D1.5
Analysis of SME training needs
version 1.0

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Abstract

This document describes a needs analysis and a training methodology to support the absorption of skills for implementing the Better Factory KTEs experiments, and from adopting cyber-physical systems and collaborative robots' technologies to maximize agility in production for the personalization of products through agile manufacturing based on the marketplace RAMP.

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1 Introduction

This document describes a needs analysis and a training methodology to support the absorption of skills for implementing the Better Factory KTEs experiments, and from adopting cyber-physical systems and collaborative robots' technologies to maximize agility in production for the personalization of products through agile manufacturing based on the marketplace RAMP.

RAMP (Robotics and Automation Marketplace) is a free and open IoT platform (FIWARE) running on state-of-the-art servers, with access to cloud storage and computing, enabling connection with robots, sensors, cameras, AR/VR and other equipment. RAMP will provide a 3D simulation tool to create Digital Twin for virtual testing, co-creation space for teams to collaborate online among other digital services. It is a one-stop shop for Manufacturing SMEs for all the technologies and services such as access to experts and infrastructure from regional Digital Innovation Hubs (DIHs), access to finance, advanced training to reskill workers, legal and business advice, etc. RAMP Marketplace plays a central role in the Knowledge Transfer Experiments (KTEs).

The objective of this Work package (WP1) is to remove the obstacles that are holding back the SMEs from adopting cyber-physical and collaborative robots' technologies to maximise agility production. This deliverable provides an overview on how the implementation of these two activities will lead to several overviews of the skill status of SMEs as well as to concrete training programs to be provided to SMEs related to the project.

Furthermore, the results will be used to help setting up the RAMP Marketplace as well as to provide training solutions through the RAMP Marketplace to ease the product personalization during the KTEs and the integration of the technologies by the application experiments.

1.1 Skill development (Task 1.4)

A “Skills Observatory” will be implemented as one of the Marketplace facilities and will collect the training needs. MWCapital, the partner specialized in providing training for digital transformation, will implement an innovative methodology to define a training program adapted to workers needs and based on existing training material. The methodology will be based on two major programs that have been implemented by MWCapital: GoingDigital and Barcelona Digital Talent.

GoingDigital uses a customer journey analysis to create a training program that mimics a business development funnel, as it brings companies from a state in which there is lack of awareness on the business opportunities of a given technology down to one in which they start implementing those technologies. Barcelona Digital Talent experience will be used in making SMEs aware of the importance of reskilling the workforce in order to make successful digital transformations. [D1.6]

At the start of the KTEs, questionnaires will be launched for Manufacturing SMEs, to identify the skills required for the deployment and use of cyber-physical systems and collaborative robots for Lean-Agile Production. The feedback from questionnaires will be analysed to create a training structure with specific modules for digital technology addressed in the KTEs. The contents to be included per module will be determined in collaboration with the Competence Centres (CCs) and DIHs in the consortium. Before creating the training material, an evaluation of the proposed content will be performed with a selection of SMEs. [D1.5]

1.2 The objectives of the task

Task 1.4 falls under WP1 Agile production enablers, as mentioned in the Grant Agreement, which objectives are:

1. Implement proper cyber-security and privacy measures for **RAMP IoT platform** for the connectivity with production equipment, worker and information management systems.

2. Implement proper cyber-security and privacy measures for information exchange outside the factory premises, with a special focus on the communication between RAMP IoT platform and RAMP Marketplace.
3. Integrate the **INESTEC factory** digital twin designer on the RAMP Marketplace to allow the easy virtual prototyping and validation of automation solutions.
4. Provide secure access to cloud services for data storage and exchange, as well as access to computationally intensive tools, not possible to use within the SME factory IT infrastructure.
5. The identification of skill gaps and development of online training modules to support SMEs staff in developing their digital skills.
6. Training courses and interactive solutions: development of interactive tools for the workers which will be made available on the RAMP Marketplace. D 1.6 is led by partner GLUON and explained more into detail below.

   GLUON will bring the more interactive and inclusive training methodology from the S+T+ArtsAcademy Labs for engaging teenagers and artists in designing AR/VR training tools for SMEs. Prototyping digital solutions has been successfully implemented by GLUON through Smart Cities Labs and Wearable Technology Labs for young citizens. Two (week-long) Labs will be organized in 2022 and 2023. The results of the solutions will be collected and uploaded to RAMP to extend the education portfolio.

   The challenge of each Lab will be defined after analysis of the questionnaires taken from SMEs. This will happen in close collaboration with MWCapital.

   Interviews SMEs à Analysis à Defining Lab challenge à Prototyping during Lab à Prototypes shared on platform

   At the start of a Lab, teenagers or students from Belgium will visit an SME in Brussels, interact with workers and get a specific challenge. Next, in the Open Media Lab of Erasmushogeschool Brussel the participants will develop VR/AR prototypes, being guided in this by artists and IT experts. The prototypes being developed will be exemplary in function and will be shared on the RAMP platform.

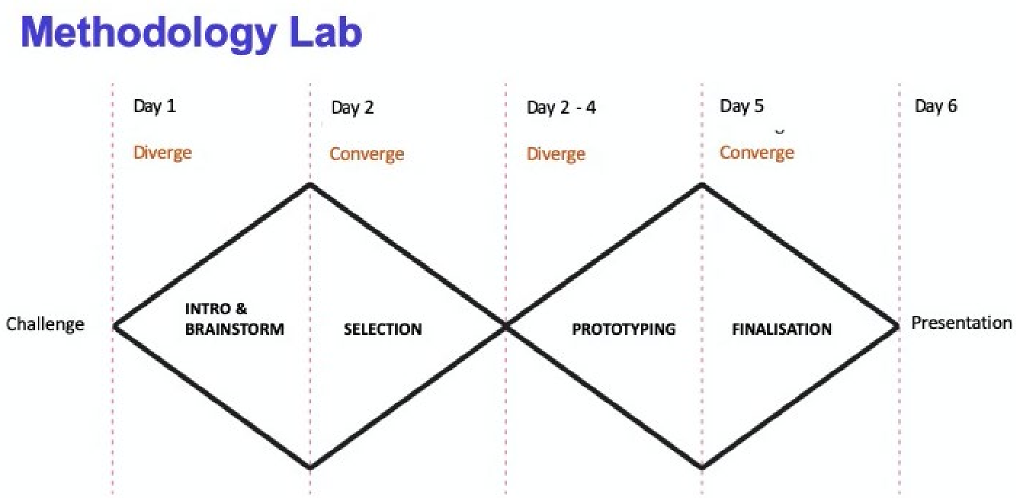

Figure 1. Methodology Lab Schedule.

The expected outcomes are:

- development of AR/VR training tool prototypes collected and uploaded to RAMP to extend the education portfolio; and
- stimulating entrepreneurship of young people and introducing them to the work floor, which supports them in making a more focused study choice.

1.3 Approach for demand analysis and methodology design

Figure 1 shows the steps followed for performing the demand analysis and designing the training methodology and skills observatory. As the figure shows, background study is the first step performed. First, it defines what a training methodology is and what a skills observatory is. Then, it explains the GoingDigital method developed at the Mobile World Capital Foundation (MWCapital), an experience upon which this task builds on. To finish, an overview of possible technical, technological, business and management topics is presented. These topics present a first overview of relevant knowledge to further direct the scope analysis during the demand analysis. The second step consists of designing the data gathering tools for performing the demand analysis. Three tools are designed, a survey for performing a customer journey, a survey for performing the scope analysis, and an interview for contrasting and validating the found results with some project members.

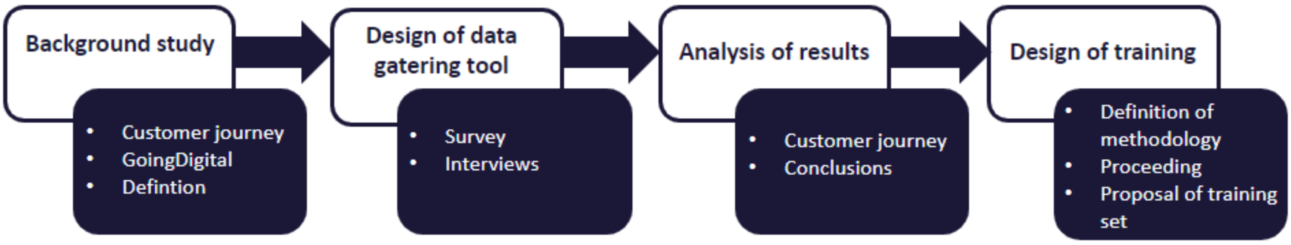

Figure 2 Approach for perming demand analysis and designing the training methodology and skills observatory.

