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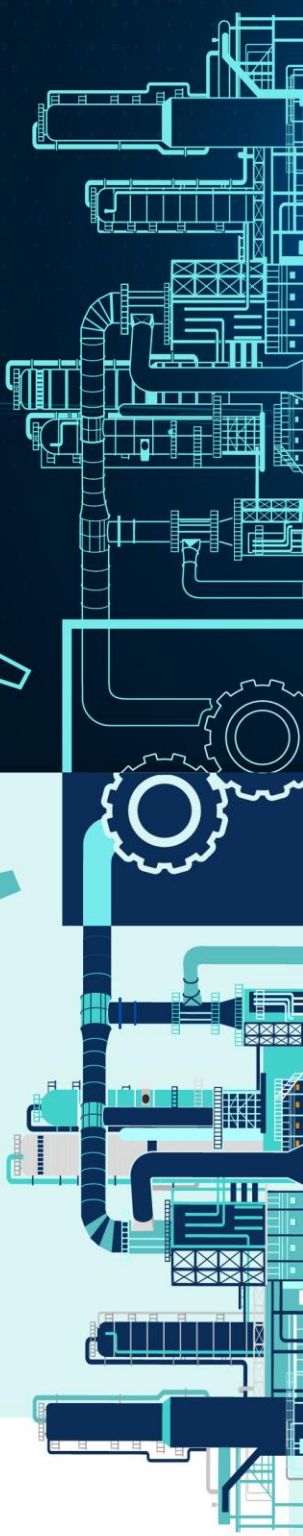
ENERGY-AWARE FACTORY ANALYTICS FOR PROCESS INDUSTRIES

Deliverable D8.9

FACTLOG Training and Educational Material V1



Version 1.1	**Lead Partner** UNP
Date 25/10/2023	**Project Name** FACTLOG – Energy-aware Factory Analytics for Process Industries

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Dissemination Level

X	**PU**	Public
	CO	Confidential, restricted under conditions set out in the Grant Agreement
	CI	Classified, information as referred in the Commission Decision 2001/844/EC

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Executive Summary

This deliverable is the first of a set of 2 deliverables, is a report on the result of task 8.4 – Industrial Interest Group and Lifelong Learning and is dedicated to reporting training material and clustering activities. It describes all the training and educational material that will be part of the project. Some of this material is already available, such as the FACTLOG overview video that gives us an overview of the project's vision and workshops developed by the pilots. The planned materials are up to each of the six assets with their respective entities, that is, they will have to create content, training and education.

It also provides an overview about the workshops that the pilots carried out, more specifically about their date, the participants and some information about the workshop.

The last chapter of the deliverable describes the Clustering and Liaison Activities of the project. FACTLOG joined 5 projects - CAPRI, COGNIPLANT, COGNITWIN, HyperCOG and INEVITABLE - and together they created SPIRE-06. "SPIRE-06" is (presently) an informal discussion group of the projects funded under the H2020 DT-SPIRE-06-2019 topic focusing on digital technologies for improved performance in cognitive production plants. The Cluster has already carried out some activities, such as:

- SPIRE Clustering webinar Organizational meeting
- Cluster Workshop: SPIRE Industries
- Workshop: 6P Methodology

As far as Liaison is concerned, FACTLOG has merged with IoT-Catalogue.com so that all the information coming from the project is available to everyone.

As this is the first deliverable of a total of two, there will be more content, workshops, training and education, which will also be placed on the website, in order to make all the material available to the public. At the moment, the FACTLOG information is not yet publicly available, but during the next few months, the information will be updated and validated by the consortium, so that everything can be made public.

Revision History

Revision	Date	Description	Organisation
0.1	19/10/2021	Initial Version	UNP
0.2	26/01/2022	Training Activities	All Partners
0.3	23/02/2022	FACTLOG Educational Material	All Partners
0.4	28/03/2022	Clustering & Liaison Activities	UNP
0.5	01/04/2022	Review	BRC & DOMINA
1.0	07/04/2022	Final Version	UNP
1.1	25/10/2023	Addressing the comments from EC	UNP

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1 Introduction

1.1 Purpose and Scope

This deliverable reports on the result of task 8.4, with respect to the training and educational materials designed both from industrial and academic partners, from the first 24 months of the project.

