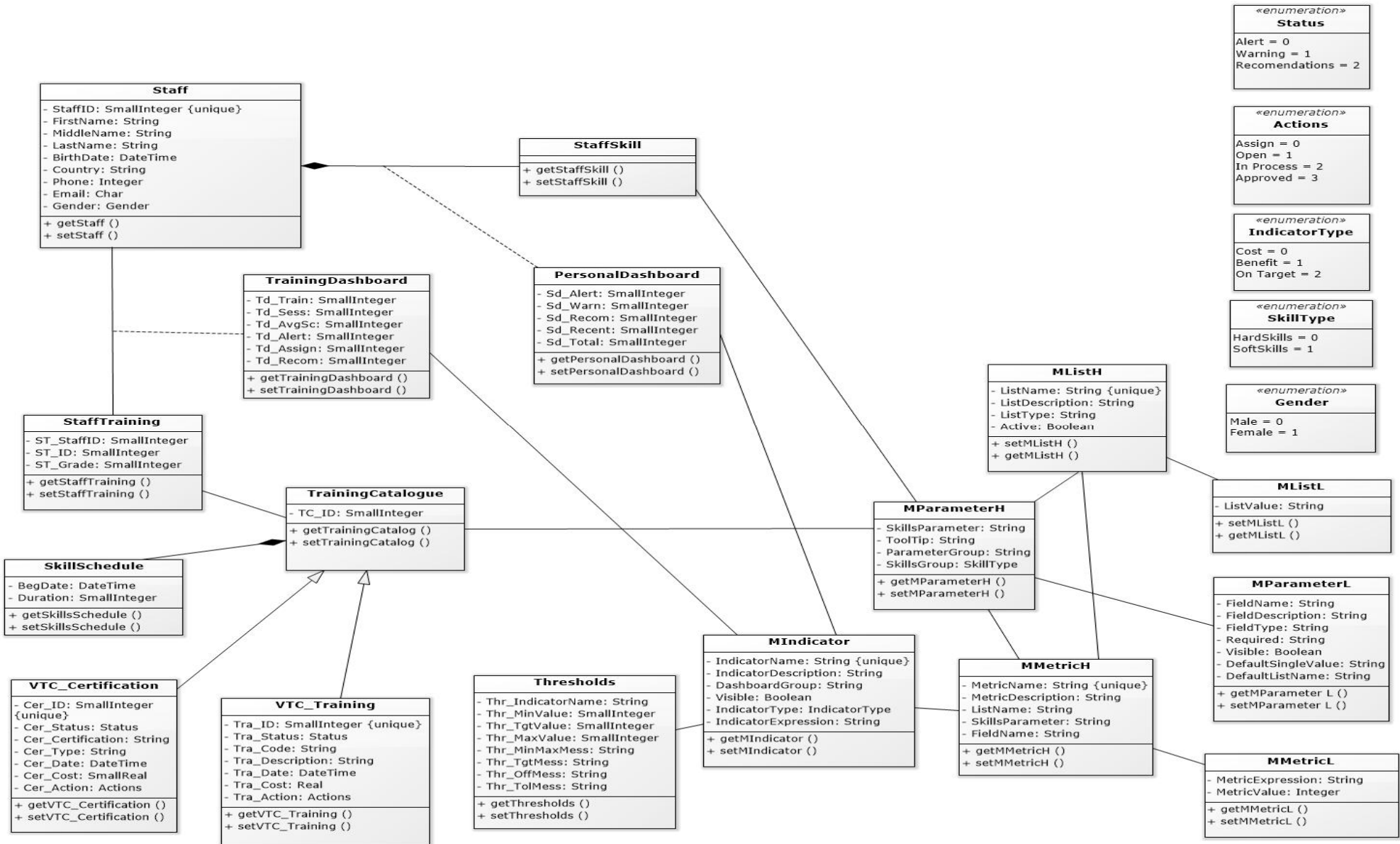


Figure 34. Skills Management domain model – Phase III

