DRIVES

Development and Research on Innovative Vocational Education Skills

Lean Six Sigma Black Belt

Job Role Skill Set

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SKILLS SET LEAN SIX SIGMA BLACK BELT

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Author(s):	H.C. Theisens, D. Harborne, T. Hesp		
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More information about DRIVES project and contact:

www.project-drives.eu

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1 INTRODUCTION

1.1 OBJECTIVE

The objective of this deliverable is to provide an introduction to described Job Role within the applied skills definition model.

1.2 PURPOSE OF THE DELIVERABLE

The purpose of this deliverable is to define skills definitions of the Lean Six Sigma Black Belt job role within the ECQA/LSSA skills definition model.

1.3 SCOPE OF THE DELIVERABLE

The deliverable contains

- Description of the content of the Job Role
- Description of used Skill Sets and skills definitions, coverage of Qualification Schemas

The deliverable does not cover:

- Course development, as this will be done after the skill definitions clearly outlined the set of required courses.

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2 ECQA SKILLS DEFINITION MODEL

A skills definition contains the following items:

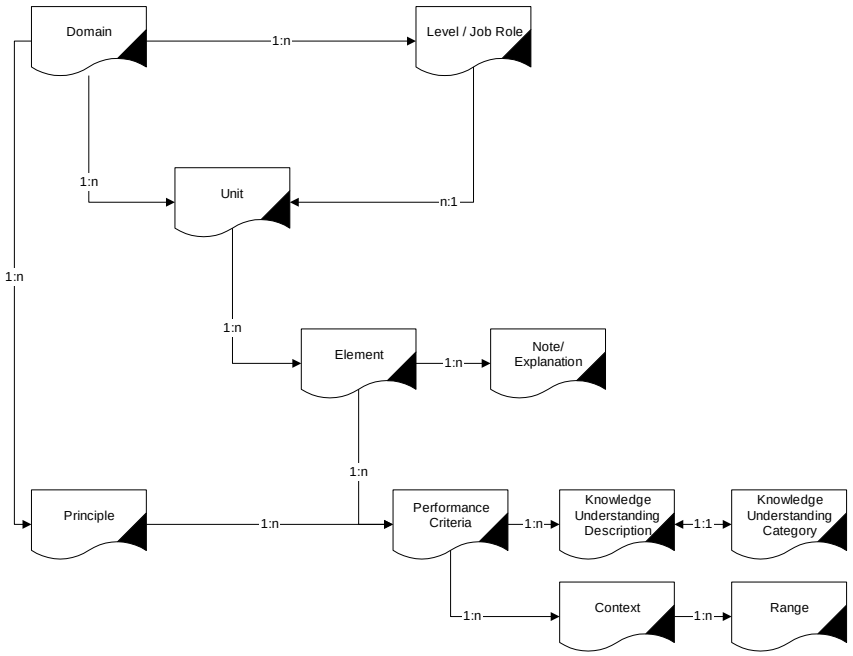

Figure 1 The Skill Definition Model (1:n = one to many relationship)

Context: A category of ranges; it represents some terminology used in a performance criterion that consists of different context, conditions or circumstances. A participant must be able to prove competence in all the different circumstances covered by the context.

Domain: An occupational category, e.g. childcare, first level management or software engineering.

Element: Description of one distinct aspect of the work performed by a worker, either a specific task that the worker has to do or a specific way of working. Each element consists of a number of performance criteria.

Evidence: Proof of competence.

Knowledge and understanding category: A category of knowledge and understanding descriptions.

Knowledge and understanding description: A description of certain knowledge and understanding. To be judged competent in a unit a participant must prove to have and to be able to apply all the knowledge and understanding attached to it.

NVQ (UK based): The National Vocational Qualification standard of England, Wales and N. Ireland.

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Performance criterion: Description of the minimum level of performance a participant must demonstrate in order to be assessed as competent. A performance criterion may have relevant contexts.

Principle: A statement of good intentions; it underpins all competent domain practice.

Range: Description of a specific circumstance and condition of a performance criterion statement.

Qualification: The requirements for an individual to enter, or progress within a certain occupation.

Job Role: A certain profession that covers part of the domain knowledge. E.g. domain = Lean Six Sigma, job role = Black Belt.

Unit: A list of certain activities that have to be carried out in the workplace. It is the top-level skill in the UK qualification standard hierarchy and each unit consists of a number of elements.

The rationales for developing the ECQA skills definition model is based on the skills definition proposed by the DTI (Department of Trade and Industry) in the UK for the NVQ (National Vocational Qualification) standards. These models have been re-used and slightly modified by other countries when they started employing skill cards [1], [2].

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). Further description and rationales are attached in annexes of this document. The ECQA structure was mapped in DRIVES project to DRIVES Reference and Recognition Framework with the links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

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3 SKILLS DEFINITION FOR THE JOB ROLE "LEAN SIX SIGMA BLACK BELT"

3.1 THE SKILLS HIERARCHY

Using the terminology outlined in the skills definition model and including the skills identified by the "Lean Six Sigma Academy (LSSA)", the following skills hierarchy for the job roles related with "Lean Six Sigma" have been designed in the DRIVES project.

	LSSYB	LSSGB	LSSBB
U1 - World Class Performance			
E1 - Continuous Improvement	Awareness	Practitioner	Expert
E2 - Customer value (VOC & CTQ)	Awareness	Practitioner	Expert
U2 - Policy development and deployment			
E1 - Policy development	Awareness	Awareness	Expert
E2 - Policy deployment	Awareness	Awareness	Expert
E3 - Competence development	-	-	Expert
U3 - Project management			
E1 - Managing a project	Awareness	Practitioner	Expert
E2 - Process Improvement roadmaps	Awareness	Practitioner	Expert
U4 - CIMM level I - Creating a solid foundation (Structured)			
E1 - Professional work environment	Awareness	Practitioner	Expert
E2 - Standardized Work	Awareness	Practitioner	Expert
E3 - Quality Management	Awareness	Practitioner	Expert
U5 - CIMM level II - Creating a continuous improvement environment (Managed)			
E1 - Visual management	Awareness	Practitioner	Expert
E2 - Kaizen	Awareness	Practitioner	Expert
E3 - Basic Quality tools	Awareness	Practitioner	Expert
U6 - CIMM level III - Creating stable and efficient processes (Predictable)			
E1 - Process Mapping	Awareness	Practitioner	Expert
E2 - Performance management	Awareness	Practitioner	Expert
E3 - Basic statistics	Awareness	Practitioner	Expert
E4 - Value Stream analysis (VSM)	Awareness	Practitioner	Expert
E5 - Reducing Muda (Waste)	Awareness	Practitioner	Expert
E6 - Reducing Muri (Overburden)	Awareness	Practitioner	Expert
E7 - Reducing Mura (Unevenness)	Awareness	Practitioner	Expert
E8 - Value Stream Improvement	Awareness	Practitioner	Expert
E9 - Process and Quality control	Awareness	Practitioner	Expert
E10 - Total Productive Maintenance (TPM)	-	Awareness	Expert
U7 - CIMM level IV - Creating capable processes (Capable)			
E1 - Statistical techniques	Awareness	Practitioner	Expert
E2 - Distributions	Awareness	Awareness	Expert
E3 - Measurement Systems	Awareness	Practitioner	Expert
E4 - Hypothesis Testing & Confidence Intervals	Awareness	Practitioner	Expert
E5 - Tests for means, variances and proportions	Awareness	Practitioner	Expert
E6 - Correlation and Regression	Awareness	Practitioner	Expert
E7 - Process Capability and Performance	Awareness	Practitioner	Expert
E8 - Design of Experiments (DOE)	Awareness	Practitioner	Expert
E9 - Statistical Process Control (SPC)	Awareness	Practitioner	Expert
U8 - CIMM level V - Creating future-proof processes (Sustained)			
E1 - Product Lifecycle Management (PLM)	-	-	Awareness
E2 - Design for Six Sigma	-	-	Awareness
E3 - The fourth industrial revolution	-	-	Awareness

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3.2 THE SKILLS DESCRIPTIONS – COMPLETE SKILLS SET LEAN SIX SIGMA JOB ROLES

Domain Acronym: LSS

Domain title: Lean Six Sigma Black Belt

Domain Description: Many organizations currently apply Lean Six Sigma as a holistic approach for continuous improvement. The 'Continuous Improvement Maturity Model' (CIMM) summarizes best practices and techniques of different methodologies in one framework, for different stages of maturity. The CIMM framework describes five consecutive stages: Creating a solid foundation, Creating a continuous improvement culture, Creating stable and predictable processes, Creating capable processes and Creating future-proof processes. Within Lean only the first three levels apply. For Six Sigma all five levels apply.