The task 8.4 objective, as stated in the DoA, is the following: *"All requirements and use cases will be shared and validated beyond FACTLOG and particularly with fellow SPIRE and FoF projects. This will be further strengthened by the formation of an Industrial Interest Group, comprising at least one manufacturing expert per FACTLOG country and aiming at an 80% coverage of all EU and associated countries. Manufacturers that are part of the FACTLOG consortium will share this with their ecosystems, i.e., 4-5 different process industry sectors. Most importantly, FACTLOG's academic partners, facilitated also by the technology providers, will implement, and run during the last 18 months of the project lifelong learning courses and measure their impact. Such courses will be done both by the industry (e.g., C2K, who has a living lab) and academic. The teaching and training material will be publicly available."*

1.2 Relation with other Deliverables

WP8 "Dissemination, Business Innovation and Impact Creation" intends to "develop a dissemination and communication plan which will explicate the individual and consortium concrete set of activities.". These activities concern WP8, more specifically in the dissemination of FACTLOG results, its content will be made available on the project website and will be used for publications on social networks, in order to attract more interest to the project. On the other hand, there is also a more explicit connection with the technical WPs, as the training materials will be generated in these WPS.

1.3 Structure of the Document

This report is divided into 4 different chapters:

- Introduction – This chapter provides an initial view on the context of the document, its objective and the relationship with other FACTLOG deliverables.
- FACTLOG Training Educational Material – In this chapter are described the material that is already made and the material that is planned to be made will be described.
- Training Activities – In this section describes the workshops developed by the pilots.
- Clustering & Liaison Activities – In this chapter, describes the partnership made between FACTLOG, CAPRI, COGNIPLANT, COGNITWIN, HyperCOG and INEVITABLE, creating the SPIRE-06 Cluster and also the liaison with IoT-Catalogue.com.

2 FACTLOG Training Educational Material

In this section of the document, the material that is already made and the material that is planned to be made will be described. In order to show all the information described below, a knowledge base will be created on the project website. So, all the information will be available to the public.

A knowledge base is a self-serve online library of information about a product, service, department, or topic. Its purpose is to make it easy for people to find solutions to their problems without having to ask for help.

Our goal is, and we are already creating a section on the factlog.eu, called knowledge base, to gather all the information and material that will be available. In this section dedicated to the knowledge base we will make available various types of content, such as:

- FACTLOG technology demo videos
- Training material
- The official project deliverables
- Publications that are made in the context of FACTLOG

2.1 Available Material

So far, the material we already have available includes a video and content used in the pilots' workshops:

- FACTLOG overview video
- Workshops

2.1.1 FACTLOG Video

The video intended to present the FACTLOG project vision on how to unlock the potentials of Cognitive Digital Twins in Manufacturing Chains. The video provides some clues on the need for cognition and digital twins, and shows how FACTLOG intends to explore this promising technology during the lifetime of the project.

Figure 1 - FACTLOG Video

Topics:

- The need for cognitive and dynamic supply chains
- Supply Chain as network of Interconnected Cognitive Digital Twins
- A vision for Cognitive Supply Chains
- Cognitive Digital Twin enablers
- Operational model
- Operational model – CDT Enablers
- Intra-Factory view
- Intra and Inter country materials flow (agile manufacturing chains)

The video can be seen on the website: https://www.factlog.eu/newsletters/newsletter-1-factlog-project-vision

2.1.2 Workshop Materials

Below, the six representations of questionnaires are an example of material used by PIACENZA Pilot in the workshops. The other pilots, in their workshops, also used the same type of material.

The following three images refer to the questionnaire that was made by the pilot, where the opinion on the system usability agreement level is asked (Figure 2), to assess the usefulness of the features (Figure 3) and to give an overall experience with system (Figure 4).

