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Capacity Building in the field of Higher Education

strENgtHening skills and training expertise for TunisiAN and MorocCan transition to industry 4.0 Era / ENHANCE

D4.6. Publications in indexed journals & conferences

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1.0	05.05.2021	Initial Version	BIBA
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1.3	29.07.2022	Final Version M18	BIBA
1.3.1	14.09.2022	Submitted to the commission	ULL
1.3.2	15.12.2023	Updated Version, ready for review	BIBA
1.3.3	20.12.2023	Updated Version with Integration of comment from reviewers	BIBA
1.4	21.12.2023	Final Version M36	BIBA

Executive Summary

The purpose of D4.6 is to present the different publications made during the project. Thus, three conferences papers were presented in international conferences and three papers were accepted in international journals. The consortium members continue to prepare other journal/conference papers

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1. Introduction

This document is developed as part of the ENHANCE project. It presents the main publications made during the project. Although the type of the project which is capacity building in Higher Education and not research, the project consortium is aware of the relevance of addressed topics and ENHANCE members considered that the projects finding are enough interesting to be the subject of papers.

1.1. Purpose of the document

This document sum-up the articles published/submitted in/to conferences and journals during the first reporting period.

1.2. Reference documents

Deliverables D1.2, D1.3 and D1.6 of the project.

1.3. Applicability

N/A

1.4. Definitions

N/A

1.5. Structure of the document

This document is organized in 9 sections:

- Section 1: introduction
- Section 2: ENANCE project overview
- Section 3: Conference article
- Section 4: Journal articles

1.6. List of acronyms

No acronyms used in this deliverable

2. 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.

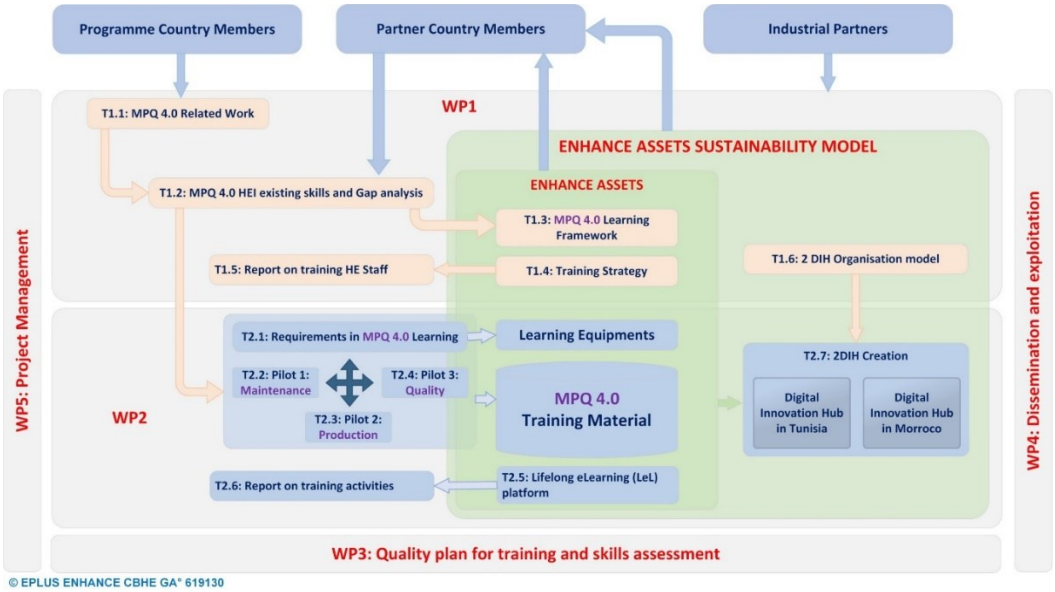

Figure 1: ENHANCE project organization.

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.

3. Conference papers

During the project period of ENHANCE, several conference articles have been presented and published in international conferences.

