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## DELIVERABLE

### D5.9 – Workers’ Training Platform-Initial version

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## Executive Summary

This deliverable represents the initial version of the Worker's Training Platform (WTP) of the STAR project. In this document we have tried to summarize the idea we have for an anonymous, privacy-centric WTP, showing a series of scenarios and requirements. From these, we have designed the architecture and shown the actual development and integration. Finally, this document encompasses a series of activities that we are conducting in the task associated with this deliverable, some of which will be integrated into the platform and shown in the demonstration activities related to the final version of the platform in deliverable D5.10.

The platform is intended to help interested workers to identify their training needs while offering them training recommendations in the form of project assets and solutions, along with external resources such as scientific articles and courses.

This WTP is based on public databases of occupations on which a series of functions have been implemented for analysing, searching, and comparing content. One of the key points of the platform is that it can be integrated into some of the use cases of the project, for this reason, the initial integration conducted with the Human Digital Twin developed by SUPSI is also detailed.

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## Definitions, Acronyms and Abbreviations

Acronym/ Abbreviation	Title
<b>AI</b>	Artificial Intelligence
<b>API</b>	Application Programming Interface
<b>AWS</b>	Amazon Web Services
<b>BLS</b>	Bureau of Labor Statistics
<b>CMS</b>	Content Management System
<b>CV</b>	Curriculum Vitae
<b>ESCO</b>	European Skills, Competences, and Occupations
<b>HDT</b>	Human Digital Twin
<b>HR</b>	Human Resources
<b>HTTPS</b>	Hypertext Transfer Protocol Secure
<b>IaaS</b>	Infrastructure as a Service
<b>ICT</b>	Internet and Communication Technology
<b>IT</b>	Information Technology
<b>JSON</b>	JavaScript Object Notation
<b>MVP</b>	Minimum Viable Product
<b>NLP</b>	Natural Language Processing
<b>OECD</b>	Organization for Economic Cooperation and Development
<b>ORM</b>	Object Relational Mapping
<b>OS</b>	Operating System
<b>REST</b>	REpresentational State Transfer
<b>SME</b>	Small Medium Enterprise
<b>STAR</b>	Safe and Trusted Human Centric Artificial Intelligence in Future Manufacturing Lines
<b>STEM</b>	Science Technology Engineering and Mathematics
<b>UI</b>	User Interface
<b>UML</b>	Unified Modelling Language
<b>VPS</b>	Virtual private server
<b>WP</b>	Work Package
<b>WTP</b>	Workers’ Training Platform

# 1 Introduction

## 1.1 Scope and objectives

The use of IA in manufacturing requires not only appropriate tools and innovative ideas, such as those being studied and developed in the project, but it also requires making available to workers and even managers knowledge about the entire ecosystem related to AI and IT technologies, such as security, privacy, or robotics.

For the employee to be able to apply these technologies, it is also necessary to know how occupations evolve and to be able to assess and decide where she/he wants to go and how she/he wants to train herself/himself.

Based on these two ideas, the task "*T5.5 Workers' Training and Continuous Learning*" was born.

In it we had three objectives: First, to create a workers' training and continuous learning system (WTP), which would allow workers to assess their current skills and detect training needs, for their current occupation or even for similar occupations that SMEs are starting to need. Second, to link to training materials in multi-media format, including video, images, animations, and presentations generated in the project, training catalogues provided by partners, or even external scientific recommendations. Third, encourage in some way that workers and managers interested in IA in the manufacturing sector can access some tools, simulation environments, or simply informative profiles of several innovations generated in the STAR[REF-01] project.

In this deliverable, we summarize the work related to the first phase of this task. And we present deliverable "*D5.9 – Workers' Training Platform-Initial version*", which has as main objective to detail the platform in which workers can self-evaluate themselves and get recommendations.

Specifically in this first phase we have focused on that, on the backend for self-assessment and recommendations. In the second phase, in addition to the extension of those developed in this first phase, we will focus more on integrating the contents and deciding the best way to position and publish them. For example, prioritizing those contents and tools are published in the marketplace and the WTP is an access point to this repository.

### 1.1.1 Why a WTP?

The importance of continuous employee learning and the provision of training opportunities on demand are key aspects of many HR programs in both SMEs and large companies.

On the other hand, the IT world is a rapidly changing world, with new occupations and new requirements in terms of skills, knowledge, or tool usage.

As IT experts ourselves, we had a couple of questions from the very beginning, for example: What are the most common skills and knowledge for my occupation? How do my skills compare to other people in the industry? Would it benefit me to boost a skill I do not have? Where can I start to learn about that skill?

To these we must also add questions related to new emerging occupations or even career changes. For example, if I compare my skills as an embedded systems engineer with those of

a robotics researcher, will I be able to detect how far off I am in case my company offers that position or even if I want to orient my career towards that position?

We believe that these questions can be answered by means of questionnaires and by analysing the results with respect to various publicly available occupation databases. Therefore, the idea of a WTP for any sector seemed relevant to us, and even more so for projects like STAR related to innovations in the manufacturing sector.

## 1.2 Outline

The deliverable is divided as follows: first we introduce the topic and present the reasoning behind the WTP. After that, in Section 2 we provide information relative to the scenarios and requirements. In section 3 the architecture and the design of the system together all the effort related to the implementation and integration is presented. Finally, we draw the conclusion and present a series of ongoing activities towards the definitive version of the Workers' Training Platform.

## 2 Data sources, scenarios, and requirements

In this section, we want to introduce some of the ideas and data sources that have guided us during the design and implementation of the platform for workers’ needs assessments and recommendations for training and knowledge seeking. We will start by briefly detailing some scenarios, move on to an initial list of requirements and finally detail the data sources we are using.

### 2.1 Scenarios

Scenarios are an exceptional tool to start defining the specification of the solution. They are easily understandable; they reflect the user perspective and interaction, and they provide details that help in the definition of the functional requirements and even in the design of the interfaces.

Scenarios serve as a description of the activities the system does, describing the proposed use of the solution, normally from an outside perspective (e.g., the user).

There are several ways to get these scenarios, e.g.: via interviews and workshops, brainstorming or discussion sessions, etc. and several ways to represent them, from the less formal cartoons or animations to UML models.

In our approach, the scenario definition for this solution is based on internal discussions conducted during the design and elaboration of a human resources plan that we are trying to implement in R2M Solution, studies on public occupation databases and ideas based on discussions with in-house academic members and collaborators about how to process the data and generate relevant recommendations.

Our preferred way of displaying and recording scenarios is by means of storyboards and tables with the sequence of actions. This allows us to have a visual aid to contextualise the solution while allowing us to go deeper. For that reason, we will start by showing the storyboards of the main scenarios and we will continue detailing these scenarios in a table format.

The main scenarios we are going to detail are:

- The worker self-evaluates her/his skills and knowledge
- The worker gets training recommendations based on her/his occupation and skills
- The worker is linked to STAR related training assets, gets information about STAR results and simulation systems
- The worker investigates which roles best fit her/his knowledge

Table 1: Scenario #1

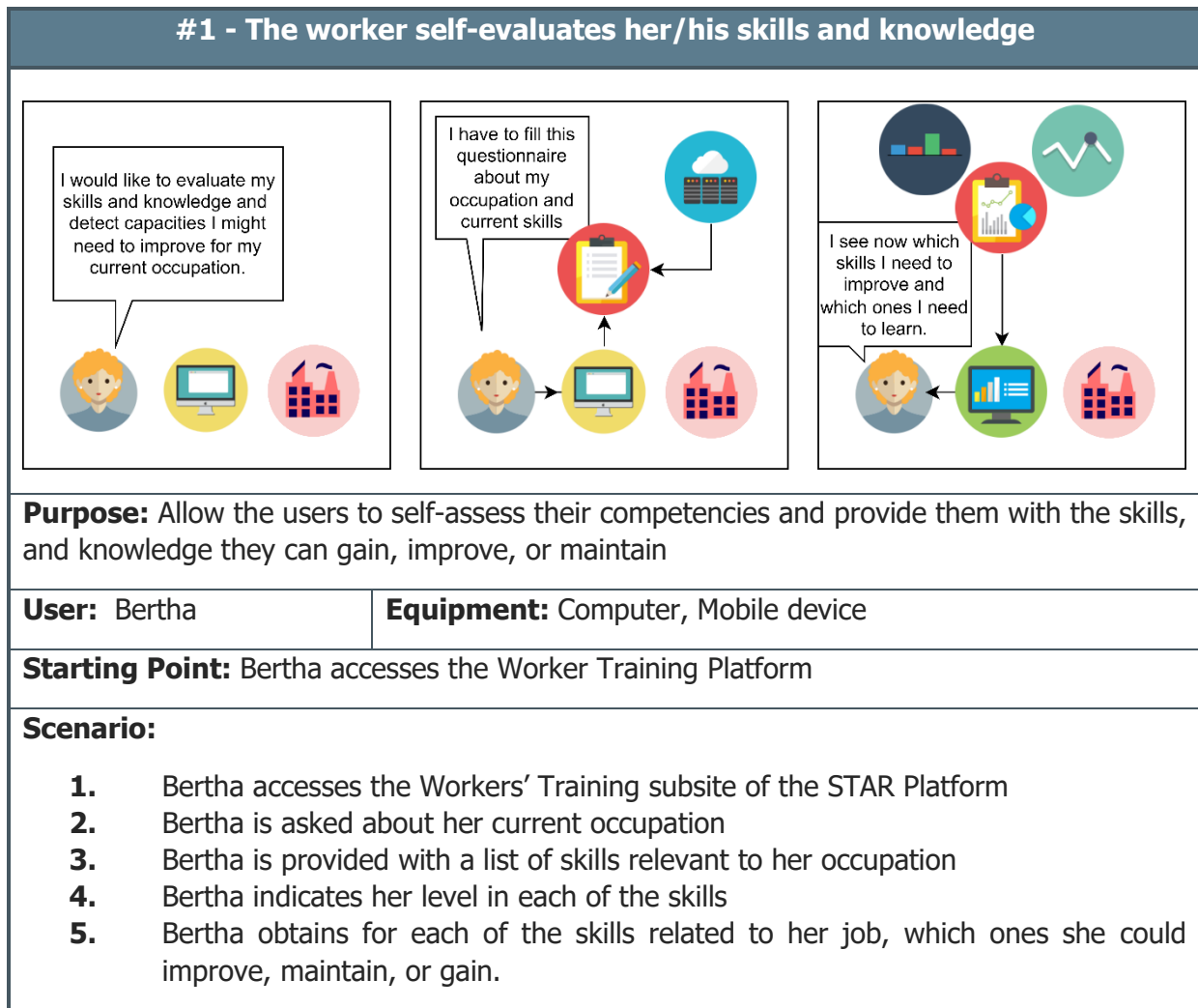
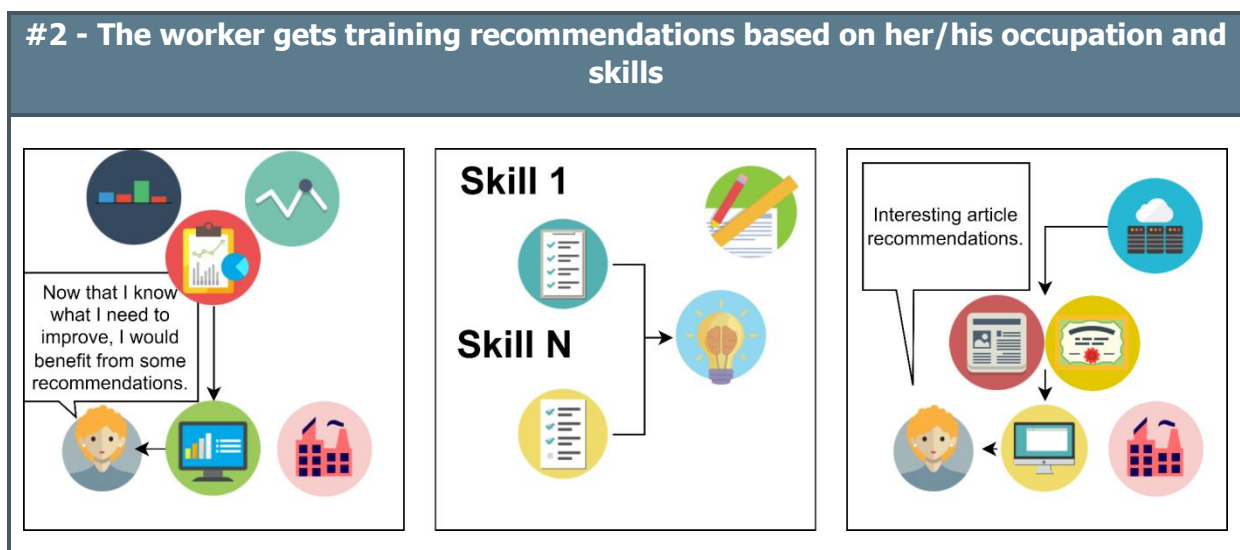
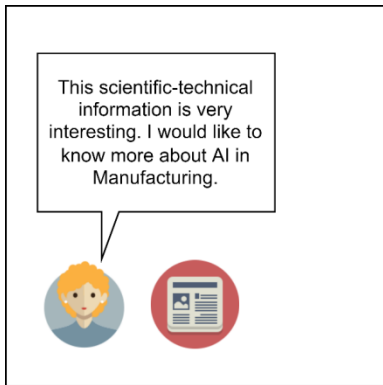
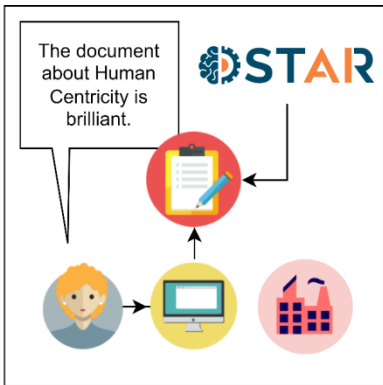
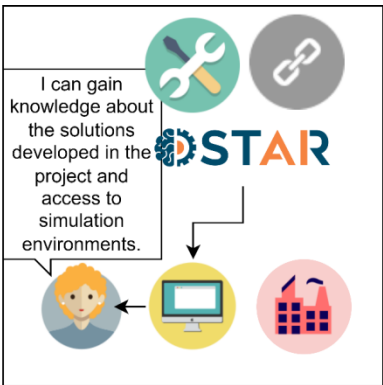