1.4 Stakeholders' perspectives

Although the general goal as stated in the project proposal is to provide the required competence and skill development resources to enable the success of the RAMP Marketplace and the implementation of the technologies made available through it, different partners might have a different perception on how to make this feasible.

More concretely, and as shown in Figure 2, there is:

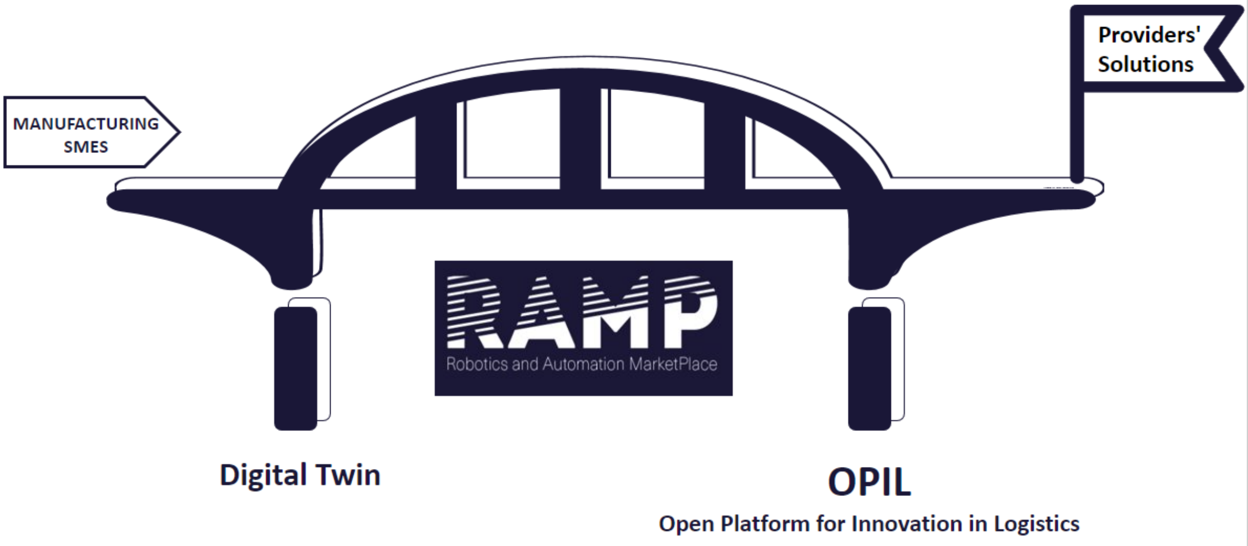

Figure 3. RAMP Trainings requirement bridge.

1.5 KPIs associated to Task 1.4

According to the GA objectives O4.1 and O4.2, the number of courses in skills repository is nine (1 per service in APPS, 1 for APPS) and the number of training sessions will be at least three per KTE's round. The objective is to do 6.

Table 1. KPIs associated to task 4.1.

Name	Description	KPIs
Nº of courses in skills repository	Extracted documents / videos from the partners work and training sessions (webinars) with SMEs selected to participate in the creation of KTEs	9 (1 per service in APPS and 1 for APPS)
Nº of training sessions	The training sessions organised will be webinars aiming to cover brand ranges of topics useful for RAMP users and other platform stakeholders	6 (At least 3 per KTEs round)
Nº of new skills covered by courses added in RAMP	Access to two skills on top of the already developed by the DIH2 and L4MS projects. This will increase manufacturing workers awareness on new technologies	2

2 Background

2.1 Skills observatory vs. training methodology

In order to understand the activities in this task, it is important to first differentiate between the two functions that are implied, namely, the ***skills observatory*** function and the ***training methodology*** function. A *skills observatory* is proactive research of skills required for adopting a new way of working or a new technology. It is also about determining to which extent those skills exist in a given sector. A skills observatory requires an initial definition of its scope and target groups. Later, as data is gathered, the scope and target groups can be adapted. The data gathering phase of a skill observatory can be performed using different research techniques, like for example literature review, surveys, questionnaires and panel discussions.

A training methodology outlines the main strategy that is used for developing skills and competences of a certain target group. The methodology does so by specifying timelines, learning objectives, training techniques, skills and competences at different levels of depth. A skills observatory and a training methodology can be coupled to each other. On the one hand, skill gaps identified with the skills observatory serve as input for structuring a training approach and for creating a training methodology. On the other hand, the deployment of the training methodology can be used to operationalize the skills observatory. It is important in this case that both are well aligned, which means that a common framework should be defined. The results presented in this report are therefore the results of an initial observatory activity, as it will determine the relevant skills in the context of IoT-based logistics automation to focus future studies on and the scope of the training methodology.

2.2 GoingDigital based methodology

The structure of both the skills observatory and the training methodology is based on GoingDigital program created by the Mobile World Capital Foundation. The method uses a customer journey analysis to define the skills required by SME users in order to successfully implement a new technology.

2.2.1 Customer Journey

A customer journey is a marketing tool, developed and used first by IDEO to support the design of services. Later, the tool became a reference for the design of other value propositions, like customer products, product-service systems, and even training trajectories. A customer journey maps the different experiences that a customer has with a product / service by identifying first and describing later the interactions of the customer with the product as well as her/his motivations and feelings during the different touchpoint phases.

A customer journey is therefore a simple, yet powerful, tool to teach an organization about its customers' needs and requirements, which can be later used to define how the organization would like its customers' experience, communication channels and touchpoints to be. The customer journey model also serves to set up the skills observatory and measure the level of skills of different company profiles in the company.

The customer journey consists of a well-defined set of customer engagement phases, a well-defined list of properties to be defined per phase and a stepwise method that can be applied for building it. A more comprehensive description of the customer journey is found in Tincher, 2013 The framework presented in this report is based on these two documents.

The phases of the customer journey are:

- Awareness: The customer becomes aware of the existence of the product or service. A design of customer journey must define touchpoints that guarantee that customers become aware of the value proposition.

Consideration: The customer has a basic understanding of the value proposition and can contrast it against personal or business criteria.

- Decision: The customer decides to engage with the value proposition, which happens as a well-defined process. The design of a customer journey needs to streamline this process and guarantee that the risk of quitting during this phase is minimized.
- Delivery and use: the customer implements the technology and makes use of it. This is when the functions of the value proposition are experienced by the customer.
- Loyalty and advocacy: Continuous engagement and feedback loops with the customer influence customer satisfaction and level of engagement with technology. On the one hand this phase consists of providing after-sales services, and on the other hand is about producing relationships that will support growth of the value proposition.

The most common properties to analyze for each phase are:

- Customer goals: what is your customer seeking at each stage of the journey?
- Touchpoints: Which channels can be defined to provide information to the customer each phase?
- Expected experience: how is your customer experiencing this phase? Typical aspects to focus on include emotional experience, problem solving perception and business perspective.

It is important to mention that there are two types of activities related to customer journeys: a customer journey analysis and a customer journey proposition. The first one analyses how customers engage with an existing product or service. The second one is about design experience. In this report, the customer journey analysis is used for structuring the observatory function, while the customer journey proposition is applied for creating the training methodology.

2.2.2 The GoingDigital Program

GoingDigital is a training program targeting industry leaders and management teams and has the goal of providing them with the required knowledge to initiate a digital transformation. The program has been developed for several verticals, like the automotive industry, agriculture, water management, civils engineering and infrastructure. The program focuses on developing the skills related to the awareness and consideration phase.

Traditionally, these two phases take a long time, and companies can easily get disengaged. Therefore, the goal is to make the customer transition during these two phases much more time effective and goal oriented. By having several management representatives of one company in the workshop, momentum is created for initiating such a transformation process. The program has the following components:

- Inspiration session: is meant to create awareness of both the technologies and the impact they can have on both the company operations and business models.
- Cases and examples: Show examples of companies that have applied Industry 4.0 technologies and their achieved gains.
- Configuration and design workings: company representatives get the opportunity to learn how to design a new value chain based on the technologies for a fictitious case. Also, the business case is worked out.
- Strategy design: the digitalization strategy is concreted, and the company gets a clear idea of the implications that the incorporation of digital technologies can have for their company.
- Networking: During the sessions, the companies are set in contact with suppliers.

