Interreg Co-funded by the European Union

Italy – Croatia

BEST4.0

BEST4.0

Blue Economy Sectors Digital Transformation towards Industry 4.0

Deliverable 1.1.1

Orientation Guidelines for the analysis

Table of Contents

Annexes

1 Introduction – The Orientation Guidelines and the need for a TML framework for BEST4.0

The Orientation Guidelines (from now on "Guidelines") aim to provide precise definitions, methodologies and the tools to be used during the SME assessment activity. The Questionnaire for the SMEs of the Blue Economy (from now on "Questionnaire") is the tool that will be used for the assessment activity with the final objective of mapping the 9 elements of I4.0 for the SMEs targeted by the project, namely:

1. Cloud Computing;
2. Internet of Things;
3. Cyber Security;
4. Augmented Reality;
5. Big Data;
6. Simulation;
7. Digital Twin;
8. Artificial Intelligence;
9. Autonomous robot.

The assessment models on which these Guidelines are based are the most widely used European and national models, which have been analyzed and further adapted to the focus, needs and main characteristics of the Blue Economy sector.
The Orientation Guidelines and the Questionnaire for the SMEs of the Blue Economy sector will be used by the partners' auditors to carry out the SME assessment and to get a first orientation on the level of adaptation of the SMEs to the I4.0 elements and also on the interventions needed.
In addition to the digitization dimension, the guidelines and the assessment will take into account the sustainability maturity, considering the level of awareness that the SME has about the ESG (Environmental, Social and Governance) criteria.
The Guidelines support the definition and calculation of the Technology Maturity Level (TML) index, which aims to assess the capacity of SMEs and their level of technological readiness and maturity with respect to the nine elements of I4.0 and other elements taken into account for an adaptation to the European indications for the DMA of EDIHs adapted to the needs of the sectors considered by the BEST4.0 project.
The TML index consists of a set of indicators related to the different dimensions defined in the guidelines, which are used in the audit and evaluated quantitatively and measured in percentages by the TML index.

Further qualitative indicators will also be considered to support a more precise technological classification of the companies interviewed.

2 Useful definitions

Within the purpose of this document and the Questionnaire the following definitions apply:

*Blue Economy sectors: t*he project addresses SMEs active in the Blue Economy, which covers a wide range of sectors. To support the analysis, the guidelines have adopted the definitions of the blue economy set out in "*The EU blue economy report 2023*". The identified sectors have then been further elaborated to better adapt to the specificities of the Adriatic Sea and the final categorization is as follows:

1. Marine living resources (primary production: fishery and aquaculture, processing and distribution of fish products)
2. Marine non-living resources (oil and gas, other minerals, support activities)
3. Marine Renewable energy (offshore wind energy, ocean energy, floating solar energy and offshore hydrogen generation)
4. Port activities (cargo and warehousing, port and water projects)
5. Shipbuilding and repair (shipbuilding, equipment and machinery)
6. Maritime transport (passenger transport, freight transport, services for transport)
7. Coastal tourism (accommodation, transport, other expenditure)
8. Blue biotechnology (any economic activity associated with the use of renewable aquatic biological biomass such as food additives, algae, bacteria, fungi, animal feeds, pharmaceuticals, cosmetics, energy, etc.)
9. Desalinization
10. Maritime defense, security and surveillance
11. Research and Infrastructure (submarine cables, robotics)
12. Other sectors related to Blue economy

Digitalization: the process of using digital technology to collect data from organizational processes and to carry out activities using digital technology to increase performance in terms of productivity, quality, traceability, responsiveness, etc. and in order to better visualize and understand the way in which the various processes take place in the value chain of the organization. Digitization (i.e. the process of converting analogue information into a binary format of 0s and 1s) is part of digitalization.

Nine elements of Technologies for Industry 4.0:

- Cloud Computing: is an elastic execution environment that enables networked, on-demand access to a shared set of configurable computing resources (e.g., network, servers, storage devices, applications, and services) in the form of tiered services of granularity;
- Internet of Things: refers to the extension of the internet to the world of concrete objects and places, which acquire their own digital identity so that they can communicate with other objects on the network and be able to provide services to users.
- Cyber Security: this term refers to and groups together different methods of protecting equipment and information systems from harmful cyber-attacks such as: computers, servers, mobile devices, electronic systems, computer networks, software, etc. It is the study of the vulnerability of a system IT and definition and implementation of a set of security measures to protect against attempted data breaches through cyber-attacks.
- Augmented reality: is an interactive experience that enhances the real world with computer-generated perceptual information. Using software, apps, and hardware, augmented reality overlays digital content onto real-life environments and objects.
- Big Data: are data sets so large in volume, velocity and variety that they require specific technologies and analytical methods to extract value or knowledge. These datasets are so voluminous that traditional data processing software cannot handle them. The term is therefore used in reference to the ability (specific to data science) to analyze or extrapolate and relate an enormous amount of heterogeneous, structured and unstructured data, in order to discover the links between different phenomena and predict future ones.
- Simulation: the term simulation means reproducing the behavior of a system. In general, we talk about simulation both when a concrete model is used and when an abstract model is used that reproduces reality through the use of computers. The model of reality allows you to evaluate and predict the dynamic unfolding of a series of events or processes following the imposition of certain conditions by the analyst or user.
- Digital Twin: is a digital model of a physical product, system or process, real or predicted, that serves as an indistinguishable digital counterpart used for practical purposes such as: simulation, integration, testing, monitoring and maintenance. The digital twin exists throughout the entire lifecycle of the physical entity it represents and can exist before the physical entity, such as in virtual prototyping. A digital twin of an existing entity can be used in real time

and regularly synchronized with the corresponding physical system. The concept of digital twin can be applied to the entire production process, in this way it is possible to extend the benefits of virtualization by applying extended reality and spatial computing to all business processes.

- Artificial Intelligence: or AI, is a technology that allows computers and machines to simulate the intelligence and problem-solving ability of human beings, artificial intelligence includes machine learning and deep learning. These disciplines involve the development of AI algorithms, modeled on the decision-making processes of the human brain, which can "learn" from available data and make increasingly accurate classifications or predictions over time. Today, generative AI can learn and synthesize not only human language, but also other types of data, including images, videos, software code, and even molecular structures.
- Autonomous robot: is a robot that acts without recourse to human control. it is a robot capable of perceiving its environment, interpreting what it has perceived, making decisions and implementing them. All without any human supervision, even when the environment is totally or partially unknown, and when the robot's activities must adapt to unexpected events, i.e. it must be able to effectively manage uncertainty. The trend of industrial robotics is to become collaborative: the evolution of robots is going from traditional industrial applications (industrial robotic arms) to those of service robotics, in which the robot is called to interact directly with human beings and to operate in environments with human scale.

Other elements: included in question Q12 and used in other assessments such as EDIH DMA and IP4FVG digital assessment:

- Additive manufacturing and rapid prototyping (3D printers...)→ Rapid prototyping constitutes the initial phase of physical production of a project, it is the process of quickly creating a physical model of an idea or project. 3D printing has become a key technology for rapid prototyping thanks to its ability to translate digital designs into physical objects very quickly. It is ideal when it is necessary to quickly evaluate aesthetic aspects, optimize geometries, improve production cycles, and evaluate functional aspects. There are several 3D printing technologies suitable for rapid prototyping, including SLS (Selective Laser Sintering) and SLA (Stereolithography).
- Advanced or High-performance Computing (HPC): we are referring to the technologies used by computer clusters to create processing systems capable of providing very high performance in the PetaFLOPS range, typically resorting to

parallel computing, and is used to solve complex and highly computationally intensive problems. it is often structured by several servers networked to form a cluster, which serves as an efficient HPC architecture system. The cluster servers run algorithms and software programs simultaneously to complete different tasks. To store or access the required information, the cluster is networked to data storage systems. Each component of the High-Performance Computing infrastructure must keep pace with the others to ensure maximum performance. All network systems must also have the ability to support high-speed data transmission between processing servers and data storage.

- Blockchain: exploits the characteristics of a computer network of nodes (i.e. computers in the network having a copy of the Blockchain register) and allows you to manage and update, in a unique and secure way, a register containing data and information in an open, shared and distributed manner without the need for a central control and verification entity. It facilitates the process of recording transactions and tracking assets in a corporate network. An asset can be tangible (a house, a car, money, land) or intangible (intellectual property, patents, copyrights, trademarks). Anything of value can be tracked and traded on a blockchain network, reducing risk and costs for everyone involved. The characteristics common to systems developed with blockchain and distributed ledger technologies are data digitization, decentralization, disintermediation, traceability of transfers, transparency/verifiable, immutability of the ledger and programmability of transfers.
- Machine Vision: is the possibility for artificial intelligence to acquire images through cameras and optical systems and their subsequent processing, thanks to image processing algorithms. Machine vision systems identify the characteristics of the image, based on certain characteristics such as shapes, dimensions and edges. They can also measure an object in different dimensions: length, height, depth, area or volume. In this way, robots are able to perceive the outside world much more precisely than previous sensor-based models. The applications of vision systems in Industry 4.0 are often integrated into a single solution: for example, it is possible to verify the conformity of products and at the same time count them using the same image acquisition program.
- Holography, rendering and 3D graphics→ 3D computer graphics is a branch of computer graphics that is based on the processing of a set of three-dimensional models using algorithms designed to produce photographic and optical verisimilitude in the final image. Rendering is the process of creating images or animations from a three-dimensional (3D) model. This model is processed using