Table 2: Scenario #2



<b>Purpose:</b> Provide users with certain relevant information related to the topics they need to improve or learn.	
<b>User:</b> Bertha	<b>Equipment:</b> Computer, Mobile device
<b>Starting Point:</b> Bertha has done a self-assessment and already knows what skills she needs to improve and what knowledge she should gain.	
<b>Scenario:</b>	
<ol style="list-style-type: none"> <li>1. Bertha performs a self-assessment and obtains information about her state of knowledge in relation to the work she performs.</li> <li>2. Bertha sees that there are a few topics and skills that she needs to improve.</li> <li>3. Bertha selects one or more of these skills</li> <li>4. The system offers her a series of recommendations in the form of literature.</li> <li>5. Bertha takes note of several of the suggestions on the list for further reading.</li> </ol>	

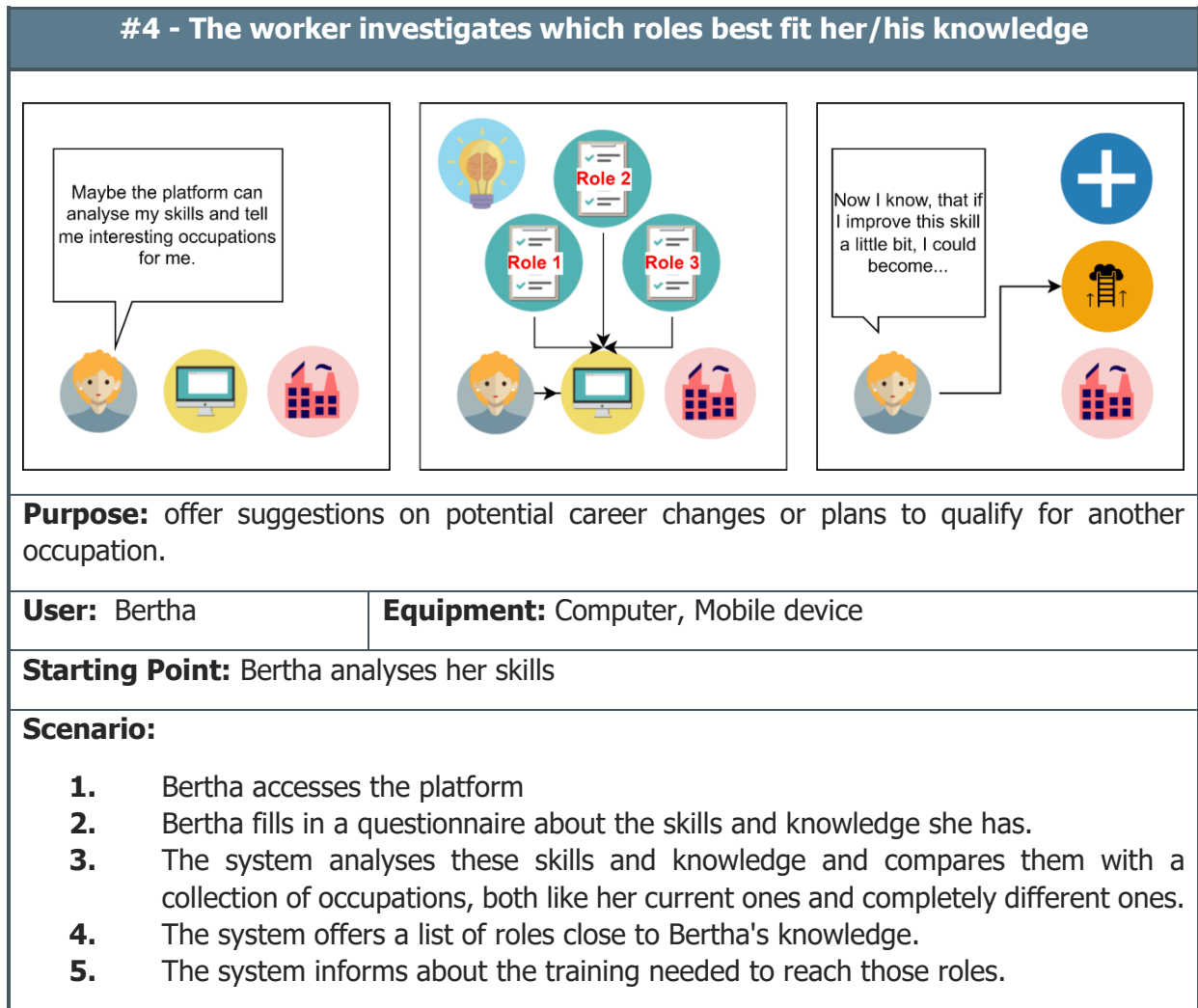
Table 3: Scenario #3

<b>#3 - The worker is linked to STAR related training assets, gets information about STAR results and simulation systems</b>		
		
<b>Purpose:</b> To provide users with assets and materials generated in the project, which can be used to improve their knowledge in the main topics of STAR, such as manufacturing, security, and artificial intelligence.		
<b>User:</b> Bertha	<b>Equipment:</b> Computer, Mobile device	
<b>Starting Point:</b> Bertha believes she could use knowledge related to AI in Manufacturing and accesses STAR to obtain this information.		
<b>Scenario:</b>		
<ol style="list-style-type: none"> <li>1. Bertha enters the Workers’ Training Platform and gets some training suggestions, some of these references are project materials.</li> <li>2. Bertha accesses the blog posts, books, and various documents and articles generated in the project.</li> <li>3. Bertha discovers that several of the project solutions have an informative page with the profile of these solutions and that some of them link directly to tools or</li> </ol>		

solutions developed by project partners that she can download or simulations that she can observe.

4. Bertha studies one of them as it may be of interest to her and to implement it in the company where she works.

Table 4: Scenario #4



## 2.2 Requirements

In certain cases, especially in complex applications, more formalisations may be necessary (e.g., by means of UML use case diagrams and the like). In this case, being a living innovative solution, with the information obtained from the scenarios we can proceed directly to the elicitation and discussion of the requirements.

Starting from the description of the task in the Grant Agreement and the general idea shown in the scenarios, in this section we are going to detail a series of functional and non-functional requirements. Regarding the elicitation of requirements, there are two main views, the more formalist one that tries to make the requirements clear from the beginning, and the more agile one that considers that the requirements are dynamic and must evolve and be discovered.

We understand both opinions, so we try to follow a mixed methodology, in which we try to list at least a series of general requirements, using a simplification of Volere[REF-02] snow cards, that we will later refine and extend in each of the interactions in which we define the work items of the Kanban Board.

### 2.2.1 Roles

In the platform we can differentiate one key role, called Bertha in the scenarios. Even though the role is represented by an individual name it represents any member of group of individuals.

- **Bertha:** Workers, Operators (sometimes called shopfloor workers, or shopfloor operators). In the context of STAR Bertha works in the manufacturing industry, but in general terms, Bertha’s role represents any worker, or any person interested in discovering skills gaps or interested in getting some understanding about AI in manufacturing.

It is important to note that initially the application is oriented primarily to the workers, therefore the data will not be presented to those responsible for them, for this reason, there is no role related to the human resources of the company.

It is also important to note that while the Workers’ Training Platform offers an API for integration with STAR modules or other tools, integration roles are not listed here.

### 2.2.2 Functional Requirements

The next tables show the initial list of the functional requirements. Each requirement provides a small description and the rationale for the requirements. The priority and the acceptance criteria are also indicated.