The length of the duration varies between 8 hours and 24 hours, according to the complexity of the sector and the specific demands of the customers. The program was designed for ACCIO, the Catalonian Trade & Investment agency with the goal of accelerating the digital transformation of companies settled in Catalonia. Therefore, it can be seen as a business development tool, and as such, it serves as a reference for the training methodology developed in this task.

2.3 Implications for demand analysis

Following the GoingDigital approach, a ***customer journey analysis*** will be performed for understanding the perspective that different organizations have had during their engagement with the IoT-based Automated Guided Vehicle (AGV) technologies since the project started. This is especially important for understanding the different functions that the training can have. Functions vary from providing skills to being able to understand the value of a certain technology up to knowing how to operate that technology in detail. Therefore, an analysis of training functions per customer journey phase will be formulated.

As one of the final goals of the Better Factory project is to set up a successful online RAMP Marketplace, it is important to define which combination of channels will be used for providing the training and information on the project. These are so called touchpoints described in the customer journey introduction. While online training is nowadays becoming a popular channel for educational purposes, some training functions and types of stakeholders might require a face-to-face approach for reaching their learning objectives.

2.4 Knowledge scope

2.4.1 Definitions

Cyber-Physical Systems (CPS) are systems of collaborating computational entities which are in intensive connection with the surrounding physical world and its on-going processes, providing and using, at the same time, data-accessing and data-processing services available on the internet. With other words, CPS can be generally characterized as “physical and engineered systems whose operations are monitored, controlled, coordinated, and integrated by a computing and communicating core” (Rajkumar et al. 2010). The interaction between the physical and cyber elements is of key importance: “CPS is about the intersection, not the union, of the physical and the cyber. It is not sufficient to separately understand the physical components and the computational components. We must understand their interaction” (Lee and Seshia 2014).

The Science and Technology Options Assessment Panel of the European Parliament created a short video (The Ethics of Cyber-Physical Systems) which explain the ethical behaviour that implied the use of Cyber-Physical Systems since “by 2050 these systems might be, driving on our roads, moving along us in our daily lives and working within our industries”. This video allows to identify some indicators such as: **benefits and core promises of the technology, the unintended impacts, the safety, responsibility and liability, the cybersecurity, and the data storage.**

A collaborative robot, or cobot, is a type of robot intended to physically interact with humans in a shared workspace. According to the Institute for Occupational Safety and Health of the German Social Accident Insurance. Collaborative industrial robots are complex machines which work hand in hand with human beings. In a shared work process, they support and relieve the human operator. One example: a robot lifts and positions a heavy workpiece whilst a human worker welds light iron hooks to it. During this task, the operator and the various elements of the robot, such as the robot arm and tool, are near each other. The robot and the worker may come into direct contact with each other as a result. A comparable situation can be found with mobile service robots, which are being used in increasing numbers in the proximity of human beings in occupational contexts and in public or private environments.

The picture below shows the different applications of collaborative robot technology listed by the Association for Advancing Automation.

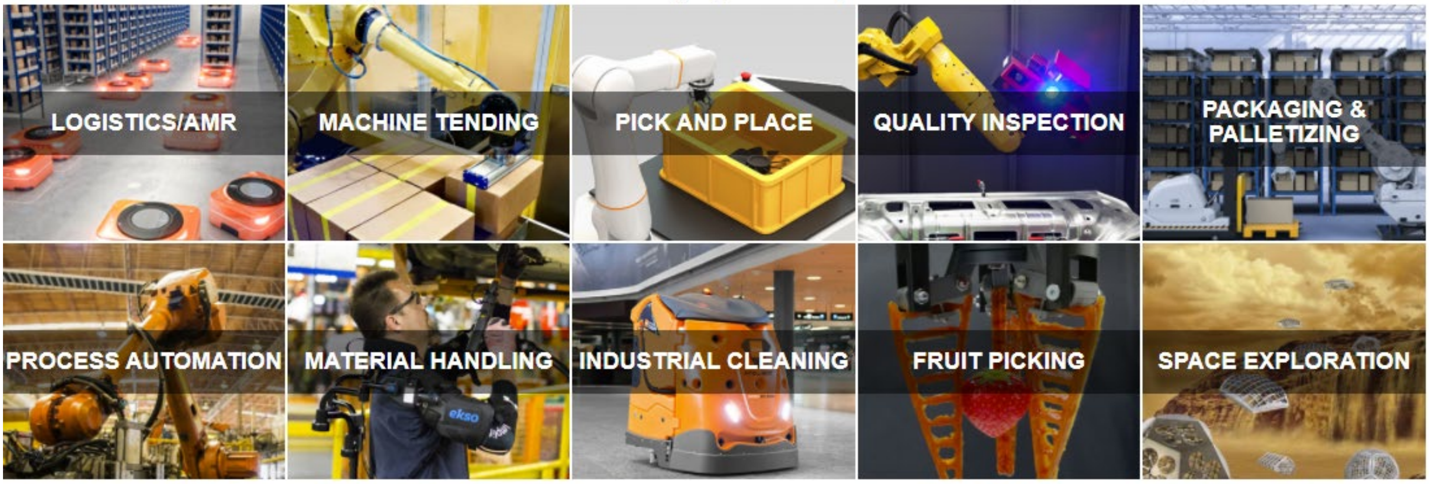

Figure 4 Applications of collaborative robot technology listed by the association for advancing automation

Force Design, a company that works for 20 years helping manufacturing industries to embrace automation, traditional industrial robots are built and programmed to do a single task at a distance from workers on the manufacturing or assembly floor. Common types include articulated arms, wheeled mobile robots, and gantry/rectilinear models, and they are often used to process large batches of single items: welding, drilling, spray application (paint, adhesive), transporting items across an area, loading and unloading heavy items. They are large, heavy, fast, and very strong, all of which make them hazardous to humans and require them to be surrounded by fencing or other barriers. Because they operate independently of the people around them, traditional industrial robots work in parallel, not in collaboration.

In addition to define collaborative robots, Force Design also provides a comprehensive guide to capabilities, safety, and applications. In this guide, some indicators can be extracted such as **safety and risk factors, implications for the workers, automation awareness and connectivity.**

Simplicity, flow and balance are the keywords that define what seems to be another new and shiny marketing concept: **Lean Manufacturing (LM) or Lean Production**. Yet, history books but more recent source Wikipedia present the multinational automotive manufacturer Toyota as the philosophy creator. Back in the post-second world wartime while the United States of America and the rest of the world were struggling to rebuild, the company which was having trouble to get materials was applying the Japanese way-of-thinking to reduce waste, improve flow and increase productivity.

In Japanese culture, Wa is a cultural concept meaning prioritising agreement and harmony over personal views. The value is about interdependence over independence, cooperation over dissent, and patience over resistance and is a guideline for all kind of interaction. To reach a system-wide efficiency, the Lean Manufacturing philosophy is looking for the entire value-chain to be harmonized, and not only a part of it, be the most performant. It is based on teamwork challenges. At the time that Toyota was running the Toyota Production System concept, there was no increase in employees' number either new equipment added. When Ford was increasing the total output increase the profits, the Japanese automotive manufacturer was doing smaller batches in order to smooth production flow in the plant.

So, what is this philosophy about? According to Takeshi Yoshida, Lean Manufacturing is not just about making a good product: "It needs to be produced in a way that is not wasteful".

The main idea of LM is to find processes and actions to reduce or eliminate Muda, which means waste but also considering the overburden, Muri and the unevenness, Mura in order to streamlining the production. The system improves quality and stability of the processes.

To seek this way of doing in the production process, the first thing to do is to identify the concepts of added-value, no added-value but necessary and waste that are the rest of activities that are not adding value to products. Here it is important to remind that the system is created first to create customer value. All the efforts are put to seek non-add value at all levels of the enterprise which can be found in defects, overproduction, waiting, not utilizing talent, transportation, inventory excess, motion waste and excess processing (DOWNTIME acronym). Each of those wastes can be avoided by applying 4 fundamental and interconnected principles:

1) Takt: the production rhythm meets with customer demand

2) Flow: smooth, uninterrupted flow

3) Pull: avoiding overproduction and inventory generation by using the production of the above phase in the production process

4) Zero defect: identifying errors or defects

There are several concepts and path to find the best way to improve productivity according to the LM. One of them is based on cleanliness and organization to organize work area: the 5S.