For each instrumental technique in the CIMM framework, it is possible to indicate the associated desired behavior. The CIMM framework identifies a number of behaviors for each improvement technique, which helps determine whether or not the implementation of the technology in question will be a success and results in a lasting impact.

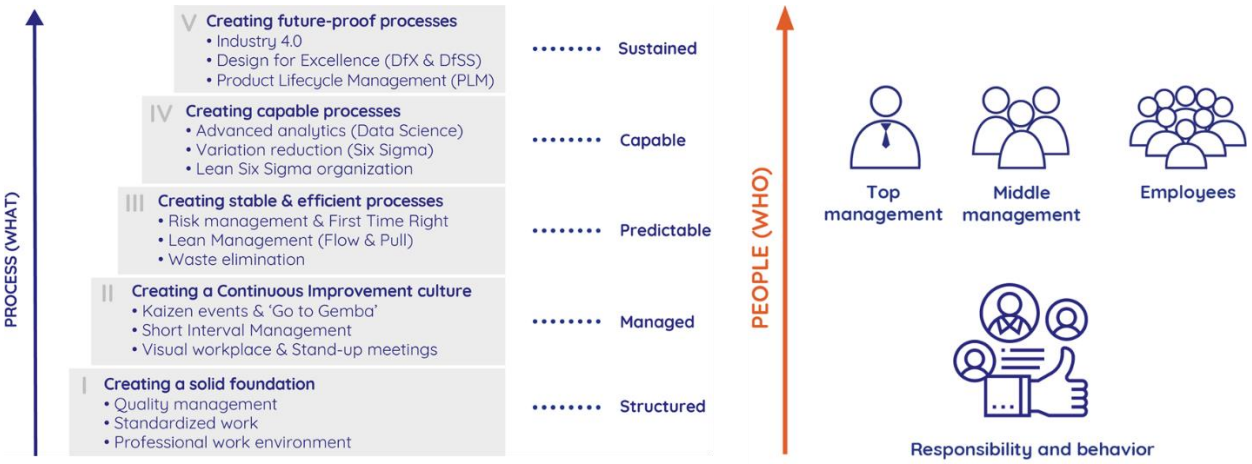

Figure 2 – CIMM Process (What) and People (Who)

Attendees that are preparing for Lean certification should a able to measure up to the first six units (U1. till U6.). Attendees that are preparing for Lean Six Sigma certification should a able to measure up to the eighth unit (U1. till U8.).

Within the domain of Lean and Six Sigma individuals can be trained and certified at different levels. The levels are listed in the Table below.

Belt level	Level
Lean Yellow Belt	Awareness
Lean Six Sigma Yellow Belt	Awareness
Lean Six Sigma Orange Belt	Foundation
Lean Green Belt	Practitioner
Lean Six Sigma Green Belt	Practitioner
Lean Black Belt	Expert
Lean Six Sigma Black Belt	Expert
Master Black Belt	Master

Tabel 1 – Overview of Lean Six Sigma jobroles

The LSSA - Lean Six Sigma Academy® was established in September 2009 with the objective to develop an international recognized certification scheme for all Lean and Six Sigma Belt levels. For each level the LSSA Exam Board has developed Skill sets with clear criteria for skills and competences. These Skill sets specify which of the overall Lean and Six Sigma techniques are expected to be included within certain Belt level competencies.

The LSSA Skill sets describe the assessment criteria for the theoretical and practical exam. Candidates are required to pass both elements to be recognized as a certified Lean or Lean Six Sigma Belt. Passing the theoretical exam is a pre-requisite to subscribe for the practical exam.

Lean Six Sigma training is provided by a global network of 'Accredited Training Organizations' (ATOs). Check the Drives or LSSA website for an overview of ATOs and the actual certification requirements.

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4 WORLD CLASS PERFORMANCE

Acronym: LSSBB.U1
Title: World Class Performance
Description: The Unit 'World Class Performance' reviews the general philosophy of continuous improvement. It discusses the overview of different process improvement methods and the history of the most important methodologies. It also explains why continuous improvement is important.

4.1 CONTINUOUS IMPROVEMENT

Acronym: LSSBB.U1.E1
Element Title: Continuous Improvement
Element Note: The Learning Element 'Continuous Improvement' reviews the history, values and principles of the most common process improvement methodologies. Also, the culture within a continuous improvement organization as well as roles and responsibilities are reviewed.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U1.E1.PC1	Understand the origins of quality management, TPM, Kaizen, Lean, Six Sigma and Agile. Bloom: Understand
LSSBB.U1.E1.PC2	Propagate the Lean Six Sigma philosophy and principles. Deploy a continuous improvement culture within the organization, which represents the collective values, beliefs and principles. Bloom: Analyze
LSSBB.U1.E1.PC3	Assess and deploy the organization's maturity level of the organization, which is a combination of developing people and process. Bloom: Analyze
LSSBB.U1.E1.PC4	Promote the various continuous improvement roles and responsibilities. Bloom: Apply

Tabel 2 - Performance Criterias for the Element LSSBB.U1.E1

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4.2 CUSTOMER VALUE (VOC & CTQ)

Acronym: LSSBB.U1.E2
Element Title: Customer value (VOC & CTQ)
Element Note: The Learning Element 'Customer first' reviews customer identification (internal/external), customer requirements and the CTQ-measure.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U1.E2.PC1	Prioritize and translate the Voice of the Customer (VOC) requirements into internal specification requirements. Differentiate customer experience into dissatisfied, expected, satisfied and desired quality levels (e.g. KANO model). Bloom: Analyze
LSSBB.U1.E2.PC2	Translate the Voice of Customer into external CTQs and internal CTQs. Construct a CTQ flowdown that represents the key measurable characteristics of a product or process whose performance standards or specification limits must be met. Bloom: Analyze

Tabel 3 - Performance Criterias for the Element LSSBB.U1.E2

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5 POLICY DEVELOPMENT AND DEPLOYMENT

Acronym: LSSBB.U2
Title: Policy development and deployment
Description: The Unit 'Policy development and deployment' reviews how policy development and deployment help organizations in defining a continuous improvement strategy and to run efficiently in achieving their objectives.

5.1 POLICY DEVELOPMENT

Acronym: LSSBB.U2.E1
Element Title: Policy development
Element Note: The Learning Element 'Policy development' explains the importance of a so-called True North and how to develop an operational excellence strategy.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U2.E1.PC1	Facilitate the organization to define its vision and mission statement and the organization's sense of purpose (e.g. Golden Circle). Support the organization to define the True North and to develop a strategy to head in the direction of the True North. Understand the three competitive strategies. Understand how Operational Excellence can be applied in different types of enterprises e.g. manufacturing, service, transactional, product and process design, innovation. Bloom: Apply
LSSBB.U2.E1.PC2	Define a transition roadmap for a continuous improvement policy development and deployment program. Bloom: Apply
LSSBB.U2.E1.PC3	Define and implement a process of business performance management, which includes developing metrics as well as collecting, analyzing and reporting data about the performance of the organization. Evaluate financial measures e.g. cost of poor quality (COPQ), total cost of quality, working capital (WC) and inventory turn ratio (ITR). Bloom: Analyze

Tabel 4 - Performance Criterias for the Element LSSBB.U2.E1

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5.2 POLICY DEPLOYMENT

Acronym: LSSBB.U2.E2
Element Title: Policy deployment
Element Note: The Learning Element 'Policy deployment' is focusing on the execution process of the improvement strategy. Within this element financial and performance metrics will be reviewed.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U2.E2.PC1	Describe the impact breakthrough projects can have on process owners, internal and external customers and other stakeholders. Facilitate initiatives and apply techniques to manage change and overcome resistance (e.g. Kübler-Ross, stakeholder analysis, Kotter approach). Bloom: Apply
LSSBB.U2.E2.PC2	Propagate long term and meaningful objectives such as sustainability, dignity and creating an inspiring and healthy work environment throughout the organization. Demonstrate team progress in relation to goals, objectives and other metrics that support team success and reward and recognize the team for its accomplishments. Describe and apply techniques that motivate team members and support and sustain their participation and commitment. Bloom: Apply
LSSBB.U2.E2.PC3	Support the organization in the strategic planning process, applying Hoshin Kanri. Understand how Hoshin Kanri forms the link between policy development and policy deployment. Bloom: Apply

Tabel 5 - Performance Criterias for the Element LSSBB.U2.E2

5.3 COMPETENCE DEVELOPMENT

Acronym: LSSBB.U2.E3
Element Title: Competence development
Element Note: The Learning Element 'Competence development' reviews how to develop those who need to ensure that the strategy is implemented successfully.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U2.E3.PC1	Guide people through the four stages of competence development including lessons learned from former projects. Bloom: Apply
LSSBB.U2.E3.PC2	Apply coaching and intervision to those involved in continuous improvement (e.g. Toyota Kata). Bloom: Apply
LSSBB.U2.E3.PC3	Use appropriate communication methods (both within the team and from the team to various stakeholders) to report progress, conduct milestone reviews and support the overall success of the project. Bloom: Apply

Tabel 6 - Performance Criterias for the Element LSSBB.U2.E3

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6 PROJECT MANAGEMENT

Acronym: LSSBB.U3
Title: Project management
Description: The Unit 'Project Management' outlines the way improvement projects should be executed. A number of process improvement roadmaps is reviewed. The Unit also reviews project selection, team formation, planning and execution.

