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D3.1. Strategic Quality Plan

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1.2		Final Draft with the integration of comments from reviewers	
1.3		Final Version	
1.4		Submitted to the commission	

Executive Summary

The purpose of D3.1 is to present a set of guidelines, procedures, and best practices to monitor the overall project outcomes like reports, training and learning material, etc. As a CBHE project, the ENHANCE vision is organized around five main pillars:

- The European vision about Maintenance, Production, and Quality engineering in the context of industry 4.0 (MPQ4.0). The programme country members synthesize the most impacting related work in MPQ 4.0, share the best practices of the teaching programmes in their institutions, and their Digital Innovation Hubs (DIHs) services and experimented solutions.
- The partner countries' vision about the existing teaching programmes in the involved Tunisian and Moroccan universities. This vision is completed with current practices and new MPQ 4.0 requirements collected from selected industrial partners in different application domains.
- The MPQ 4.0 Learning Framework to cover the gaps and draw the path for training the trainers on the three main topics.
- The MPQ 4.0 pilots' development to create effective skills, competencies, and technology acquisition channels to support digital transformation in the industry. The generated materials are to be structured in the Long life eLearning (LeL) platform to be deployed at each partner countryside.
- The creation of 2 DIHs, one in Tunisia and one in Morocco to sustain the ENHANCE outcomes and organize their exploitation model to support MPQ 4.0 industrial challenges in both countries.

The proposed rules in the D3.1 deliverable will contribute to ensuring the quality of these pillars' outputs.

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0. ENHANCE Project Overview

ENHANCE – strENgtHening skills and training expertise for TunisiAN and MorocCan transition to industry 4.0 Era – is an Erasmus Plus project founded under the KA2 Cooperation for innovation and the exchange of good practices (Capacity Building in the field of Higher Education) programme by the European Commission under Grant Agreement N° 619130, to be conducted in the period January 2021 until January 2024. It engages 7 partners from 5 countries with a total budget of 779k€. Further information can be found at http://eplus-enhance.eu/.

The emergence of industry 4.0 concepts and applications brings new paradigms impacting all the industrial business domains when they need to conduct successful digital transformations or increase workshops connectivity. The evolution of Maintenance, Production and Quality Engineering (MPQ 4.0) represents the main application domains where Industry 4.0 produces effective beneficial results.

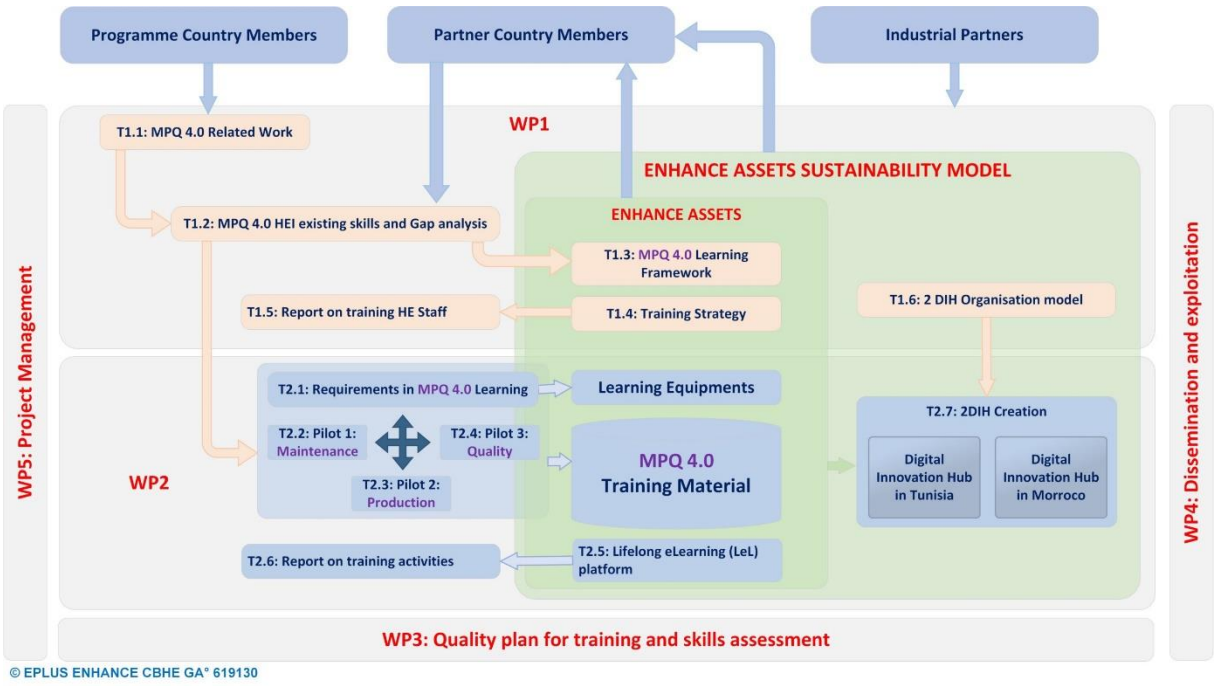

Figure 1. ENHANCE Project Organization

The ENHANCE project focuses on building new MPQ training capacities at Higher Education Institutions (HEI) in Tunisia and Morocco to establish interactions between the following stakeholders:

- European universities and research institutions (from France, Germany and Portugal) confirmed MPQ 4.0 competencies, training materials, collaborative research projects, full operational Digital Innovation Hubs (DIH), technology transfer experiences, etc.
- Partner country universities (from Tunisia and Morocco) with teaching and training activities in MPQ and existing connections with their local industrial partners.

The ENHANCE project will create several outputs and two primary tangible outcomes:

- New MPQ 4.0 equipment and training materials developed in connection with the existing training programmes and consolidated through three industrial pilots. The new material will be used to train the trainers and the students in the different partner country universities.
- Two DIHs, one in Tunisia and one in Morocco to sustain the project outcomes through their reuse for training in industry.

ENHANCE aims to become the reference model for creating effective and sustainable training material for MPQ 4.0 in both partner countries with content approved by academia and industry.

1. Introduction

This document is developed as part of the ENHANCE project.

1.1. Purpose of Document

The purpose of the document is to present the plan with the set of guidelines, procedures, and best practices to monitor the overall project outcomes like software, tasks reports, training and learning programs. This report will also define the plan to form the quality expert team.

1.2. Reference Documents

N/A

1.3. Applicability

As mentioned above, this document intends to provide the guidance to assure the quality of the outcomes of the ENHANCE project.

1.4. Definitions

In the following, the main concepts used in this document are briefly explained:

- *Knowledge* – "is central to any discussion of learning and may be understood as the way in which individuals and societies apply meaning to experience. It can therefore be seen broadly as the information, understanding, skills, values and attitudes acquired through learning. As such, knowledge is linked inextricably to the cultural, social, environmental and institutional contexts in which it is created and reproduced" [1].
- *Skill* – "a bundle of knowledge, attributes and capacities that can be learnt and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning" [2].
- *Competencies* – "refers to the application of knowledge, skills, and attitude required to complete a work activity in a range of context and environment to the standard expected in the workplace" [3].
- *Training* – "is the process and methods which aim to equip people with the Skills, attitudes and knowledge needed for employment" [4].
- *Learning* – "is the individual acquisition or modification of information, knowledge, understanding, attitudes, values, skills, competencies or behaviours through experience, practice, study or instruction" [5].
- *Industry 4.0* – is the ongoing automation of traditional manufacturing and industrial practices, using data exchange and modern smart technologies (e.g., IoT, cloud computing, cyber-physical systems, and cognitive computing) to improve companies' operation, products, and services [6].
- *Digital transformations* – in the process of integrating digital technologies into all areas of a business. Digital transformation transforms traditional and non-digital business processes and services or creating new ones, to meet changing business and market requirements [7].
- *Maintenance engineering* – is the discipline and profession of applying techniques and engineering skills (e.g., checking, repairing and servicing machinery, equipment, systems and infrastructures) for the optimization of equipment, processes, and procedures [8].
- *Production engineering* – is the discipline of using machines, tools, materials, and human resources and creating safe and efficient processes for transforming raw materials into high-quality products [9].

- *Quality engineering* – is a discipline of engineering concerned with the assurance of the overall quality of the manufactured products and delivered service [10].
- *Higher Education Institution* – "a legal entity that offers at least one program leading to a higher education credential" [11].
- *Stakeholder* – "a person or organization with an interest or concern in something. In vocational education and training stakeholders include government, providers of training, industry, clients and the community" [12].
- *Digital Innovation Hub* – is an ecosystem consisting of governments, industry associations, large companies, SMEs, start-ups, investors, corporations, extension agencies, accelerators, incubators, and research organizations that form a one-stop-shop to best serve their clients within the local region and beyond in order help them to digitalize their functions [13].

1.5. Structure of the Document

Apart from this chapter, this document starts by having a chapter (2) that presents the Quality strategy objectives mentioning generically its main concepts and interpretation. Then the following chapters present each of the quality approaches to be followed to evaluate the identified main project outcomes and supporting mechanisms to the organization of the overall project management.