*Table 5: Functional requirement #1*

#F1 - Self-assess worker skills	
<b>Description:</b> The solution should allow the user to assess themselves on the skills and knowledge related to their occupation.	
<b>Rationale:</b> The main objective of the platform is that the user is presented with a set of knowledge, skills or activities related to their work and can self-assess themselves. This information will be processed by an engine in the backend to provide useful information to the user.	
<b>Priority:</b> 1	<b>Conflict:</b> -
<b>Acceptance criteria:</b> The user can select an occupation, obtain the skills/knowledge related to this occupation and submit their ratings for these skills.	
<b>Notes:</b> The main interface for obtaining user information is through questionnaires.	

Table 6: Functional requirement #2

#F2 - Profile STAR Tools	
<b>Description:</b> The platform should present, integrate content, and provide access to simulation systems from other STAR tasks	
<b>Rationale:</b> As part of WP5 of the project, several ideas and solutions will be developed. Some of them may be interesting for future implementation in workplaces. Therefore, it would be interesting for each of these solutions to have a page or profile on the platform: informing about the idea, the contact person and showing images, videos, or documents about the solution. If the solution is downloadable (e.g., in a virtual machine), deployable in the cloud, or its code is available to build it, the profile page should provide access or links to these.	
<b>Priority:</b> 2	<b>Conflict:</b> -
<b>Acceptance criteria:</b> There are profile pages on the platform showing WP5 developments.	
<b>Notes:</b> It may be of interest that the profiles we develop can be compatible with the main platform of the project or even eventually be transferred there.	

Table 7: Functional requirement #3

#F3 - Compare workers skills	
<b>Description:</b> The solution must have an engine to compare the data sent by the user with a baseline for their occupation.	
<b>Rationale:</b> It is necessary to have an engine that processes the data entered by the user and compares them against references for that occupation stored in the database.	
<b>Priority:</b> 1	<b>Conflict:</b> -
<b>Acceptance criteria:</b> The engine can receive user data and compare it with the reference in the database.	
<b>Notes:</b> -	

Table 8: Functional requirement #4

#F4 - Recommended actions and plans	
<b>Description:</b> The platform should recommend actions, plans to improve skills, and knowledge.	
<b>Rationale:</b> As a result of the user's self-assessment of skills and knowledge, it is necessary to inform the user about which skills and knowledge they should keep, which they should improve and which of them, which they currently do not have, would be interesting for their current occupation.	
<b>Priority:</b> 2	<b>Conflict:</b> -

<p><b>Acceptance criteria:</b> As a result of the assessment, the worker is presented, for each skill, what needs he/she has in each skill.</p>
<p><b>Notes:</b> -</p>

Table 9: Functional requirement #5

#F5 - External learning materials	
<p><b>Description:</b> The platform should suggest materials and programs related to skills.</p>	
<p><b>Rationale:</b> It would be interesting if the system could recommend some readings related to the skills, knowledge, and technologies that the user needs to improve. In the absence of better databases, databases of scientific articles could be used, on which to search for relevant terms, evaluate the citations/recommendations and present a top five of relevant articles.</p>	
<p><b>Priority:</b> 2</p>	<p><b>Conflict:</b> -</p>
<p><b>Acceptance criteria:</b> The user is provided with a list of reading materials related to the skills they need to improve.</p>	
<p><b>Notes:</b> -</p>	

Table 10: Functional requirement #6

#F6 - STAR Related learning materials and assets	
<p><b>Description:</b> The platform should suggest materials and assets created in STAR</p>	
<p><b>Rationale:</b> The project has authored a book, published several articles and dozens of technical posts. WP5 will also create specific documentation on certain topics of interest for AI in manufacturing, such as Human Centricity. It is interesting that these articles also appear in the recommendations.</p>	
<p><b>Priority:</b> 2</p>	<p><b>Conflict:</b> -</p>
<p><b>Acceptance criteria:</b> The user is provided with a list of reading materials related to the skills they need to improve. Some of these materials are materials developed as part of the STAR project</p>	
<p><b>Notes:</b> Some of these materials will be part of the materials to be produced in WP7 and included in the main project platform, and vice versa. Some of the materials developed ad-hoc for the WP5 task, in which the Workers’ Training Platform is included, can be transferred to the global platform.</p>	

Table 11: Functional requirement #7

#F7 - Integration API
<p><b>Description:</b> The platform must have an API for integration.</p>

<b>Rationale:</b> The most critical part of the Workers’ Training Platform is the backend that collects the data and performs the analysis; thus, a frontend application is not strictly needed. However, some functionalities of WTP may be useful for other project's applications (e.g., the Human Digital Twin GUI collecting workers' static data, or the project's CMS publishing the WTP content as a series of specific pages). For these reasons, it is important to provide an API rest for the integration of at least the part related to the analysis and recommendations.	
<b>Priority:</b> 1	<b>Conflict:</b> -
<b>Acceptance criteria:</b> A REST API is available.	
<b>Notes:</b> Is worth providing support for OpenAPI and JSON Schema to simplify the integration.	

Table 12: Functional requirement #8

#F8 - User Interface	
<b>Description:</b> The solution should provide a User Interface to facilitate the interaction with the operators.	
<b>Rationale:</b> The solution would benefit from offering an intuitive and simple interface so that the user can self-assess and obtain the results.	
<b>Priority:</b> 3	<b>Conflict:</b> #F7 (Low impact) As mentioned in the #F7 the user interface might be finally included in the project platform or one of the tools.
<b>Acceptance criteria:</b> There is a user interface, and it is accessible to workers.	
<b>Notes:</b> For cohesion and homogeneity the UI of the solution could eventually be integrated as part of the main project platform. For this reason, it is of interest to keep the look and feel of the main platform.	

Table 13: Functional requirement #9

#F9 - Career Suggestions	
<b>Description:</b> The solution could offer recommendations related to changes of position	
<b>Rationale:</b> Once the user has submitted data related to his or her skills and knowledge, the system could try to search for a few relevant jobs related to the user's skills.	
<b>Priority:</b> 3	<b>Conflict:</b> -
<b>Acceptance criteria:</b> The user is offered an ordered list of five relevant roles, occupations, or jobs.	
<b>Notes:</b> -	

Table 14: Functional requirement #10

#F10 - Visual Results	
<b>Description:</b> The solution could deliver results in visual form.	
<b>Rationale:</b> Sometimes it can be interesting for the user to receive the information in a slightly more visual format. For that reason, it can be worth to present radar charts and other similar graphics.	
<b>Priority:</b> 4	<b>Conflict:</b> -
<b>Acceptance criteria:</b> The user is offered various graphs related to their skills and how far or close they are to the baseline.	
<b>Notes:</b> Depending on the final form of the UI, it could be interesting to generate a PDF document with the visual summary of the information.	

Table 15: Functional requirement #11

#F11 - Public Data Sources	
<b>Description:</b> The system engine must be based on public information.	
<b>Rationale:</b> There are several widely used and well-known databases such as ESCO and O*NET. For the credibility of the results, it is interesting that the system is based on one or both. There is also Open Data from the OECD and from various workers' offices, which can allow us to complete the data.	
<b>Priority:</b> 1	<b>Conflict:</b> -
<b>Acceptance criteria:</b> The engine relies on Open Data or in well-known public databases.	
<b>Notes:</b>	

### 2.2.3 Non-Functional

Apart from the functional requirements, there are a few non-functional requirements we must consider from the very beginning of the product development. These requirements are detailed in the tables below.

Table 16: Non-functional requirement #1

#NF1 - Secure API	
<b>Description:</b> APIs must support HTTPS and require authentication.	
<b>Rationale:</b> While the platform does not have high security requirements, it is important that at least the traffic is encrypted, and the use of the API is controlled by at least basic authentication.	
<b>Priority:</b> 2	<b>Conflict:</b> -

<b>Acceptance criteria:</b> HTTPS and authentication support.
<b>Notes:</b>

Table 17: Non-functional requirement #2

#NF2 - Privacy first	
<b>Description:</b> The solution should take care of the privacy of the workers	
<b>Rationale:</b> The platform is using personal data about the knowledge of the workers. To avoid privacy problems or this data being used to profile workers, the project's worker training platform should not require authentication, or at least authentication that can relate the platform user to the worker. In addition, the data of the workers or the self-assessment will not be saved.	
<b>Priority:</b> 2	<b>Conflict:</b> -
<b>Acceptance criteria:</b> The self-assessment data is not saved in the database of the working training platform.	
<b>Notes:</b> In the case of third-party integration, where the Workers’ Training Platform is only the calculation and recommendation engine, we can guarantee privacy within the training platform, but not in third-party applications, since these are the ones that collect the data.	

Table 18: Non-functional requirement #3

#NF3 - Multiplatform, multi device	
<b>Description:</b> The solution should be universal and depend as little as possible on the device.	
<b>Rationale:</b> The REST API already offers a certain universality. In the case of the user UI, it is necessary that this can be used from computers or mobile devices.	
<b>Priority:</b> 3	<b>Conflict:</b> -
<b>Acceptance criteria:</b> The solution works on mobiles, tablets, and computers.	
<b>Notes:</b> -	

Table 19: Non-functional requirement #4

#NF4 - Containerised and deployable anywhere	
<b>Description:</b> The platform should be containerized and facilitate deployment and integration.	
<b>Rationale:</b> With the objective that the platform does not depend on third-party cloud services and that at the same time integration with the main platform of the project is facilitated, it is interesting that Docker and Docker-compose be supported as means of composing and containerizing the platform.	

<b>Priority:</b> 3	<b>Conflict:</b> -
<b>Acceptance criteria:</b> Dockerfiles are available, and the solution runs on top of docker.	
<b>Notes:</b> -	

## 2.3 Data sources

As we have mentioned before, we rely on public data and open data for the analysis of the data sent by the workers and for the recommendations.

The main data sources are the ESCO[REF-04] and O\*NET[REF-03] databases of skills and competencies. In some cases, the information in these databases is supplemented with information from other public databases, such as the OECD Data or some tables and results from the U.S. Labor Office. Below we present a summary of each of them.

### 2.3.1 O\*NET

O\*NET, Occupational Information Network (O\*NET), (<https://www.onetcenter.org/>) is a program of the U.S. Department of Labor/Employment and Training Administration through a grant to the North Carolina Department of Commerce, addressed to understanding the work and the workforce in the United States.

Among other tools, O\*NET offers a taxonomy that currently includes 900+ occupations, together with a list of knowledge, skills and abilities related to the occupation and the activities and tasks performed by the workers.

In addition to a series of data consultation services, O\*NET also offers the database with all the information, which can be used for the development of new applications that can help workers understand the needs of their jobs, or students or job seekers to learn more about the characteristics of the job to which they aspire.