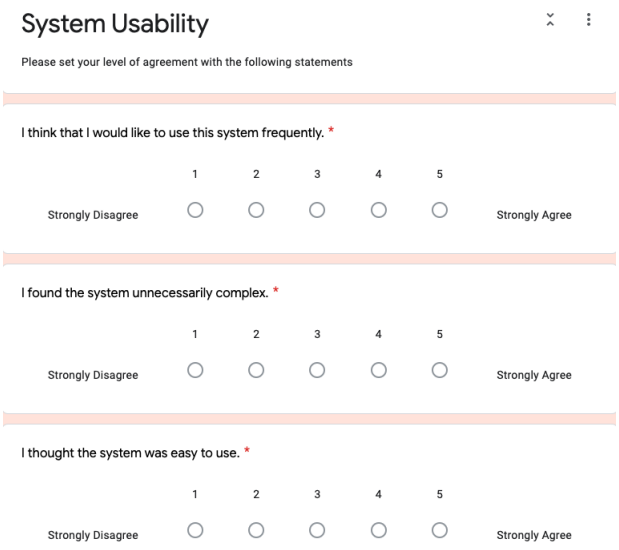

Figure 2 - Questionnaire: System Usability

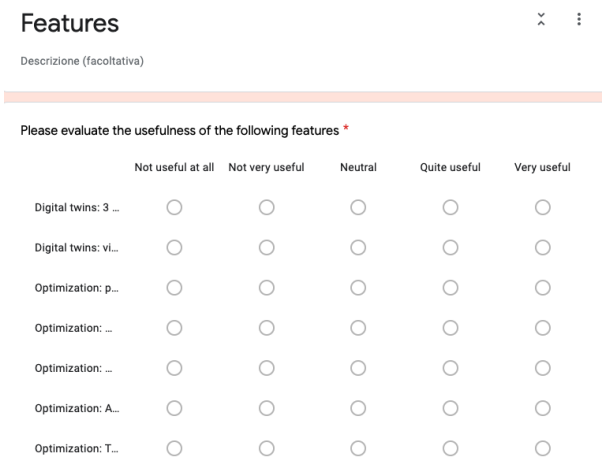

Figure 3 - Questionnaire: Features

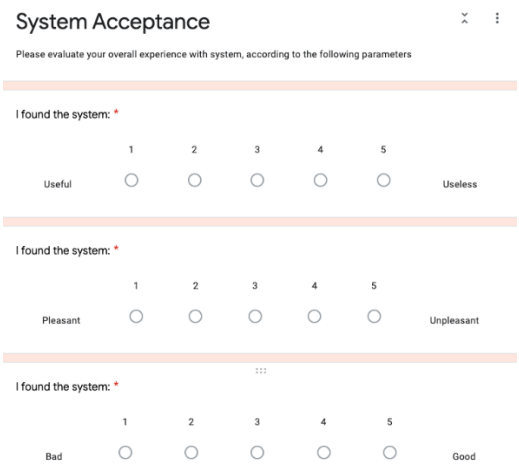

Figure 4 - Questionnaire: System Acceptance

The following two images represent the way to see the Digital Twins (Figure 5) and one can define the characteristics of the equipment (Figure 6).