1.6. List of Acronyms

- A – Answers
- AB – Advisory Board
- AU – Answers of Users
- C – Components
- CH - Characteristics
- CL – Check Lists
- DIH – Digital Innovation Hub
- EC – European Commission
- EM – Evaluation Modules
- EMP – Efficiency Metric of the Pilot
- EMSS – Efficiency Metric of a Scenario Step
- F - Faults
- FMP - Functionality Metric of the entire Pilot
- FMHESS - Functionality Metric Handling Errors for each pilot Scenario Step
- FMSS – Functionality Metric of a Scenario Step
- GDPR – General Data Protection Regulation
- GQM – Goal Question Metric
- ICT – Information Communication Technologies
- IPR – Intellectual Property Right
- ISO – International Organization for Standardization
- IVMP - Information Validation Metric of the entire Pilot
- IVMSS - Information Validation of each pilot Scenario Step
- KPI – Key Performance Indicators
- LeL – Long life eLearning
- MAV - Maintainability Answers Value
- MB – Management Board
- MMP – Maintainability Metric of the Pilot
- MMSS – Maintainability Metric of a Scenario Step
- MPQ – Maintenance Production Quality

- MQ - Maintainability Questions
- PC – Project Coordinator
- PMC – Portability Metric Components
- PMP – Portability Metric of the Pilot
- PMSS – Portability Metric of the Scenario Step
- PO – Project Office
- PQC – Project Quality Committee
- QC – Quality Committee
- R&D – Research and Development
- RM – Risk Manager
- RM – Risk Manager
- RMSS – Reliability Metric of a Scenario Step
- RMP - Reliability Metric of the entire Pilot
- SS – Scenario Steps
- TB – Technical Board
- TSS – Test of a Scenario Step
- TU – Training Unit
- UMSS – Usability Metric of a Scenario Step
- UMP - Usability Metric of an entire Pilot
- UTSS - Unit Tests executions of Scenario Steps

2. Quality Plan Strategy

This document as part of the ENHANCE project provides guidelines around the quality assurance, improvement plans, respective practices, resources, specifications, and the sequences of activities relevant to deliverables.

2.1. Overview

This document suggests some procedures for monitoring the project preparation and development with a high standard quality plan. In this respect, in the following the project management organization is presented. Some quality assurance principles are then presented which will be considered in the establishment of the Enhance quality management mechanisms.

2.2. Project Management Organization

- **Project Coordinator (PC)**: Prof. Nejib Moalla (from ULL) is the operative coordinator of the project, and he is the unique contact person in the project with the European Commission. Also, he chairs the Management Board (MB) and the Advisory Board (AB). He is responsible for the overall contractual, ethical, financial, and administrative management of the project.
- **Management Board (MB)**: should carry out the management of how the results are transferred to reach the expected impacts. It is chaired by the project coordinators, and it is composed by a technical manager and a representative of each partner. MB is responsible for all the aspects of the project including: to review progress against the defined deliverables and timetables and propose corrective actions whenever necessary. MB maintains and monitors the project risks. Each MB meeting should be announced no later than one week before the proposed date. During the meeting, if consensus cannot be obtained, decision shall be taken by a two-third majority of members present and voting. These voting members are partners' representatives, or any active member appointed by the representative through a formal proxy (email) sent before the meeting. Inside this board, there is also in abstract what is called Risk Manager (RM) that will be led by Prof. Joao Sarraipa (UNL). He oversees controlling and monitoring both identified risks and unexpected risks and activating the corresponding risk management strategies (contingency plans, mitigation strategies, accepting the risks, etc). The RM will be in constant communication with the rest of the consortium to detect any risks related to the actual implementation of the ENHANCE platform in the partners countries sites to propose adequate measures to deal with the different events.
- **Technical Board (TB)**: it is composed by WP leaders and chaired by Dr. Sabeur Elkosantini (from UCAR). Its role is to assess the project progress. It will guarantee that the engineering tasks (WP1 and 2) are carried out on schedule and in accordance with the scheduled work plan.
- **Advisory Board (AB)**: is composed of the European and Tunisian associated partners. It will support the TB in improving the quality and effectiveness of all activities and outcomes of the project.
- **Quality Committee (QC)**: is composed of the AB and some experts selected from partner universities.
- **Project Office (PO)**: is composed by Finance and Administrator Manager appointed by ULL as the project coordinator.

2.3. Project Quality Assurance Principles

The overall project quality assurance is the process of auditing and analysing the systems that ensures the project deliverables meet the planned quality standards. To meet such project quality assurance, the following principles need to be considered:

2.3.1. Methodologies and Standards

Methodologies for project quality assurance are a set of principles (e.g., ensure timely delivery and effective tracking) and guiding techniques (e.g., peer review) that can be used for managing and controlling the quality of project's deliverables to ensure that the quality expectations are met.

2.3.2. Standards for project quality assurance

Standards for project quality assurance refers to a defined degree of quality, that the project sets for the creation of deliverables. It defines what the project expects of the deliverable creator in creation and delivering the related materials.

2.3.3. Quality Review

Quality review helps to identify the root causes of problems on a failing project and provides detailed guidance for how to get it back. The quality review considers the following three issues:

- Project Quality Actors.
- Project Evaluation and Review.
- Management of Changes to Project Scope.

2.3.4. Risk Assessment and Management

It is a systematic process of identifying hazards and evaluating any associated risks within the project, then implementing reasonable control measures to remove or reduce them. The main associated risks are listed in the following:

- Legal and administrative issues related to the implementation of the frameworks and the creation of DIH,
- Some deadlines are not respected,
- Difficulties to collect data from companies,
- Problems with the selection of trainers, and
- Misunderstanding about some key concepts.

2.3.5. Information Management

It is the process of collection, storage, development, dissemination, archiving, and destruction of documents, images, drawings, and other sources of information used in the project. Information management considers the following main issues:

- Document Management
- Record Keeping
- GDPR (General Data Protection Regulation)
- Ethics

2.4. Output Quality Control

It is the measurement of outputs to determine whether they meet the accepted criteria. This process considers the following two issues:

- Output Review Procedures: focus on reviewing and testing the outputs to ensure they meet specified functional and technical requirements.
- Output Acceptance Procedures: deal with the steps that should be taken and the decisions that need to be made about the degree of conformance of the output tested to the specification and acceptance criteria, and what action to take in the event of non-conformance.

3. Quality Strategy for Technological Results

It is an overarching process (or a system) whereby quality assurance and quality improvement activities are incorporated and infused into all aspects of an organization's technological operations. To develop this process, it is essential to define the main objective(s) and respective concepts:

3.1. Define the Main Objective(s)

It determines what we expect to achieve by part of the project. It also should identify from which objectives what kind of expected results are intended to reach and what technologies were implemented in relation to them as well. With such characterization it is possible to define an evaluation methodology approach as proposed in the following.

3.2. Define the Main Evaluation Concepts

This part defines the general idea of the following concepts that would have impact in the quality checking to be defined for the technological results of the project:

A. Protocols

Protocols are an established set of rules that determine how data is transmitted between different entities and devices within the hub of stakeholders.

B. Instruments

To evaluate the project outcomes, the following major issues need to be considered:

- Business
  - To define general common processes/activities/scenarios
  - To define which application, have an impact on each KPI
  - Evaluate the use of the applications against the KPI
- Technological
  - To verify that the developed software meets the specifications set in the project
- Standards
  - To verify which standards should be checked in the work performed as an example for technological developments – e.g., IS0 9241

C. Qualitative and Quantitative Indicators

There are two types of indicators used to evaluate any project results namely, qualitative, and quantitative indicators. Qualitative indicators are mainly associated to business objectives and quantitative indicators are more associated to the technical results. Both should be considered according to the instruments presented earlier.

The GQM (Goal Question Metric) method was followed to organize the process of defining the questions that could be used to characterize the assessment or achievement of a specific goal [24]. This method intends to define a measurement model composed by three levels: the conceptual, operational, and quantitative level, as illustrated in Figure 2.

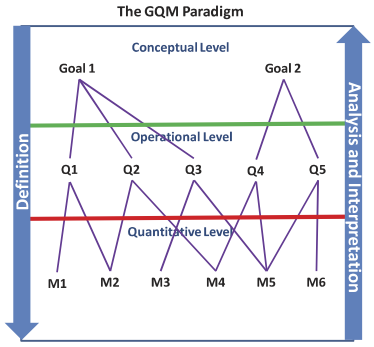

Figure 2. The GQM Paradigm

Such method includes three main constituents:

- Goals (conceptual level): identify the desired outcome or functionality and they are defined for an object representing products, processes, or resources.
- Questions (operational level): are used for the characterization of defined goals. Questions identify key points that are critical for the assessment of such goals.
- Metrics (quantitative level): provide answers to questions in a qualitative or quantitative way. Thus, metrics can be objective (independent of a certain viewpoint) or subjective (combining measurements and a certain viewpoint).