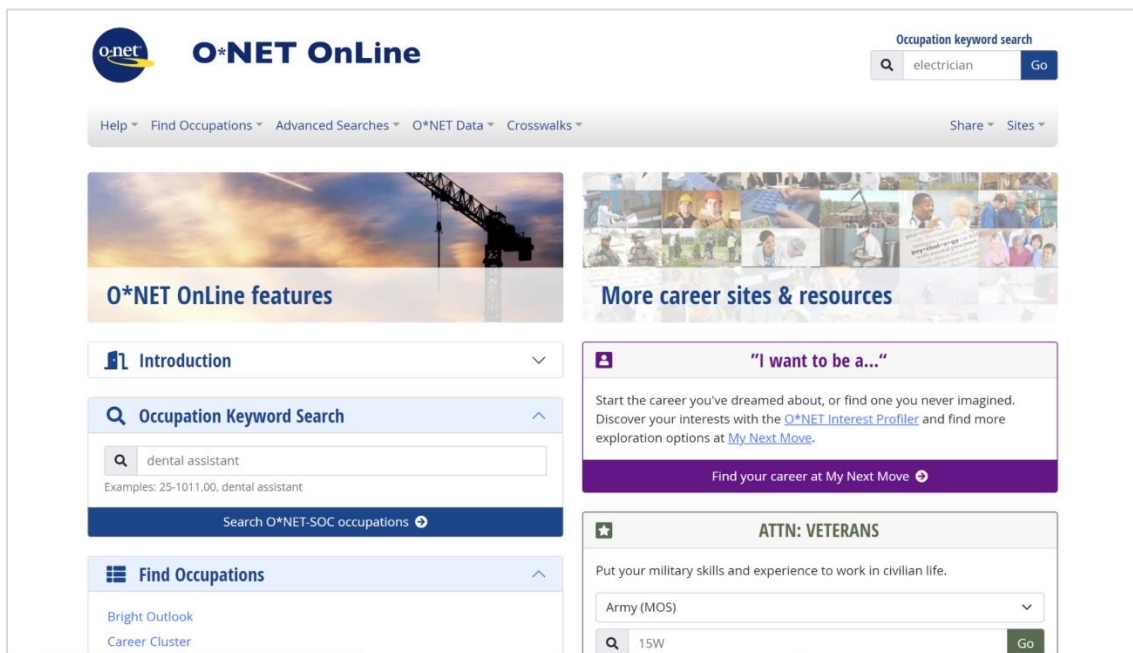


Figure 1: O\*NET website

### 2.3.2 ESCO

ESCO (European Skills, Competences, Qualifications and Occupations) is presented as the European multilingual classification of Skills, Competences and Occupations. (<https://esco.ec.europa.eu/>). It can be considered as a dictionary and classification of occupations and skills relevant for the EU labor market, education, and training. ESCO includes information, translated into 27 languages, about 3000+ occupations and 13000+ skills linked to the occupations.

ESCO also offers a series of endpoints that can be called from the applications and the possibility of downloading the datasets to be integrated into new applications.

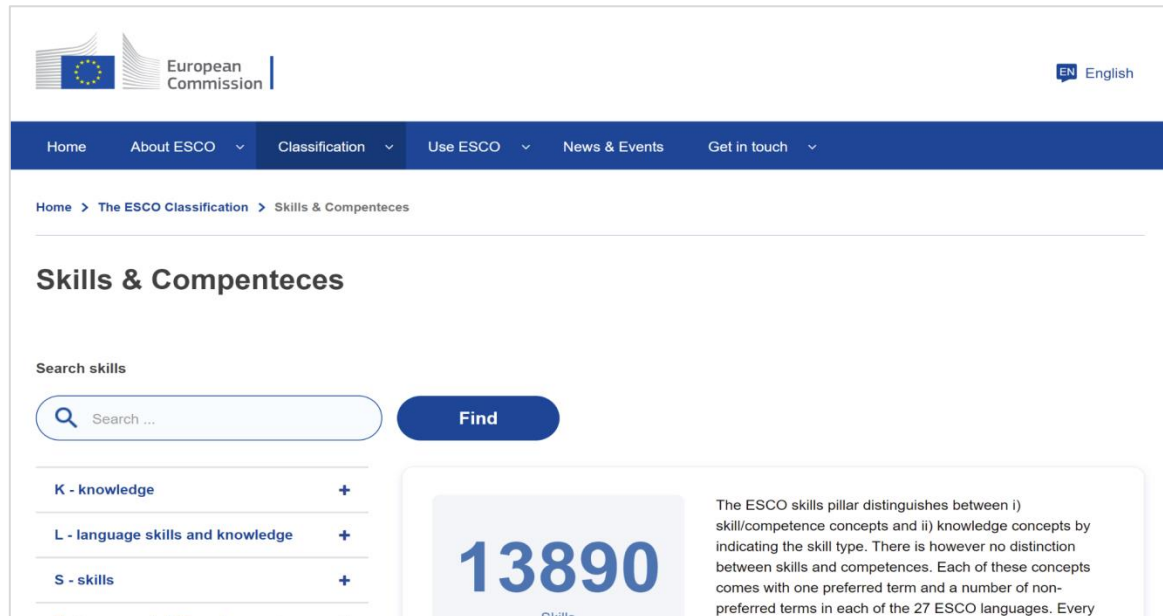


Figure 2: ESCO website

### 2.3.3 U.S. BUREAU OF LABOR STATISTICS

U.S Bureau of Labor Statistics (BLS)[REF-05] is presented as an organisation that “*measures labor market activity, working conditions, price changes, and productivity in the U.S. economy*”. (<https://www.bls.gov/>)

Among its statistics, we find relevant information for the project such as "Occupation requirements", "Worker characteristics" or "Work experience over time". Information regarding age classifications by occupation is also useful as it can help workers better understand their occupation or even consider training to reach other positions.

BLS information can be consulted online in diverse ways and its tables, many of them classified by year, can be downloaded, and processed offline.

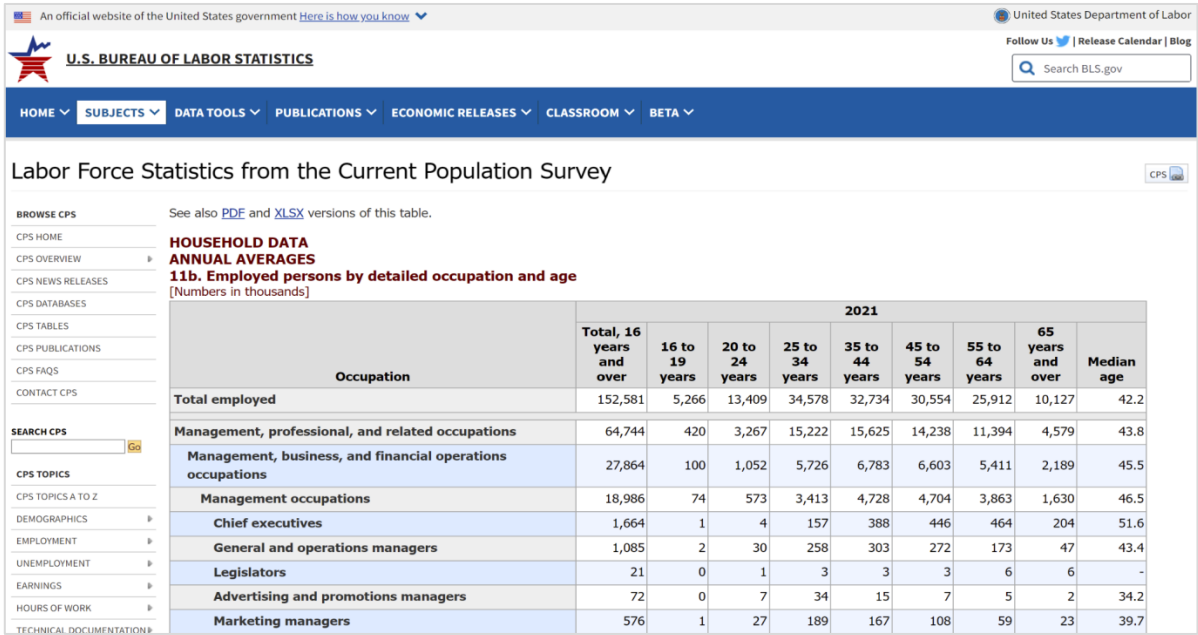


Figure 3: US BLS website

### 2.3.4 OECD

The Organization for Economic Co-operation and Development[REF-06], through its data portal (<https://data.oecd.org/>), also offers several tables and groups of data of interest to consider for the elaboration of applications aimed at improving the knowledge of workers. Data on employment and its differences by country are some of the information that can be useful for the platform.

As in the previous cases, an API is provided and the possibility of consulting and downloading the data.

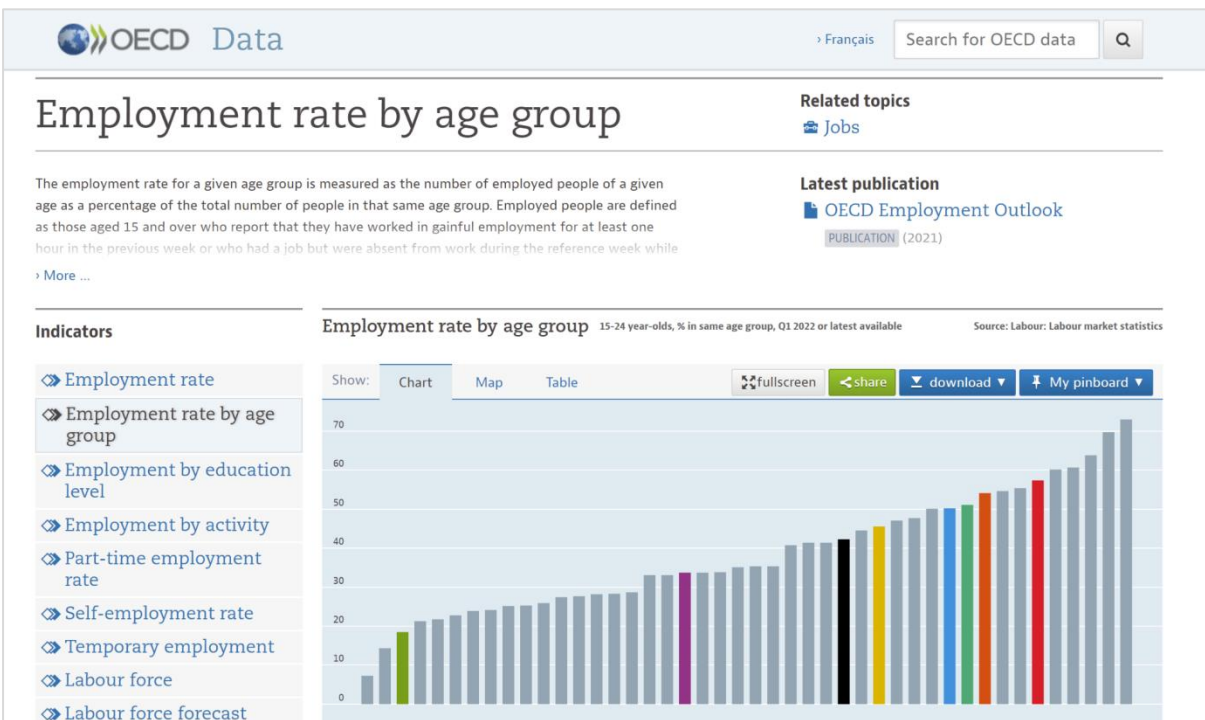


Figure 4: OECD Data website

### 3 Architecture and technologies

In this section, we will first detail the components of the high-level architecture so we can describe later components and the technologies involved.