powerful rendering software to generate images that appear realistic and detailed. A hologram is a recording of an interference pattern that can reproduce a 3D light field using diffraction. In general usage, a hologram is a recording of any type of wavefront in the form of an interference pattern. It can be created by capturing light from a real scene, or it can be generated by a computer, in which case it is known as a computer-generated hologram, which can show virtual objects or scenes. Optical holography requires a laser light to record the light field. The reproduced light field can generate an image that has the depth and parallax of the original scene. The 3D image from a hologram can often be viewed with non-laser light. A 3D model and a hologram are both technologies used to represent three-dimensional objects, but they operate in different ways and have distinct characteristics.

- Computer-aided design (CAD) and computer-aided manufacturing (CAM)→ CAD/CAM refers to the integration of computer-aided design (CAD) and computer-aided manufacturing (CAM). Both require powerful computers. CAD allows for faster iterations in the design process; allows a smooth transition to the CAM phase. While manually created drawings do not produce a machine-readable result for directly building a prototype, CAD can be used to "ensure that all the separate parts of a product fit together as intended" and can also be linked to simulation. In computer-aided manufacturing (CAM), using computerized specifications, a computer directs machines such as lathes and milling machines. This process, called numerical control (NC or CNC). At the beginning of the 21st century CAM introduced the use of 3D printers. CAM creates a quick transition from CAD to finished product.
- Manufacturing execution systems (MES): refers to a computerized system that has the main function of managing and controlling the production function of a company such as: order dispatch, progress in quantity and time, deposit into the warehouse, as well as the connection directed to the machinery to deduce useful information to integrate the execution of production as well as to produce information for the control of the production itself. An MES is a software system that is applied to manage a company's production process in an integrated and efficient manner, through direct connections to the machines (PLC/SCADA) or manual declarations from the operators who are working. This information is provided in real time to the offices (also transmitting the data to the management system already present in the company, ERP system) which have a complete view of the progress of orders, the physical state of the resources and the materials used.

Systems for horizontal and vertical integration→ horizontal integration means integration of production processes. Vertical integration means the integration of production with other company areas, at a higher level, such as purchasing, quality control, design, etc.

Vertical links are designed primarily for control, horizontal ones are designed for coordination and collaboration.

Innovation (Technological)→ is the evolution over time due to the expansion of technical and scientific knowledge of the process of creating certain products, services and technologies, aimed at their improvement and speed-up.

- Incremental innovation: continuous, gradual improvements and enhancements made to existing products, services, or processes over time, rather than through major breakthroughs or radical changes.
- Disruptive innovation: process in which a new product, service, or technology disrupts an existing market by creating a new market or significantly altering an existing one.

Small and medium-sized enterprises (SMEs):

Company category	Staff headcount	Turnover	or Balance sheet total
Medium-sized	< 250	≤ € 50 m	≤ € 43 m
Small	< 50	≤ € 10 m	≤ € 10 m
Micro	< 10	≤ € 2 m	≤ € 2 m

1. The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.

2. Within the SME category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million.

3. Within the SME category, a microenterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million.

Sustainability: evaluated by ESG criteria, sustainability assesses the company's environmental impact, social responsibility and governance practices to analyze if they operate in a manner that is environmentally sound, socially equitable, and ethically governed.

Technology Maturity Level (TML): it refers to the degree of technology development and adoption within the organization. To calculate a company's TML, a few steps should be followed:

- *Identification of key technologies:* identify the relevant technologies for the company, that may include software, hardware, technology processes, development platforms, IT infrastructure, and so on.
- *Assessment of the degree of adoption:* assess how far the company has adopted these technologies and integrated them into its operational processes. Different factors could be considered (usage penetration, diffusion among employees, integration with other business systems, etc).
- *Technology maturity analysis:* refers to the maturity of the identified technologies in terms of stability, scalability, security, technology upgrade, risk management, innovation and adaptability to business needs.
- *Assigning scores or levels:* define a score or maturity level to each technology, such as a scale from 1 to 5 or a set of maturity levels (e.g. 'basic', 'intermediate', 'advanced', 'industry leader', etc.).
- *Calculation of overall TML:* calculate an overall TML for each company by averaging the scores of the individual technologies or using other appropriate formulas.
- *Gap analysis and improvement planning*: according to the results obtained, identify any gaps in the company's technology maturity and plan improvement actions such as investment in training, technology upgrades, internal skills development, external collaborations, etc.