6.1 MANAGING A PROJECT

Acronym: LSSBB.U3.E1
Element Title: Managing a project
Element Note: The Learning Element 'Managing a project' reviews how to set up, plan and execute a project.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U3.E1.PC1	Define project selection criteria. Identify continuous improvement opportunities. Apply project selection techniques to select the projects that contribute to the strategy of the organization. Bloom: Apply
LSSBB.U3.E1.PC2	Develop the project charter in relation to customer requirements and business goals. Develop and evaluate the problem statement, project boundaries (scope), objectives, benefits and measurable targets for the project. Support Green Belts in developing their project charter. Bloom: Analyze
LSSBB.U3.E1.PC3	Apply techniques to select team members (e.g. MBTI, Belbin). Facilitate the team through the classic stages of development: forming, storming, norming, performing and adjourning. Bloom: Apply
LSSBB.U3.E1.PC4	Select and construct time management techniques. Set up team meetings, tollgates and publish agendas and ensure that the proper people and resources are available. Ensure that the project will meet its requirements for time, quality and costs. Bloom: Apply
LSSBB.U3.E1.PC5	Manage the project and apply the proper tools and techniques. Bloom: Analyze

Tabel 7 - Performance Criterias for the Element LSSBB.U3.E1

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6.2 PROCESS IMPROVEMENT ROADMAPS

Acronym: LSSBB.U3.E2
Element Title: Process Improvement Roadmaps
Element Note: The Learning Element 'Process Improvement Roadmaps' reviews a number of roadmaps, including PDCA and DMAIC..

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U3.E2.PC1	Apply project management methods that can be used in the work place for Kaizen initiatives (e.g. PDCA, A3-report). Bloom: Apply
LSSBB.U3.E2.PC2	Facilitate the problem-solving process (e.g. 8D approach). Bloom: Apply
LSSBB.U3.E2.PC3	Apply the DMAIC roadmap for Lean and Six Sigma projects. Select the proper tools to use during the project. Bloom: Apply
LSSBB.U3.E2.PC4	Facilitate self-organizing teams and define clear boundaries for self-organizing teams. Propagate Scrum in product development and continuous improvement initiatives. Bloom: Apply
LSSBB.U3.E2.PC5	Describe the DMADV-roadmap for Design for Six Sigma projects. Bloom: Understand

Tabel 8 - Performance Criterias for the Element LSSBB.U3.E2

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7 LEVEL I – CREATING A SOLID FOUNDATION

Acronym: LSSBB.U4
Title: Level I – Creating a solid foundation
Description: The Unit 'Creating a solid foundation' reviews how to achieve a solid foundation for further process improvement programs. This foundation consists of a proper and organized work environment, reliable equipment and standardized work.

7.1 PROFESSIONAL WORK ENVIRONMENT

Acronym: LSSBB.U4.E1
Element Title: Professional work environment
Element Note: The Learning Element 'Professional work environment' is about good housekeeping and how to set up a proper and safe work environment in a structured manner.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U4.E1.PC1	Develop an organized work environment by applying 5S (Sort, Straighten, Shine, standardize, Sustain). Understand that an organized environment will improve safety and moral. Bloom: Analyze

Tabel 9 - Performance Criterias for the Element LSSBB.U4.E1

7.2 STANDARDIZED WORK

Acronym: LSSBB.U4.E2
Element Title: Standardized work
Element Note: The Learning Element 'Standardized work' is about implementing and improving standards and protocols.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U4.E2.PC1	Standardize tasks and processes to establish the foundation for continuous improvement. Develop or modify documents, standard operating procedures (SOPs) and one-point-lessons to ensure that the improvements are sustained over time. Bloom: Apply

Tabel 10 - Performance Criterias for the Element LSSBB.U4.E2

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7.3 QUALITY MANAGEMENT

Acronym: LSSBB.U4.E3
Element Title: Quality Management
Element Note: The Learning Element 'Quality Management' is about developing procedures to identify and detect defects. Also preventing mistakes and avoiding problems is part of this element.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U4.E3.PC1	Propagate the quality management system and procedures. Facilitate the evaluation of processes, including auditing (internal / external) and identification of opportunities for improvement. Bloom: Apply

Tabel 11 - Performance Criterias for the Element LSSBB.U4.E3

8 LEVEL II – CREATING A CONTINUOUS IMPROVEMENT CULTURE

Acronym: LSSBB.U5
Title: Level II – Creating a continuous improvement culture
Description: The Unit 'Creating a continuous improvement culture' reviews how to create a continuous improvement culture at the shop floor. This Unit reviews setting up and facilitate Kaizen teams. It also reviews a number of problem-solving techniques and tools.

8.1 VISUAL MANAGEMENT

Acronym: LSSBB.U5.E1
Element Title: Visual management
Element Note: The Learning Element 'Visual management' reviews how to set up a workplace that is organized and self-explaining.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U5.E1.PC1	Develop the elements of Visual Workplace and describe how they can help to control the improved process. Bloom: Analyze

Tabel 12 - Performance Criterias for the Element LSSBB.U5.E1

8.2 KAIZEN

Acronym: LSSBB.U5.E2
Element Title: Kaizen
Element Note: The Learning Element 'Kaizen' reviews how to organize and facilitate improvement teams at the shopfloor that work on Kaizen improvement initiatives.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U5.E2.PC1	Describe and propagate the Kaizen principles. Empower improvement teams and facilitate Kaizen events. Develop root cause analysis, recognize the issues involved in identifying a root cause. Analyze problems by applying problem solving process and tools. Bloom: Analyze
LSSBB.U5.E2.PC2	Implement and facilitate stand-up meetings to drive continuous improvement initiatives. Understand basic principles of Scrum. Bloom: Apply

Tabel 13 - Performance Criterias for the Element LSSBB.U5.E2

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8.3 BASIC QUALITY TOOLS

Acronym: LSSBB.U5.E3
Element Title: Basic quality tools
Element Note: The Learning Element 'Basic quality tools' reviews techniques to visualize data and guidelines how to facilitate and participate in brainstorm sessions.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U5.E3.PC1	Apply brainstorm techniques: Affinity diagram, 5-Why's and Ishikawa. Bloom: Apply
LSSBB.U5.E3.PC2	Apply and analyze the outcome of basic quality tools to visualize data: Check sheet, Pareto chart, Scatter plot, Bar chart, Pie chart, Time Series Plot, Histogram and Box plot. Bloom: Analyze

Tabel 14 - Performance Criterias for the Element LSSBB.U5.E3

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9 LEVEL III – CREATING STABLE AND EFFICIENT PROCESSES

Acronym: LSSBB.U6
Title: Level III – Creating stable and efficient processes
Description: The Unit 'Creating stable and efficient processes' reviews how the logistical flow of processes can be improved and made more stable, predictable and efficient. This Unit reviews tools which can be used to visualize and analyze the process flow as well as a number of tools and techniques that can be used to improve efficiency, effectiveness, productivity and agility of processes. All Level III Learning Elements and Performance Criteria follow the DMAIC structure.

DEFINE

9.1 PROCESS MAPPING

Acronym: LSSBB.U6.E1
Element Title: Process mapping
Element Note: The Learning Element 'Process Mapping' reviews a number of tools to map and analyze the flow of a process.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E1.PC1	Distinguish between key process input variables and key process output variables based on a high-level process map e.g. SIPOC. Bloom: Analyze
LSSBB.U6.E1.PC2	Apply process mapping to visualize the flow of activities and decisions within a process. Bloom: Apply
LSSBB.U6.E1.PC3	Analyze process flow and utilization. Apply Little's Law. Bloom: Analyze

Tabel 15 - Performance Criterias for the Element LSSBB.U6.E1

MEASURE

9.2 PERFORMANCE MANAGEMENT

Acronym: LSSBB.U6.E2
Element Title: Performance management
Element Note: The Learning Element 'Performance management' reviews performance metrics for both logistics as for quality.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E2.PC1	Calculate and analyze performance metrics related to time (e.g. takt time, cycle time, lead time, queue time, WIP and OEE). Bloom: Analyze
LSSBB.U6.E2.PC2	Distinguish and calculate performance metrics related to quality (e.g. ppm, DPMO, DPU and RTY). Describe the difference between a defect and a defective. Calculate rolled throughput yield for a number of defects. Bloom: Analyze

Tabel 16 - Performance Criterias for the Element LSSBB.U6.E2

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9.3 PERFORMANCE MANAGEMENT

Acronym: LSSBB.U6.E3
Element Title: basic statistics
Element Note: The Learning Element 'Basic statistics' reviews different types of data, measurement scales and data collection tools. Also a set of measures (statistics) that characterizes a given set of data are reviewed.