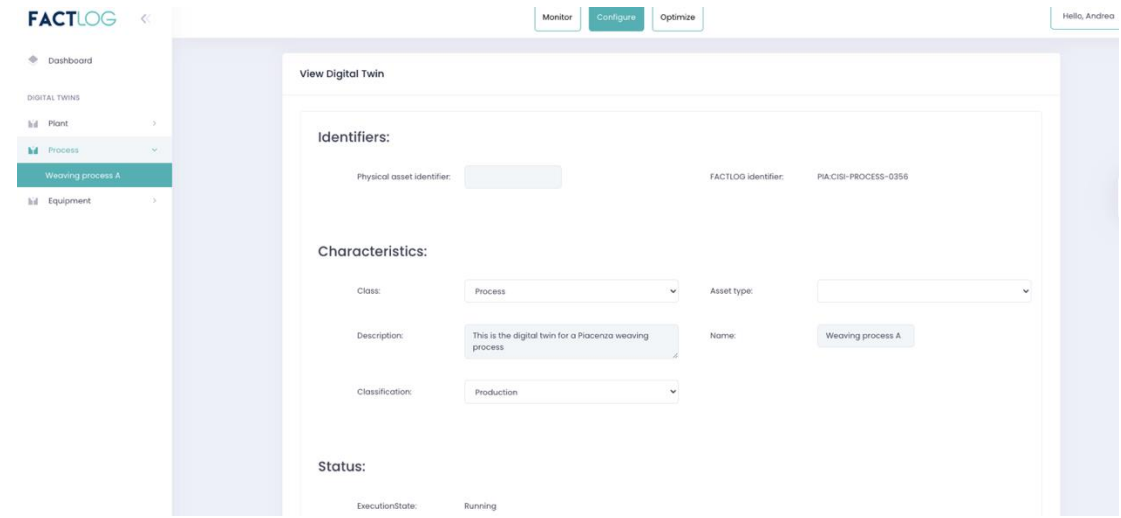

Figure 5 - Digital Twins Visualizer

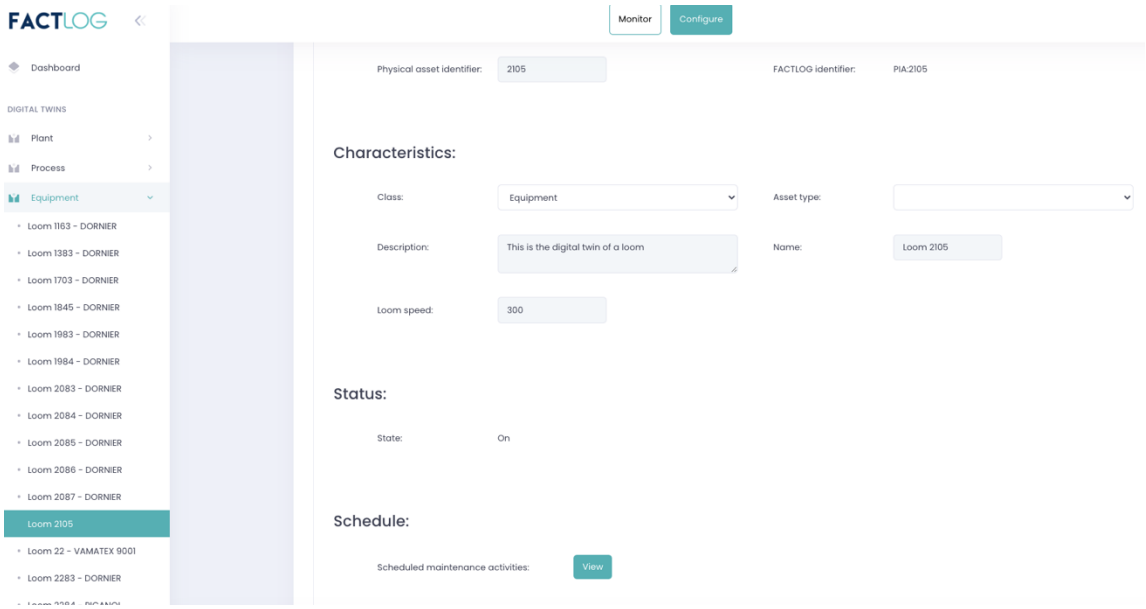

Figure 6 - Equipment Characteristics

2.2 Planned

This section of the document describes the planned material that will be made. The following table represents six assets and their respective entities. Each entity referenced in the table will have to create content, training and education, so that you can teach people about your asset.

This content can be a document, a presentation or another, so that people can understand the functionality of the asset. In the end, each entity will present a questionnaire to people, to see if they will understand the content presented about their asset. This questionnaire will help to understand what needs to be improved.

Table 1 - Assets

Assets	Entities
Analytics for Cognition	NISSA
Data-driven methods and tools for cognition	Qlector/JSI
Robust optimization engine	MAG/AUEB
Pilot-Specific Optimization models/algorithms	AUEB/UNIPI
Knowledge Graph	EPFL
Digital Twin Platform	MAG

3 Training Activities

In this section is information about the workshops that the pilots developed in order to present their FACTLOG technologies and how they can be applied in the context of each pilot. These workshops aim to create a first contact between the FACTLOG technology and the factory people. The main focus of the workshops was to evaluate the intermediate version of the systems (platform, services and User Interface), and that as additional factor they were used to train people / create a first contact with the platform.

3.1 Waste-to-Fuel Transformer Plants: JEMS pilot[1]

- 30th of September
- Participants: main technology partners JSI, Qlector, JEMS, MAG and other interested technology and pilot partners who showed interest.
- Modality: web workshop; main technology partners show the interface and explain the implemented functionalities; group discusses how these functionalities meet the expectations from the proposal and how the pilot functionalities were limited for the implementation controllability purposes.

3.2 Oil Refineries: TUPRAS pilot

- 25th of September
- Participants: the pilot owner, Maggioli and the main technical partners supporting the pilot.
- From the Tüpraş side, end users coming from R&D and production departments, as well as some human machine interface experts attended the meeting and gave their opinions about the current version of the FACTLOG platform, expressing their needs about the further developments. Workshop agenda was shared with the attendees beforehand and a questionnaire was also shared with the relevant participants.

3.3 Textile Industry: PIA pilot

- 28th of September: In order to comply with the COVID-19 restrictions still active in Italy, the workshop was completely handled remotely.
- Participants: The partners actively involved in the pilot (i.e., the modules developers, the platform developers and technical support of the pilot, in charge of handling the data extraction and the data ingestion processes) have participated to the workshop. Additionally, a sample of people from the end-user (not directly involved in the project) has participated to provide feedbacks on the current development, and to drive the design of the platform and the applications in the second project cycle. 4 persons of PIACENZA, strongly aware of the production processes and, in some cases, not directly involved in FACTLOG, participated to the workshop. The same sample has also provided answers to the questionnaire, in order to allow the evaluation of Usability and Acceptability parameters, as defined in Chapter 2.
- The workshop started with a short introduction of FACTLOG project, intended to clarify the project scope and concept to people not directly involved. An introduction

[1] JEMS pilot did not meet its objectives, especially with regards to the integration of the FACTLOG system to its plant since there is not yet an operative plant in Slovenia.

on the test cases has been also provided to define the scope of the project. Then, a demonstration of all the different functionalities enabled by the platform has been done, in order to show the potential of the integrated system. The demonstration has been performed using real plant's data, coming from looms in real production set up, used to train the modules and to perform the simulations. Participants were asked to provide observations, e.g., on the data visualization modalities (e.g., representations of production GANTT chart, a unique view of all the looms in the weaving department etc.) and on the prominence of the information displayed (e.g., what an ideal user would see on a principal dashboard page, which are the main data to be shown regarding the single looms digital twins). Additionally, it has been performed a standalone demonstration of the Analytics module, used to monitor energy consumption data from the sensors installed in the weaving department in the first project cycle. The module is currently developed but not integrated yet in the platform for PIA case: one of the scopes of the second cycle (besides extending the covering of sensors to other looms) will be to integrate it in order to enrich the digital twins and to provide the end users with more information, also coming from pseudo real time data. The outcomes of the workshop, including the comments and insights provided by the relevant stakeholders, and the results of the survey will be reported in D7.5.