The following image shows the high-level modular architecture of the solution. The picture shows three different blocks:

- **UI:** This part of the architecture is focused on the field user’s side, and includes the part related to the STAR platform and the Workers’ Training Platform UI
- **Backend:** This part targets the main application logic and the link with the occupation and competences database
- **Integration:** This section includes the integration and interfaces with the STAR Human Digital Twin and potentially with other project tools and services

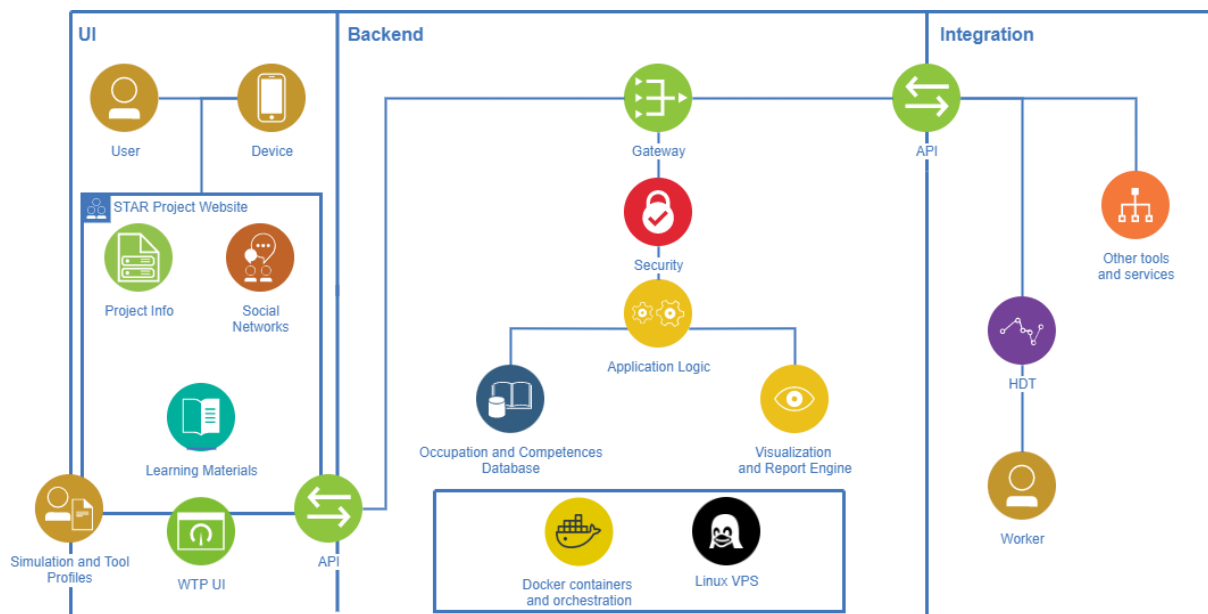


Figure 5: WTP high-level architecture

In detail these are the high-level components:

- **UI**
  - **STAR project website and project learning materials:** This element represents the main website of the project, along with all its content and social capabilities. As mentioned above, WP7 of the project will elaborate project assets and materials, to which will be added some materials related to the tools developed in WP5 and some specific training documents. While these assets can be part of the Workers’ Training Platform UI content, it makes sense to include them in the main platform of the project, making them easily accessible to the interested public.
  - **WTP UI:** It represents the main user interface of the worker's training platform. In this interface, the questionnaires will be presented to the workers, and they will be able to receive recommendations and suggestions. This component will be implemented on a responsive layout so that it can be browsed from any type of device. It will also follow a clean and easily integrable

design, so that it can be integrated in a uniform and coherent way with the public platform of the project.

- **Simulation and Tool Profiles:** One of the objectives is to facilitate access and integrate different applications and simulation systems developed in the project into the ecosystem of the worker's training platform. Given that different companies develop the systems, some are specific to these companies, require specific authorisation or not all the solutions are downloadable or executable on a virtual machine or docker container, we have decided that the easiest way to integrate them in the same web space is by means of profile pages. In them, we will show the information of the applications, a series of images and/or documents, a contact person, and a pointer to the official page of the project partner and their solution where the visitors can download or request access to it.
- **Backend**
  - **API:** We want our solution to work in isolation but also to be easily integrated into the main Content Management System of the project, in the pilots or even as an extension for some of the applications that are being developed. For this reason, we have developed a REST API, which allows among other things the query and search of occupations, receive the necessary information to generate questionnaires, receive the values of these and even get recommendations of similar occupations. This API is being extended to offer more recommendations, such as articles or study materials.
  - **Gateway:** This component offers a high performance and robust access point to the application logic. It includes the web server, the web server gateway interface, and the framework for the development of the specific API code.
  - **Security:** From the beginning, we have considered that a large part of the logic of the solution must be in the cloud to allow integration and scalability. For this reason, it is essential to provide an API for access to this logic. This API will use encrypted traffic, password-controlled access and will potentially action accountability to reduce potential security issues.
  - **Application Logic:** This element is the core of the application. It oversees the processing of the information coming from the workers, it deals with consulting the database and with performing the calculations to detect the training needs. This element also includes the engine for the recommendation of articles.
  - **Occupation and Competences Database:** This element represents the data persistence and the content of the data sources adapted to the needs of the project. It is not intended to store user or questionnaire data, so the writing part is not critical. In addition to the data source data, information related to the training assets will be included, including pointers to their storage location.
  - **Visualisation and Report Engine:** The aim is not only to provide users with information about their lifelong learning needs, but also to offer it to them in a visual form that allows them to understand it easily. For this reason, this component is responsible for the generation of radar-type charts. It is possible that this component could be extended with a system for generating PDF reports so that the user can store the results and see their progression at different points in time.
- **Integration**

- **HDT:** During the initial period we conducted a test integration with the Human Digital Twin, as training needs analysis can be an interesting extension to a system that monitors various aspects of employee well-being. This element represents this integration and its future added functions such as recommendations.
- **Other tools and services:** In addition to the interface with the UIs and the HDT. The Workers' Training Platform can be integrated into other pilots or HR tools. For example, we are considering the possibility that in a future post-project, the functionality of this tool could become part of the project and people management tool that we develop and exploit commercially at R2M. This element represents these integrations.

### 3.1 Technologies

The next section provides an overview of the different technologies used in this platform. It is not intended to go into all the details but to inform about them and to specify the plan to use them.

- **Docker Containers:** We want the application to be scalable and to be able to offer different backend installation possibilities in the future (e.g., in Cloud or on-premises), that is why we are going to use Docker containers. Docker offers an OS-level virtualisation in container format that facilitates the deployment and even the testing of software applications. Finally, Docker Compose facilitates the creation and definition of multi-component systems with which we can simplify the deployment of the system or even the support of different databases.

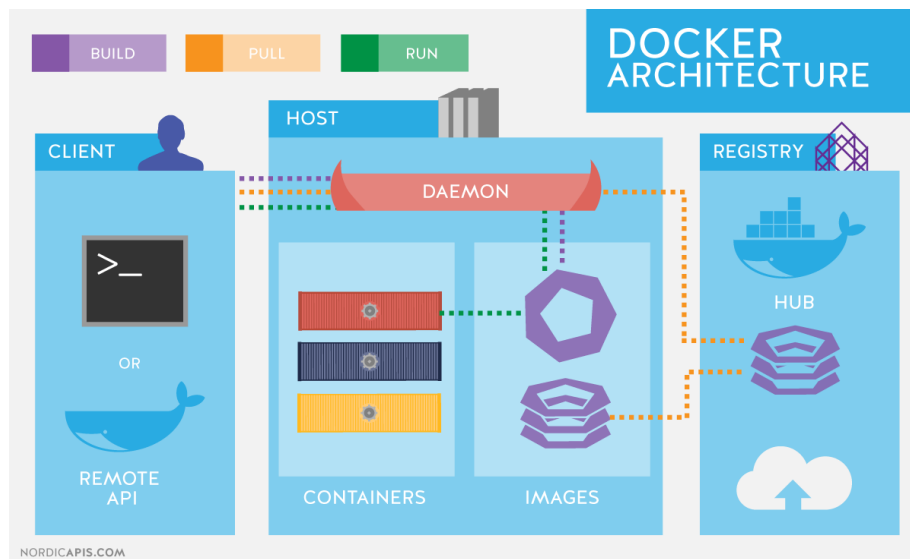


Figure 6: Docker architecture

Our goal is to create a docker image that includes the backend logic and can be deployed in as many components as necessary to support the number of users we have.

- **Linux VPS:** Also thinking about the potential deployment of the backend and Docker containers, we had thought about Debian Linux virtual private servers. These servers offer superior performance in general and can be reserved in different formats with

different capacities. We indicated VPS, as an initial idea, but own servers, dedicated cloud servers or any provider that allows the deployment of Docker containers is valid as a server. We chose Linux because of its superior performance on the server side and good integration with Docker. Initially, the cloud part of the solution will be self-hosted in one of the servers at R2M’s cloud (r2m.cloud). Thanks to containers and to the use of well-known widely tested tools, we can deploy later the operational prototype to any IaaS (Azure or AWS Cloud Computing Services) when the volume of users and scalability needs demand it.

- **Python + FastAPI + NGINX + Gunicorn:** for developing a reliable backend we need a broad selection of tools and solutions. This collection of open-source solutions and languages will allow us to develop and run the cloud backend of the application. The selection is based on previous experiences, and corresponds to mature open-source solutions, with a good community around and excellent performance.
- **Database and Storage:** as responsible for the persistence of the data. While it is true that most of the data is going to be managed by applications using our APIs, a database is needed to store all the occupations and competencies data and the other information detailed in the data sources section above. The data persistence will be done in well-known databases (PostgreSQL/MariaDB mainly) running on docker so that its ease of deployment and scalability are assured. Sensitive data, if any, will be stored in encrypted form.