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E3.PC1	Propagate the importance of reliable and accurate data. Describe and distinguish between qualitative and quantitative data (continuous and discrete data). Define and analyze nominal, ordinal, interval and ratio measurement scales. Apply Likert scale to convert an ordinal scale into a discrete interval scale. Bloom: Analyze
LSSBB.U6.E3.PC2	Define and analyze tools for collecting data e.g. data sheets, check sheets, concentration diagrams and questionnaires. Bloom: Analyze
LSSBB.U6.E3.PC3	Calculate population parameters and sample statistics: measures of central tendency, measures of dispersion, ratios and proportions. Bloom: Apply

Tabel 17 - Performance Criterias for the Element LSSBB.U6.E3

ANALYZE

9.4 VALUE STREAM ANALYSIS

Acronym: LSSBB.U6.E4
Element Title: Value Stream Analysis
Element Note: The Learning Element 'Value Stream Analysis' reviews how to create a Value Stream Map of the current situation.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E4.PC1	Distinguish value adding from non-value adding and necessary activities Bloom: Analyze
LSSBB.U6.E4.PC2	Apply Value Stream Mapping to construct a Current State Map of the process to identify waste and non-value adding activities. Bloom: Apply
LSSBB.U6.E4.PC3	Understand the way process mining can support the analysis of flow within the organization. Recall what product attributes are needed for process mining. Bloom: Understand

Tabel 18 - Performance Criterias for the Element LSSBB.U6.E4

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IMPROVE

9.5 REDUCING MUDA (WASTE)

Acronym: LSSBB.U6.E5
Element Title: Reducing Muda (Waste)
Element Note: The Learning Element 'Reducing Muda' reviews how to identify and eliminate Waste in the organization and its processes.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E5.PC1	Identify and analyze process Waste (Muda): Overproduction, Waiting, Transport, Overprocessing, Inventory, Movement, Defects and Unused expertise. Bloom: Analyze

Tabel 19 - Performance Criterias for the Element LSSBB.U6.E5

9.6 REDUCING MURI (OVERBURDEN)

Acronym: LSSBB.U6.E6
Element Title: Reducing Muri (Overburden)
Element Note: The Learning Element 'Reducing Muri' reviews how to identify overburden in the organization. This element also reviews how to implement flow and work balancing to reduce overburden.

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E6.PC1	Describe the importance of Flow for reducing Muri. Develop flow in the organization. Bloom: Analyze
LSSBB.U6.E6.PC2	Describe the importance of Work balancing for reducing Muri. Develop Work balancing. Bloom: Analyze
LSSBB.U6.E6.PC3	Describe how competence management supports the reduction of Muri. Set up and apply a competence management system. Bloom: Apply

Tabel 20 - Performance Criterias for the Element LSSBB.U6.E6

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9.7 REDUCING MURA (UNEVENNESS)

Acronym: LSSBB.U6.E7
Element Title: Reducing Mura (Unevenness)
Element Note: The Learning Element 'Reducing Mura' reviews how to identify unevenness in the organization and its processes. This element also reviews a number of techniques to reduce unevenness.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E7.PC1	Describe the importance of pull for reducing Mura. Develop and implement pull in the organization by applying Kanban systems. Bloom: Analyze
LSSBB.U6.E7.PC2	Implement a balanced process flow by both volume leveling, type leveling and one piece flow. Understand how Modularization in product development can support One piece flow in operation. Differentiate between the different order fulfilment strategies. Bloom: Apply

Tabel 21 - Performance Criterias for the Element LSSBB.U6.E7

9.8 VALUE STREAM IMPROVEMENT

Acronym: LSSBB.U6.E8
Element Title: Value Stream Improvement
Element Note: The Learning Element 'Value Stream Improvement' reviews how the techniques and tools that reduce Muda, Muri and Mura can be applied in constructing a Future State Value Stream Map.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E8.PC1	Define the gap between the current state and the target condition. Develop a Future state map using Value Stream Mapping. Apply techniques to reduce Muda, Mura and Muri. Bloom: Analyze

Tabel 22 - Performance Criterias for the Element LSSBB.U6.E8

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CONTROL

9.9 PROCESS AND QUALITY CONTROL

Acronym: LSSBB.U6.E9
Element Title: Process and Quality control
Element Note: The Learning Element 'Process and Quality control' looks at how results that have been achieved in process improvement projects can be sustained. This element reviews the following techniques and principles: Process FMEA, Control plan, Jidoka and Poka Yoke.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E9.PC1	Deploy the importance of the First Time Right principle. Implement a culture of stopping to fix problems to get quality right the first time. Empower the work force to stop the line when there is a quality problem (Jidoka). Apply Poka Yoke to prevent quality problems. Bloom: Analyze
LSSBB.U6.E9.PC2	Prepare all elements of a Process FMEA, calculate the risk priority number (RPN) and action priority (AP). Review the effect of FMEA results on processes, products and services. Bloom: Apply
LSSBB.U6.E9.PC3	Prepare a control plan to document and hold gains. Define controls and monitoring systems. Transfer of responsibility from the project team to the process owner. Bloom: Apply

Tabel 23 - Performance Criterias for the Element LSSBB.U6.E9

9.10 TOTAL PRODUCTIVE MAINTENANCE (TPM)

Acronym: LSSBB.U6.E10
Element Title: Total Productive Maintenance
Element Note: The Learning Element 'Total Productive Maintenance' reviews the coherence between reliable systems and equipment and continuous improvement.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U6.E10.PC1	Describe the eight pillars of TPM and describe how it can be used for process improvement. Apply elements of TPM to control the improved process. Bloom: Apply
LSSBB.U6.E10.PC2	Calculate the Overall Equipment Effectiveness (OEE) performance metric Bloom: Apply
LSSBB.U6.E10.PC3	Reduce change over times by implementing Single Minute Exchange of Die (SMED). Bloom: Apply

Tabel 24 - Performance Criterias for the Element LSSBB.U6.E10

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10 LEVEL IV – CREATING CAPABLE PROCESSES

Acronym: LSSBB.U7
Title: Level III – Creating Capable Processes
Description: The Unit 'Creating Capable Processes' focuses on reducing variation in a stable process with the objective to create a process capable of meeting customer requirements. This Unit reviews the application of Six Sigma and statistical tools used to assure a valid and reliable performance measurement system, to collect data and to analyze the performance of processes. Six Sigma focuses on quality breakthrough improvement projects. All Level IV Learning Elements and Performance Criteria follow the DMAIC structure.

MEASURE

10.1 STATISTICAL TECHNIQUES

Acronym: LSSBB.U7.E1
Element Title: Statistical techniques
Element Note: The Learning Element 'Statistical techniques' reviews a number of metrics that are often used in Six Sigma projects. The element also reviews a number of sampling methods for assuring data accuracy and integrity.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E1.PC1	Evaluate special cause and common cause variation. Bloom: Analyze
LSSBB.U7.E1.PC2	Develop and apply appropriate sampling methods that ensure representative data e.g. random sampling, stratified sampling and systematic sampling. Calculate power and sample size for common hypothesis tests. Bloom: Analyze

Tabel 25 - Performance Criterias for the Element LSSBB.U7.E1

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10.2 DISTRIBUTIONS

Acronym: LSSBB.U7.E2
Element Title: Distributions
Element Note: The Learning Element 'Distributions' reviews a number of continuous and discrete distributions. The element also reviews the central limit theorem and a number of probability concepts.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E2.PC1	Interpret Probability Density Functions and Cumulative Distribution Functions. Apply continuous distributions: Normal, Weibull, Student's t, Chi square, F-distribution, Lognormal and Exponential distribution. Apply normality test (Anderson-Darling) describe shape parameters (Skewness and Kurtosis). Bloom: Apply
LSSBB.U7.E2.PC2	Apply discrete distributions: Poisson, Binomial. Apply the central limit theorem. Bloom: Apply
LSSBB.U7.E2.PC3	Identify non-normal data and use Box-Cox or Johnson transformation. Bloom: Apply