3.4 Automotive Manufacturing: CONT pilot

- 12th of September
- The list of workshop participants from the Continental pilot includes the following responsible people within the organization:
    - Mr. Flavius Mihaila – Head of Industrial Engineering
    - Mr. Alin Popa - Group Leader Smart Factory Industry 4.0 group
    - Mr. Cristian Bozan – Leader of the Automation and Mechanical Engineering team
    - Mr. Lucian Pavel – Leader of the MES team
    - Mr. Bogdan Posa – Automation engineer
    - Mr. Ciprian Kamenik – MES Engineer
    - Mr. Bogdan Helgiu – Production planner
- The workshop intends to start with a retrospective of the Continental pilot's needs, but also of its expectations regarding the results of the FACTLOG project and to continue with a presentation of the platform developed by Maggioli (intermediate version) with the Digital Twin Representation. During the workshop, feedback will be collected from the end-user to confirm if the features already developed are relevant and to acknowledge what could be improved for the final version of the platform.
- SIMAVI as the technical partner supporting the Continental pilot, will be represented by the Project Manager in the FACTLOG Project on behalf of the organization, Mrs. Andreea Paunescu, and the technical leader in FACTLOG Project, Mr Radu Popescu. Maggioli's technical team and the representatives of the technological partners who developed the modules for the Continental pilot will also participate in the workshop.

3.5 Steel Manufacturing: BRC pilot

- 30th of September
- Mode of demonstration is via Microsoft Teams due to conferencing capability and taking into account Covid-19.

- It is presented by Control2k, the lead technical party for the BRC Pilot.
- The workshop shall last an hour.
- Questionnaires are filled in after the workshop.
- Participants from BRC end users: Operations manager, Engineering manager, Senior production manager, Planning and Transport manager, Industrial Process Engineer/Quality Analyst.

4 Clustering & Liaison Activities

As part of the project's clustering activities, FACTLOG joined other projects such as CAPRI[2], COGNIPLANT[3], COGNITWIN[4], HyperCOG[5] and INEVITABLE[6] to create the SPIRE-06 projects' cluster.

To facilitate access to all FACTLOG information about the project results, like use cases and technologies, a liaison was made with IoT-Catalogue.com. This liaison makes it possible to increase FACTLOG's outreach to reach out to more people and audiences.

One of the objectives of the Cluster from the point of view of the FACTLOG project, as mentioned in Task 8.4 - *strengthened by the formation of an Industrial Interest Group*, is to reach the network of other projects, so that sharing is increased. This is by sharing information with other Cluster partners, they can share their knowledge in their network, thus reaching more people.

4.1 SPIRE-06 Cluster

"SPIRE-06" is (presently) an informal discussion group of the projects funded under the H2020 DT-SPIRE-06-2019 topic focusing on digital technologies for improved performance in cognitive production plants, and that includes representatives from the CAPRI, COGNIPLANT, COGNITWIN, FACTLOG, HyperCOG and INEVITABLE projects.

The group is exploring ways in which the projects can collaborate, share information and organise joint activities that are of mutual interest and for the community of interest/practice on cognitive production plants. It is expected that, in a near future, the group with become a formal cluster between these projects.

Some of the objectives of this Cluster, formed by the 6 projects above, are:

- Share knowledge between projects
- KPIs for cognitive production plants: catalogue of KPIs, ways they are measured, targets, etc. from all the projects
- Standards for cognitive production plants: the standards that each project is using and/or contributing to
- Joint dissemination activities: check dissemination activities of project to see what can be done together

The Cluster has already outlined some activities and has already carried out others, such as the SPIRE Clustering Organizational meeting webinar, the Cluster Workshop "SPIRE Industries" and the Workshop on the 6P Methodology, which are described below.

4.1.1 SPIRE Clustering webinar Organisational meeting

- Online Meeting: November 23

[2] https://www.capri-project.com
[3] https://www.cogniplant-h2020.eu
[4] http://www.cognitwin.info
[5] https://www.hypercog.eu
[6] https://inevitable-project.eu

- Objective: discuss a title, finalize the agenda and AOB.