In general, TML assessment should be a continuous and dynamic process, as technologies and business needs evolve over time.

3 Overview of TML framework methodology

3.1 TML framework design

As a first step, an in-depth study of the current literature and various digital and technological assessment tools and in particular the EDIH DMA was carried out (DMA Tool | European Digital Innovation Hubs Network (europa.eu). This analysis paved the way for the design and development of a new technological and innovation maturity assessment framework able to capture the technological and digital maturity of companies of the Blue economy sectors of the Italy-Croatia areas.

During the project meeting held in Ferrara on 22/05/2024, a comparison was done between different partners' experiences and territorial needs agreeing on the format and criteria to be used for the TML framework design.

The TML tools were selected based on a series of criteria including:

-The partners' prior knowledge of digital maturity tools.

-The experiences gained in the assessment of the IP4FVG project (based on that of the Polytechnic of Milan), sustainability assessment tools developed by the partners of Enterprise Europe Network and approved by the European Commission, assessment of the Newtopia project - sustainability and digitalization laboratory for artisan businesses of the DIH of the CNA with the scientific partnership of Re:lab, laboratory of the high technology network of Emilia Romagna

-Internet search based on publicly available information, considering the maturity of the tools, the country of reference, the digital maturity of the companies.

After this initial mapping and evaluation phase, the following tools were selected:

- IMP3ROVE Digital Innovation Quotidient (DIQ) (Germany)
- DREAMY 4.0 by Politecnico di Milano (Italy)
- DMA by EDIHs
- Assessment sulle tecnologie CNA HUB 4.0

Thanks to the collaboration between Area Science Park and CNA Ferrara, a comprehensive questionnaire was prepared consisting of a set of questions within different modules:

Module 1: Customer data

Module 2: Innovation and Technology/Digital maturity

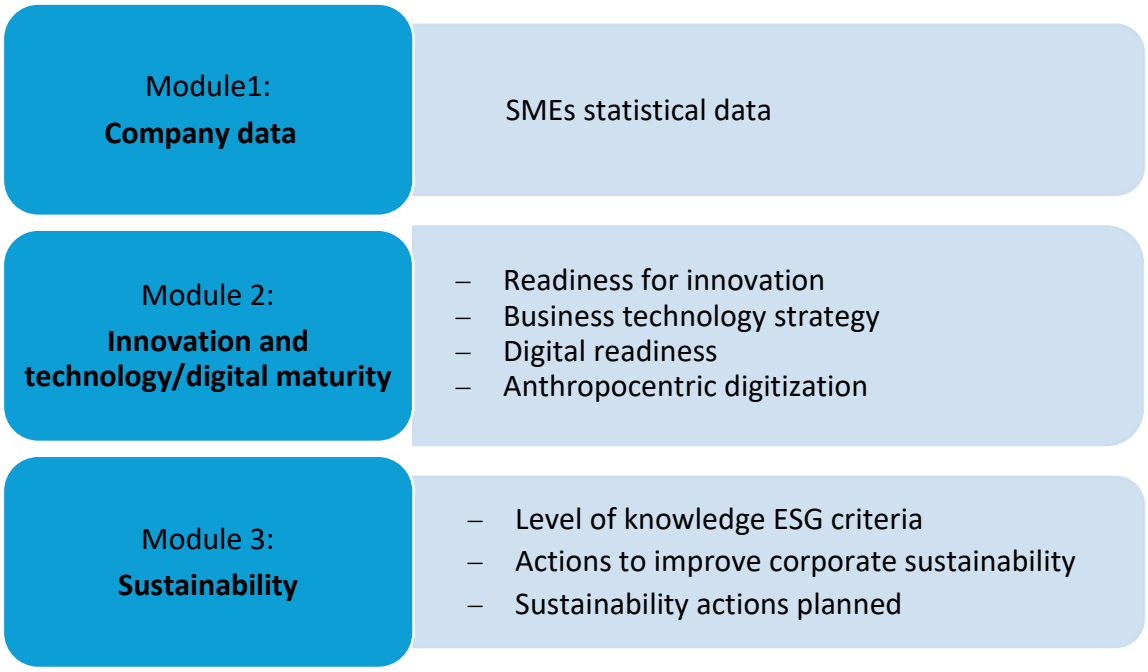
Module 3: Sustainability.