Tabel 26 - Performance Criterias for the Element LSSBB.U7.E2

10.3 MEASUREMENT SYSTEMS

Acronym: LSSBB.U7.E3
Element Title: Measurement Systems
Element Note: The Learning Element 'Measurement Systems' reviews how to evaluate measurement systems.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E3.PC1	Define and implement measurement methods for both continuous and discrete data. Analyze measurement systems for continuous data. Interpret repeatability and reproducibility (R&R), stability, bias, linearity, precision to tolerance and number of distinct categories. Bloom: Analyze
LSSBB.U7.E3.PC2	Analyze measurement systems for qualitative properties. Establish attribute agreement within appraiser, between appraisers and appraisers versus standard. Bloom: Analyze

Tabel 27 - Performance Criterias for the Element LSSBB.U7.E3

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ANALYZE

10.4 HYPOTHESIS TESTING & CONFIDENCE INTERVALS

Acronym: LSSBB.U7.E4
Element Title: Hypothesis Testing & Confidence Intervals
Element Note: The Learning Element 'Hypothesis Testing & Confidence Intervals' reviews test methods that are used to test a hypothesis. This Learning Element also discusses Confidence Intervals that indicate the reliability of test conclusions.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E4.PC1	Define and analyze the significance level, power, type I and type II errors in statistical tests. Bloom: Analyze
LSSBB.U7.E4.PC2	Calculate confidence, prediction and tolerance intervals. Distinguish between statistical and practical significance. Bloom: Analyze

Tabel 28 - Performance Criterias for the Element LSSBB.U7.E4

10.5 TESTS FOR MEANS, VARIANCES AND PROPORTIONS

Acronym: LSSBB.U7.E5
Element Title: Tests for means, variances and proportions
Element Note: The Learning Element 'Tests for means, variances and proportions' reviews the most common hypothesis tests to investigate the difference between population means (μ); difference in variances (σ); difference in proportion (p) and difference in counts (λ). Also the ANOVA analysis is reviewed.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E5.PC1	Apply and analyze hypothesis tests for means. Bloom: Analyze
LSSBB.U7.E5.PC2	Apply and analyze hypothesis tests for variances. Bloom: Analyze
LSSBB.U7.E5.PC3	Apply ANOVA. Analyze the results and the main effect and interaction plots. Bloom: Analyze
LSSBB.U7.E5.PC4	Apply and analyze hypothesis tests for proportions. Bloom: Analyze
LSSBB.U7.E5.PC5	Apply and analyze Chi-square goodness-of-fit test and Contingency tables. Bloom: Analyze
LSSBB.U7.E5.PC6	Apply and analyze non-parametric tests: Mann-Whitney, Kruskal Wallis and Mood's median test. Bloom: Analyze

Tabel 29 - Performance Criterias for the Element LSSBB.U7.E5

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10.6 CORRELATION AND REGRESSION

Acronym: LSSBB.U7.E6
Element Title: Correlation and Regression
Element Note: The Learning Element 'Correlation and Regression' describes the predictive models using regression techniques to determine the relation between factors on a response.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E6.PC1	Calculate and analyze the correlation coefficient. Determine its statistical significance (p-value) and recognize the difference between correlation and causation. Bloom: Analyze
LSSBB.U7.E6.PC2	Apply linear and polynomial regression analysis. Analyze the regression model for estimation and prediction. Interpret the residual analysis to validate the model. Bloom: Analyze
LSSBB.U7.E6.PC3	Apply attributes data using (binary) logistic regression to investigate sources of variation. Bloom: Apply
LSSBB.U7.E6.PC4	Apply multivariate studies such as principal components and factor analysis. Bloom: Apply

Tabel 30 - Performance Criterias for the Element LSSBB.U7.E6

10.7 PROCESS CAPABILITY AND PERFORMANCE

Acronym: LSSBB.U7.E7
Element Title: Process Capability and Performance
Element Note: The Learning Element 'Process Capability and Performance' explains process capability and performance in relation to specification limits.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E7.PC1	Apply and analyze process capability studies. Develop sampling plans to verify stability. Calculate and analyze Cp and Cpk to assess process capability. Bloom: Analyze
LSSBB.U7.E7.PC2	Describe and use appropriate assumptions and conventions when only short-term data or attributes data are available and when long-term data are available. Analyze the relationship between long-term and short-term capability. Bloom: Analyze
LSSBB.U7.E7.PC3	Calculate and analyze Pp and Ppk to assess process performance. Interpret the relationship between capability and performance indices. Bloom: Analyze
LSSBB.U7.E7.PC4	Calculate the process capability and process sigma level for attribute data. Bloom: Apply

Tabel 31 - Performance Criterias for the Element LSSBB.U7.E7

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IMPROVE

10.8 DESIGN OF EXPERIMENTS (DOE)

Acronym: LSSBB.U7.E8
Element Title: Design of Experiments
Element Note: The Learning Element 'Design of Experiments' reviews efficient ways of experimenting. Design of Experiments examines the influence of factors and interactions on a process.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E8.PC1	Design experiments by determining the objective, selecting factors, responses and measurement methods. Apply DOE elements: responses, factors, levels, transfer function, run order, randomization, balanced designs, residual error, main effects, interaction effects, replicates, repetitions, curvature and centerpoints. Bloom: Analyze
LSSBB.U7.E8.PC2	Design and analyze full factorial experiments. Understand and apply contrast, covariate, blocking. Bloom: Analyze
LSSBB.U7.E8.PC3	Design and analyze fractional factorial experiments and describe how confounding affects their use. Understand and apply alias tables and folding. Bloom: Analyze
LSSBB.U7.E8.PC4	Design and analyze Response Surface Models (RSM) such as Box Behnken and Central Composite Designs. Analyze the response surface using path of steepest ascent and apply Evolutionary Operations (EVOP). Bloom: Analyze

Tabel 32 - Performance Criterias for the Element LSSBB.U7.E8

CONTROL

10.9 STATISTICAL PROCESS CONTROL (SPC)

Acronym: LSSBB.U7.E9
Element Title: Statistical Process Control
Element Note: The Learning Element 'Statistical Process Control' explains the controls methods used to identify out-of-control situations and deviations over time. Different types of SPC charts are reviewed.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U7.E9.PC1	Describe the objectives of SPC. Select and construct the following types of control charts: Xbar-R, Xbar-S, individuals and moving range (I MR), median, p, np, c, u, short-run SPC and moving average. Bloom: Analyze
LSSBB.U7.E9.PC2	Interpret control charts and distinguish between common and special cause variation using rules for determining statistical control. Bloom: Analyze

Tabel 33 - Performance Criterias for the Element LSSBB.U7.E9

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11 LEVEL V - CREATING FUTURE-PROOF PROCESSES

Acronym: LSSBB.U8
Title: Level III – Creating future-proof processes
Description: The Unit 'Creating future-proof processes' is about applying Lean Six Sigma techniques in the product development process with the objective to design products and services that will perform on a Six Sigma level from the earliest phase.

11.1 PRODUCT LIFECYCLE MANAGEMENT (PLM)

Acronym: LSSBB.U8.E1
Element Title: Product Lifecycle Management
Element Note: The Learning Element 'Product Lifecycle Management' reviews the entire lifecycle of products from inception, engineering, and manufacturing to service and disposal.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

LSSBB.U8.E1.PC1	Understand the lifecycle for products from creation, engineering, manufacturing to service and disposal. Bloom: Understand
LSSBB.U8.E1.PC2	Participate in new product and process development. Bloom: Understand

Tabel 34 - Performance Criterias for the Element LSSBB.U8.E1

11.2 DESIGN FOR SIX SIGMA

Acronym: LSSBB.U8.E2
Element Title: Design for Six Sigma
Element Note: The Learning Element 'Design for Six Sigma' reviews a number of methodologies and techniques that can be applied within Design for Six Sigma, such as Quality Function Deployment, Reliability engineering and Tolerance analysis.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U8.E2.PC1	Describe and eliminate design constraints, including design for cost, design for manufacturability and producibility, design for test and design for maintainability. Bloom: Understand
LSSBB.U8.E2.PC2	Understand that QFD can be applied to translate customer requirements into product performance measures. Bloom: Understand
LSSBB.U8.E2.PC3	Describe key functions of a design, the primary potential failure modes relative to each function and the potential causes of each failure mode. Describe critical parameter management (CPM) and the DMADV roadmap. Bloom: Understand
LSSBB.U8.E2.PC4	Understand that reliability specifications and design tests can be used to demonstrate reliability specifications. Understand basic principles of failure rate function of life time tests. Bloom: Understand
LSSBB.U8.E2.PC5	Understand the basic principles of tolerance analysis using worst case, RSS, Monte Carlo and empirical methods. Bloom: Understand

Tabel 35 - Performance Criterias for the Element LSSBB.U8.E2

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11.3 THE FOURTH INDUSTRIAL REVOLUTION

Acronym: LSSBB.U8.E3
Element Title: The fourth industrial revolution
Element Note: The Learning Element 'The fourth industrial revolution' reviews the role of continuous improvement methodologies that currently used and the fourth industrial revolution.