3.1. Towards A Conceptual Framework for Developing Sustainable Digital Innovation Hubs

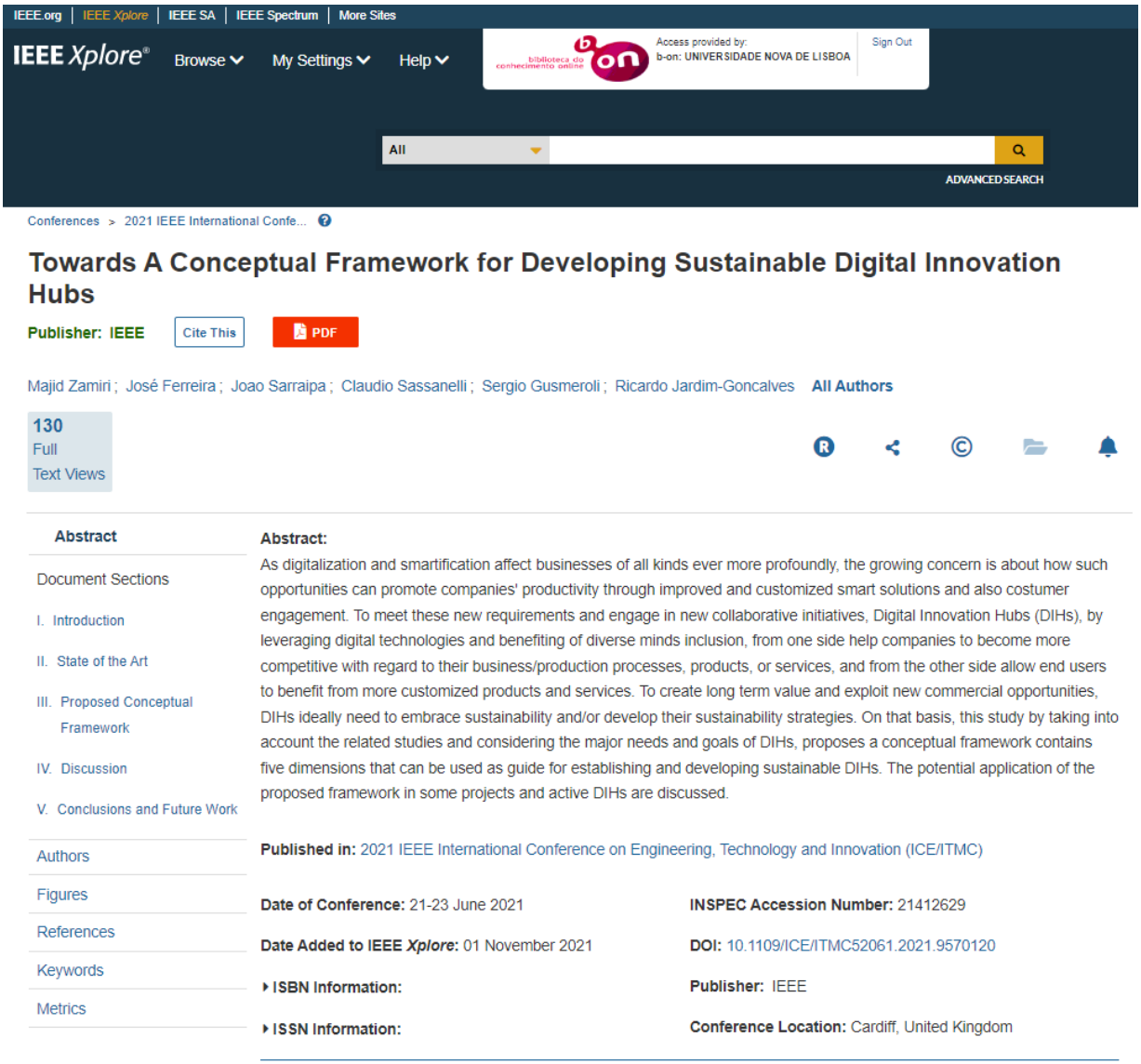

Figure 2: ICE 2021 paper

Its details are given below (see figure 2):