Figure 7 - Cluster Meeting November 23

4.1.2 Cluster Workshop: SPIRE Industries

On the 24th of January 2022, FACTLOG joined forces with 5 other SPIRE projects (CAPRI, COGNITWIN, INEVITABLE, HYPERCOG and COGNIPLANT) and was present in an on-line session dedicated specifically to the use-cases addressed by the projects.

Figure 8 - Cluster Workshop: Digital Technologies in Cognitive Production Plants

Event schedule:

- SPIRE aims – Presentation of the industrial situation, the technological challenges and the proposed approach
- 1 use case per project presentation:

  - COGNIPLANT: Increasing efficiency and productivity of a biomass-powered quicklime kiln;
  - CAPRi: Cognitive Automation Platform in Asphalt Use Case
  - COGNITWIN: Predicting ladle degradation in the steelmaking process using AAS-based Hybrid Digital Twin
  - INEVITABLE: UC1 – Implementation of the methods for monitoring and optimization of the EAF process
  - HyperCOG: Optimization of the steelmaking process through a Hyperconnected and Cognitive Cyber-Physical Architecture
  - **FACTLOG: Cognitive Digital Twins in an Oil Refinery Case**
- Final roundtable – Key aspects that can assimilate or differentiate the use cases. Elements that can be applied to other cases, Discussion (including Q&A from the audience)
- Next steps for our clustering activities – Methodology for Cognitive Digital Transformation of process industry

With each project approaching the validation phase, the six presentations focused on the cyber-physical systems being tested in different process industries. For FACTLOG, Stravos Lounis, from AUEB, presented the Cognitive Digital Twins in the Oil Refinery Case, that need a predictive and prescriptive tool which considers the current production realization for estimating product quality in the pool and the new targets and evaluating the impact of the new schedule. The presentation focused on the FACTLOG Architecture and DT Platform for ECTs, on Cognition in FACTLOG, on Cognitive Digital Twins in an Refinery Case and on Interaction of CDTs with the Services.

4.1.3 Workshop: 6P Methodology

On 9 February 2022, the 6 projects came together for a meeting: **6Ps methodology for Cognitive Digital Transformation of process industry**, presented by CAPRI and POLIMI.

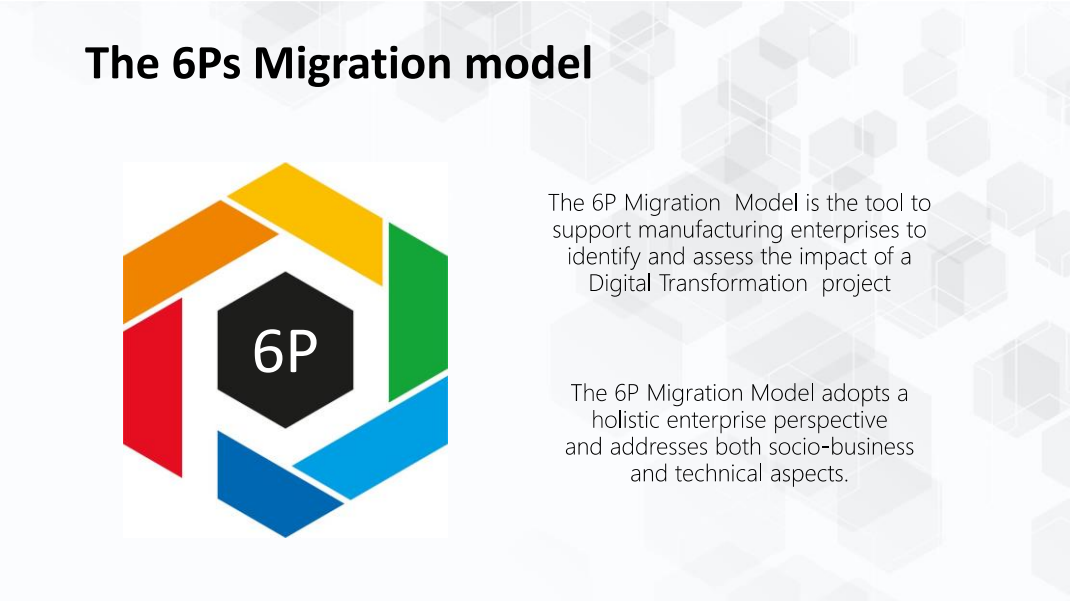

Figure 9 - The 6Ps migration model

The 6Ps methodology is a tool conceived to support enterprises along their digital transformation journey, by providing a complete analysis of the main six pillars that

characterised the production process. It is based on the assumption that, to succeed in a digital transformation process, it is important to boost not only the technical dimensions but also the so called “socio-business” dimensions.