Table 1 presents an example of an instantiation of using such method for the generic goal on market analysis and business models:

Table 1. GQM Instance for Market Analysis and Business Models [25]

Goal	**Market Analysis and Business Models**
Question (Q1)	***How can the Market analysis help identifying business opportunities??***
Metrics (M1)	***Market density*** represents an estimated number of potential customers in particular area/region. This metric can be very important for small and medium enterprises regionally oriented.
Metrics (M2)	***Competitive density*** [23] represents the number of competitors in particular domain offering similar products/services.
Metrics (M3)	***Potential market volume*** represents the size of the market at specific time stamp. It can be represented through the time-dependent function.
Metrics (M4)	***Time-to-market*** represents the amount of time needed for the product to reach the market. The time includes the whole period from the idea to the ready-to-sale product/service (all phases from idea, design and development, entering the market).
Metrics (M5)	***Required resources to reach the market*** represents estimated amount of human and financial resources needed to reach the market with product/service.
Question (Q2)	**What is the impact of developed business models?**
Metrics (M1)	***Innovation to product/service conversion rate*** represents the number of products/services developed, divided through number of innovative ideas formulated.
Metrics (M2)	***Applicability of business models developed.***
Metrics (M2.1)	***General Acceptability*** – subjective assessment of the business model implementation by the partners involved in the pilots.
Metrics (M2.2)	***Success rate*** – e.g., numbers of jobs created, added value (product price - cost of producing), reduction of the ecological pressure, etc.

After applying this method, it is possible to assure how to evaluate the defined goal and determine different importance levels or metrics.

D. Quality Measurements

To measure the quality, the following specified technical evaluation procedure can be considered. It is composed by 8 Evaluation Modules (EM)[1], in which the measurement approach is explained in the following statements:

- EM1 – Functionality (End Users), the Functionality Metric for each pilot Scenario Step (FMSS) will be the number of successful Test of Scenario Steps (TSS) executions divided by the number of executions, 'FMSS = TSSsucess/TSSn'. The Functionality Metric of the entire Pilot EM1 execution (FMP1) will be measured by FMSS of each scenario step divided for the total scenario steps (SS), 'FMP1 = ∑ FMSSi/SSn'
- EM2 – Functionality handling errors (by End Users), the metrics will be the number of success pilot scenario step executed, handling and testing-specific submitted errors. The Functionality Metric Handling Errors for each pilot Scenario Step (FMHESS) will be the number of such successful executions handling such errors divided by the number of Unit Tests executions of Scenario Steps (UTSS), 'FMHESS = UTSSsucess/UTSSn'. The functionality metric of the entire pilot EM2 execution (FMP2) will be measured by FMHESS of each scenario step divided for the total scenario steps (SS).
- EM3 – Reliability – number of faults per number of executions (Developers), the metrics will be the number of Faults (F) detected when performing pilot scenario step executions. The Reliability Metric for each Scenario Step (RMSS) will be the number of Faults divided by all the number of scenario step executions, 'RMSS = F/TSSn'. The Reliability Metric of the entire Pilot (RMP) will be measured by the Reliability Metric of each scenario step (RMSS) divided for the total Scenario Steps (SS), 'RMP = ∑ RMSSi/SSn'.
- EM4 – Usability – User Interfaces (End Users) (accessibility is something able to be considered), the user interface of the software is evaluated in accordance with the software-related parts 12–17 of IS0 9241 (ISO 'ISO 9241' 2011), which are respectively related to: presentation of information; user guidance; menu dialogues; command dialogues; direct manipulation dialogues; and form filling dialogues. The Usability Metric for each Scenario Step (UMSS) will be the number of successful Answers (A) divided by the number of Check Lists (CL), 'UMSS = Asucess/CLn'. The usability metric of the pilot (UMP) will be measured by UMSS of each scenario step divided for the total scenario steps (SS), 'UMP = ∑ UMSSi/SSn'.
- EM5 – Efficiency – meaning improve of capabilities (End Users), the Efficiency Metric for each Scenario Step (EMSS) will be the average of Answers of Users (AU) given to classify the efficiency of the scenario step, 'EMSS = ∑ AU/Un'. The Efficiency Metric of the Pilot (EMP) will be measured by EMSS of each scenario step divided for the total of scenario steps (SS), 'EMP = ∑ EMSSi/SSn'.
- EM6 – Maintainability - how much difficult is to adapt the system to handle specific changes (Developers), the maintainability of each the scenario step (MMSS) is measured by evaluators by asking developers-specific questions (Maintainability Questions - MQ), about what is the effort and how much difficult is to adapt the system to handle specific changes, 'MMSS = ∑ MAV/MQn'. MAV represents the Maintainability Answers Value related to the degree of easiness to adapt the system. The Maintainability Metric of the Pilot (MMP) will

[1] Marcelino-Jesus, E.; Sarraipa, J.; Ferro-Beca, M.; Jardim-Goncalves, R. (2016). A Framework for Technological Research Results Assessment. Published In: IJCIM - International Journal of Integrated Manufacturing (2016).

be measured by MMSS of each scenario step divided for the total of scenario steps (SS), 'MMP = ∑ MMSSi/SSn'.

- EM7 – Portability - (Developers), the metrics of the Portability (degree of independence that a component has in relation to the operating system platform) for each pilot scenario step (PMSS) will be the average result of all the Portability Metric Components (PMC) that each scenario step use, 'PMSS = ∑ PMC/Cn'. The Portability Metric of the Pilot (PMP) will be measured by portability result of each scenario step divided for the total scenario steps (SS), 'PMP = ∑ PMSSi/SSn'.
- EM8 – Information Validation (pre-pos-conditions; requirements checking) (Evaluators), the measurement of the Information Validation of each pilot Scenario Step (IVMSS) will be the number of successful addressed characteristics (project scenario requirements) divided by the number of such characteristics (CH), 'IVMSS= ∑ IVMSSsuccess/CHn'. The Information Validation Metric of the entire Pilot (IVMP) will be measured by IVMSS divided for the total scenario steps (SS), 'IVMP = ∑ IVMSSi/SSn'.

E. Projects Results Impacts

The project results can be assessed by following some specific standards, such as:

- ISO/IEC CD 25010 for the quality model,
- ISO/IEC 25030 for the software product quality requirements specification, and
- Parts 12–17 of IS0 9241 for usability evaluation of user interfaces.

4. Quality Strategy for Text Based Deliverables

Quality strategy articulates broad aims and priorities that have guided the development of text-based deliverable including the general project documents and training materials.

4.1. Project Documents

The list of project documents is extensive and basically includes all documents used/generated for/during the project such as, project charter, statement of work, contracts, requirements documentation, stakeholder register, change control register, activity list, quality metrics, risk register, issue log, and other similar documents. All these documents that are resulted from the project should assure a certain level of quality. Thus, in the following subsection a set of main considerations are generically stated that should be taken into consideration in producing such kind of documents. Then, in the following sub section some considerations about the quality procedure over deliverables (that must be delivered to EC) are presented.

4.1.1. General Document Quality Check Lists

This subsection provides guidance for the control of quality manuals tailored to the specific project needs. The resultant quality manuals reflect standard required quality system procedures.

The quality control is based on a general review checklist for all project documents. The review checklist involves the following questions:

1. Has the document been subjected to an internal/external review?
2. Does the document satisfy the defined goals and objectives?
3. Is the body of document valid?
   - 3.1. Well titled: title, team name, date, version number, status (draft, ready for review, approved). It should be added that no codification is used for the different deliverables other than Dx.y where w is the number of the work page and y is the number of the task in the WP.
   - 3.2. The writing style and grammar have high quality (e.g., spelling & grammar check)
   - 3.3. The document uses consistent tense.
   - 3.4. The language is appropriate for the audience.
   - 3.5. Unnecessary information and words are eliminated.
   - 3.6. Each acronym or abbreviation is introduced.
   - 3.7. Text is of the same font, color, and size.
4. Does the document describe well all specific and related project activities?
5. Is the relationship to prerequisite documents explicitly stated?
6. Is the content consistent with other documents?
7. Are all open issues clearly marked as such?
8. Is terminology used consistently (both within a document and across documents)?
9. Is duplication of information avoided? (cross-reference rather than copy)

10. Are the references to other material completed (no missing references)? Are they precise (Including author(s)? Are they accessible and durable?

After the general review checklist, the document will be either approved (if there are no issues) or returned to the author/creator for modification (when it is needed).

4.1.2. Main Deliverables Reviewing Procedure

The deliverables reviewing procedures occur within different time frames based on project complexity and implementation level. Thus, the adopted procedures will be followed to ensure timely and effective review of deliverables that correlates to the project life cycle. The reviewing procedure that should be adopted in this project is according to the following:

- Two types of quality assessment will be taken place: internal and external
- Each deliverable should be assessed by 2 internal reviewers:
  - ✓ One from EU and one from PC (if possible)
  - ✓ Deliverables should be sent 6 weeks before the due date:
    - 3 weeks for review, 3 weeks for improvement

Table 2represents the suggested reviewers' assignment for the different deliverables.