- Status: published
- Title of the article: Towards A Conceptual Framework for Developing Sustainable Digital Innovation Hubs
- Abstract of the article: As digitalization and smartification affect businesses of all kinds ever more profoundly, the growing concern is about how such opportunities can promote companies' productivity through improved and customized smart solutions and also costumer engagement. To meet these new requirements and engage in new collaborative initiatives, Digital Innovation Hubs (DIHs), by leveraging digital technologies and benefiting of diverse minds inclusion, from one side help companies to become more competitive with regard to

their business/production processes, products, or services, and from the other side allow end users to benefit from more customized products and services. To create long term value and exploit new commercial opportunities, DIHs ideally need to embrace sustainability and/or develop their sustainability strategies. On that basis, this study by considering the related studies and considering the major needs and goals of DIHs, proposes a conceptual framework contains five dimensions that can be used as guide for establishing and developing sustainable DIHs. The potential application of the proposed framework in some projects and active DIHs are discussed.

- Keywords: Productivity, Technological innovation, Conferences, Collaboration, Companies, Sustainable development, Business
- Name of the conference: 2021 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)
- DOI : https://doi.org/10.1109/ICE/ITMC52061.2021.9570120
- WP/Task/Deliverable: This article was part of the tasks 1.3 and 1.6, which are related to the design of the learning framework and the design of DIH in Tunisia and Morocco. A part of the content of this article were presented in the deliverables D1.3 and D1.6 of the project.

3.2. Integration of AI Use Cases in Training to Support Industry 4.0

- Status: In press
- Title of the article: Integration of AI Use Cases in Training to Support Industry 4.0
- Abstract of the article: As the demand for Artificial Intelligence (AI) continues to grow across industries, there is a need for effective training programs that support the successful deployment of AI in various organizational contexts. This study aims to bring attention to the importance of training programs in preparing industry professionals for AI implementation and highlights key considerations for designing effective training initiatives. It identifies the needs of the industry, hands-on learning experiences, and continuous skill development to ensure the optimal utilization of AI technologies in the context of Industry 4.0. In line with the objective of this work and with the support of an EU project and an associated Digital Innovation Hub (DIH), three comprehensive training programs in Maintenance, Production, and Quality are being developed. Industries can benefit from these training programs, which foster a workforce that is equipped with the necessary knowledge, skills, and awareness to enhance the implementation of Industry 4.0-related technologies and concepts, including AI and supportive technologies. The paper is terminated with concluding remarks and briefly looks into possible future work.
- Keywords: training program, Artificial Intelligence (AI), Industry 4.0, Digital Innovation Hub (DIH), machine learning.
- Name of the conference: Presented in the 3rd International Conference on Big Data Engineering
- and Education (BDEE 2023). The paper will be published by Journal of Advances in Information Technology (JAIT).
- DOI : NA yet.
- WP/Task/Deliverable: Tasks T2.3 and T2.4