Performance Criteria: The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student is able to
LSSBB.U8.E3.PC1	Understand the future of operational management. Describe elements of Industry 4.0. Bloom: Understand

Tabel 36 - Performance Criterias for the Element LSSBB.U8.E3

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APPENDIX A – BLOOM'S TAXONOMY

In addition to specifying content, each performance criteria in this skill set also indicates the intended complexity level of the test questions for each topic. These levels are based on 'Levels of Cognition' (from Bloom's Taxonomy – Revised, 2001), and can be used to create learning outcomes for students.

The Taxonomy of Educational Objectives, often called Bloom's Taxonomy, is a classification of the different objectives that educators set for students (learning objectives). The taxonomy was proposed in 1956 by Benjamin Bloom, an educational psychologist at the University of Chicago. During the nineties, Lorin Anderson a former student of Bloom revisited the cognitive domain in the learning taxonomy. Bloom's Taxonomy divides educational objectives into three 'domains': Affective, Psychomotor and Cognitive. This Skill set only notices the Cognitive domain. The 'Levels of Cognition' are in rank order - from least complex to most complex.

Remember
Recall or recognize terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc. The LSSA uses the following verb at this level: Recall.

Understand
Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc. The LSSA uses the following verbs at this level: Describe, Follow, Identify, Interpret, Participate, Understand.

Apply
Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc. The LSSA uses the following verbs at this level: Apply, Assess, Assure, Calculate, Convert, Define, Demonstrate, Divide, Eliminate, Empower, Facilitate, Implement, Motivate, Organize, Plan, Prepare, Present, Promote, Propagate, Review, Select, Standardize, Support, Use.

Analyze
Break down information into its constituent parts and recognize their relationship to one another and how they are organized; identify sublevel factors or salient data from a complex scenario. The LSSA uses the following verbs at this level: Analyze, Construct, Deploy, Design, Develop, Distinguish, Evaluate, Lead, Manage, Translate.

Evaluate
Make judgments about the value of proposed ideas, solutions, etc., by comparing the proposal to specific criteria or standards. The LSSA does not uses this level in their skill sets.

Create
Put parts or elements together in such a way as to reveal a pattern or structure not clearly there before; identify which data or information from a complex set is appropriate to examine further or from which supported conclusions can be drawn. The LSSA does not uses this level in their skill sets.

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APPENDIX C – LEAN SIX SIGMA CERTIFICATION

THEORETICAL ASSESSMENT CRITERIA

The assessment criteria for the theoretical exam are as follows:

- The Lean Black Belt theoretical exam consists of 40 multiple choice questions.
- The duration of the Lean Black Belt exam is 120 minutes.
- The Lean Six Sigma Black Belt theoretical exam consists of 60 multiple choice questions.
- The duration of the Lean Six Sigma Black Belt exam is 180 minutes.
- The pass mark for the exams is set at 63% (25 marks or more required to pass).
- The duration of the exams is 180 minutes.
- The exams are Open book exams, where a maximum of 2 books are allowed.
- A calculator or statistical software (e.g. Minitab) is allowed.
- You must be able to identify yourself with photographic ID.

If you pass you will receive a 'Partial certificate' from the LSSA that states you passed the theoretical exam. You will receive the 'Full certificate' if you pass the practical assessment within a maximum period of three years after passing the theoretical exam.

PRACTICAL ASSESSMENT CRITERIA

The assessment criteria for the practical part include the submission of two practical projects that meet the following criteria:

- For Lean Black Belt: two successful projects at CIMM level-III (or higher).
- For Lean Six Sigma Black Belt: two successful projects at CIMM level-III and IV or higher.
- The project should have a significant impact to the organization. This means that it has a financial impact of € 50,000 on an annual basis or another relevant CTQ (like Lead Time) has substantially been improved.
- The project must follow the PDCA, DMAIC or DMADV roadmap.
- The templates for submitting the projects can be downloaded from the LSSA website (max. of 25 pages).
- The projects should be signed off by the Champion to declare that the projects have been carried out professionally and that objectives have been achieved and sustainable.
- A single Black Belt can submit the projects for certification in its role of project manager.
- The project must be submitted no later than three years after passing the theoretical examination.

The projects will be assessed by a Master Black Belt, assigned by the LSSA. The criterion listed in Appendix B will be applied. It is advisable to use these criteria during your project. It is additionally strongly advised that the submission is also checked by an internal (Master) Black Belt or coach.

- A 'Pass' result will be awarded when all criteria are addressed within the submission and are deemed to be 'Correct' or 'Not Applicable'.
- The submission must contain a justification of any criteria that is claimed to be 'Not Applicable'.

Development and Research on Innovative Vocational Skills -DRIVES – Project number 591988-EPP-1-2017-1-CZ-EPPKA2-SSA-B
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The result of the practical assessment will be either Pass or Fail. No score will be given. In the event of a 'Fail' result, brief guidance will be given on those criteria that are deemed 'Missing' or 'Incorrect'. Subsequently, a single retake resubmission is allowable.

PRACTICAL PROJECT ASSESSMENT CRITERIA

Kaizen & Lean project criteria PDCA

Phase	Nr	Criteria
Plan	1	The project addresses a customer complaint, problem or business case.
	2	There is a clear problem definition.
	3	Objectives are clearly defined and are measurable.
	4	VOC and VOB are defined and specifications are clear.
	5	The scope of the project is clearly defined.
	6	The most important stakeholders have been identified.
	7	Relevant CTQ (s) have been selected and a CTQ flowdown has been made.
	8	A high level process description has been made (e.g. SIPOC).
	9	The reliability of the data has been investigated.
	10	Process performance has been constructed and assessed against specifications.
	11	A detailed process description has been made (e.g. VSM Current State).
	12	Potential causes have been identified.
	13	Analyzes have been used to identify factors of influence (e.g. Fishbone or FMEA).
	14	The main root causes have been identified and explained.
	15	Conclusions are clear and supported.
Do	1	Risks have been defined and addressed (e.g. pFMEA).
	2	The improved process meets the specifications of the VOC and VOB.
	3	There is a clear communication and action plan towards the stakeholders.
	4	The client has approved the improvement proposals.
Check	1	There is a proven improvement of the CTQ compared to the baseline measurement.
	2	Standards have been adjusted and documentation has been updated.
	3	Roles and responsibilities have been described.
	4	Employees are instructed and/or trained.
	5	It has been shown that the improvements are sustainable.
Act	1	It has been indicated how performance will be monitored in the future.
	2	The final report is ready and lessons learned have been communicated.
	3	The champion has indicated that objectives and/or savings have been achieved.

Tabel 37 - Project Practical Assessment PDCA

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Lean en Six Sigma project criteria DMAIC

Phase	Nr	Criteria
Define	1	Project addresses a clear problem description or business opportunity.
	2	Problem description has been clearly defined.
	3	Goals have been clearly defined and are measurable.
	4	VOC and VOB have been clearly defined and requirements are understood.
	5	Scope of the project has been clearly delineated.
	6	Key stakeholders have been identified.
	7	Relevant CTQ(s) have been selected and a CTQ-flowdown has been constructed.
	8	High level process description has been made (e.g. SIPOC).
Measure	1	The collected data has been proven to be representative for the project.
	2	Validity of the data has been verified in an appropriate way.
	3	Historical data has been used to visualize process performance over time.
	4	Performance against requirements has been checked.
	5	Variation in the process has been considered (common cause or special cause).
	6	Short term versus long term performance has been considered.
Analyze	1	Process has been mapped in detail (e.g. VSM Current State).
	2	Potential factors of influence have been determined.
	3	Analysis have been used to identify factors with highest influence.
	4	Hypothesis for root cause has been defined properly.
	5	Input data has been collected and analyzed correctly.
	6	Graphical and statistical techniques have been applied to investigate root causes.
	7	Major root causes have been identified.
	8	Conclusions are clear and have demonstrated strong evidence/are statistically valid.
Improve	1	Risks have been identified and addressed (e.g. pFMEA).
	2	Improved process meets the requirements of the VOC and VOB.
	3	There is a clear communication and action plan towards the stakeholders.
	4	The client (Champion) has approved the improvement proposal.
	5	An improvement of the CTQ compared to the baseline is demonstrated.
Control	1	Standards are adjusted and documentation has been updated (pFMEA, CP).
	2	Rolls and responsibilities have been described.
	3	Employees are instructed and/or trained.
	4	Evidence of 'In-Control situation' is available and sufficient.
	5	Improvements have proven to be sustainable.
	6	Measures have been put in place to monitor process performance.
	7	Project report has been completed. Lessons learned have been communicated.
	8	Champion signed that project targets and/or savings have been achieved.
	9	The controller signed the project for approval.