Table 2: Deliverables Reviewers List

Deliverables	Title	Wpleade	Reviewer1_Universit	Reviewer2_Universit	RP1	RP2
D1.1	Literature review about required skills related to MPQ4.0	BIBA	UNL	ECC	X	
D1.2	Gap analysis between HEIs and industry 4.0 skills related to MPQ4.0	UCAR	ECC	BIBA	X	
D1.3	MPQ4.0 learning framework (LF-MPQ4.0)	UNL	UCAR	ULL	X	
D1.4	Design of training strategy for partner HE staff	IIT	ULL	UIT	X	
D1.5	Report on Train Tunisian and Moroccan HE staff according to the LF-MPQ4.0	UIT	IIT	UNL	X	
D1.6	The administrative organisation of the DIH	ULL	UCAR	BIBA	X	
D2.1	Requierements in learning materials for targeted MPQ4.0 skills (WP2)	IIT	BIBA	UIT	X	
D2.2	Pilot 1: Maintenance Engineering	ECC	UNL	IIT		X
D2.3	Pilot 2: Production Engineering.	UCAR	ULL	UNL		X
D2.4	Pilot 3: Quality Engineering	UIT	IIT	ULL		X
D2.5	The Lifelong eLearning (LeL) platform	ULL	BIBA	UIT		X
D2.6	Reports on the conducted training rounds	UIT	UCAR	BIBA		X
D2.7	The 2 Digital Innovation Hubs	IIT	ULL	UIT		X
D3.1	Strategic Quality Plan	UNL	ULL	UCAR	XX	
D3.2	Sustainability assurance plan	BIBA	IIT	UNL		X
D3.3	Quality Audit reports	ULL	ECC	UCAR		XX
D3.4	Quality expert team training reports	ECC	UIT	UNL	X	
D4.1	Strategic plan for awareness raising, communication and dissemination (+Exploitation)	ULL	UCAR	ECC	X	
D4.2	Project identity and guidelines	UCAR	ECC	ULL	X	
D4.3	Project website	UCAR	UIT	BIBA		X
D4.5	Meetings report	UCAR	BIBA	IIT	X	
D4.7	Reports on Communication, dissemination and awareness (report on exploitation)	UCAR / UNL	BIBA	ECC		XX
D4.6	Publications in indexed journals & conferences	BIBA	UIT	UCAR	X	X
D4.4	Project Worshops	ECC	UNL	IIT	X	
D5.1	Project Management, Quality and Risk Plan	ULL	ECC	UIT	X	
D5.2	Project periodic reports	ULL	IIT	UCAR	X	X
D5.3	Project final report	ULL	UNL	ECC		X
D5.4	Project quality and risk management guidelines	UNL	IIT	ULL	X	

It should be noted that yearly periodic reports will be reviewed by external evaluators who will be selected later by project quality committee (PQC). PQC will be constituted by advisory board members and some experts selected from partner universities.

External evaluators will be selected for their academic expertise and their experience in the assessment of European projects and should be related to their expertise in the MPQ domain without any conflict of interest. They will receive yearly ENHANCE project reports, deliverables, and all quality audit report from PQC. Their mission is to identify weaknesses and strengths of the project. These evaluators will meet two times during the project. The first meeting will take place during the second year during when the evaluators will suggest the possible actions (related to project's management,

activities, outcomes and results, and deliverable's structure) to be considered for the remain of the project. The second meeting will take place at the end of the project (before the presentation of the final project report) during which the evaluators will suggest some recommendations to insure the sustainability of the project.

4.2. Templates

As is presented in Table 3, a list of templates is available for all type of documents provided in the cloud (ENHANCE_Partners>Marketing and Templates).

Table 3: The List of Templates

Templates	File name
Meeting agenda	ENHANCE_Agenda_Template.docx
Meeting minutes	ENHANCE_Minutes_Template.docx
Deliverable	ENHANCE_Deliverables_Template.docx
Presentation	ENHANCE_Presentation_Template.pptx
Internal & External review	ENHANCE_Review_Template.docx

The project deliverables should follow the template mentioned in the following:

- Cover page: all partners should apply the same cover page template for public and internal documents
- Table of Contents
- List of Figures
- List of Tables
- Executive Summary
- Introduction
- Chapters
- Conclusion
- References
- Annexes

4.3. Deliverables Status and Naming Conventions

All documents and deliverables prepared by the consortium or shared with other project partners should include both document version number and date. The name of project's documents may include:

- Deliverables
- Presentations of the project results (presented in workshops, seminars, and conferences)
- Meeting minutes and agendas
- Internal audit reports
- External review reports
- Training and teaching materials

The name of documents should respect, as much as possible, the following guidelines and rules:

- The name of documents should be short, descriptive, unambiguous, and understandable.
- The name of the document should include the following information:
    - Project acronym
    - Document type
    - Document code

- Document short title
- Revision number (if applicable)

Therefore, the following naming conventions are adopted depending on the document type:

- For Deliverables:
  - **Name structure**: *ENHANCE_[Deliverable Code] [Deliverable Title]_vA.B* (where A is Major version of the deliverable, and B is Minor version of the deliverable for updates during the preparation phase. For final version, replace vA.B by VF)
  - **Example**: ENHANCE_D2.1_Gap_Analysis_V1.1.pdf
- For Presentations:
  - **Name structure**: *ENHANCE_WP[Number]_[Short title]_[Event]_[Place]_[Partner]_vA.B* (where A is Major version of the deliverable, and B is Minor version of the deliverable for updates during the preparation phase. For final version, replace vA.B by VF)
  - **Example**:ENHANCE_WP4_Future_Trends_For_Production4.0_IESM_Paris_UCAR_V2.1.ppt
- For Meetings Agenda:
  - **Name structure**: *ENHANCE_Ag_[Meeting Number/type]_[Place]_[Date]_vA.B* (where A is Major version of the deliverable, and B is Minor version of the deliverable for updates during the preparation phase. For final version, replace vA.B by VF)
  - **Example**: ENHANCE_Ag1_KickOff_Online_08_02_2021_V2.1.pdf
- For Meetings minutes:
  - **Name structure**: *ENHANCE_MM_[Meeting Number/type]_[Place]_[Date]_vA.B* (where A is Major version of the deliverable, and B is Minor version of the deliverable for updates during the preparation phase. For final version, replace vA.B by VF)
  - **Example**: ENHANCE_MM_KickOff_Online_08_02_2021_V2.1.pdf
- For Internal or External reviewing documents:
  - **Name structure**: *ENHANCE_[Deliverable Code]_[Deliverable Title]_[IR/ER]_[Partner]-vA.B* (IR is means internal reviewing, ER means external reviewing, A is Major version of the deliverable, and B is Minor version of the deliverable for updates during the preparation phase. For final version, replace vA.B by VF)
  - **Example**: ENHANCE_D2.1_Gap_Analysis_IR_ULL_V2.1.doc
- For Training and teaching materials:
  - **Name structure**: *ENHANCE_TM_[L/T/C]_[short title]_[Partner]-vA.B* (L/T/ are the type of the document, L means lecture, T means tutorial, C means case study, A is Major version of the deliverable, and B is Minor version of the deliverable for updates during the preparation phase)
  - **Example**: ENHANCE_TM_L_Predictive_Maintenance_ECC_V3.1.ppt

At the end it should be added that the deliverables can take one of the following statuses:

- Draft
- Under Review
- Under Update
- Accepted by the coordinator
- Submitted to the commission

4.4. Training Materials

Training Materials consists of digital or printed contents which may include but is not limited to videos, digital learning nuggets[2], data, instructor specific course guideline, activity sheets, exercises, slides, workbook.

4.4.1. Training Validation

The training validation and evaluation in ENHANCE ensure that training-under-development stays on track, safeguarding achievement of training goals and analyzing system performance. A quality review process based on decisions and revisions for future course iterations can be made after evaluating the strengths and weaknesses in a completed training program, thus ensuring achievement of desired goals. The main quality aspects of the training courses are briefly explained in the following.

- Training Courses General Quality Aspects

The general quality aspects to be assessed by the training courses validation and evaluation include:

1. *Correctness / Reliability / Clearness* - to ensure that all training material is correct and reliable according to the ENHANCE training objectives and high-quality standards.
2. *Efficiency / Suitability* - these terms are taken to ensure the suitability of each of the training package towards the related target audience. To have appropriate trainees' self-assessment and to improve their self-learning effectiveness. Adding to this, regarding post-update of the training material, suitable questionnaires to be used to gather trainees' feedback to subsequent improvement.
3. *Modularity / Flexibility /Portability* - all training materials must be developed in modules. So that they can be reused or integrated in various training units and for different purposes (training programs).
4. *Coding Standards* - proper coding standards followed (e.g., synopsis definition) by the training materials development to ensure an easily comprehensible and highly effectiveness of the training executions.
5. *Functionality / Robustness* - the training material functionality should be operational under various conditions. The material should be developed in the most common accepted software formats.
6. *Intellectual Property Rights (IPR)* - all the developed materials need to be carefully reviewed by the ENHANCE Steering Committee to ensure that any material released to the public is audited.

- Training Courses Design Quality Aspects

The Design quality aspects to be assessed by the training courses validation and evaluation include:

1. *Coherence of courses with targeted skills* - the link between each teaching unit of the course and the skills to be acquired is formally established (for example in the form of a cross-matrix), in line with training courses related to MPQ programs.
2. *Course Syllabus* - students are clearly informed about the training objectives of the course in terms of learning outcomes, course outline and content, progression, required resources, prerequisite knowledge and skills, assessment, and evaluation methods.

[2] Digital Learning Nuggets is a term used to describe a mini learning education activity that is less than 5 minutes in length. The nuggets may vary depending on the subject matter. As an example, try to imagine any modern type of online learning course that uses videos.

3. *Teaching and learning methods* - for this case a pedagogy is adapted to the competence-based learning approach with active methodologies and digital technologies. Students are encouraged to reflect on various situations ideally transdisciplinary (projects, problem-based learning, game-based learning, etc).
4. *Sense of concrete* - the curriculum is based on training through experimentation in relation to training through simulation. The training is applied to concrete use cases and achievements, within collective projects.
5. *Research activities* – some use cases should include a fundamental or applied research activity. It must allow the student engineer to conduct inductive reasoning and its confrontation with an academic or industrial research environment.
6. *Sustainable development* – some case studies should address the major challenges of sustainable development, specific to the economic sectors and to the professional fields concerned by the training.