3.3. Supporting Mass Collaborative Learning Communities Through Digital Innovation Hubs

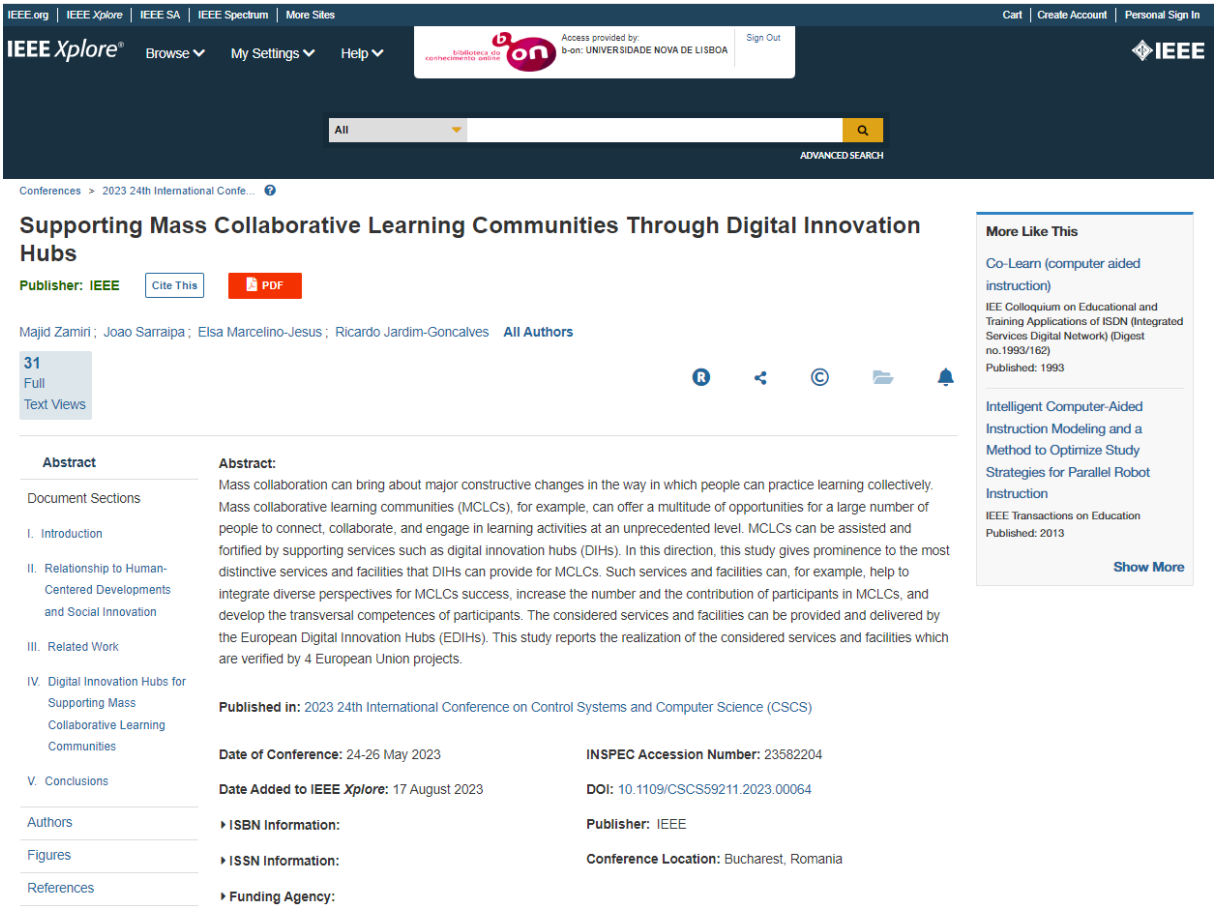

Figure 3: CSCS 2023 paper

Its details are given below (Figure 3):

- Status: published
- Title of the article: Supporting Mass Collaborative Learning Communities Through Digital Innovation Hubs
- Abstract of the article: Mass collaboration can bring about major constructive changes in the way in which people can practice learning collectively. Mass collaborative learning communities (MCLCs), for example, can offer a multitude of opportunities for a large number of people to connect, collaborate, and engage in learning activities at an unprecedented level. MCLCs can be assisted and fortified by supporting services such as digital innovation hubs (DIHs). In this direction, this study gives prominence to the most distinctive services and facilities that DIHs can provide for MCLCs. Such services and facilities can, for example, help to integrate diverse perspectives for MCLCs success, increase the number and the contribution of participants in MCLCs, and develop the transversal competences of participants. The considered services and facilities can be provided and delivered by the European Digital Innovation Hubs (EDIHs). This study reports the realization of the considered services and facilities which are verified by 4 European Union projects.
- Keywords: mass collaborative learning communities, digital innovation hubs, support services
- Name of the conference: 2023 24th International Conference on Control Systems and Computer Science (CSCS)
- DOI : https://doi.org/10.1109/CSCS59211.2023.00064

- WP/Task/Deliverable: This article was part of the tasks 1.3 and 1.6, which are related to the design of the learning framework and the design of DIH in Tunisia and Morocco. A part of the content of this article were presented in the deliverables D1.3 and D1.6 of the project.

4. Journal papers

During the project period of ENHANCE, several journal articles have been published.