Tabel 38 - Project Practical Assessment DMAIC

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Design for Six Sigma project criteria DMADV

Phase	Nr	Criteria
Define	1	Project addresses a clear problem description or business opportunity.
	2	Project charter includes the risks to investigate.
	3	Goals have been clearly defined and are measurable.
	4	VOC and VOB have been clearly defined and requirements are understood.
	5	Scope of the project has been clearly delineated.
	6	Key stakeholders have been identified.
	7	Functional requirements have been defined.
	8	High level process description has been made (e.g. SIPOC).
Measure	1	Risks or customer requirements have been made tangible and specific.
	2	Historical data and issues have been taken into account.
	3	Customer requirements have been translated into technical requirements.
	4	Relevant CTQ(s) have been selected and a CTQ-flowdown has been constructed.
	5	It has been defined how the CTQs are measured.
	6	The measurement procedure has been validated (Gage R&R)
Analyze	1	All risks have been identified and a mitigation plan is available (e.g. dFMEA)
	2	Design concepts have been develop.
	3	Potential factors of influence have been identified.
	4	Data have been collected and analyzed.
	5	Transfer functions Yi = f(X_1, X_2,…,X_n) have been developed.
	6	Graphical and statistical techniques have been applied to investigate risks.
	7	Transfer function shows (theoretical) that capability meets customers specifications.
	8	There is a clear difference between confirmed and non-confirmed information.
Design	1	Validation plan is designed.
	2	Samples, prototypes or concepts are available for validation.
	3	Risk mitigation measures have been identified (e.g. Poka Yoke, Control Plan).
	4	Product Lifecycle management and reliability have been addressed (if applicable).
	5	Optimum settings for all significant factors of influence have been defined.
Verify	1	Pilot run results have been evaluated.
	2	Factors of influence will be controlled in a way that the risk will not appear.
	3	Documentation has been updated (pFMEA, CP, SOPs).
	4	Training has been performed for the new product/process.
	5	Project report has been completed. Lessons learned have been communicated.
	6	Full scale ramp-up plan has been developed.
	7	Project has been completed within time and budget.
	8	Champion signed that project targets and/or savings have been achieved.

Tabel 39 - Project Practical Assessment DMADV

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MAPPING BASED ON EUROPEAN QUALIFICATION FRAMEWORK (EQF) LEARNING LEVELS

Level	Knowledge	Example
Level 1	Basic general knowledge	
Level 2	Basic factual knowledge of a field of work or study	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	Yellow Belt
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Green Belt
Level 7	• Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • Critical awareness of knowledge issues in a field and at the interface between different fields	Black Belt
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Master Black Belt

Tabel 40 - Mapping with EQF framework

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ANNEXES

The annex provides overview of used skills set, coverage of Qualification Schemas and Legal background for Certification

ANNEX A ECQA DESCRIPTION

ECQA – EUROPEAN CERTIFICATION AND QUALIFICATION ASSOCIATION

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). ECQA is the pilot Certification body, which structure is mapped to DRIVES Reference and Recognition Framework providing the EU-wide overview of training courses and possible certifications, and micro-credentials. DRIVES Reference and Recognition Framework provides links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

Europe Wide Certification

The ECQA is the result of a number of EU supported initiatives in the last ten years where in the European Union Life Long Learning Programme different educational developments decided to follow a joint process for the certification of persons in the industry.

Through the ECQA it becomes possible that you attend courses for a specific profession in e.g. Spain and perform a Europe wide agreed test at the end of the course.

Access to a Vast Pool of Knowledge

ECQA currently supports 27 professions in Europe and with the continuous support until 2012 by the European Commission the pool is growing to 30 certified professions in Europe. ECQA offers certification for professions like IT Security Manager, Innovation Manager, EU project manager, E-security Manager, E-Business Manager, E-Strategy Manager, SW Architect, SW Project Manager, IT Consultant for COTS selection, Internal Financial Control Assessor (COSO/COBIT based), Interpersonal Skills, Scope Manager (Estimation Processes), Configuration Manager, Safety Manager, and so forth.

The ECQA guide can be downloaded at www.ecqa.org -> Guidelines.

Defined procedures are applied for:

- Self assessment and learning

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- http://www.ecqa.org/fileadmin/documents/Self_Assessment/eucert-users-self-assessment-learning-guide-v5-doc.pdf
- Exam performance
- http://www.ecqa.org/fileadmin/documents/ECQA_Exam_Guide_Participant_v2.pdf

ECQA SKILLS DEFINITION MODEL

The ECQA skills definition model, used for Job Role definition, is described in section 2 of this document.

ECQA SKILL SET STRATEGY

Imagine that in the future Europeans will have a skill set like a card with a chip which stores your skill profile to fulfil specific professions, job roles, and tasks. It's working like an ID card. This future scenario requires -

- A standard way to describe a skill set for a profession, job, or specific task.
- A standard procedure to assess the skill and to calculate and display skill profiles.

Such a common set of skill sets in Europe is needed due to the free mobility of workers. European countries such as UK, The Netherlands, and France already have well established open universities which support APL (Accreditation of Prior Learning). In APL the skills of students are assessed, already gained skills are recognised, and only for the skill gaps a learning plan is established. The skill assessment bases on defined skill units and a skill profile displaying how much of the skill units are covered.

In a previous project CREDIT (Accreditation of Skills via the Internet) [1] in which some of the project partners were involved such an Internet based skills assessment system has been built. Therefore another possible scenario of the future is that representative educational bodies per country in Europe maintain skill profiles in databases which can be accessed via defined ID codes for people.

ECQA SKILLS ASSESSMENT MODEL

Step 1 – Browse a Skills Set: You select a set of skills or competencies, which are required by your profession or job using national standards or your company standards. You browse different skills cards and select a job role you would like to achieve.

Step 2 – Register for Self Assessment with a Service Unit : This can be a service unit inside your own company (e.g. a personnel development department) or a skills card and assessment provider outside

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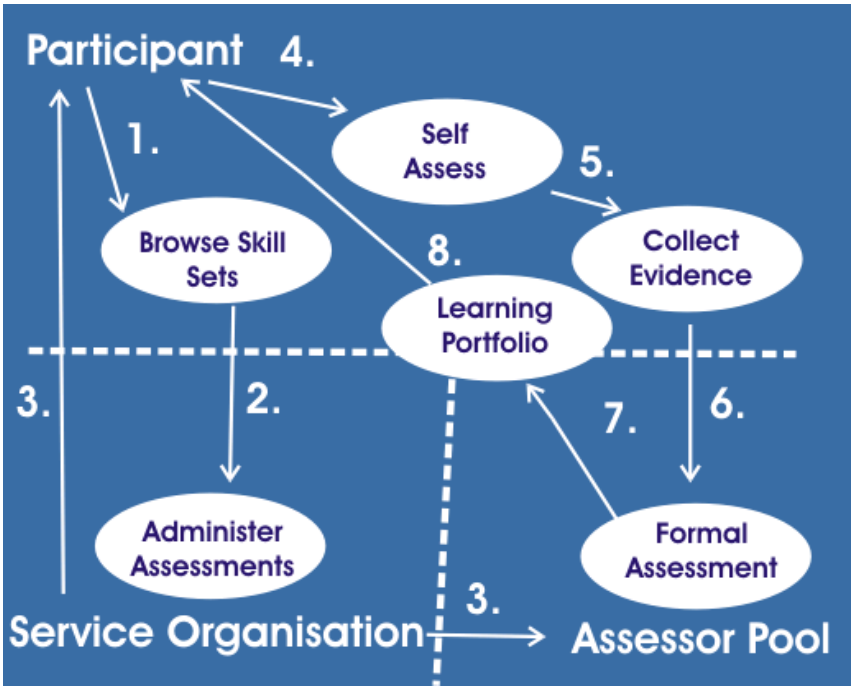
your company which offers skills assessment services. In case of the Safety Manager Project the registration will automatically assign a predefined service unit.

Step 3 – Receive an Account for Self-Assessment and Evidence Collection : With the registration you automatically received an account to login to the working space in which you can go through the steps of online self assessment and the collection of evidences to prove that you are capable of certain performance criteria.