1. Sort (eliminate that which is not needed)
2. Set in Order (organize remaining items)
3. Shine (clean and inspect work area)
4. Standardize (write standards for above)
5. Sustain (regularly apply the standards)

The continuous improvement philosophy is composed of many other tools seeking to reduce waste such as Kanban, a strategy where employees work together proactively to achieve regular or incremental improvements in the manufacturing process or Jidoka, design equipment to partially automate the manufacturing process (partial automation is typically much less expensive than full automation) and to automatically stop when defects are detected.

The system, based on teamwork challenge and Kaizen meaning change for better, has two pillars: continuous improvement and respect for people. The benefits that can emerge can be stunning: improved employee engagement and morale, reduced operating costs and improve safety. The “Toyota-way” also allows innovation opportunities, better distribution, positioning, productivity increment, high customer satisfaction, etc.

There are numerous cases of success in many sectors. Big companies such as Nike or Intel have been applying LM in their own factories, but SMEs are also enabled to apply the philosophy. For instance, the Italian small size company studied in “Implementation of Lean Production in small-sized Enterprises” (Matt & Rauch, 2013) has employed LM methods to face predicted phase of the market cycle and started a project to improve the productivity rate. Wastes were identified when employees had to pick up the needed component themselves by leaving their work cell involving an enormous waste of time. Also, each team was responsible for the quality of the own process steps with the elaboration of standardized instructions. The application of those processes allowed the SME to increase the productivity of more than 25% overall products. To conclude, Lean Manufacturing is a methodology focused on minimizing waste within manufacturing systems while simultaneously maximizing productivity.

2.4.2 Application in the manufacturing environment

For Cyber-physical systems: According to Nexus integra, the technological company, pioneer in the implementation of Industrial IoT, for cyber-physical systems to add value to manufacturing processes, there are four steps that must be considered when implementing them:

- Connection: the main source for an intelligent factory is the data generated. It is essential to have a hyper-connected, data-intensive factory, based on a 100% secure, industrial-grade 5G network.

- Cyber level: interconnected objects must be implemented in a studied way that, through algorithms, process the data and convert it into information.
- Cognition: machine signals must be processed to convert them into information and be able to compare this information with other results. At this level, the machine monitors and diagnoses its own faults, becoming aware of potential problems.
- Configuration: the machines adapt their operation based on the information. They can modify their operation according to workloads or malfunctions.

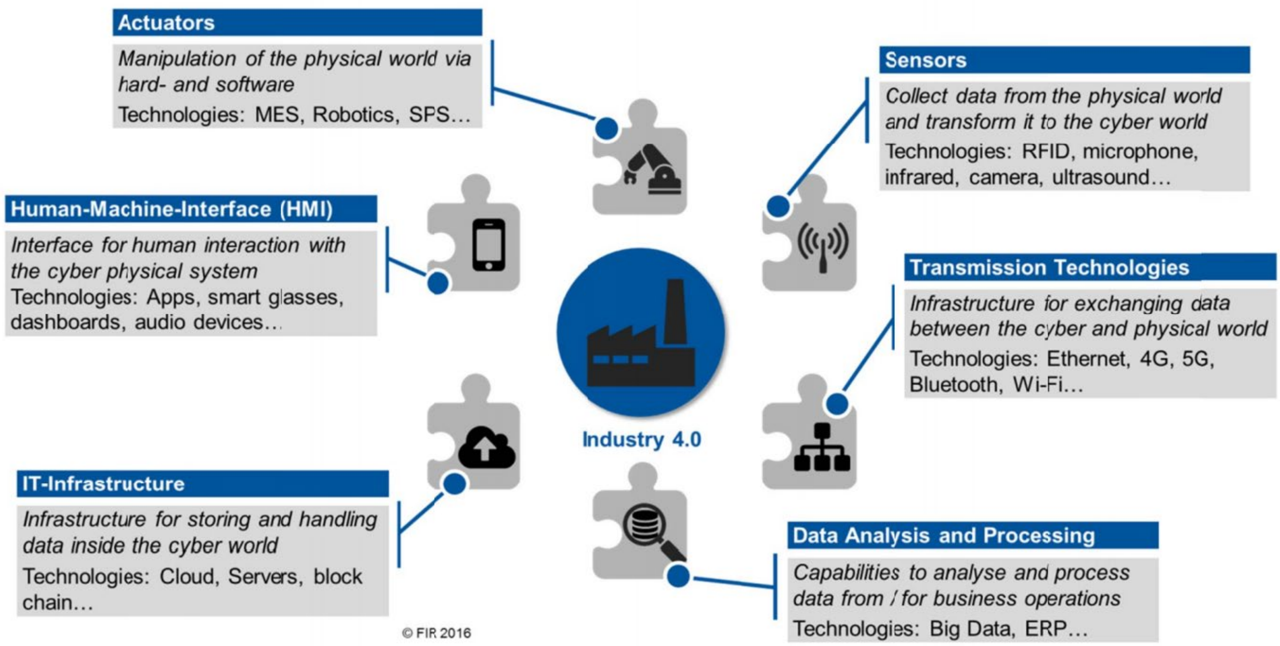

Figure 5. The six technology clusters.

For Collaborative Robot: The factory of tomorrow is implementing robots that assist humans (The Rise of Collaborative Robots in Manufacturing). Ideally, collaborative robot technology can be used in three scenarios according to the Association for Advancing Automation:

1. Repetitive and unergonomic tasks
2. Short or variable production runs
3. Collaborative environments

Rather than removing human workers from jobs entirely, explains Force Design, cobots usually integrate into the portions of a process that are repetitive or dull enough to risk errors or injury. Their small size and dexterous movement mean they make great assistants for tasks with small parts or intricate placement – the types of jobs humans do at workbenches and on the manufacturing floor. Examples include:

- pick and place (e.g. moving item from conveyor to tray)
- machine tending (e.g. injection molding or CNC machines)
- packaging and palletizing
- process tasks, when equipped with end effector tools (e.g. gluing, drilling, welding)
- finishing (sand, polish, deburr, trim)
- quality inspection, when equipped with a vision camera
- assembly
- dispensing (e.g. adhesive, lubricant, sealant)
- painting, coating, dipping

Industrial automation with collaborative robots - Pick and place

In the Kuka presentation, Collaborative Robot Technology and Applications, safety is the most highlighted argument in order to adopt the technology in the manufacturing environment.

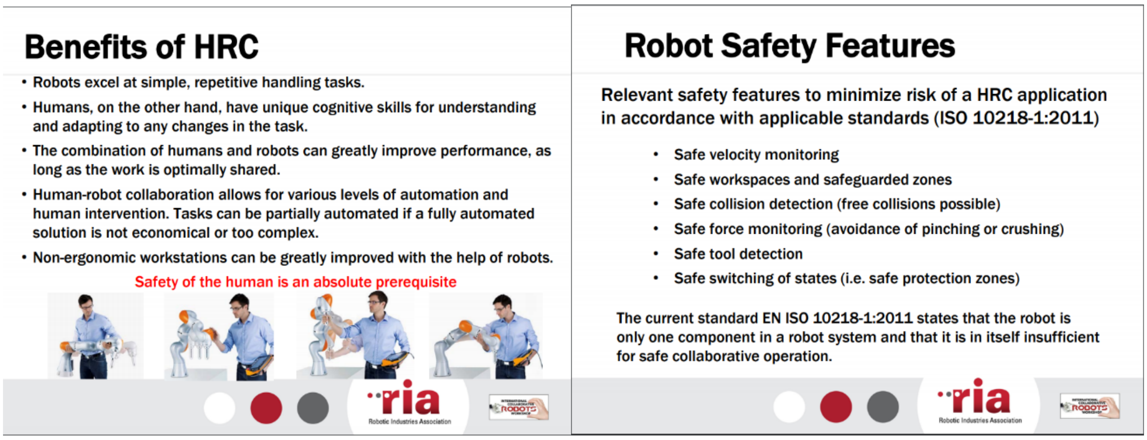

Figure 6. Benefits of HRC and Robot Safety Features representation of KUKA.