The analysis and evaluation of the proposal provided the following key findings and recommendations:

- There is no specific tool that meets the TML monitoring and evaluation requirements for Blue Economy companies and it is necessary to develop a purpose-built framework/tool inspired by existing ones.
- This tool should be linked mainly to Interreg Italy-Croatia territories, but also fit into the technological and digital policies of European Programmes.
- The TML evaluation questionnaire should cover the main areas where potential impacts are expected.
- The framework and questionnaire should not be strictly related to Industry 4.0 criteria but be broader to cover most market sectors, including services.

The TML evaluation will be carried out by means of in-person interviews based on an online questionnaire ready to be used by companies assisted by an expert appointed by the partners' technical teams who will ensure better interpretation of the questions to get more accurate feedback and results.

At the end of this process, a scheme of the new TML framework was released as presented in the figure below:



Overall structure of the proposed TML framework for SMEs
Source: Author's own elaboration

3.2 TML framework modules for SMEs

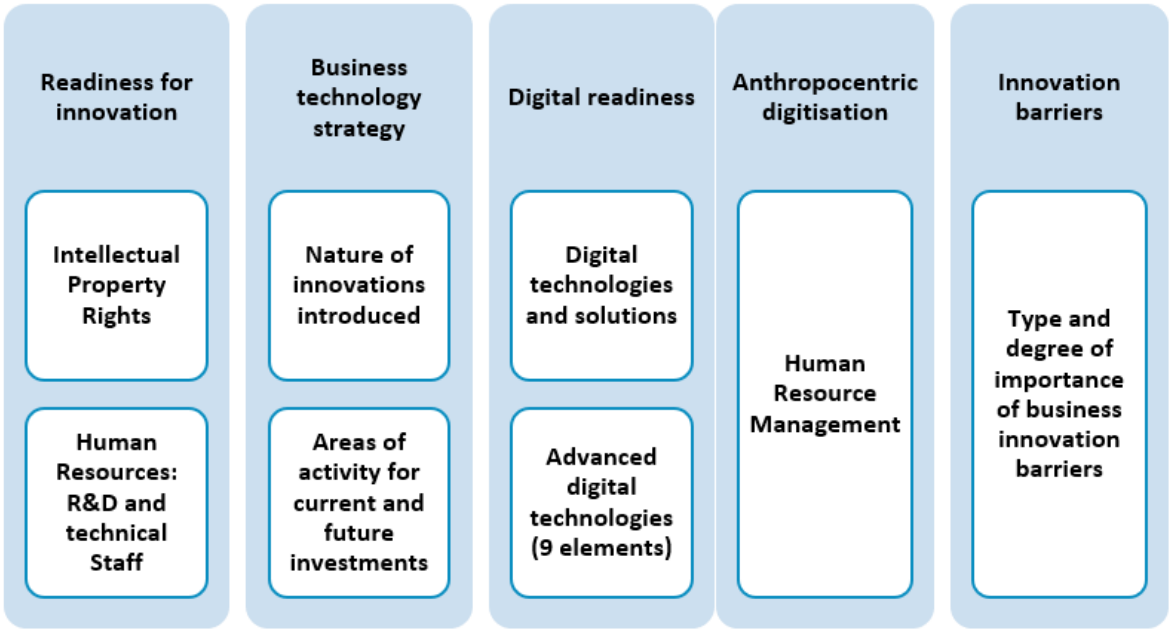
In this section, the three Modules of the questionnaire and the kind of information they aim to obtain will be presented in detail.

MODULE 1: Company data
This first module collects general data about the SME such as contact details, address, type and size of organization, sector of activity and more that will serve for statistical analysis. This information will also serve to analyze the company's level of technology and digital maturity compared to that of others in the same sector, size or category (from micro to large), region and/or country. This will be possible only when a substantial number of questionnaire data will be filled into the database.

MODULE 2: Innovation and technology/digital maturity
The second module is the core part of the questionnaire and is aimed to assess the different aspects of technological and digital maturity within an organization, grouped under the following five company dimensions:

1. Readiness for innovation
2. Business technology strategy
3. Digital readiness
4. Anthropocentric digitization
5. Innovation barriers

These 5 main dimensions contain 8 sub-dimensions (questions) and several options (items) that all together aim to capture in a holistic, but not exhaustive, way the digital maturity within a business entity today. This information will provide a picture of the starting point of the company's journey via digitalization and will help identify potential areas for improvement defined under WP3.