4.4.2. Training Development

The Training Development phase translates design specifications into training materials as well as teaching and learning strategies. It starts by identifying the objectives and the target audience including desired roles and competences. Then, it uses an appropriate instructional approach to perform the training courses definition and its training materials development complemented with a set of different quality reviews.

The training development follows a specific process, composed by three different task tracks (training development, overall training validation and training execution) that complement each other (see Figure 3).

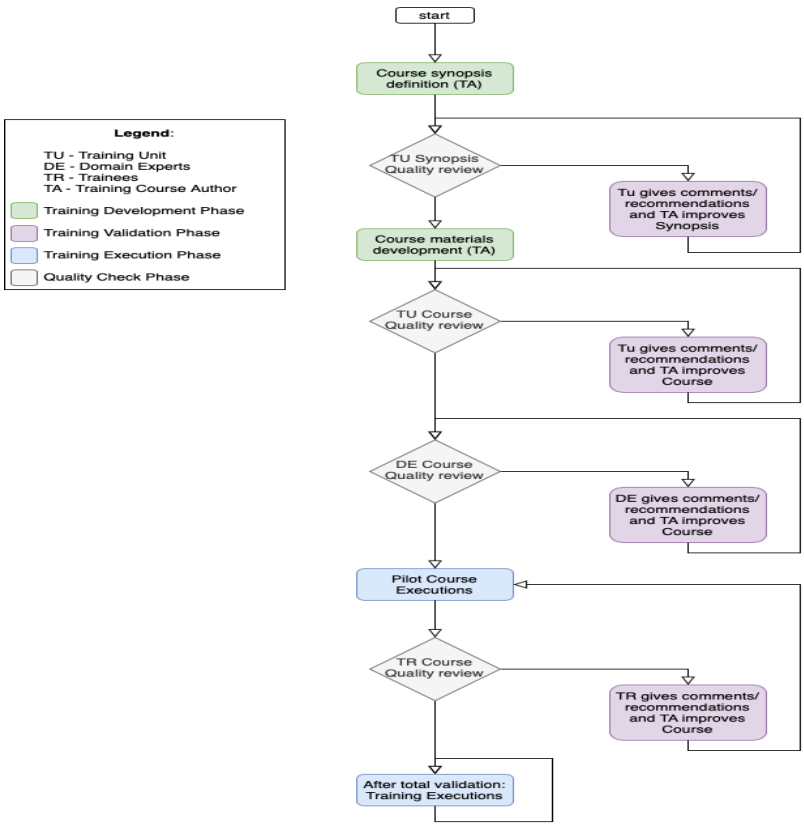

Figure 3: Training Development Procedure

The training development starts by defining the course's synopsis, the teaching and learning strategies according to the directives obtained from the ENHANCE training overall objective. Then the training unit (TU) performs a quality review of the synopsis. This is done in the training validation track. Thereafter, the course materials are developed, followed by two more quality review cycles, like the first. The first is made internally in the TU. Experts who are familiar with the training contents and able to analyse and validate the courses will perform the second cycle. The training authors improve the courses based on the feedback from these two validation activities. After this, in the next phase, another quality review is performed through pilot course executions. Here trainees (trainers first and then students) are the ones who give comments about the courses and then the training authors once again improve the materials of the courses for the final release.

5. Quality Strategy for Deliverables sustainability

The ENHANCE strategy for deliverables sustainability covers the adoption process of ENHANCE training activities, the exploitation of the selected equipment, and the empowerment of the capacity building process.

5.1. Adoption of ENHANCE training activities

As designed, the ENHANCE training activities (42 in total) are designed as a set of connected training tasks to facilitate their consumption in upgrading the identified 8 programmes among the four partner institutions.
During the four train the trainers' sessions (10 days each), each partner institution selects till 20 training activities to be presented to the institution trainers. At the end of the presentation of each activity, the local trainers are discussing the ways to adopt the proposed content and the ways to adapt the existing training activities by transforming or extending them. The project global approach tends to avoid accreditation impact of existing programmes. That's way, the applied modifications vary from adding 2 hours in existing content to the adoption of all the tasks in the ENHANCE activities as the case for the UIT partner with the new Master programme created in the beginning of the ENHANCE project basing on the set of proposed training activities.
We will summarise in deliverable D2.6 (M30) the outcomes of each Train the Trainers session with:

- The number of participant trainers per institution partner
- The number of impacted training module per institution partner
- The implementation plan for the proposed adaptation during the academic years (22-23 and 23-24)

5.2. Maximising the exploitation of the selected equipment to support the training activities

Each partner institution was invited during the first year of the ENHANCE project to refine their selection of the training equipment according to the selected training activities. The final list of equipment was submitted to the ENHANCE Project Officer for validation. In the deliverable D2.1, we present the different types of equipment, the list of equipment selected per each partner, and the association between selected training activities and selected equipment. The proposed analytics allow to illustrate :

- The number of equipment used to support the development of labs for each ENHANCE training activity.
- The number of activities impacted by the exploitation of each equipment.

As the ENHANCE partner selected different categories of equipment, they may develop different labs to use different equipment to support the same training activity. These labs will be shared between the different partners' institutions to increase the variability of the training processes.

5.3. Maximising the sustainability and the empowerment of the capacity building process

As designed, the ENHANCE capacity building approach aims at supporting partner countries' trainers at improving their training materials to teach industry 4.0 (MPQ 4.0) concepts and applications. At the short term, the interaction between partner country and programme countries trainers can be summarised in the following figure (Figure 4).

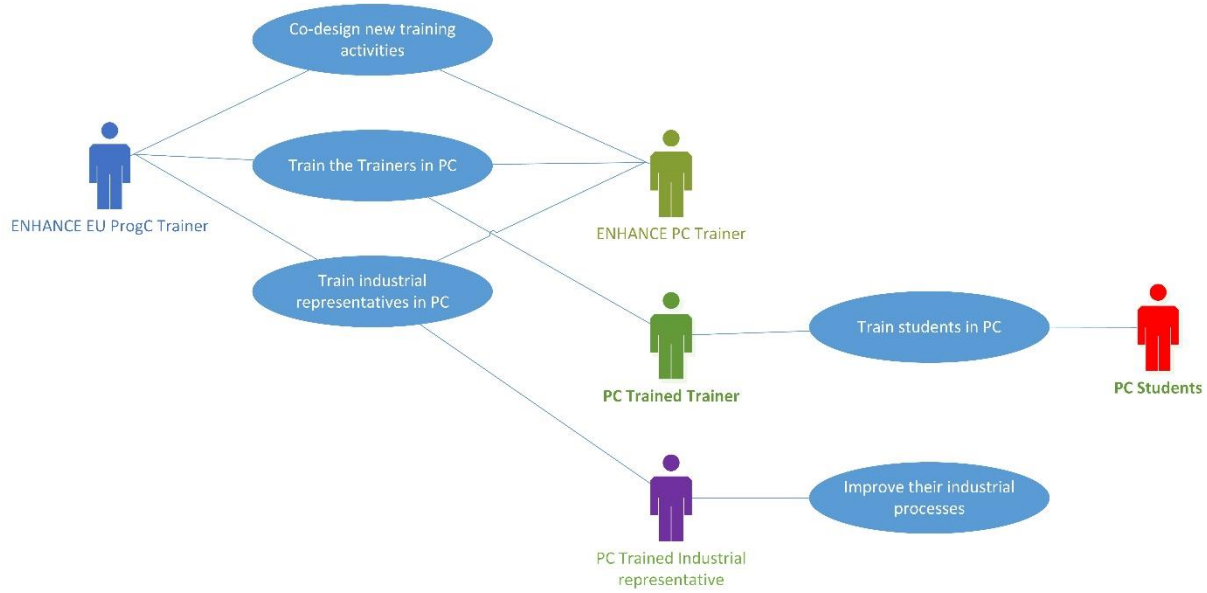

Figure 4:Training stakeholders and related activities during the ENHANCE project

The sustainability of the ENHANCE project can be obtained at the end of the project when partner countries' institutions use and maintain the developed training materials (Figure 5).