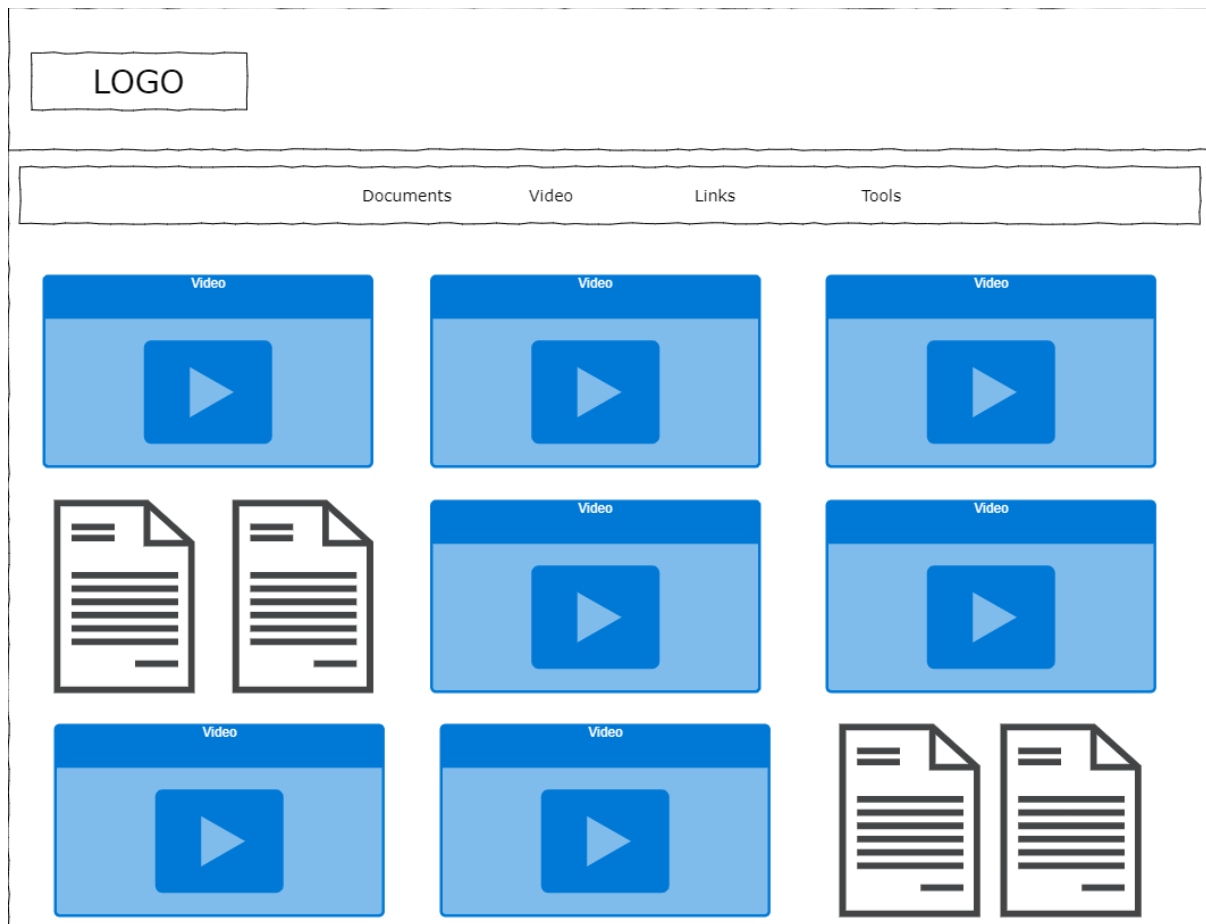
## 3.2 Design

To capture the initial ideas of user interaction, especially from a user interface, we decided to develop a series of mock-ups summarising the main concept. Although these mock-ups are subject to modification, they illustrate the 3 blocks of the platform: The knowledge repository, the information profiles and access to components and simulation systems, and the main core, the training needs assessment and recommendation of educational materials.

### 3.2.1 Document and Knowledge Repository

One of the parts of the platform is related to the search and provision of information about the project assets and training materials to be developed.

As mentioned, the idea of providing this information is also part of the overall project platform (WP7). For this reason and to avoid that the same contents are in two places and that there may be synchronization problems, that certain materials are in one platform and others in another, and to avoid confusing the user, we are discussing the possibility that the materials and assets are hosted in the CMS of the project and that the Workers’ Training Platform points to the most relevant contents within the project page. In any case, the general idea for this section is a Content Management System, which can list all the contents, filter by type and download or view them on site if possible.



*Figure 7: Document and Knowledge repository*

### 3.2.2 Simulations and Tools Profile pages

Another of the main points of the platform is to offer workers access to code, simulations or tools produced in the project, and in WP5. Given the peculiarity of these tools and simulations, they cannot all be integrated in the same way on the platform. Some offer the source code; others require specific sensors or are very oriented to be used in specific installations or only in the shopfloor of the tool creator. Finally, there are some that require contacting the developers to get some support in the installation and use. For this reason, we have opted for a more universal solution and consistent with the idea of a marketplace or showroom of the project. This solution is to create a kind of profile pages as exemplified in the following image. These profile pages will include information about the solution, contact information, description, some demo pictures and documentation, videos, and source code if any. Finally, it will include the access link to the simulation platform (in the cases in which the simulation platform is available on the Internet) or access to the download of the tool, virtual machine, or Docker image when available.

As in the previous case, if these modules are finally included in the main page of the project, they will follow a similar format to the rest of the profiles of the marketplace solutions.

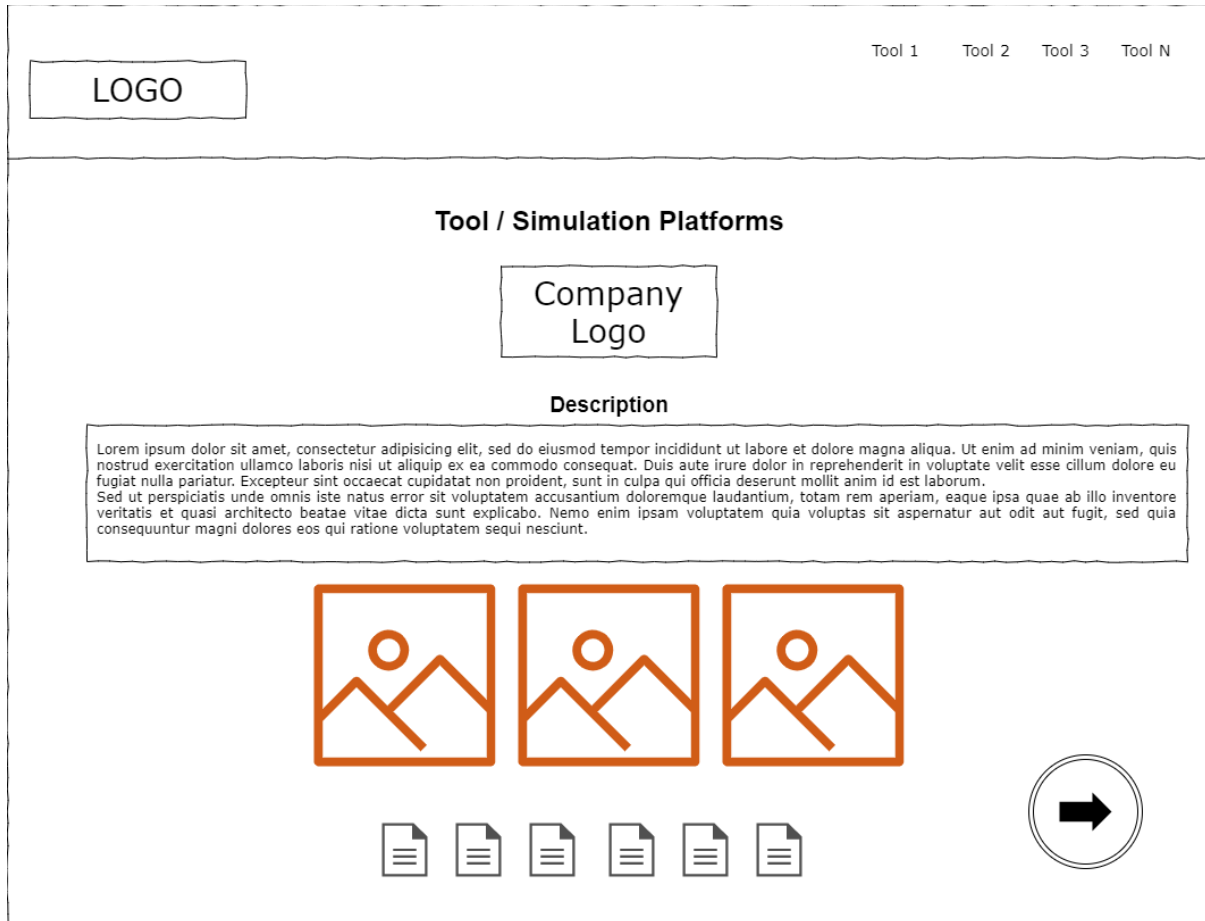


Figure 8: Simulations and tools profile pages

### 3.2.3 Skills assessment and training recommendations

The following three images show the main part of the platform, which is the one in charge of identifying training needs and offering recommendations.

The first image is related to the job search. This page includes a search engine, in which the worker can find his/her current occupation and then be evaluated according to their skills or knowledge. It should be noted that initially it has been considered not to limit the search only to technical or IA related jobs in the manufacturing sector and the search engine allows any type of worker to search for their occupation in a database of 13000+ jobs. In the final version of the application, we will consider the option of filtering it only to more technical positions, so that the recommendations will be more appropriate and in line with the topic of STAR.



*Figure 9: Occupation selection*

The following image represents the questionnaire that the user receives once the occupation has been selected. This questionnaire presents a series of skills or abilities related to the selected occupation and allows the user to select on a scale the level she or he has in that aspect. This information is then sent to the server for analysis.

LOGO

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Phasellus non sapien vestibulum, malesuada massa in, vulputate turpis. Aliquam eu mollis dolor. Vestibulum et lobortis ex. Nunc tempus nibh et orci rutrum porttitor. Phasellus justo elit, pellentesque vel maximus id, pharetra vitae turpis. Proin et vehicula quam, vulputate efficitur elit. Cras in arcu vitae ligula dapibus fermentum in eget lorem. Integer in condimentum diam, sit amet scelerisque arcu. In iaculis id eros in fringilla. Morbi porta accumsan interdum. Nunc nisi mi, vehicula id tellus sit amet, cursus porttitor orci. Quisque tellus felis, cursus id mollis quis, lacinia in arcu.

**Skill A**

Ad leggings keytar, brunch id art party dolor labore. Pitchfork yr enim lo-fi before they sold out qui. Tumblr farm-to-table bicycle rights whatever. Anim keffiyeh carles cardigan. Velit seitan mcsweeney's photo booth 3 wolf moon irure. Cosby sweater lomo jean shorts, williamsburg hoodie minim qui you probably haven't heard of them et cardigan trust fund culpa biodiesel wes anderson aesthetic. Nihil tattooed accusamus, cred irony biodiesel keffiyeh artisan ullamco consequat.

1

2

3

4

5

**Skill B**

Veniam marfa mustache skateboard, adipisicing fugiat velit pitchfork beard. Freegan beard aliqua cupidatat mcsweeney's vero. Cupidatat four loko nisi, ea helvetica nulla carles. Tattooed cosby sweater food truck, mcsweeney's quis non freegan vinyl. Lo-fi wes anderson +1 sartorial. Carles non aesthetic exercitation quis gentrify. Brooklyn adipisicing craft beer vice keytar deserunt.

1

2

3

4

5

**Skill C**

Ad leggings keytar, brunch id art party dolor labore. Pitchfork yr enim lo-fi before they sold out qui. Tumblr farm-to-table bicycle rights whatever. Anim keffiyeh carles cardigan. Velit seitan mcsweeney's photo booth 3 wolf moon irure. Cosby sweater lomo jean shorts, williamsburg hoodie minim qui you probably haven't heard of them et cardigan trust fund culpa biodiesel wes anderson aesthetic. Nihil tattooed accusamus, cred irony biodiesel keffiyeh artisan ullamco consequat.