Picking, packing, and palletizing, Welding, Assembling items, Handling materials, Inspecting products for quality would be

5 Applications of Collaborative Robots in Manufacturing

2.4.3 Learning Platform

CPS and Cobot skills will be identified in learning platforms and workshop that teach those technologies; in scientific papers; and thought interviews done to technology providers. The careers option of both technologies will also be identified in order to establish the skills needed for SMEs to use them. This work will help to extract the necessity skills needed to work with those technologies but also to identify the indicators needed to develop the questionnaire and the depth interview that will be done to the SMEs that is or will integrate CPS and Cobot technologies.

Three workshop and courses have been identified:

Cyber Physical Systems Workshop | Cyber Physical Systems (CPS) Workshop (3 days)

Cyber Physical Systems Workshop, Cyber Physical Systems (CPS), a 3-day workshop on Cyber Physical Systems Security and Privacy (CPS-SPC), aims to be the premier workshop on security of Cyber-Physical Systems such as medical devices, manufacturing and industrial control, Supervisory Control and Data Acquisition (SCADA), robotics, autonomous vehicles, and smart cities. The 3-day workshop tackles security and privacy issues in Cyber Physical Systems.

- Overview of Cyber Physical Systems (CPS)
- CPS domains and security
- Cyber-attacks over Cyber Physical Systems (CPS)
- CPS cyber issues
- Data and test beds in security for CPS methods
- Success and failures in designing for resiliency
- Identify CPS tools and techniques
- Metrics for CPS security

https://www.tonex.com/training-courses/cyber-physical-systems-workshop-cyber-physical-systems-cps-workshop/

Cyber-Physical Systems: Modeling and Simulation

Modeling and Simulation provides you with an introduction to modeling and simulation of cyber-physical systems. The main focus is on models of physical process, finite state machines, computation, converters between physical and cyber variables, and digital networks.

1. Basic Modeling Concepts: Discrete-time and Continuous-Time Systems
2. Modeling Cyber Components: Finite State Machines, Computations, Algorithms, and a First CPS Model
3. Modeling Interfaces for Cyber-Physical Systems: Conversion, Networks, and Complete CPS Models
4. Trajectories in CPS and Simulations: Time Domains, Executions, and Complete CPS Models

https://www.coursera.org/learn/cyber-physical-systems-1

Cyber-Physical Systems Design & Analysis

Cyber-physical systems, such as automobiles, cars, and medical devices, comprise both a physical part and a software part, whereby the physical part of the system sends information about itself to the software part, and the software sends information, usually in the form of commands, to the physical part.

1. CPS design: Models, Low-level control, Mid- and High-level automation
2. CPS environment: Humans and CPS, Hardware-software co-design, Sensors, actuators, and processors
3. CPS engineering: General principles, Architecture and Design Language, Formal methods for Verification and Validation

https://www.udacity.com/course/cyber-physical-systems-design-analysis--ud9876

In the career options identified in order to work with cyber physical system technology, the competences will be identified. The DePaul University of Chicago listed the professionals the career options when studying Cyber-Physical Systems Engineering

- Automotive embedded software engineer,
- Computer hardware engineer,
- Cyber security analyst,
- Cyber security engineer,
- Information systems security manager,
- IT security engineer, Researcher

Cobots require no special skill or experience, but the maintenance and the programming of the machine require a training. Free online training from the Universal Robots Academy helps current employees become successful cobot programmers and integrators in less than 90 minutes. Six short interactive modules cover all the basics of robot logic, set-up, programming, interfaces, and safety. The Core training allows to learn how to manage the robot safely understanding safety concepts, to build and optimize programs for several typical applications such as pick & place, palletizing, polishing or dispensing, to connect and handle peripheral equipment, such as sensors, grippers or conveyor belts, know the online tools and resources available to help with application programming

Universal Robot (UR) in its presentation about How cobots help you bridge the automation skills gap, explains that "Cobots are one of the easiest forms of automation to deploy. They help reduce the skills gap because your existing employees can program, operate, and maintain them with no previous experience. The out-of-box experience for an untrained operator to unpack a UR robot, mount it, and program the first simple task is typically less than an hour".

Collaborative Robot Safety: Design & Deployment

This course equips you to assess the safety of a collaborative robot workcell and prevent the chances of injury or harm. It imparts industry-endorsed safety standards, technical report recommendations and best practices from the International Organization for Standardization (ISO), Robotic Industries Association (RIA) and Occupational Safety and Health Administration (OSHA). Learners are introduced to similarities and differences between traditional robots, cobots and conventional machinery before delving into risk assessments, causes of robot accidents and collaborative applications. Material also includes key design techniques for reducing collision:

1. Best Practices
2. Robots to Cobots
3. Safety-Minded Design
4. Collaborative Workcells

Collaborative Robot Training

HMK offers courses that cover topics such as an overview of the system, basic programming and vision system training. Along with this, there will feature a number of application examples, such as vision based pick & place. With many future courses already scheduled.

Cobot Training

Proper training is essential when it comes to getting your collaborative robots to perform to their full potential. For this reason, Shelley Automation is offering free in-class training courses across Canada. This ensures that Small and Medium Enterprises will also be able to maximize the potential of their cobots through complex applications in automation that raise production quality while increasing productivity with minimal additional cost and manpower requirements.

Collaborative manufacturing, techniques, system setup and deployment, grippers & end of factors for solving application, application examples for: machine tending, palletizing, material handling, inspection & assembly and more.

Cobot seminar

1. State of the art Collaborative Robots
2. Robots v.s. Collaborative Robots
3. Applications Collaborative Robots
4. How to program a Collaborative Robot?

2.5 Virtual Reality training solutions

Virtual Reality might be useful for training SME employees in simulating safety scenarios and new technologies. Research studies suggest that VR trainings might have positive characteristics compared to physical trainings. The impact of VR trainings on an SME might be positive as VR trainings might reduce the number of unsolved training errors and thereby their potential undesired consequences; they might create a risk free and injury free environment; and through simulating real-time movements they decrease the cost and risk of physical implementation.

Figure 7. Captation of a worker testing VR.

3 Data collection

3.1 Questionnaire

CPS and cobots definitions have help to identify some general indicators such as benefits and core promises of the technology, the unintended impacts, the safety, responsibility and liability, the cybersecurity, and the data storage.

- **Benefits and core promise of the technology:** the first indicator has to help understand the technology's concept and its benefits for the company. It would be important to figure out the SMEs' expectations and the possible impacts in four areas: the company, the workers, the customers, and the fourth area would be dedicated to asking about other kinds of impact such as environmental ones.
- **Implementation**: ensuring a good implementation of the technology will allow to perceive the advantages of it for what it is interesting to ask about the methodology, the steps, and the timeline thoughts.
- **Information and Data awareness:** both technologies require a high level of information and data to be correctly implemented and ensure the efficiency expected. It is essential to know if the SMEs have the knowledge and the professionals necessary to gather and analyze the data. In addition, cybersecurity is a topic that is becoming a worry for the industries that want to embrace the digitalization transformation, for it is essential to implement the right strategy with the objective to avoid possible attacks.
- **Workers' training:** the indicator has to help formulate the training needs to manage the technologies daily and ensure that all new employees who integrate the SME will easily and flexibly be active assets. Elaborating questions around this indicator will help to understand at a granularly level the SME necessity of training.
- **Workers' VR training**: this indicator will help understand what the experience, background knowledge and expectations of VR applications in SMEs are. It will be used for identifying the challenges in the development of VR training tools for SMEs.

Figure 8. Treemap of the identified indicators.

According to the indicators previously identified, the questions will be divided into four categories:

Describe the statue of your company.