The 5 dimensions and 8 sub-dimensions of the Technology Maturity module for SMEs
Source: Author's own elaboration

Within these dimensions there are some questions that do not directly contribute to the quantitative TML evaluation but are very useful to get a qualitative insight of the company necessary for a more complete and correct classification.

1. Readiness for innovation

This dimension seeks to determine the company's propensity for technological innovation and digitalization.

2. Business technology strategy

The questions of this dimension intend to capture from a business perspective the overall status of an enterprise's digitalization strategy. These questions investigate the enterprise's investments in digitalization per business areas (either executed or planned) as well as the company's readiness to embark in a digital journey that might require organizational and economic efforts not yet foreseen.

3. Digital readiness

The digital readiness dimension provides an assessment of the current uptake of digital technologies (both mainstream and more advanced technologies) that is valid for both manufacturing and service companies.

4. Anthropocentric digitization

This dimension looks at how employees are trained, engaged and empowered with and through digital technologies, and how their working conditions are improved to increase their productivity and well-being.

5. Innovation barriers

This dimension measures the enterprises' difficulty in adopting an innovative approach to technologies and digitalization often caused by obstacles external to the company. Its evaluation will be reversed because it is a negative value.

MODULE 3: Sustainability

The third module has been inserted in the assessment to:

- Raise awareness to the SMEs about ESG criteria
- Analyze the level of sustainability of the SMEs by ESG criteria
- Understand the potential of innovative strategies (including sustainability aspects) of the company
- Give a more complete action plan to the company

The third module is composed of 3 qualitative questions that investigate how much the company knows about ESG, which types of actions (27) have already been done to be more sustainable and which actions (3 macro-areas) they are planning to do in the next 3 years.

This module will not contribute to the definition of the TML index.

4 TML testing and validation

The TML assessment tool was presented and validated by the partners during the project meeting held in Ferrara on 22 May 2024.

Afterwards, the questionnaire tool was tested by experienced auditors working for CNA Ferrara in order to evaluate its structure, modules and wording and to identify any issues to be improved according to the organizations' background and personal experiences and observations in the field.

The revised version of the questionnaire was again shared with all the partners in June 2024 and some additional integrations and suggestions for improvement were included in the final version.

The questionnaire was also tested in the online Microsoft Form version by entering more than 10 simulated cases into the online form and testing the correctness of the output and the effective use of the dataset.

Thanks to the collaboration between the team partners (CNA Ferrara and Area Science Park), after several rounds of refinement and simplification, the TML framework, guidelines and questionnaire for SMEs were finalized.

5. Digital Maturity evaluation criteria – Scoring rules

Microsoft Form will be used to fill-in the on-line questionnaire and the results in percentages will be calculated using a separate calculation sheet implemented specifically for this project (xls file) XL.

As a final result we will have a radar graph composed with the five dimensions described in detail in the previous paragraphs.

Definitions

Dimension: is the term used to describe the 5 main categories of the TML framework. Each dimension is scored on a 0-100 scale (with higher scores indicating higher maturity).

Question: is the term used to describe the eight sub-dimensions of the TML framework. The other questions contained in the questionnaire will contribute to have a qualitative and not quantitative positioning, therefore they are excluded from the sub-dimensions.

Item: is the term used to describe each of the several options within each question of the questionnaire. The actual number of options in each question varies.

Each Item contributes equally to a question score and each question contributes equally to Dimension score. Considering that the answers will have the same weight, it was decided to assign a unique score to the items as shown below:

- Item grading types:
  - No/Yes (No = 0, Yes = 1);
  - No/Planned /Done (No=0, Planned=1, Done=2)
  - 0-5 scale

The score for **Dimension 1** (readiness for innovation) has been calculated as follows:

Dimension 1	**Readiness for innovation**	
Questions	**Q7**-Intellectual Property Rights (patents, copyright, industrial design rights, trademarks)	**Q8**-Human Resources: R&D and technical Staff
Number of Items for each question	6	6
Scoring for Items	A=0; B=1; C=2; D=3; E=4; F=5	A=0; B=1; C=2; D=3; E=4; F=5
Estimation of the Dimension (100/100)	$D_1 = mean(\overline{Q7}, \overline{Q8}) * 100$ where $\overline{Qi} = \frac{\overline{Qi}}{\max(Qi)}$ Note : D_1 is normalized between 0% and 100%	