1

2

3

4

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**Skill D**

Veniam marfa mustache skateboard, adipisicing fugiat velit pitchfork beard. Freegan beard aliqua cupidatat mcsweeney's vero. Cupidatat four loko nisi, ea helvetica nulla carles. Tattooed cosby sweater food truck, mcsweeney's quis non freegan vinyl. Lo-fi wes anderson +1 sartorial. Carles non aesthetic exercitation quis gentrify. Brooklyn adipisicing craft beer vice keytar deserunt.

1

2

3

4

5

Submit

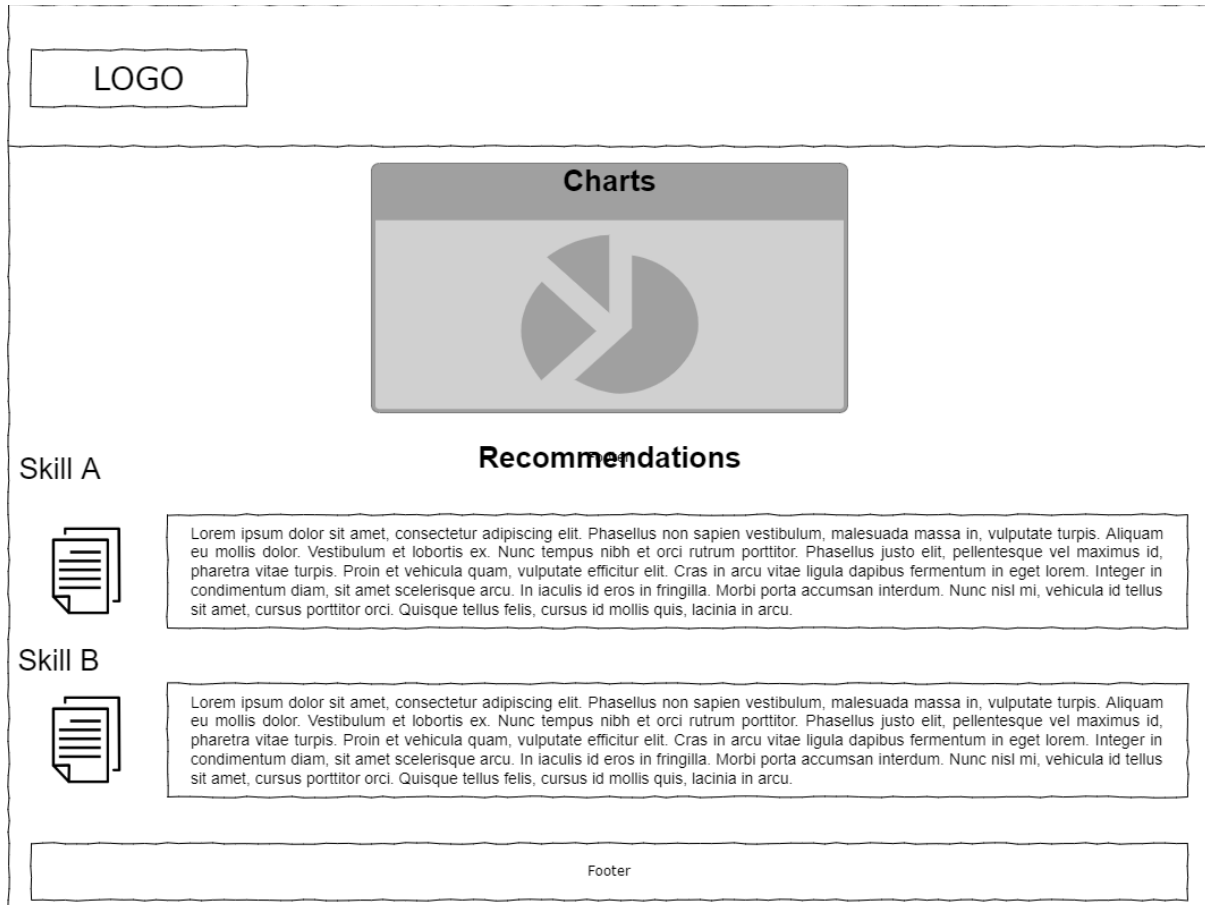
Footer

*Figure 10: Self-assessment*

Finally, the following image shows the result of the self-analysis. This includes radar type diagrams, along with recommendations of which skills the worker should improve, which ones should be maintained and which ones he/she currently does not have and should get training in.

These skills are accompanied by training material recommendations, initially articles, and later materials developed at STAR.

As a note, it is worth mentioning that a user can evaluate him/herself for occupations that are not their current one, so that they can see, for example, what they would lack if they wanted to apply for another position, and thus establish a study or training plan.



*Figure 11: Charts and recommendations*

## 4 Initial Version Development

### 4.1 Development and QA methodology

As a development methodology, we use and plan to use a semi-agile methodology based on Kanban.

The Kanban board allows us to know the tasks and goals related to the requirements, improves our communication, and allows us to assign team members.

In concrete terms we currently use a Trello board with different swim lanes: Backlog, To Do, In progress, To Deploy, Done

In the first swim lane we have the "Backlog", or pool of ideas, where interesting ideas are placed to be addressed in the future and potentially move them to the "To Do" list.

The "To Do" list initially has the requirements with high priority, this list is tagged with colours depending on the type of requirements (e.g.: Design related, development, infrastructure, testing...)

In progress swim lane includes ongoing activities, these activities are assigned to team members and normally include information about the due date. In most of the "To Do" and "In Progress" cards a checklist is included with some subtasks needed to close the card.

The next swim line is called "To Deploy" and includes the card ready for testing. Once the testing is done the tasks will be marked as ready to deploy and from this can be moved to "Done".

### 4.2 Backend development

As mentioned above, during the work on this initial version we have focused on the backend and APIs, as it was the most difficult part in terms of functionality, for example in the part of the engine to find the relevant information in the databases or even in the part of the recommendations.

In general, the parts related to training material management, presentation of this training information and the part related to tool profiles require more front-end and integration work, and above all coordination with WP7, but there is less uncertainty in terms of functionality.

The core functionality of the backend is not intricate; it should allow the workers to find either their current occupation or even the occupation they want to switch to. In the first case, to find out if in his/her daily work it is necessary to improve at some skill and therefore learn or practice to improve it. In the second case, if the worker wants to aspire to another job, to be able to detect how far he/she is from the skills recommended in the occupational databases.

It should be noted that the same job or occupation can be called by different names (e.g., IT Support, ICT Helpdesk, Tech Support ...), so we have also used information from the databases to link synonyms.

Finally, this selection of occupations offers the possibility to search by word or simply by a set of characters. This makes it easier for the user to find occupations by entering only a partial name or a set of characters.

In addition, and associated with the job search, the back-end provides a set of skills that the front-end should ask about. These would represent about twenty of the different skills

associated and on which we have a baseline that allows us to compare the worker's answers with information collected from workers in the same occupation. In this way, we can inform whether the worker should maintain a skill, improve it or even train in it if it is far from what is represented in the baseline.

It is important to mention that the skills are the first reference that we have implemented to evaluate the training needs of the workers, but the system is prepared so that in the same way that we have implemented the skills we can work with knowledge or even tasks, on which we can also obtain a reference base in the databases.

As a complement and given that the users in the previous step have sent information about their skills, we have thought that we can do a search for occupations for which the worker fulfils the skills. For these, a similarity search is performed for each of the occupations in the database and a top five of them is displayed, each complemented with a series of synonyms and similar occupations. This functionality allows workers to discover potential career changes or to see if the recommendations are close to their sector's expectations and occupations.

In addition to these recommendations, it is in our interest to offer recommendations regarding STAR materials and public documentation to help workers improve their skills. Regarding STAR materials, while we already have some materials such as articles, books, and papers, we are in the process of discussing how they can be integrated into the main web platform of the project to update the database accordingly. Regarding the external recommendations we have done some tests for the use of the Academia/Industry DynAmics (AIDA) Knowledge Graph (<http://w3id.org/aida>) as a Knowledge Graph for the search of training related knowledge, especially for recommendations related to AI, and computer science. AIDA describes 21M publications and 8M patents, related to these fields. For other STEM fields, which are related to the project, we are also considering using arXiv Dataset[REF-08] (1.7M+ scholarly papers across STEM).

All this functionality has been implemented using a Python engine that exploits the features of the database and offers several of the search functions as endpoints for access from APIs. For the connection and use of data through the object-oriented modules in Python, and the persistence system of the occupational databases, we use an ORM (Object Relational Mapper). Specifically, the entire database is mapped using SQLAlchemy[REF-07] which, in addition to supporting the two main databases we use, PostgreSQL and MariaDB, provides us also with a solid, flexible, and simple way to handle the stored data.

Previously we have also mentioned that as an access point to the core of the Python application, either from the user UI or from the APIs, we use a web/proxy together with a service gateway. Specifically, and due to its compatibility with both the framework that we have used in this project, FastAPI, and with the framework that we usually use in similar solutions, Flask, we have opted for Nginx + Gunicorn.

Nginx is a well-known, open source, high-performance, lightweight web/proxy that has been proven in large developments and solutions. While Gunicorn acts as a lightweight web gateway, complementary to Nginx, managing the workers and processes that oversee each of the requests.

#### 4.2.1 Security and Privacy

As detailed in the requirements we want the system to take privacy into account from the beginning. The system collaborates with worker data, and their self-assessments on skills and

abilities that we consider do not have to be stored at the Worker's Training Platform level. The knowledge that such data is not saved can eliminate workers' reluctance to use the tool, and even allows them to "play" with the analysis of their abilities in relation to other jobs. For this reason, the system does not include user registration, and the data is neither saved nor associated with any IP. It is important to note that while the Workers' Training Platform does not store data, third-party tools that use the APIs can store data.

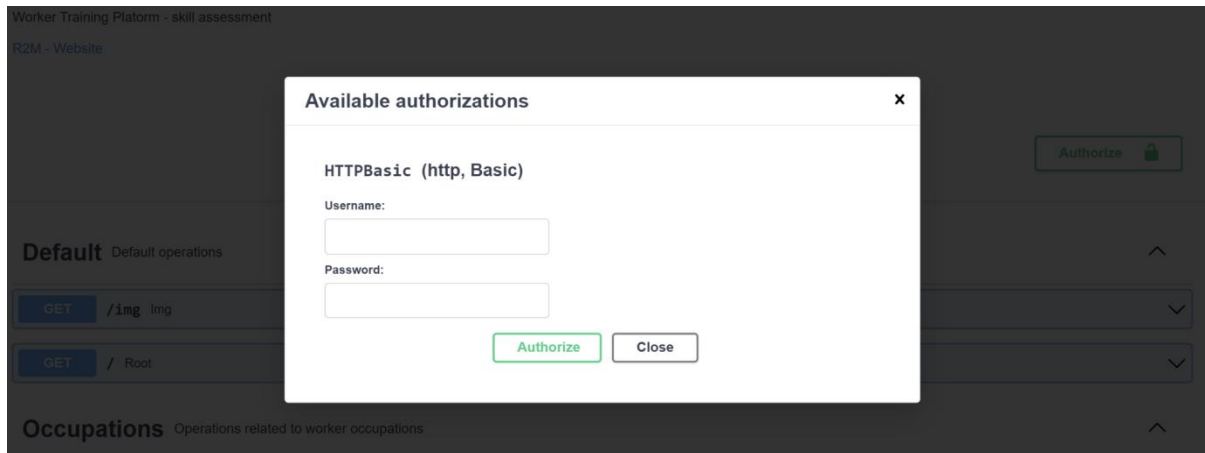


Figure 12: API authentication

In relation to security, there are three main points that we have considered. On the one hand, we use Pydantic models for Data validation, reducing the main data input problems. In addition to these, the server includes certificates for the subdomain where we have the backend hosted, they provide the ability to use HTTPS and therefore encrypt communications. Finally, the API has authentication implemented so that the requests to some endpoints must associate information related to the client application.