1. Benefits and Core promises of the technology implementation:
    a. What will be the expected impacts for the company? (Value chain)
    b. How will the implementation of the technology affect the factory floor?
    c. What will be the expected benefits for the workers? Specify the roles of the workers that will benefit from the technology implementation.
    d. What are your workers' expectations?
    e. What will be the advantages for the final customers?
    f. What could be the other impacts of the integration of technology?
    g. What would be the challenges regarding implementation? (Negative impacts)

2. The technology implementation approach
    a. What will be the specific use of technology on the manufacturing chain?

b. How did you identify your company's main manufacturing process challenge?

c. What will be the steps you will follow for the implementation of the technology?

d. Are you aware of the implementation methodology that you will have to follow to use the technology?

e. What is the planned timeline for implementation of the technology? (Outcomes)

3. Data and information awareness

a. Where do you store your data?

b. What is the source of your data? (Owned or earned)

c. Are there any sensors on your factory floor? How do you gather, store and analyze their data?

d. Do you have a cybersecurity strategy, or do you plan to have one?

4. Workers' training

a. What is the level of education of your employees? (High school, Bachelor, Master, PhD, Occupational studies)

b. Do you have a long-life training program for your employees?

c. What is the level of experience of your employees? < 1 year, 1-3 years, 3-5 years, 5-10 years, more than 10 years.

d. What is the average age range of the employees that will work with this technology?

e. Do you know if your employees are following training courses?

f. What are the skills required to work in your company? (Depending on the roles for e.g. factory workers, engineers...)

g. What will be the requested skills to work in your company after the integration of technology?

5. Workers' Virtual Reality training

a. Does your enterprise use Virtual Reality applications?

b. In case your company is applying Virtual Reality,

- what platforms your enterprise is using;
- for what purpose;
- what was/is the overall experience;
- can you give more details about the usage of VR in your enterprise?

c. Specifically for your enterprise, do you believe that Virtual Reality can result in:

- higher profits?
- reduced working hours?
- better work atmosphere?
- more personalized products?
- better trainings?

- Safety?
- Other?

d. Do you believe that VR can be useful for training SME employees in:

- simulating safety scenarios?
- any new technology?

e. Do you believe that the impact of VR trainings on your SME might be positive on next points?

- VR trainings reduce the number of unsolved training errors and thereby their potential undesired consequences.
- VR trainings create a risk free and injury free environment.
- Through simulating real-time movements VR trainings decrease the cost and risk of physical implementation.

3.2 RAMP Ideal Customer journey

In order to identify which can be the needs of the SMEs when register to the RAMP platform, a session was organized together with Panagiotis Bouklis, customer journey specialist. The presentation of the different steps to an everyday use from the register to the project management have help to establish some of the possible needs:

1) How does a SME register to RAMP Marketplace? What happened when it registers in RAMP?

Validate legal representative when company register on the platform before being able to use RAMP. Possibility to add people to administrate the account that it is not the CEO or the responsible of the company (e.g.: head of a department).

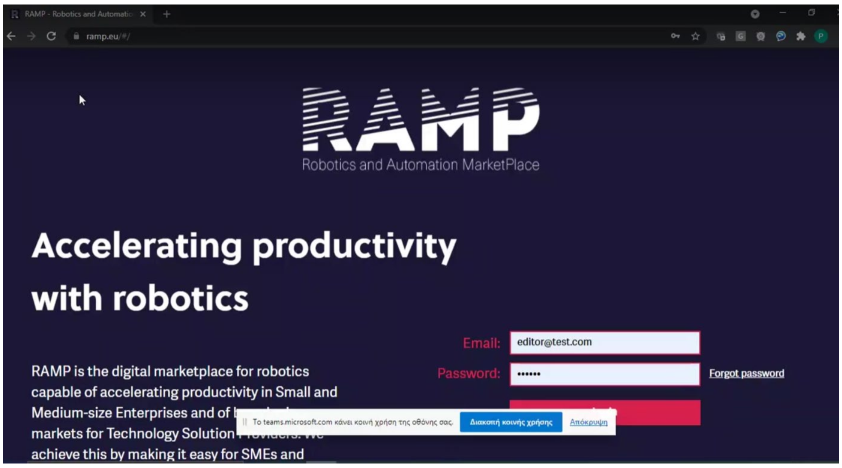

Figure 9. RAMP Marketplace register form.

2) Why does the SME need to fulfil an audit?

The Digitization Audit: Although it would take time – two to three hours – it can be relevant for the SMEs to take the audit since it will arise awareness of their company needs. Do ensure a correct assessment, it would be recommended to have the help of a more technical person.

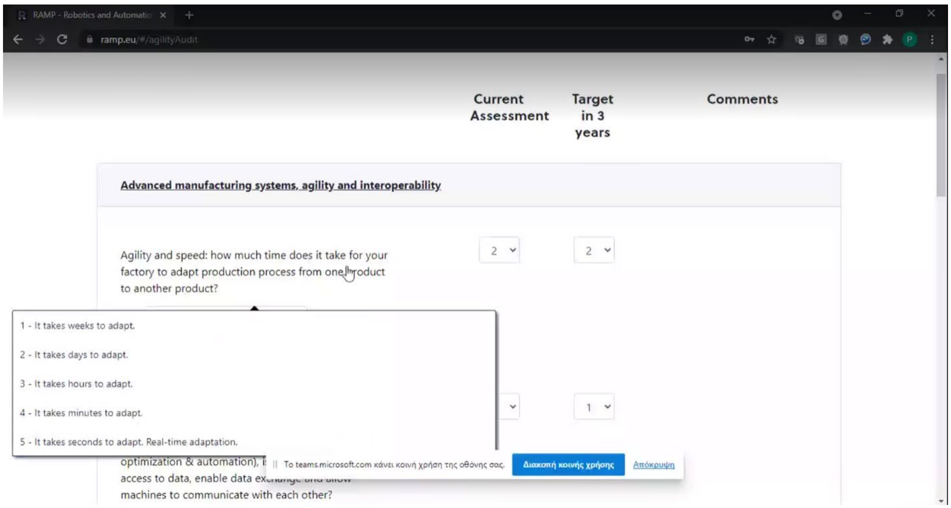

Figure 10. Digitization audit: Assessment tool on the RAMP marketplace.

3) Why Tenders tools are not public? How does the SME contact with a provider? How does it accept the offer? Does the SME can get help with the contract process?

Tenders' documents are not public; SME can invite specific suppliers/providers to answer their needs which will find in the expression of interest phase. Person details are sealed but the details can be request. Then during the proposals phase, the SME works in detail with each provider, it can exchange files or messages within RAMP to reach a contract agreement. Once accepted by the manufacturing SME, the file moves on the Contract stage. Templates are provided to assist with the contracting process.

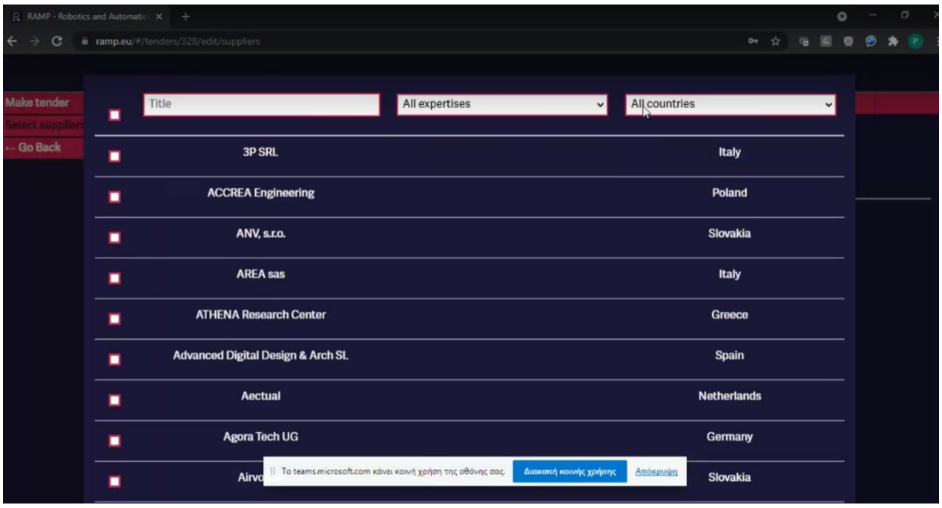

Figure 11. Tender tool interface on the RAMP marketplace.

4) Where does the SME find its files? What are the tools available?

"The section called "Project" is like a google drive but for Manufacturing SMEs". There are three different subsections available: automation, product design and consultancy. In each project created, there is the possibility of having an overview of the project (description, partners), then to access to the tools such as factory dashboard and digital twin.