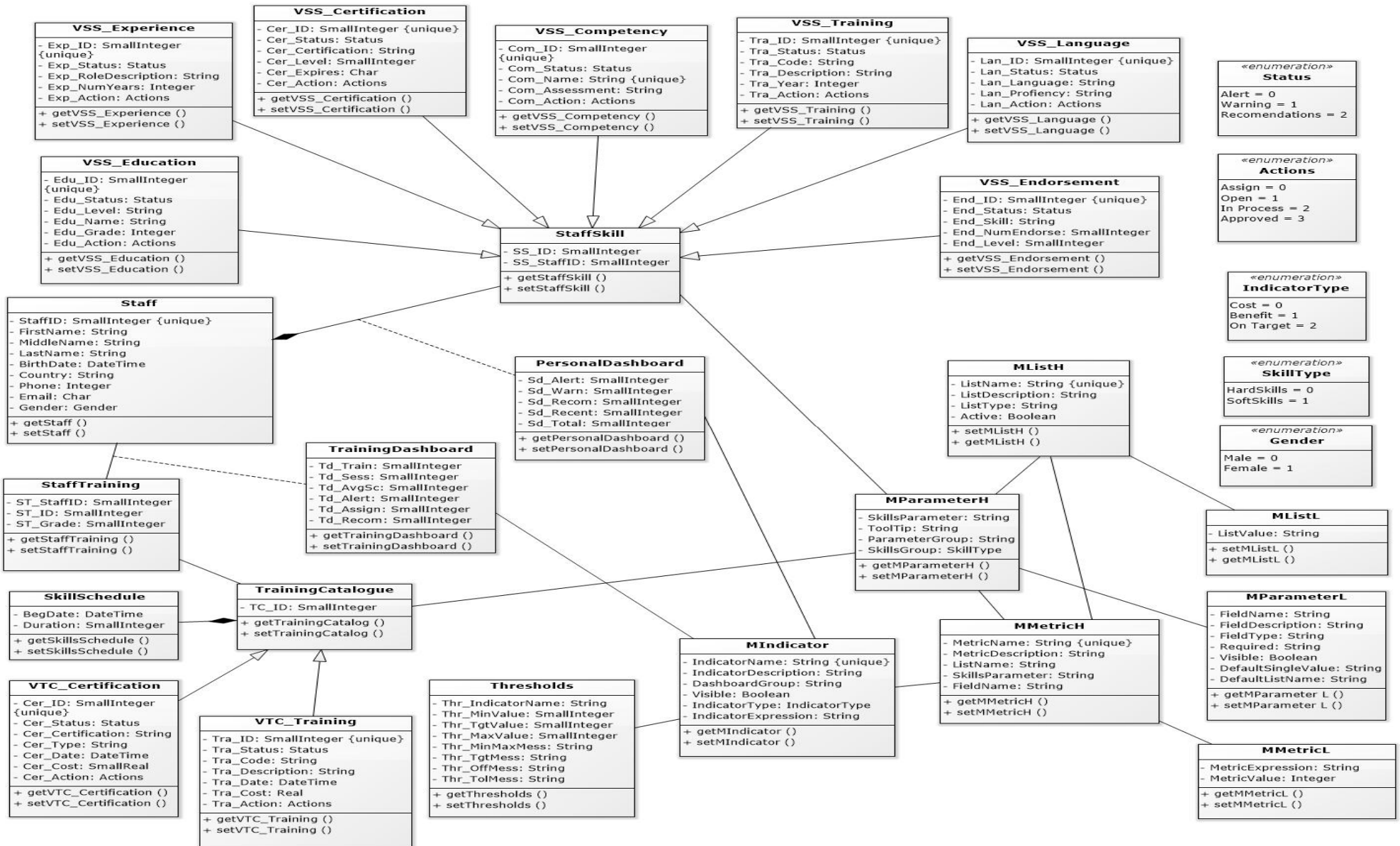


Figure 35. Skills Management domain model – Phase IV