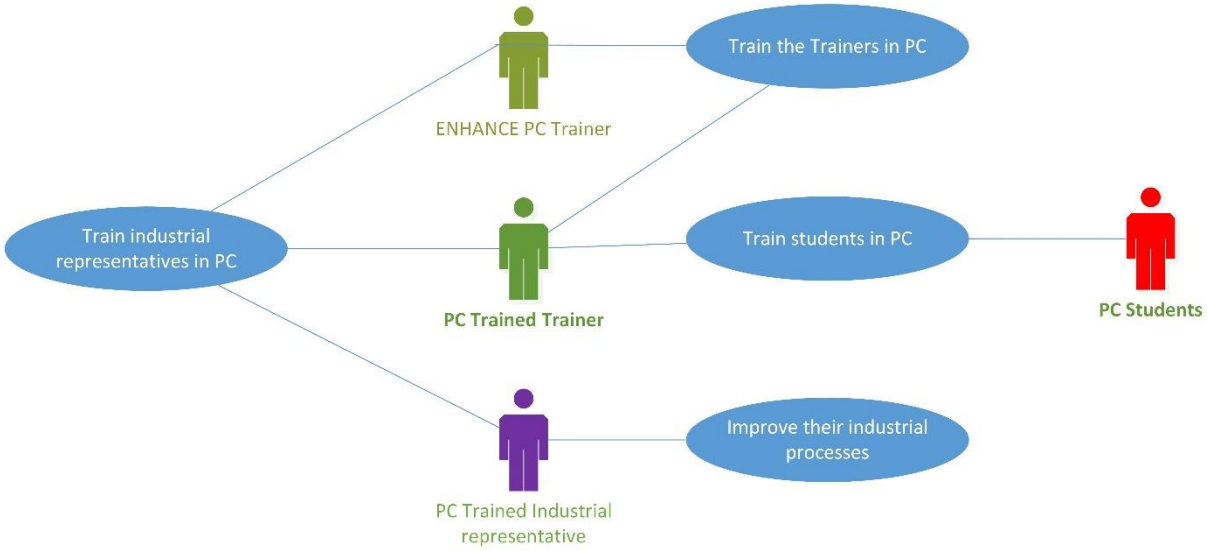

Figure 5:Training stakeholders and related activities after the ENHANCE project

6. Quality Strategy for DIH Establishment

DIH was introduced as a key priority in the Digitizing European Industry Initiative to increase digital challenges. As defined in line with regional priorities in Europe, DIHs are regional one-stop shops that help companies become more competitive regarding their business/production processes, products or services using digital technologies (Figure 6). DIHs provide access to technical expertise and experimentation, so that companies can "test before invest". They also provide innovation and support services, such as financing advice, training and skills development that are needed for a successful digital transformation.

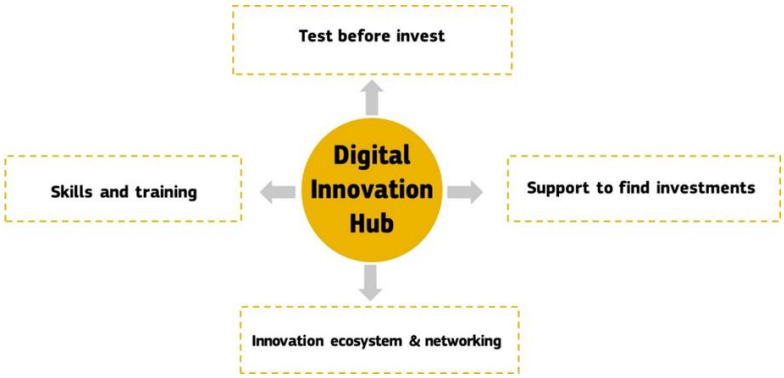

Figure 6. DIH Main Activities

The ENHANCE project aims at creating MPQ 4.0 digital skills for training as well as new related services to support digital transformation in industry in Tunisia and Morocco. The project will support the creation of two DIHs.

The quality strategy for DIHs aims at increasing the quality of DIH establishment and making more competitive advantages in the digital sphere. The following conceptual framework (shown in Figure 7) can be used as a guide for developing DIHs.

The framework stands on five main pillars:

- *Environmental* — aims at maintaining stable territory, atmosphere, and circumstances that stakeholders are working in such as, developing effective collaborative networks, preserving ecosystems and biodiversity, maintaining a stable base of resources, and safeguarding the quality of the atmosphere.
- *Social* — concerns with stakeholders, their functions and relations including, complementing partners, sharing common goals, preserving cultures, keeping positive relationships, developing commitment, providing social services, providing incentives, guaranteeing social inclusion, achieving equity, and engaging customers.
- *Economical* — focuses on financial issues and core business activities that hub generally deals with such as, generating wealth in long term, using resources efficiently, keeping balance between costs and true values, increasing revenue streams (e.g., funding, sponsorship, sales and licenses, services, consultancy, membership fees, collaborative R&D fees, and training courses, events).
- *Governance* — refers to all the processes of effective governing such as, developing efficient structure, increasing bureaucratic accountability, increasing safety and protection, reaching broad consensus, developing collaboration, and managing risks.
- *Technological capabilities* — refer to superior and heterogeneous technical resources and knowledge that can help to for example, supporting information processing and communication process, providing appropriate ICT infrastructure, maximizing access to ICTs and facilities, ensuring access to ICT training, consulting, and support (for all partners), developing ICT solutions, and developing ICT skills.

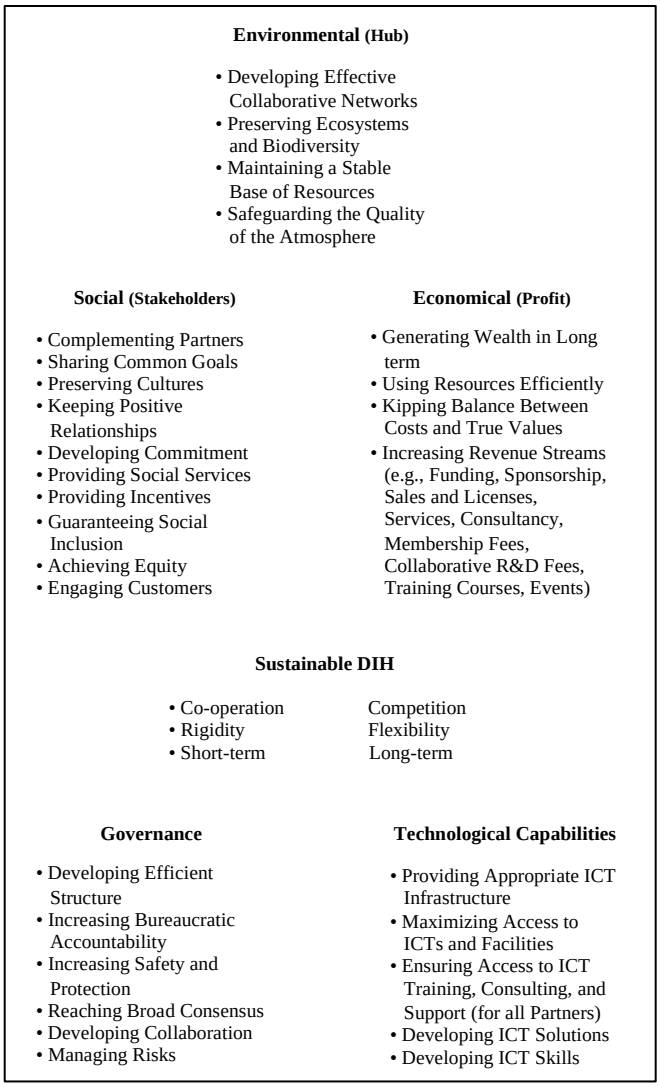

Figure 7. A DIH Framework

To properly adapt and customize this framework for the DIH and facilitate the evaluation of its functions the following checklist (presented in Table 4) can be used as a guide:

Table 4: DIH Establishment Checklist

Sample Checklist			
Pillars	**Considerations**	Yes	No
Environmental	Is the collaborative network effectively developed?		
	Is the environmental responsibility of the project is analysed?		
	Will the Project result in environmentally related social changes, for example, in demography, traditional lifestyles, employment?		
	Will the Project release pollutants or any hazardous, toxic or noxious substances to air or lead to exceeding Ambient Air Quality standards in Directives 2008/50/EC and 2004/107/EC)?		
	Is the Project located in a previously undeveloped area where there will be loss of greenfield land?		
	Are there any areas within or around the location which are already subject to pollution or environmental damage e.g., where existing legal environmental standards are exceeded, that could be affected by the Project?		

	Is the Project location susceptible to earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions e.g., temperature inversions, fogs, severe winds, which could cause the Project to present environmental problems?		
Social	Are the partners well completed?		
	Are the workers motivated and engaged and can they carry out their work in an autonomous manner when working with the new systems?		
	Is parity is targeted in term of resource utilization during project development		
Economical	Can the DIH generate wealth in the long run?		
	Is the DIH services catalogue provides a clear pricing model?		
	Is the digital transformation capability and impact of each DIH services are clearly highlighted?		
	Is the DIH proposes progressive transition to a new economic model?		
	Is the DIH supports regional innovation ecosystem, regardless of economic domains?		
Governance	Is the structure effectively developed?		
	Are the collaboration business models are clearly defined?		
	Is the IPR rules are defined?		
	Are dedicated resources are assigned to the DIH service catalogue development?		
	Is the DIH can channel and coordinate different support mechanisms, integrating regional, national and EU-level programmes and initiatives, and attracting forefront companies?		
Technological	Is the ICT infrastructure appropriately developed?		
	Are intelligent systems used for decision making that understand and adjust to the specific circumstances?		
	Are there systems that can predict and plan in a way that improve quality and optimize capacity?		
	Is it possible to access data in a secure and real-time manner?		
	Are systems and machines exchanging data, do they form an integrated part of the business processes?		
	Is the final solution is evaluated through a sustainability plan?		

7. Learning Framework for Supporting Digital Innovation Hubs Sustainability

As mentioned above in Section 5 and shown in Figure 7, the proposed conceptual framework can be used as a guide for developing DIHs ecosystem. On top of that, in the project, the new strategy is to support the DIHs in providing education, training, and learning services (and their related knowledge outputs) that can be used for technology transfer (TT) to companies, which will work as catalyst for its sustainability. Consequently, a learning framework (LF) integrated with a proposed knowledge development model is proposed to fulfil this strategy. The following subsections elaborate this issue.