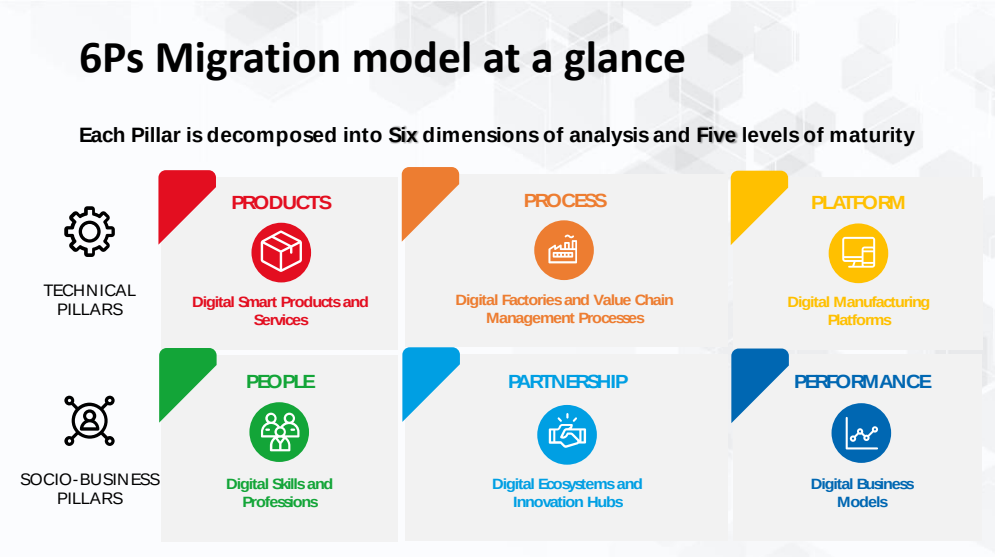

Figure 10 - 6Ps Migration model at a glance

The Six dimensions mentioned in the figure above have as objective:

- Products: To support the transition towards digital smart products & services.
- Process: To support migration towards digital factories and production processes.
- Platform: To support adoption and integration of digital manufacturing platforms.
- People: To support digital skills development and professions.
- Partnership: To support enterprise joining digital ecosystems and digital innovation hubs.
- Performance: To support the adoption of digital business models and data / platform economy.

4.2 Liaison: IoT-Catalogue.com

The IoT-Catalogue.com is a web based tool developed by UNP, available in http://www.iot-catalogue.com/ developed to be the one-stop-source for Internet of Things (IoT) knowledge, innovations and technologies, aiming to help IoT stakeholders (developers, integrators, advisors, end-users, etc.) to take the most advantage of the Internet of Things for the benefit of society, businesses and individuals. It is an explorer for innovations in IoT applications and technologies; it is a web-based tool that enables to pick & choose IoT solutions; it is a wide repository of knowledge, use cases, contacts, etc of the Internet of Things.

A key purpose of the ‘IoT Catalogue’ is enabling users to explore IoT solutions based on domain-related Value Propositions and/or ICT Problems described on use-cases defined along applications domains. The ‘IoT Catalogue’ also enables users to inspect solutions and technologies from other domains that might fit their intents or analyse use-cases similar to their projects thus promoting synergies and reusability between application domains.

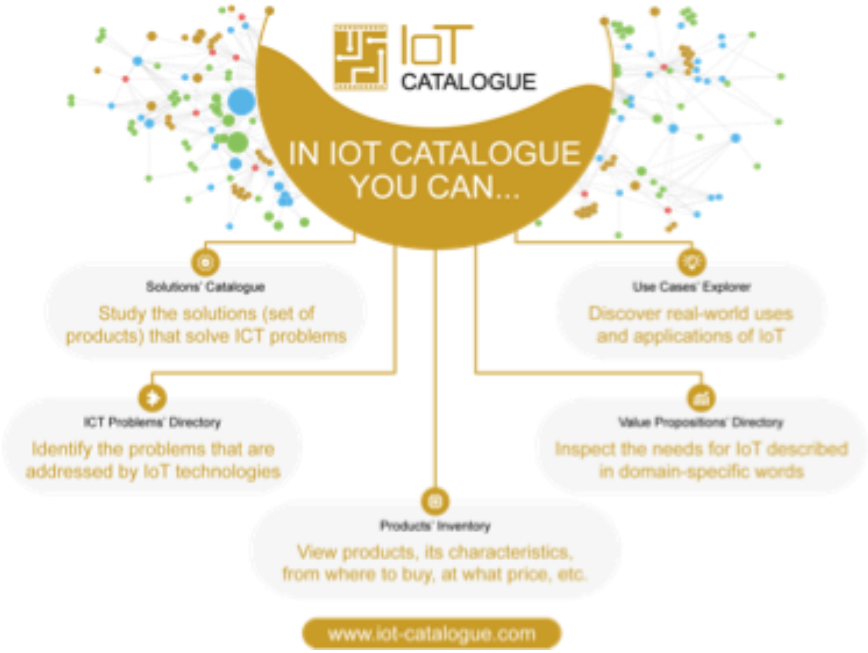

Figure 11 - IoT-Catalogue.com overview

4.2.1 FACTLOG @ IoT-Catalogue.com

FACTLOG will have a page dedicated to the project, in order to show its results on IoT-Catalogue.com.