4.1. Industrial needs v. engineering education curricula related to maintenance, production and quality in industry 4.0: A gap analysis case study in Tunisia and Morocco

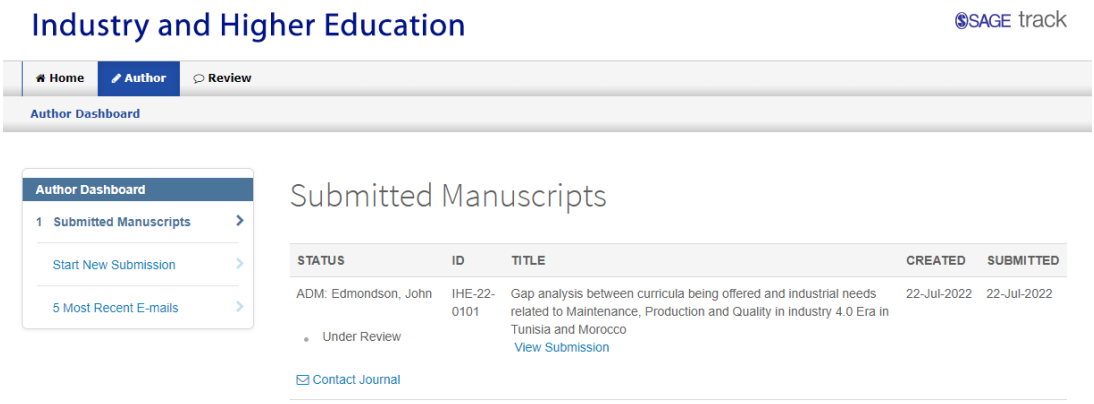

Figure 4: IHE 2022 paper

The details of the article are as following (Figure 4):

- Status: published
- Title of the article: Gap analysis between curricula being offered and industrial needs related to Maintenance, Production and Quality in industry 4.0 Era in Tunisia and Morocco.
- Abstract of the article: To improve the competitiveness of industry in Tunisia and Morocco, local authorities have adopted strategies to support industrial companies in modernizing their value-adding infrastructures. A sustained effort has been dedicated to encouraging industrial organizations to embrace the Industry 4.0 paradigm and technologies. Despite these continued efforts, engaging with Industry 4.0 is still difficult in countries like Tunisia and Morocco, particularly because industrial organizations struggle to find fresh graduates on the job market who are both skilled and qualified in Industry 4.0 operations. The contribution of this article is to initiate a process to better understand and assess the gap between industrial needs and academic offer with respect to Industry 4.0 skills and qualifications, considering the specificities of Tunisia and Morocco. We particularly focus on analyzing to what extent existing curricula in engineering education institutions satisfy or miss industrial needs and requirements in three core industrial business processes: maintenance, production, and quality (MPQ4.0). Therefore, a survey was conducted, from which a set of MPQ4.0 targeted skills and competencies were extracted and synthesized. Based on these skills and competencies, sample engineering education curricula are analyzed, gaps are identified, and recommendations for improvement are offered.
- Keywords: Digitalization, gap, industry 4.0, technologies
- Name of the journal: Industry and Higher Education
- DOI : https://doi.org/10.1177/09504222231153782

- WP/Task/Deliverable: this article was part of the task 1.2, which related to the analysis of the gap between programs being offered in Tunisian and Moroccan universities and skills required by local industry. This work was reported in the deliverable D1.2 of the project.