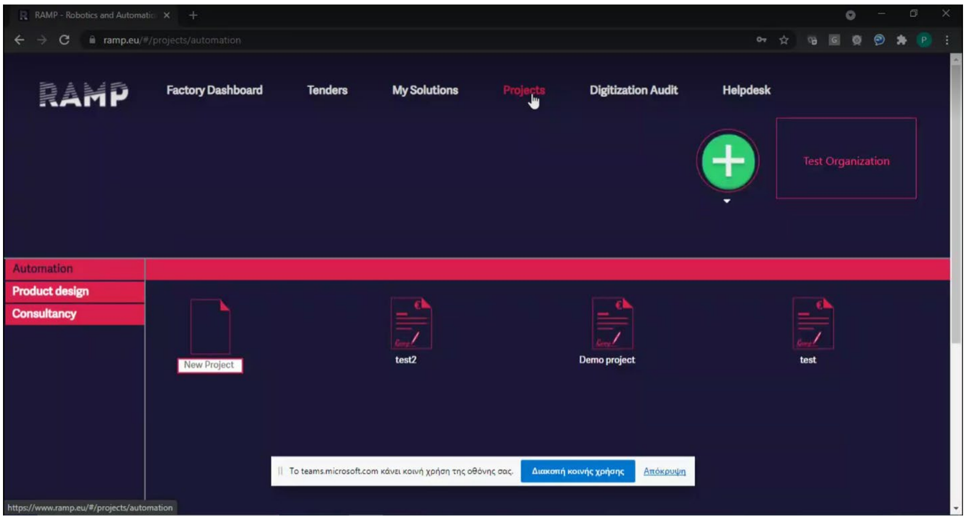

Figure 12. Project interface on the RAMP marketplace.

4 Training Methodology

Training customers and partners is fundamentally different to training internal employees. When external audiences take training, their engagement with the material is entirely voluntary, whereas internal audiences are required to complete training for the purposes of HR compliance or receiving academic credit. Furthermore, trainings in the context of the RAMP Marketplace are developed to serve other purposes than just learning how to manage operational aspects of the technologies being promoted. The trainings serve the purpose of engaging with manufacturing users and helping them in configuring conceptual solutions and business cases upon which to make the decision for implementing the promoted technologies or not. So, training is also a business development mechanism. Therefore, a customer journey approach to structuring the training methodology and skills observatory is adopted in this project.

The customer journey helps define how the technology adoption lifecycle relates to the skills development path that an organization follows when incorporating new technologies and techniques. Differentiating training trajectories of early adopters interested in self-paced learning to that of late majorities that need a more structured courseware approach is fundamental for optimizing the effect of trainings on the technology adoption process, and in the case of this project, the success of the RAMP Marketplace. The customer journey is a tool that provides good insights into these different types of organizations by simply relating them to different customer phases. In this way, by having a clear definition of skills and competence development trajectories per customer journey phase will allow approaching different company profiles with different technology adoption approaches.

4.1 Concept training methodology and skills observatory

Based on the previous results, a training methodology has been designed. The methodology is coupled to observatory activities that will allow to understand the level of current skills in the companies engaging with the RAMP Marketplace. The method is partially based on the GoingDigital methodology developed at the MWCapital and uses the customer journey as base for structuring different aspects of the training methodology. As shown in Figure 11, four levels of training are defined, each with different objectives and target groups. Furthermore, each level focuses on different decisions taken in an organization. The goal is to couple business development to skills development. Each level has different target groups, goals, skills and times. Each level focuses on a different life cycle phase of the technology. It can be applied to both the manufacturing user side as well as to the solution provider side RAMP Marketplace. This will also serve as the core structure for performing the Skills Observatory.

Furthermore, the life cycle phases of the KTEs match the 5 phases of the Customer journey. Therefore, the KTEs can be used as an environment for designing and testing the training methodology as it should be integrated in the business context of the RAMP Marketplace.

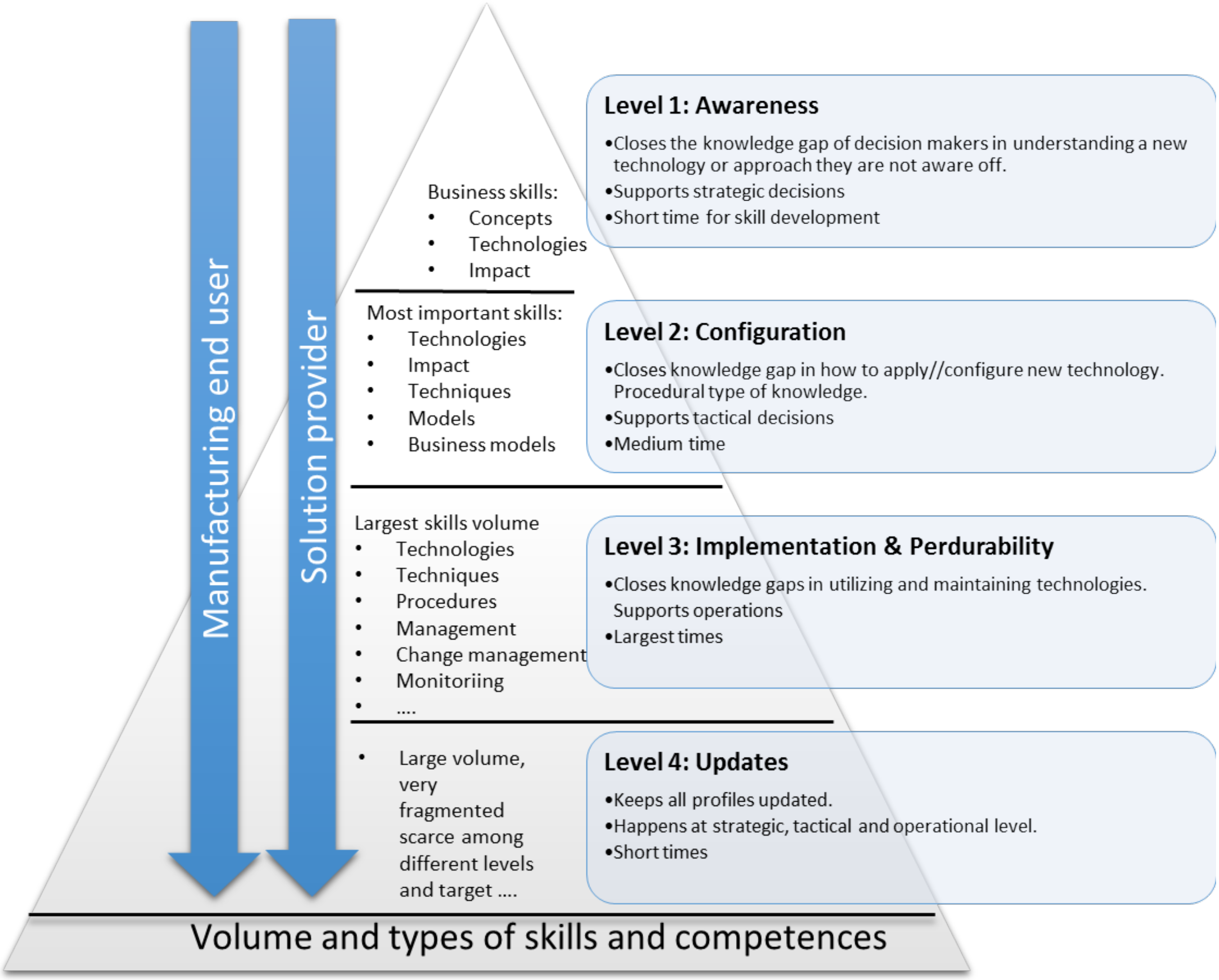

Figure 13 Volumes and types of skills and competences

4.2 Timeline

1. November (first week) [3 hours course]: 1. Technology Adoption Cycle (Juan Jauregui) 2. What is RAMP? (Contributions from Panos ED) 3. How to use RAMP for every stakeholder (MWCapital)
2. November (second week) [3 hours course]: 1. Presentation of each APPS module 2. Training about Advanced Plant Model (INESC) 3.Workshop (MWCapital)
3. November (third week)[: 1. Logistics Automation Library (OPIL) (MWCapital)
4. November (third week)[: questionnaires and focus groups (GLUON – MWCapital)
5. December: analysis results of the questionnaires and focus groups (GLUON – MWCapital)
6. January 2022: defining GLUON Lab Challenge and SME partners (GLUON – MWCapital)
7. July 2022: GLUON VR Lab (GLUON)
8. August 2022: Evaluation Lab I (GLUON – MWCapital)