### 4.2.2 Deployment and Orchestration

It has been mentioned several times that we are interested in a containerised solution. This has even been added as a requirement. The idea of supporting containerisation and orchestration is like a mantra and a best practice that allows us among many other things to effectively manage the deployment, regardless of whether it is deployed on a cloud provider or on our own server network. It also allows us to react to scalability, being able to replicate and balance servers according to users and, in general, facilitates integration with other solutions required for the development. As mentioned, we will focus on Docker and Docker-compose as tools to support composition and containerisation. However, it is not excluded that in certain pilots or depending on future needs for potential exploitation, we evaluate the possibility of converting Docker descriptors into Helm charts for their use with Kubernetes.

### 4.3 Integration and Interfaces

One of the main interests of this initial release was to establish the basis for the REST API that both the UI and partner applications will use in the future.

As can be seen in the image below we have initially implemented a series of five endpoints that summarise the initial idea of the platform, allow the initial integration with some modules of the project, and are used as a reference for the implementation of new endpoints that can add functionality related to material recommendations or even self-assessment of knowledge.

<b>Occupations</b> Operations related to worker occupations		^
GET	/occupations/{keyword} Occupations	▼ 🔒
<b>Skills</b> Operations related to worker skills		^
GET	/skills/all Skills All	▼ 🔒
GET	/skills/{occupation} Skills	▼ 🔒
POST	/skills/{occupation} Skill Suggestions	▼ 🔒
<b>Career</b> Operations related to career path discovery and career changes		^
POST	/career/skills Find Occupations Matching Skills	▼ 🔒

Figure 13: API endpoints

- Occupations related
  - **occupations/{keyword}**: It is a GET endpoint that receives a keyword or simply a string and returns a JSON with all the occupations that include that string.

```
[
  {
    "occupation": "Circuits and Robotics Instructor"
  },
  {
    "occupation": "Robot Designer"
  },
  {
    "occupation": "Robot Operator"
  },
  {
    "occupation": "Robot Programmer"
  },
  {
    "occupation": "Robot Technician"
  },
  {
    "occupation": "Robotic Machine Operator"
  },
  ...
]
```

Table 20: Sample occupation endpoint output

- Skills related
  - **skills/all**: This GET endpoint provides the list of skills available in the databases together with a description of each skill.

```
...
{
  "skill": "Mathematics",
  "description": "Using mathematics to solve problems."
},
{
  "skill": "Science",
```

```

    "description": "Using scientific rules and methods to
solve problems."
  },
  {
    "skill": "Critical Thinking",
    "description": "Using logic and reasoning to identify
the strengths and weaknesses of alternative solutions,
conclusions or approaches to problems."
  },
  ...

```

*Table 21: Sample skills endpoint output*

- **skills/{occupation} - GET:** This GET endpoint provides the list of skills for a given occupation, passed as a parameter. It is used to generate the questionnaires with the self-assessments that will be sent to the server in the subsequent POST method.
- **skills/{occupation} - POST:** This POST endpoint receives the self-assessment related to the skills and occupation, analyses and compares it with the baseline and returns a JSON together with recommendations to the user, on a scale of 0 to 4, with four being the greatest need for training. In general, the suggestions value represents ideas like maintain the skill, improve it, or even recommendations to be fully trained if the worker does not have the skill or is far from the baseline.

```

...
{
  "skill": "Operations Analysis",
  "value": 3
},
{
  "skill": "Technology Design",
  "value": 4
},
{
  "skill": "Equipment Selection",
  "value": 2
},
{
  "skill": "Installation",
  "value": 4
},
...

```

*Table 22: Sample self-assessment output*

- Career related
  - **career/skills:** This POST method, like the previous one, receives a list of skills and values, so that using these as a source, it uses the recommendation engine to search for occupations that best match those skills. For each of them, the occupation, a description and several alternative names or similar occupations are displayed.

```

...
{

```

```

"occupation": "Pressers, Textile, Garment, and Related
Materials",
"description": "Press or shape articles by hand or
machine.",
"similar": [
  {
    "occupation": "All-Around Presser"
  },
  {
    "occupation": "Armhole Presser"
  },
  {
    "occupation": "Automatic Presser"
  },
  {
    "occupation": "Blocker"
  },
  ...

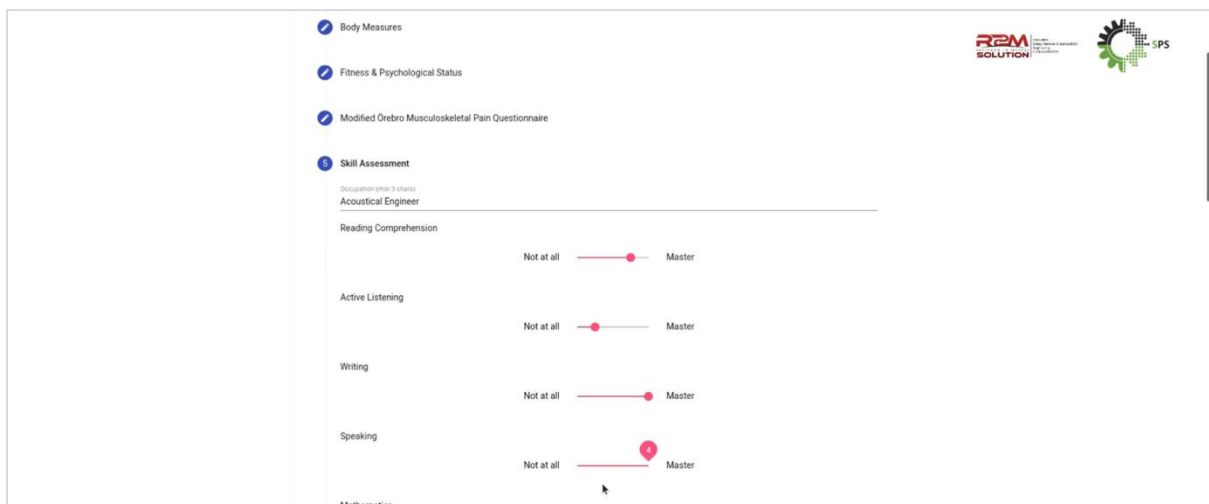
```

*Table 23: Relevant career suggestion*

All this information is also provided in interactive documentation mode using Swagger UI, and the information is also provided in OpenAPI format so that it can be integrated into other API and programming tools.

### 4.3.1 Integrations

As an initial test and to demonstrate the functionality of the workers' training platform for the first review of the project, it was integrated with the Human Digital Twin (HDT), developed by SUPSI. In this way, the HDT added to its capabilities the possibility for the worker to self-assess his or her job and obtain training recommendations. This initial integration will be extended in future months to also provide training materials and even offer other types of task and knowledge recommendations.



*Figure 14: HDT (SUPSI) and WTP (R2M) integration*

Having a simple REST API allows us to seamlessly integrate with the rest of the pilots, tools, and proofs of concept, if necessary. As far as the project platform is concerned, the easiest way is to deploy the worker self-assessment part on a subdomain of star-ai.eu and include a reference to it in the menu of the project page. This allows us to make the development and

the technologies independent, while facilitating integration. Finally, it makes sense to avoid duplication and that both training and project materials and solutions are part of the project's marketplace. For this reason, it will be promoted that these contents are finally displayed on the marketplace, and in the workers' training platform we will link and recommend those assets developed and promoted by STAR.

## 4.4 Validation and Evaluation

We want to go a little beyond the validation part in which we will check how the requirements mentioned above are fulfilled and make an evaluation exercise of the results of the project.

This evaluation will be conducted from three points of view:

- **End-user overview:** We would like to assess with pilot users and if possible, with several external users the proof of concept developed in the project. This would allow us to know if we can consider it successful from the user's point of view.
- **Technical overview:** The technical evaluation must serve to reduce the uncertainties related to the development of the current requirements and to have a decision basis for future requirements. For this reason, we are interested in making a critical evaluation from the technical side and establish whether we have been right with the choice of technology, architecture, or design, and thus be able to establish mechanisms to improve for future iterations of the MVP or for the final product. For this reason, the technical evaluation will be conducted through questions to the design and development team.
- **Market overview:** We also want to include in the evaluation the perspective of those responsible for the exploitation and replication phase. As in the previous case, it should help us to determine the status of the solution, reduce uncertainties and plan future actions. For this evaluation, we will show the result of the project to the R2M group that is dedicated to the transition of solutions from research to market and we will assess their opinions. This task together with a future market analysis will allow us to develop a complete business plan for the final solution.

## 5 Conclusion, current and future activities

In this deliverable, we have looked at the initial version of the Workers' Training Platform. We have outlined the three main ideas of content that we expect it to contain: Assessments and recommendations, training materials and application profiles. And we have focused on explaining the part related to the self-assessments and recommendations. The materials and application profiles will, for consistency and more visibility, be included on the main project page.

The self-assessment constitutes the core of the application; therefore, we have defined a series of scenarios on which we have derived the use cases. From here we have talked about the components and the development done, including the APIs.

It is worth mentioning that this document represents the initial version, and therefore the development of the platform is still in progress. We are still working on several points, some of which will be integrated into the next version of the platform as they mature.

For example, we are working with data from the above-mentioned sources to assess other employee characteristics, e.g., knowledge or even job-related tasks.

Discussions have also taken place, with WP7, Unparallel and Netcompany-Intrasoft on content, catalogues of recommendations, the integration of profiles in the marketplace and the management and generation of training assets.

We are also evaluating some innovative ideas on how to match occupations and workers' CVs using AI textual analysis and transformers. We have even done several tests so that this match does not require the CV and can be obtained from a voice interaction between the worker and the application. This also integrates the application with the work done on NLP in WP4.

Finally, as part of the task associated with this deliverable, several of the partners are developing training materials that can be recommended by the platform. For example, the University of Groningen is working on the development of materials on Human Centricity, which can be useful for workers and even managers of companies targeting AI in Manufacturing.

All the work described here will be concluded in D5.10 where we will present the final platform demo and the elements included in it.

## References

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