4.2. Meta-Governance Framework to Guide the Establishment of Mass Collaborative Learning Communities

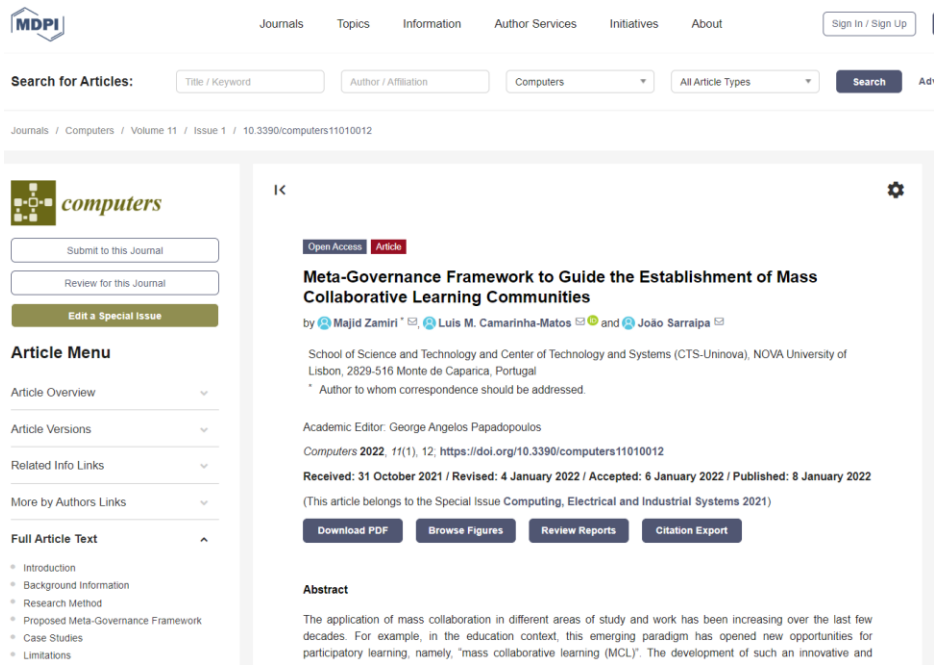

Figure 5: MDPI 2022 journal paper

The details of the published article (Figure 5) are:

- Status: published
- Title of the article: Meta-Governance Framework to Guide the Establishment of Mass Collaborative Learning Communities
- Abstract of the article: The application of mass collaboration in different areas of study and work has been increasing over the last few decades. For example, in the education context, this emerging paradigm has opened new opportunities for participatory learning, namely, "mass collaborative learning (MCL)". The development of such an innovative and complementary method of learning, which can lead to the creation of knowledge-based communities, has helped to reap the benefits of diversity and inclusion in the creation and development of knowledge. In other words, MCL allows for enhanced connectivity among the people involved, providing them with the opportunity to practice learning collectively. Despite recent advances, this area still faces many challenges, such as a lack of common agreement about the main concepts, components, applicable structures, relationships among the participants, as well as applicable assessment systems. From this perspective, this study proposes a meta-governance framework that benefits from various other related ideas, models, and methods that together can better support the implementation, execution, and development of mass collaborative learning communities. The proposed framework was applied to two case-study projects in which vocational education and training respond to the needs of collaborative education–enterprise approaches. It was also further used in an illustration of the MCL community called the "community of cooks". Results from these application cases are discussed.

- Keywords: mass collaborative learning; meta-governance framework; mass collaboration assessment
- Name of the journal: MDPI Computers 2022
- DOI: https://doi.org/10.3390/computers11010012
- WP/Task/Deliverable: this article was part of the task 1.3, which related to the design of the learning framework. A part of the content of this article was presented in the deliverable D1.3 of the project.