The score for **Dimension 2** (business technology strategy) has been calculated as follows:

Dimension 2	**Business technology strategy**			
Questions	**Q10** - Areas of investment in the last 3 years and/or in which you plan to invest in the future	**Q11** - Nature of innovations introduced in the last 3 years	**Q12** - Activity areas in which the company has invested in digitization (in the last 3 years) and/or in which it plans to invest in the future	**Q13** - Nature of innovations introduced in the last 3 years
Number of Items for each question	8	8	13	13
Scoring for Items	0=No; 1=Planned; 2=Done	0= Any; 1= random incremental inn.; 2=semi-structured incremental inn.; 3=regular /planned incremental inn.; 4=incremental or disruptive inn. not using specific tools; 5=incremental and disruptive balanced innovation using specific tools	0=No; 1=Planned; 2=Done	0= Any; 1= random incremental inn.; 2=semi-structured incremental inn.; 3= regular /planned incremental inn.; 4=incremental or disruptive inn. not using specific tools; 5=incremental and disruptive balanced innovation using specific tools
Estimation of the Dimension (100/100)	$D_2 = mean(\overline{Q10}, \overline{Q11}, \overline{Q12}, \overline{Q13}) * 100$ where the score of each question is the mean of all corresponding items,			

	normalized between 0 and 1 $\overline{Q_k} = \frac{mean(Q_{k,items})}{\max(Q_{k,items})}$ Note: D_2 is normalized between 0% and 100%

The score for **Dimension 3** (digital readiness) has been calculated as follows:

Dimension 3	**Digital readiness**	
Questions	**Q14** - Which of the following digital solutions are already used by the company?	**Q15** - Which of the following advanced digital technologies are already being used by your company?
Number of Items for each question	6	18
Scoring for Items	0= Not used; 1=Use under evaluation; 2= in prototyping phase; 3=Undergoing testing; 4=under implementation; 5= operational	0= Not used; 1=Use under evaluation; 2= in prototyping phase; 3=Undergoing testing; 4=under implementation; 5= operational
Estimation of the Dimension (100/100)	$D_3 = mean(\overline{Q14}, \overline{Q15}) * 100$ where the score of each question is normalized between 0 and 1 $\overline{Q_i} = \frac{Q_i}{\max(Q_i)}$ Note: D_2 is normalized between 0% and 100%	

The score for **Dimension 4** (anthropocentric digitalization) has been calculated as follows:

Dimension 4	**Anthropocentric digitalization**
Questions	**Q16 -** Human Resource Management: Business investments in HR
Number of Items for each question	8
Scoring for Items	0 = poor; 5 = a lot
Estimation of the Dimension (100/100)	$D_4 = \frac{mean(Q_{16,items})}{\max(Q_{16,items})}$ Note: D_4 is normalized between 0% and 100%

The score for **Dimension 5** (innovation barriers) has been calculated as follows:

Dimension 5	Innovation barriers
Questions	**Q17** - Innovation barriers. Type and degree of importance of business innovation barriers
Number of Items for each question	9
Scoring for Items	From 0 to 5 (0 = strong barrier to innovation - 5 = no barrier to innovation):
Estimation of the Dimension (100/100)	$D_5 = \frac{mean(Q_{17,items})}{\max(Q_{17,items})}$ Note: D_5 is normalized between 0% and 100%

Finally, the TML score will be calculated as the average percentage of the scores of the dimensions.

6. How to use the questionnaire and how to carry out an audit of a company

- Scope
  BEST 4.0 project partners should use the TML questionnaire to evaluate the initial level of technological maturity of SMEs in their area before recommending any service for improvement. Each partner should interview at least 20 enterprises in their territory.