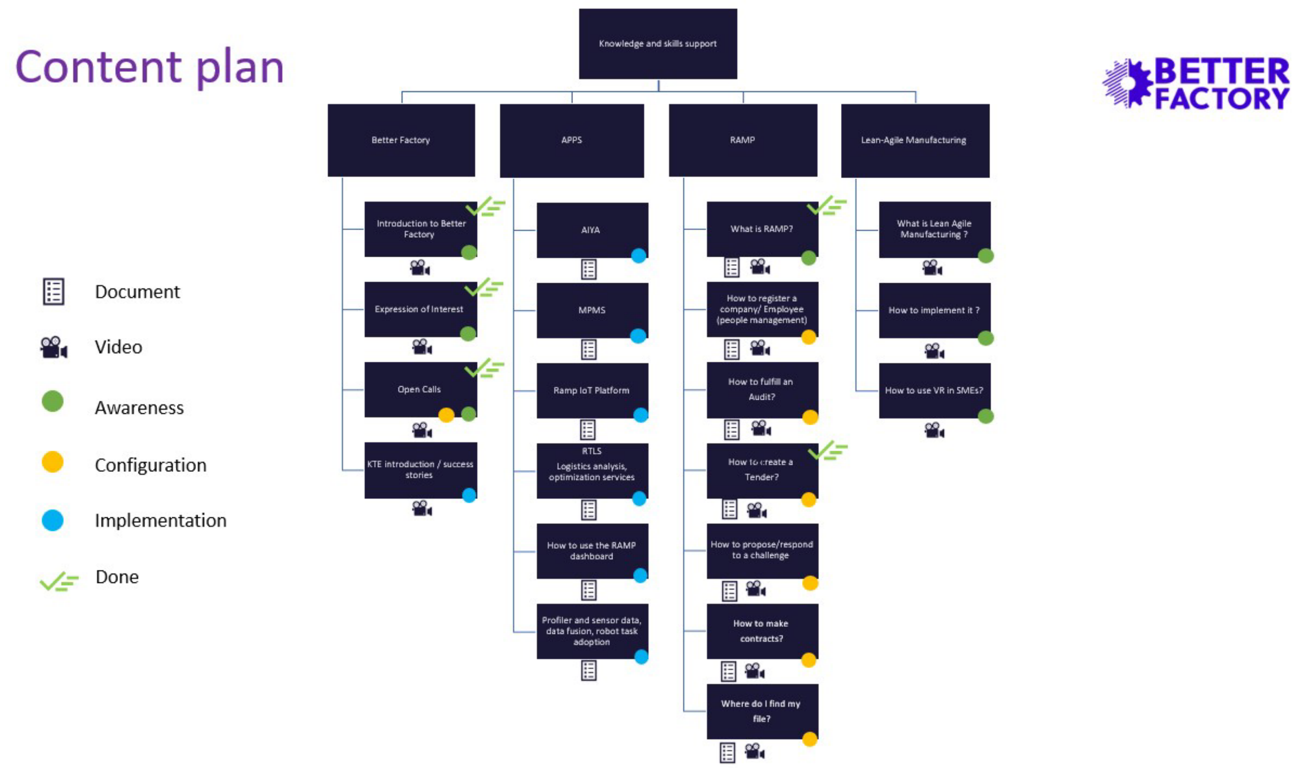

Figure 14. Content plan.

5 Conclusion

This document has presented the methodology and the training strategy that will be deployed for the Better Factory KTEs experiments to be implemented but also for the SMEs to tackle the obstacles faced when adopting new technologies such as cyber-physical and collaborative robots'. During the next weeks and months, MWCapital together with the partners involved in the task will start to organise the different steps that have been described in this deliverable.

The seven SMEs selected during the Jury day that took place on 1st of September 2021 will be contacted for the focus group to be organised. Their answers to the questionnaire will be analyzed in order to prepare the trainings that will help them integrate with ease the technologies.

Annexe 1 APPS training documentation

Type of partner	Partner	Expertise Please share with us the knowledge you are offering in Better Factory	Products The products you are offering under Better Factory for the SMEs	What will you provide to RAMP? What will you share: the documentation, the software, videos, trainings,....	URL of documentation/trainings Please share with us any online tools that will help out to understand the components you will be sharing with SMES, such as github, youtube videos...	What SMEs need to learn?	What contents should we create as trainings for Better Factory?	What do you think SMEs challenges will have when using your tool?
Competence Center	VTT	IOT Platform	RAMP IOT Platform	The software and components of OPIL Logistics Automation Library	https://opil-documentation.readthedocs.io/en/latest/	Automated Logistics	documentation and introductory videos created	
Competence Center	FHG	Cyber-Cognitive Intelligence, CPS	Digitools					
Competence Center	AIMEN	Optimization, Collaborative HRI						
Competence Center	SUPSI	Cognitive Autonomous Systems	Fatigue Monitoring System, Intervention Manager	The Fatigue Monitoring System (FaMS) and the Intervention Manager (IM), that are two elements not designed to be bought off the shelf.	https://www.youtube.com/watch?v=D5NyPhOE3DY	SMEs will have to integrate the involved components in their production processes.	Video, Bets Practices, Handbook	1) Informing workers properly about scope of the solution and how it can positively affect their well-being; 2) Training the system through data collection campaigns; 3) Redesigning their processes so that they can exploit the potential benefits of the proposed software package.
Competence Center	NCR	R&D in robotics and automation	N/A	Logistics Optimization in OPIL library	https://opil-documentation.readthedocs.io/en/latest/	How to use and implement OPIL library	Basic courses and demonstrators of OPIL library (something very similar to this: https://www.plant-simulation.de/schulungen/tutorial/tutorial-chapter1/	1. Complexity of installation of the related libraries 2. Understanding of how to digitalize material transport in their production system
Competence Center	CUT	Robotics, Logistics Optimization	Logistics Optimization software which handles some aspects of material flows from an optimization viewpoint	Business Process Optimization (software)	https://github.com/rcdslabcut/mod.sw.bpo	The user needs to specify the system capabilities, the system constraints and the end result he\she wish to have		To provide optimized solutions to solve the motion task sequencing problem while minimizing the infrastructure logistics resources required and the total cost of the task.
Techonlogy suppliers	GESTALT	Cognitive HRI	AI advance Human monitoring system					
Techonlogy suppliers	Infotech	Logistics Optimization	RTLS	Logistical flow optimisation		To interpret the data provided by our system.	Use cases from other users · It is nearly certain their challenges will be similar.	Making a decision based on the results.
Techonlogy suppliers	ED	Process modeling	MPMS		https://docs.camunda.org/manual/7.14/	BPMN	How to model a process using BPM notation	Getting familiar with moving from business level model to executable model
Techonlogy suppliers	INESC	Digital representation of an assembly or logistics area and simulation of the operation of robotic manipulators	3d digital twin	Service letting user create the digital representation of a manufacturing or logistics area and simultate the operation of robots. The tool provides training material: instructions and videos	https://vcese09.inesctec.pt:8450/ (need to use a RAMP account to enter into the Tool)	To create CAD models (i.e. STEP) of the physical objects they want to represent in the Tool (equipments, logistic containers, etc). The steps within the Tool to create the digital representation.	How to create a digital area. How to implant objects o the physical area. How to add new objects to the Catalogue.	How to create CAD (STEP) models of physical objects comprising the manufacturing area
Techonlogy suppliers	HLX	IoT Integrator	Graphana dashboard creation	Creation of graphana dashboard based on requirements	/	How to use and navigate into graphana. Define what they want to see in graphics	Graphana briefly explanation	Understand tool functioning, defining what they want to visualize
Techonlogy suppliers	TDS	data driven AI software	AIYA					
Technology coordinator for APPS	HLX	Leadership of APPS developments	Leading WP4 APPS development, check and guide other partners' work	Documentation in a deliverable, including all what we'll do	/	/	/	/
Techonlogy suppliers	HLX	Sensing layer	Sensing layer development	Documentaiton, software back end	/	It's in back end	Document including sensing layer developed	/

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