7.1. Features and Characteristics of Digital Innovation Hubs

DIHs have the potential to become the main actor in transferring technology and bringing digitalization within the reach of almost all industry sectors. DIHs attempt to provide a series of support services (e.g., offering new digital services, promoting the existing services) and innovation services (e.g., customer support, maintenance plans, product use enhancements, training, and skill development) to a wide variety of companies in their region and beyond [14][15]. As proximity is considered crucial, DIHs act as a doorway and a first regional point of contact that can offer multiple concrete and tangible assistance in TT and digitalization issues. To strengthen the innovation ecosystem, the DIHs provide such support services either by their involved partners and stakeholders or through collaboration with networked DIHs. A wide range of partners and stakeholders in DIHs strive to support companies with access to their services and solutions. Furthermore, DIHs proactively try to identify the relevant and potential customers. It goes to the heart of the Hubs' mission to create added value and reflect the industry needs [13][16]. Even though the DIHs have actively provided a set of useful supports, their service portfolios still require to be distinctly defined and clearly organized to be then extensively considered and used by their customers. To clarify the scope of working and facilitate the understanding of related concepts in this context, the main stakeholders, services, and benefits of DIHs are summarized in Table 5.

Table 5: Main Features and Characteristics of DIHs.

Main Features and Characteristics of DIHs		
Main Stakeholders	Main Supports and Services	Main Benefits for Companies
Public sectors Government agencies Private sector Academia NGOs Chambers of commerce Industrial sectors Industry associations Large companies SMEs Strat-ups Midcaps Corporations Extension agencies Accelerators Entrepreneurs Real estate agents Regional development agencies Incubators/accelerators RTOs	Innovation Activities and TT Awareness creation (e.g., about digital technologies, funding opportunities) Digitalization → Digital maturity assessment → Digital transformation road-mapping Developing technologies Providing lab facilities Access to infrastructure Providing innovative solutions Experimentation Testing and validation Concept validation and prototyping Learning and Skill Creation Training/mentoring Sharing knowledge, experiences, and good practices Developing skills Access to specialist expertise	Understanding the company's needs Identifying opportunities for digitization Adapting advanced technologies Transforming business Developing business Possessing significant know-how spanning Developing and validating innovative solutions Tackling innovation-related problems Assessing digital maturity Rapid access to consultative and expertise Access to related roadshows, workshops, and innovation camps Access to Funding and investor readiness services Access to learning channels

Research centres Living Labs Training institutes Knowledge communities Specialized experts Mentors Media Suppliers Investors Customers	Advising (e.g., financing advice) Collaborative research on issues of common interest Business Development Supporting and strengthening businesses Improving business/production processes, products, or services Visioning and strategy development for businesses Commercialisation Supporting incubation Networking Fostering relationships Brokering/matchmaking Connecting companies with investors Linking suppliers with customers	Access to new knowledge and information Access to tailored help and advice Access to experimentation environments Access to living labs for validating new products/business Trying co-creation and synergy capture Prototyping, testing, and implementing the solutions Learning from experimenting Being mentored about the issues such as trend analysis, business model development, value-chain creation, market assessments, internationalization Training the workforce to be able to deal with the newly digitized processes, services, and products Developing skills Reducing risks

Among the DIHs' supports and services mentioned above, the education, training, and learning programs and activities are considered the lifeblood of almost every business. On the other hand, such supports, and services play a significant role in building capabilities and credibility for the DIHs. In an agreement with potential beneficiaries, DIHs can, for example, provide short-term training for the laborers (of companies), internships for the students (of training institutes), and digital skill development for administrative (of public sectors). These services can range from basic skills for how to use software suites, to advanced and high-level courses in universities.

Supports and services related to education, training, and learning (for companies) can cover the whole employment spectrum but should be tailored to the specific needs of the company and should be defined based on an analysis of the regional demands. For example, nowadays, digitally skilled laborers are in high demand. To meet this demand, the DIHs can pool the needs of their customers/companies and then create and develop more specific training programs (e.g., vocational training, training the trainers) that can better match supply and demand. DIHs can provide various training programs in many forms including but not limited to short or long-term courses, seminars, workshops, showrooms, factory tours, commercials, interactive demonstrations, and events. To improve the knowledge and skills of laborers and promote their learning culture, the DIHs can, for example, take the advantage of different training methods, instructor-led training, technology-based learning, on-the-job training, use cases, films, and videos to name but a few [15][17][18]. Table 6summarizes the main education, training, and learning supports and services that can be provided by DIHs for up-skilling and/or re-skilling the laborers of companies, mentors of training institutes, and employees of public sectors.

Table 6: Main services of DIHs relate to education, training, and learning

DIHs' Services Relate to Education, Training, and Learning	
Raising awareness Professional education Training (e.g., quality, safety, sale) Mentoring and coaching Internship Traineeships and apprenticeship Exchanging curricula and training material	Skills (technical and soft) development Consulting Networking and collaboration Defining the research and innovation priorities Access to the latest trends, technologies, and innovations Access to expertise

Access to the latest knowledge Exchanging knowledge Developing competencies Testing and experimenting	R&D Road-mapping Assessment Group discussion and activities Role-playing

It should be noted that the role of DIHs in TT (in general) and digitalization (in particular) has been further highlighted during the global crisis caused by the COVID19 pandemic. The use of digital technologies and the fast shift to digital alternatives (e.g., online jobs, teleworking) have enabled companies (particularly SMEs and small businesses) to mitigate the disruptions caused. This crisis enforced the need to accelerate the TT and digital transformation and make companies and businesses more agile, resilient, consistent, and flexible, underlying that the role of DIHs is nowadays more important than ever.

Broadly speaking, TT refers to the process of conveying the discoveries into products or services to be sold and/or developed by companies. In other words, TT focuses on the process of disseminating the inventions, materials, scientific outcomes, data, designs, software, technical knowledge and skills, know-how, methods of manufacturing, and other related profit motives (for various reasons and at different development stages). Since TT is about transforming ideas into opportunities, it can be considered an intrinsic part of the technological innovation process. An effective TT can guarantee the expansion of opportunities for innovation, allowing companies to concentrate more on market development and profit generation without involving in (all stages of) technology creation and development [19][20].

TT is, by nature, a challenging undertaking that can even involve many non-scientific and non-technological factors and many different stakeholders. To deal with this issue, in the literature, different types of processes for performing TT are reported. For instance, [20] proposes 8 steps to be followed namely, the discovery of novel technologies at universities and/or research institutions, disclosure, technology evaluation, intellectual property protection, marketing, licensing, product development, and public use and financial returns. In another study, [21] proposes a qualitative and linear model for the TT process that may not consider certain external factors, such as market demand, regulatory state policies, and environmental aspects. The process is composed of six phases including, invention disclosures, patent applications, technology licenses executed, technology licenses yielding income, technology royalties, and start-up companies that can use the transferred technology and consequently the creation of jobs and profit. The proposed TT process by [22] involves four main phases. In this process, the first phase is innovation, where the idea is created, and the technology is developed. The second phase is static validation, which involves experimentation to explore the basic concepts of technology to solve the identified problems. The third phase is dynamic validation which evaluates the technology by asking related questions and finding suitable answers. The last phase releases the technology for wider use when it is discerned as a useful and usable means.

The fact is that not only the process of TT but also its enhancement can be supported by DIHs, both locally and globally. The education, training, and learning services provided by DIHs plus their output knowledge (e.g., guidance, procedures, lessons learned, templates) can also be used (directly or indirectly) for creating, developing, and transferring the (digital) technologies to the companies. TT can be done in different ways such as through training the workforce (so that bringing wider access to trained people who can then further develop and exploit the technology to develop new products, processes, applications, materials, or services), licensing patented intellectual property to corporations, publishing the results of investigations and experiments, developing the relationships with industry and community partners, etc.

As mentioned earlier, TT is a complex process in which the created or developed technology (and most likely its related technical knowledge, designs, materials, and inventions) at one organization (e.g., DIH) will convey to other organizations (e.g., companies, training institutes, public sectors, and even other DIHs), typically for the purpose of commercialization, development, and progression. Most of DIHs are basically specialized in the creation, development, and transferring of technologies. It should be

underlined that in the context of DIH, the TT mostly focuses on digital transformation which incorporates digital and computer-based technologies and applications into a company's products, processes, services, and strategies. It is also note-taking that no one DIH can deliver all demanding services. Collaboration and networking with other DIHs, however, enable a DIH to provide more customized and personalized solutions.
The following subsection provides more detailed information about the knowledge development model that leads to forming LF for supporting DIHs.

7.2. Proposed Knowledge Development Model

Given the above, we propose our knowledge development model for supporting TT that stands on two main pillars:

a) *Knowledge creation process* — in this process, the related problems will be first identified. Then, based on the research and experiments that will be respectively conducted, our understanding of the scope of the content will be increased. Afterward, the potential solutions could be suggested, and the nominated solutions will be lastly assessed to ensure that they can adequately improve the knowledge. This process can be done in a DIH network (entirely or in part). After identifying certain solutions and creating knowledge to a satisfactory or acceptable extent, the next process (training implementation) can be undertaken.

b) *Training implementation process* — in this process the training courses will be initially designed. They will be then developed according to the objectives of the training program. Then after, the training content/knowledge will be used by the trainers and trainees. Lastly, through the training assessment, the strengths and weaknesses of the contents/knowledge will be identified and then adjusted if needed. Such assessment methods could for example provide valuable indications about the quality, quantity, and effectiveness of created content/knowledge as well as determine where needed changes should be made. As such, the assessment can pave the way for gradually and continually improving the contents/knowledge of the training courses (see Figure 8).