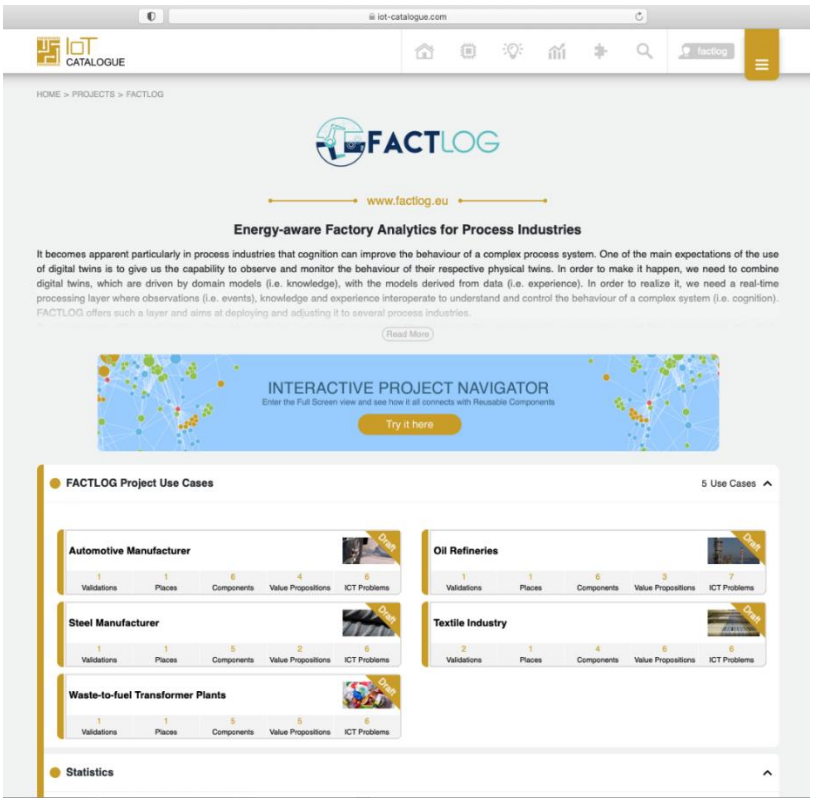

Figure 12 - FACTLOG page on IoT-Catalogue.com

On the FACTLOG page on IoT-Catalogue.com, you will have several sections, such as:

- A small description of the project;
- the project's Use Cases, such as, Automotive Manufacturer, Oil Refineries, Steel Manufacturer, Textile Industry and Waste-to-fuel Transformer Plants;
- the statistics;
- the team, composed of 20 project partners;
- and the components used in use cases and these components are reusable.

At the moment, the FACTLOG information is not yet publicly available but during the next few months the information will be updated and validated by the consortium, so that everything can be made public.

5 Conclusion

This deliverable is the first of a set of 2 deliverables and is a report on the result of task 8.4, with respect to the training and educational materials designed both from industrial and academic partners.

In this document describes the material that is already available and the material that is planned to be made. All the material that was developed and that will be developed in the future will be available on the project website, so that it is accessible to everyone.

The pilots developed workshops and are briefly described in the document. The main focus of the workshops was to evaluate the intermediate version of the systems (platform, services and User Interface), and that as additional factor they were used to train people / create a first contact with the platform.

In the document reports the SPIRE-06 that was created by FACTLOG together with CAPRI, COGNIPLANT, COGNITWIN, HyperCOG and INEVITABLE. "SPIRE-06” is (presently) an informal discussion group of the projects funded under the H2020 DT-SPIRE-06-2019 topic focusing on digital technologies for improved performance in cognitive production plants. The group is exploring ways in which the projects can collaborate, share information, and organise joint activities that are of mutual interest and for the community of interest/practice on cognitive production plants. This last chapter also addresses the liaison made between the project and IoT-Catalogue.com, where the site will have a page dedicated to FACTLOG.

In the next period it is intended to execute the training materials that are planned to be made and, if it is possible to produce more materials, to complete the base knowledge on the FACTLOG website, so that more information about the project can be shared. It is intended to organize training activities and continue with the activities of the SPIRE-06 Cluster with the projects that are part of it.