4.3. A Learning Framework for Supporting Digital Innovation Hubs

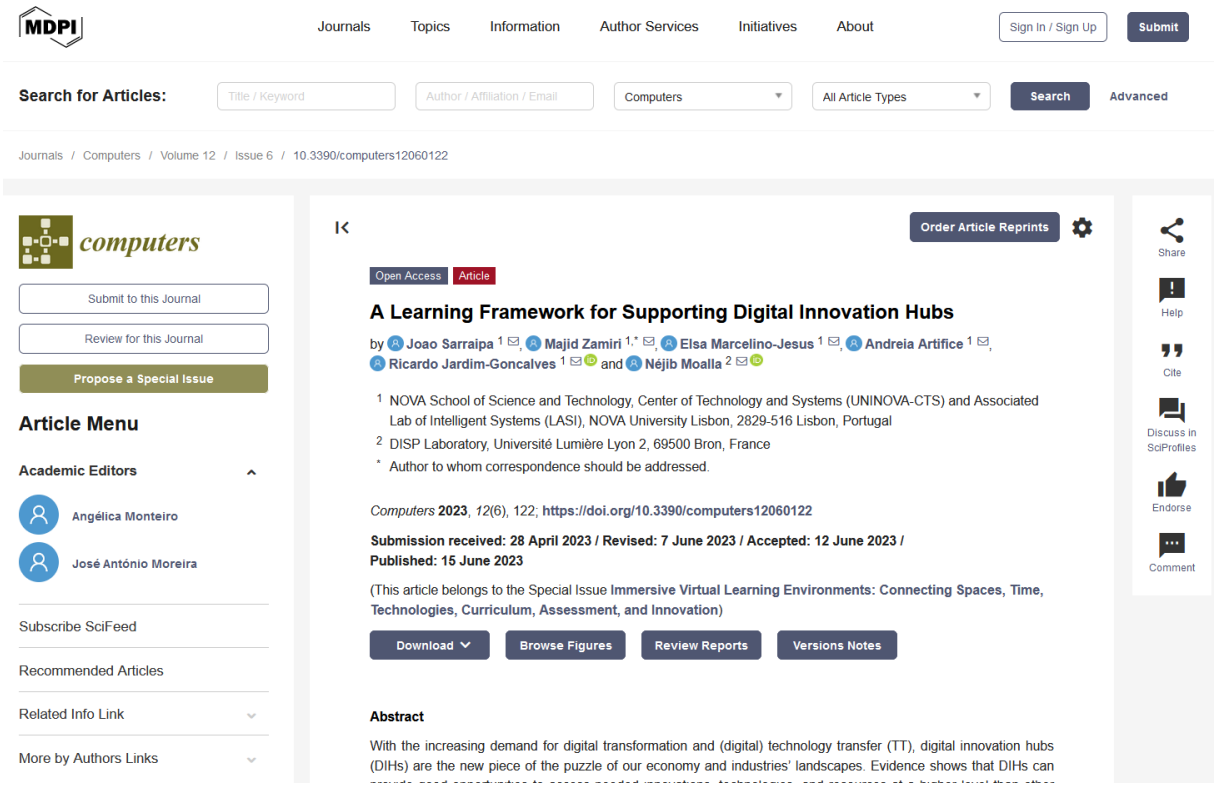

Figure 6: MDPI 2023 journal paper

Its details (Figure 6) are given below:

- Status: published
- Title of the article: A Learning Framework for Supporting Digital Innovation Hubs
- Abstract of the article: With the increasing demand for digital transformation and (digital) technology transfer (TT), digital innovation hubs (DIHs) are the new piece of the puzzle of our economy and industries' landscapes. Evidence shows that DIHs can provide good opportunities to access needed innovations, technologies, and resources at a higher level than other organizations that can normally access them. However, it is critically important to note that DIHs are still evolving, under research, and under development. That is, there are many substantial aspects of DIHs that should be considered. For example, DIHs must cater to a wide spectrum of needs for TT. From this perspective, the contribution of this work is proposing a generic and flexible learning framework, aiming to assist DIHs in providing suitable education, training, and learning services that support the process of (digital) TT to companies. The proposed learning framework was designed, evaluated, and improved with the support of two EU projects, and these processes are discussed in brief. The primary and leading results gained in this way show that the learning framework has immense potential for application to similar

cases, and it can facilitate and expedite the process of TT to companies. The study is concluded with some directions for future works.

- Authors:
  - Joao Sarraipa, Majid Zamiri, Elsa Marcelino-Jesus, Andreia Artifice, Ricardo Jardim-Goncalves (from UNL) and Néjib Moalla (from ULL)
- Keywords: learning framework; digital innovation hub; technology transfer
- Name of the journal: MDPI Computers 2023
- DOI: https://doi.org/10.3390/computers12060122
- WP/Task/Deliverable: This article was part of the tasks 1.3 and 1.6, which are related to the design of the learning framework and the design of DIH in Tunisia and Morocco. A part of the content of this article were presented in the deliverables D1.3 and D1.6 of the project.

5. Conclusion and Future activities

During the project tile-time, a huge dissemination effort has been performed. The consortium has published 6 articles (3 conference papers, 3 journal papers). Nevertheless, the project partners will continue working on dissemination activities. UNL is developing an article titled: Inventory management System relying on deep neural networks for demand forecasting: An Automotive Industry Use.Case. BIBA is working on a journal paper addressing required and realistic measures for enabling the transition of PC stakeholders (Authorities, HEIs, industry) to Industry 4.0 and Industry 5.0. For the development of this journal paper, the findings/results that have been collected/achieved during the project lifetime will be considered.