In fact, the process of knowledge creation, training implementation, knowledge development, and technology transfer are considered as a part of education, training, and learning services of DIHs that can be potentially performed in a collective effort with public sectors, training institutes, and/or companies.

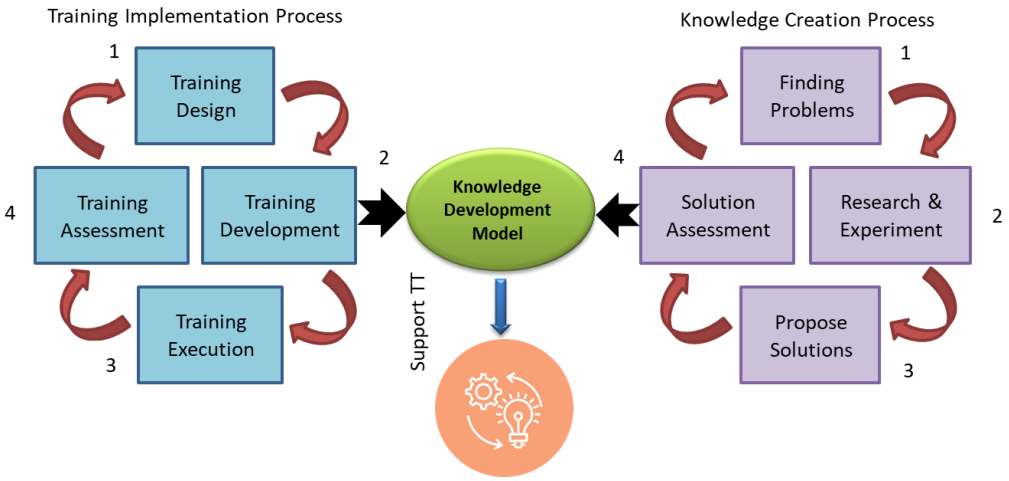

Figure 8: Proposed knowledge development model.

The proposed knowledge development model has the potential to be used for facilitating and accelerating the TT at different levels.

7.3. Proposed Learning Framework

Taking the above into consideration, we proposed a general LF for DIHs (LF-DIHs). LF-DIHs represents a hybrid approach and follows the evidence-based practice (a problem-solving and decision-making approach that focuses on conscientious, explicit, and judicious use of the best available evidence) to better help DIHs in defining and designing the training programs, training courses, and training materials as a service. LF-DIHs can help DIHs and instructors to (a) align learning goals with classroom activities, (b) create a motivating and inclusive environment for training and learning purposes, and (c) integrate appropriate assessment mechanisms into training and learning activities. Furthermore, the LF-DIHs can provide guidance for training preparation, training execution, and training development.
As mentioned earlier, LF-DIHs is a general framework and contains several specific components that work together to facilitate the process of training and learning services for DIHs. For applying the LF-DIHs to each specific DIH, however, it should be appropriately adapted to the conditions, requirements, and goals of the target case.
In Figure 9 different parts of LF-DIHs are presented (on the left side of the image) such as the main components (e.g., Learning Record Storage, xAPI, Moodle, Authoring Tools, Portal, knowledge from DIHs, and Learning Activities Syllabuses,) and their interactions and relationships. The idea is that the preparation of learning activities syllabuses to be supported by the portal. That is, the learning activities syllabuses should be created, improved, and updated directly or indirectly by the components and findings of (involved) DIHs. For example, the Authoring Tool allows instructional designers to create and customize the responsive online courses and related content/knowledge and publish them in desired formats. The Authoring Tool can also help in creating software simulations, gamification, and building questions. Moodle is a learning management system for managing learning content and processes. Moodle helps to conceptualize the various courses, course structures, and curriculum thus facilitating interaction and communication with online learners (for example in discussion forums). xAPI introduces the standards that define and adjust the tracking, sharing, and storing of the learners' learning performance across the portal. With xAPI, the authorities can track (almost) anything that the learners do. The Learning Record Storage (LRS) is the heart of xAPI ecosystem and assists receiving, bringing together, storing, and returning learning records and xAPI statements where the learning activities are conducted (e.g., in portal). As shown in Figure 9, LF-DIHs serves to support the knowledge development model.

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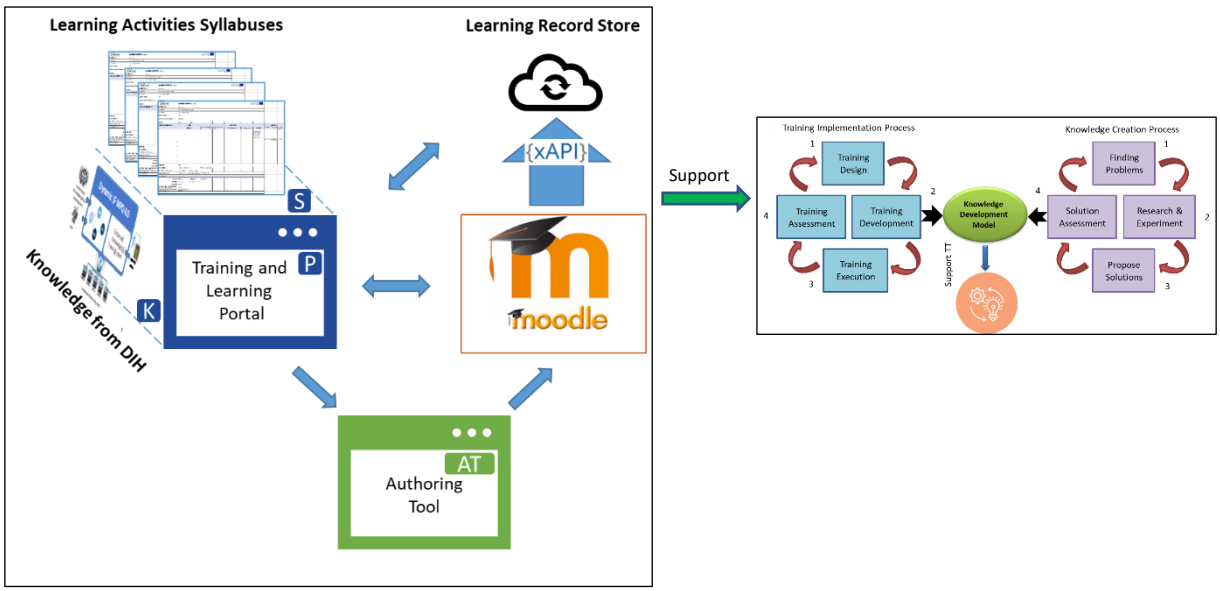

Figure 9: Proposed LF-DIHs for supporting the knowledge development model.

To make a clarification about the components addressed in LF-DIHs, a brief description is provided for each one in Table 7.

Table 7: Descriptions of the components addressed in LF-DIHs.

Descriptions
Learning Record Storage (LRS) – is a data storage system that serves as a repository for learning records collected from connected systems where learning activities are conducted. Every other tool which sends or retrieves learning activity data will interact with the LRS as the central store.
xAPI – is an e-learning software specification that allows learning content and learning systems to speak to each other in a manner that records and tracks all types of learning experiences. Learning experiences are recorded in LRS.
Moodle – is an open-source learning management system that (in addition to content management) allows to build and upload e-learning content, deliver it to learners, assess the content continually, track learners' progress and recognize their achievements. Moodle also provides a central space on the portal where learners can access a set of tools, resources, and courses anytime anywhere.
Authoring Tools – is a software program that assists instructional designers to create eLearning courses, lessons, tutorials, and digital content using various forms of media (e.g., text) and interactions. Authoring Tools can organize and deploy content or upload them to a learning management system (e.g., Moodle).
Syllabuses – are a set of documents that communicates information about a specific academic course or class. Syllabuses can include the expectations, responsibilities, course policies, rules, regulations, required texts, and schedule of assignments. Generally, syllabuses provide an overview or summary of the curriculum, and they can be served as a guide to a course and what will be expected of the learner in the course.
Portal –is a web-based platform (and historically used to refer to a gateway for a World Wide Web) that collects information from different sources (e.g., like online forums, search engines, and emails) into a single user interface and presents users with the most relevant information for their context.
Knowledge from DIHs – refers to the facts, truth, awareness, and findings that are identified, acquired, created, shared, and/or developed by DIHs for different purposes (e.g., education, training, and learning).

8. Conclusions

This document introduces a set of guiding principles to assure the overall project outcomes quality. It introduces some considerations followed in this work and define four main types of results that the project will have. Those results are technological or software-based results; text-based results as deliverables and training materials, and finally the DIHs that the project wants to establish in Morocco and Tunisie. Additionally, there are some other management mechanisms that has a direct influence in such quality assurance as the intra project activities, the project KPIs and the consortium communications supported by the project management organization. All these mechanisms are introduced to clarify how they be used to quality assess the overall results of the project. Finally, an overall sustainability strategy that associates the ENHANCE LF with a knowledge development model is introduced.

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