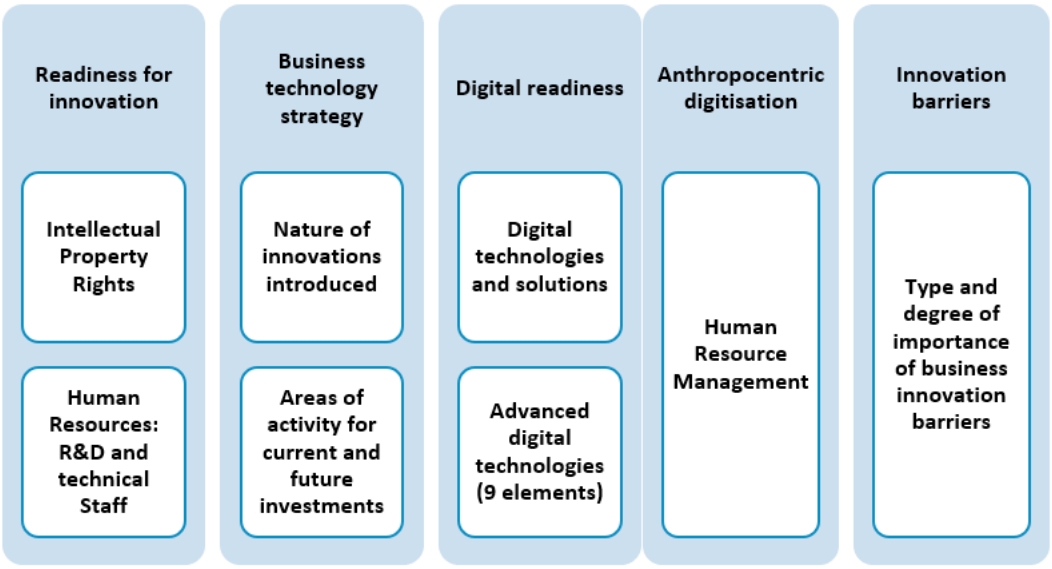
- When
  All interviews must be carried out within WP1, by mid-November 2024.

- Who
  The assessment will be conducted by partners' most experienced auditors that will first map, select and then involve local company.

- How
  The TML questionnaire tool will be filled in during a single face-to-face interview of the auditor with the company representatives.
  The audit will be performed in local languages and to this aim the validated questionnaire will be translated into Italian and Croatian languages.
  Answers must be filled in the digital release of the tool that can be found here https://forms.office.com/e/PsayiBPZGJ

Demographic data company will not be published online and won't be shared by PPs.

Before starting an interview with the questionnaire, companies should be informed about the aims and objectives of the BEST 4.0 project, the data collection method, and the timing of returning the final report. An "invitation letter" will be used to get in contact with the enterprise and officially present the initiative objectives.
The BEST 4.0 auditor will interview the company, possibly in the presence of 3 company members with different profiles such as: 1 managing director, 1 chief technician and 1 IT manager (even if external to the company).
The questionnaire is based on company knowledge and future plans at the time of the interview.
Questions may contain technical terms or unfamiliar aspects: to facilitate filling out the questionnaire, auditors will guide the interview through the modules and questions and provide clarifications whenever necessary.
As written before, the questionnaire is structured in different modules:
- Module 1 collects the basic data of the Company/Organization (for further statistical analysis)
- Module 2 is the central one and is structured in 5 dimensions of technological maturity (with a focus on digital aspects and in particular considering the 9 elements) with eight sub-dimensions, as illustrated in the following figure. This model considers technological maturity in a broad but comprehensive way: from the digital business strategy and the company's willingness to operationalize it, to the use of technologies, including fundamental dimensions such as human factors and sustainability. It is assumed that none of the proposed dimensions are in themselves a sufficient condition to reap the benefits of implementing digitalization but, when considered together, they capture the multidimensional nature of the enterprise's level of digital maturity.



The 5 dimensions and 8 sub-dimensions of the Technology Maturity module for SMEs
Source: Author's own elaboration

- Module 3: Sustainability, which does not contribute to the TML index.

The estimated time to complete the questionnaire is approximately 1 hour.
The drafting of the report (D1.2.2 Company_data_sheet) composed by qualitative and quantitative parts, expressed in the graphs, will be drawn up by experts in the language of the country of the company's headquarters and returned to the company by Dec. 2024.
Thanks to the report the company will be able to have a clear positioning of its level of technological/digital maturity and its sustainability.
Thanks to the report, companies will also become aware of their own strengths and weaknesses and level of technological maturity by identifying their position with respect to the reference markets. More importantly, the resulting digital maturity profile will enable to get a comprehensive approach – considering aspects not so obviously relevant to digitalization, such as sustainability or human centricity – and a reference point to properly plan, implement, and monitor transformation plans digital tools aimed at improving the growth of your company.

7. Disclosure and data storage

Since only anonymized data will be jointly handled for the purposes of the BEST 4.0 survey, each partner will collect and manage the demographic data of the interviewed companies, as well as their privacy consents using the template available on this link https://docs.google.com/document/d/1IOw8xkmsT33w3ivMjJJW3Vo47B3ywE39/edit?usp=drive_link&ouid=112244431570801267885&rtpof=true&sd=true