Picture 1: Basic steps of the skills assessment model

Step 4 – Perform Self Assessment: You log into the system , browse through the skills required and self assess performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. A skills gaps profile can be generated and printed illustrating in which areas your self assessment shows improvement potentials.

Testing of Skills (Addition to Step 4) – The system provides a multiple-choice test for each performance criteria so that you can check your capabilities as realistically as possible.

Step 5 – Collect Evidences: Before you want to enter any formal assessment you need to prove your skills by evidences. Evidences can be any electronic files (sample documents, sample graphics, results of some analysis, etc.) or any references with details (e.g. a certificate received from a certain

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institution). Evidences you can then link to specific performance criteria or whole elements of skills units.

Testing of Skills (Addition to Step 5) – In traditional learning schemes people have always needed to go to a learning institution (university, accreditation body, professional body, etc.) to take exams and they received a certificate if they pass. This traditional approach however is insufficient when it comes to measuring experience and (soft) skills learned on the job and fails to give recognition to skills gathered on the job. The APL (Accreditation of Prior Learning) approach, by contrast, collects so called evidences. Evidences can be certificates obtained in the traditional way, but also references from previous employers, materials from previous projects in which the person took ownership of results (e.g. a test plan) to prove their capability, as well as any kind of proof of competence gathered on the job. The assessors will then evaluate the evidences provided and not only rely on certificates and exams.

Step 6 – Receive Formal Assessment: Formal assessors are assigned by the service unit to the skills assessment. Once formal assessors log into the system they automatically see all assigned assessments. They select the corresponding one and can see the uploaded evidences. They then formally assess the evidences and assess the formal fulfilment of performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. In case of missing competencies they enter improvement recommendations, a well as learning options.

Step 7 – Receive Advise on Learning / Improvement Options: After the formal assessment the participants log into the system and can see the formal assessment results from the assessors, can print skills gaps profiles based on the assessor results, and can receive and print the improvement recommendations and learning options. If required, the generation of learning options can also be automated through the system (independent from assessor advises).

ECQA CERTIFICATE TYPES

In the standard test and examination procedures for levels of certificates are offered:

- Course Attendance Certificate
  - Received after course attendance
  - Modular per Element
- Course / Test Certificate
  - Test in a test system (European pool of test questions)
  - 67% satisfaction per element

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- Summary Certificate
    - Overview of covered elements where the student passed the test, all elements shall be covered
    - Generation of certificate
- Professional Certificate
    - Uploading applied experiences for review by assessors
    - Rating by assessors
    - Observation of 2 years

The certificates show credited elements in comparison to all required.

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ANNEX B ECQA COVERAGE OF QUALIFICATION SCHEMAS

MAPPING BASED ON NVQ QUALIFICATION LEVELS

Qualification / training levels: Five levels of qualification / training are defined by European legislation and this structure can be used for comparability of vocational qualifications from the different European countries.

- Level 1: semi-skilled assistant performing simple work
- Level 2: basic employee performing complex routines and standard procedures
- Level 3: skilled professional with responsibility for others and performing independent implementation of procedures
- Level 4: middle management & specialist performing tactical an strategic thinking
- Level 5: professional / university level

In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

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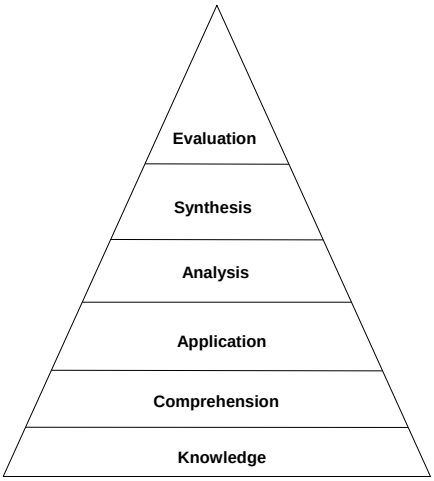
MAPPING BASED ON EUROPEAN QUALIFICATION FRAMEWORK (EQF) LEARNING LEVELS

- Six level taxonomy:

  Level 0: I never heard of it

  1. Knowledge (I can define it):
  2. Comprehension (I can explain how it works)
  3. Application (I have limited experience using it in simple situations)
  4. Analysis (I have extensive experience using it in complex situations)
  5. Synthesis (I can adapt it to other uses)
  6. Evaluation (I am recognized as an expert by my peers)



Picture 3: Blooms Learning levels

Level	Knowledge	Example
Level 1	Basic general knowledge	
Level 2	Basic factual knowledge of a field of work or study	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	Six Sigma Yellow Belt
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Six Sigma Green Belt
Level 7	• Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • Critical awareness of knowledge issues in a field and at the interface between different fields	Six Sigma Black Belt

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Level	Knowledge	Example
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Six Sigma Master Black Belt

Picture 4 : EQF Learning levels

MAPPING BASED ON ECTS AND ECVET SCHEMA

ECQA has established a procedure to map ECQA skills sets onto the ECTS (European Credit Transfer System) and the ECVET framework n the European Union.

A job role is assigned ECTS and ECVET points using a defined framework.

ECTS Mapping

Each element of the skills set is assigned hours of lecturing and exercises. These hours determine the ECTS points which are then agreed among a cluster on different universities in Europe.

Level	Knowledge	AQUA	ECTS	Safety Manager	ECTS
Level 1	Basic general knowledge	-		-	
Level 2	Basic factual knowledge of a field of work or study	-		-	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study				
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study				
Level 5	Comprehensive, specialized, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge				
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	AQUA - Automotive Quality Integrated Skills - presentations / theory	3	AQUA - Automotive Quality Integrated Skills - presentations / theory	3
Level 7	- Highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research - Critical awareness of knowledge issues in a field and at the interface between different fields	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5

Picture 5 : Example Automotive Quality Engineer and Safety Manager

The 2 job roles illustrated in the picture above have been assigned to ECTS and are taught using the same skills set at industry and also universities.

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ECVET Mapping

Also ECQA provides a framework to assign ECVET points onto elements of the skills set. The ECQA guidance recommends to offer the ECQA course (which is offered as a lecture at university) as a short course (2 weeks with exercises) in industry to retrain for a job role in industry. The recommended size is 30 ECVET points in total. The lecturing time and exercise per element determine how many ECVET points ae assigned to an element of the skills set.

Automotive Quality Engineer			
			ECVET L7&8
U1	4	U1.E1: Introduction	2
		U1.E2: Organisational Readiness	2
U2	32	U2.E1 Life Cycle	8
		U2.E2 Requirements	8
		U2.E3 Design	8
		U2.E4 Test and Integration	8
U3	12	U3.E1: Capability	2
		U3.E2: Hazard and Risk Management	8
		U3.E3 Assessment and Audit	2
U4	12	U4.E1: Measurement	6
		U4.E2: Reliability	6
		ECVET Points Total	60

Picture 6 : ECVET Mapping example - Automotive Quality Engineer

Functional Safety Manager / Engineer			
			ECVET L7&8
U1	2	U1.E1 International Standards	1
		U1.E2 Product Life Cycle	1
		U1.E3 Terminology	
U2	4	Safety management on organisational	1
		Safety Case Definition	1
		Overview of Required Engineering an	1
		Establish and Maintain Safety Plannin	1
U3	16	System Hazard Analysis and Safety Co	4
		Integrating Safety in System Design &	4
		Integrating Safety in Hardware Design	4
		Integrating Safety in Software Design	4
U4	4	Integration of Reliability in Design to I	2
		Safety in the Production,Operation an	2
U5	4	Legal aspects and Liabilities	2
		Regulatory & Qualification Requireme	2
		ECVET Points Total	30

Picture 7 : ECVET Mapping example – Functional Safety Manager / Engineer

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ANNEX C ECQA LEGAL BACKGROUND FOR CERTIFICATION

ISO/IEC 17024 STANDARD FOR PERSONNEL CERTIFICATION PROGRAMMES

The ISO/IEC 17024 standard describes standard processes for the examination and certification of people. Some of the basic principles described include:

- Standard exam procedure
- Standard certification procedure
- Identification of persons receiving the certificate
- Independence of examiner and trainer
- Certification system that allows to log the exam to keep a record/proof that the examinee passed the exam
- Mapping of processes towards ISO 17024

ECQA AND ISO/IEC 17024 STANDARD

- ECQA defined standard exam processes
- ECQA defined standard certification processes
- ECQA developed an exam system that generates random exams and corrects exams.
- ECQA developed a certification database to identify persons and map them to exam results
- ECQA established a mapping onto the ISO 17024 norm and published that in form of a self declaration.

LIASION WITH NATIONAL UNIVERSITIES

ECQA established cooperation with national universities who teach job roles with ECTS. The same job roles are offered with ECVET on the market by training bodies.

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