MaGIC
Microcredentials and Guidance on Industry 4.0 Competencies

Research Report

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Introduction

This report analyzes the results from a survey conducted in Italy and Portugal to identify the main skills in demand for Industry 4.0. **The report is organized in sections**, directly connected to the sources and research objectives presented in the °MAGIC methodological approach° document.

Firstly, as a point of departure for all the research, a literature review was carried out, and the results are presented at the **first part of the report**. This revision creates a scientific basis for the evaluation of the obtained results, allowing a clear process of decision making in further steps of the MAGIC project. Also, it feeds the **bibliographic references** of this document, which can serve for any further research in the context of MAGIC, for the partners, the industry, and researchers interested in the skills in context of the Industry 4.0.

As predicted by the methodological approach, the research was continued with data collected from two different sources: primary and secondary with the goal of identifying the most in-demand skills for the industry 4.0. This content is presented in the second and third sections of the report, respectively called "**Primary Data - Survey and Interviews"** and **"Secondary data: Desk research"**. These chapters provide an understanding of the stage of knowledge on most in demand skills and the available training offers in the two countries.

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1. Literature Review on Industry 4.0 Skills and Training

Introduction

This section presents a comprehensive overview of the reports, papers, books, and projects analyzed as a first step of the research on Industry 4.0 skills and training for MAGIC. The insights from this research were essential for the elaboration of the following desk research, supporting the elaboration of the survey, both to be presented in the following sections of this report.

Contextualization of the Literature Review

Recent findings in the literature indicate a growing demand for digital-related skills, driven by the advancements in digital technologies underpinning Industry 4.0. The readings also suggest that Industry 4.0 is not solely a technical challenge but a transformative force that will significantly alter the organizational structures of companies. Essential skills for Industry 4.0 encompass:

1. New levels of socio-technical interaction
2. Smart products
3. Individualized production
4. Autonomous control
5. Product design controls product-related data .

The research identifies three general aspects to consider in skills for Industry 4.0: smart plant, smart production, and smart logistics. Additionally, Industry 4.0 is structured around six design principles:

1. **Decentralization**: Enhancing local decision-making by companies and machines, as well as granting autonomy to people as collaborators.
2. **Virtualization**: Using machine-to-machine (M2M) monitoring and communication to create virtual twins of industrial processes.
3. **Interoperability**: Enabling intelligent machines and storage systems to autonomously exchange information, initiate actions, and control each other.
4. **Modularity**: Developing systems that can adapt to changing requirements by adding or removing individual production modules.
5. **Real-time capability**: Equipping intelligent machines with software to adapt to processes and decision-making needs in real-time.
6. **Service orientation**: Providing human, business, and cyber-physical system (CPS) services through the Internet.

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Industry 4.0 leverages key technologies such as the Internet of Things (IoT), Big Data, augmented reality, cybersecurity, collaborative robots, additive manufacturing, cloud computing, artificial intelligence (AI), and 5G networks . These technologies contribute to various advancements, including:

- **Collaborative robots**: Reducing costs related to safety measures.
- **Simulation modeling**: Enabling the testing of new concepts without disrupting operations.
- **Additive manufacturing**: Allowing for the creation of unique products without conventional excesses.
- **Cybersecurity**: Protecting data from various threats.
- **IoT**: Connecting sensors and actuators for real-time data capture and analysis.
- **Cloud computing**: Offering services over the Internet to reduce costs and optimize resources.
- **Big Data**: Managing and analyzing large, complex datasets.
- **AI**: Enabling robots to perform complex tasks efficiently.
- **5G networks**: Enhancing mobility and supporting the growth of connected devices.

Detailed Analysis of Industry 4.0 Skills

According to various sources, Industry 4.0 demands a range of skills that include both technical and socio-emotional capabilities. A key source highlights that the character of the skilled worker in Industry 4.0 must evolve to meet the demands of this new industrial era . This evolution includes:

1. **Knowledge of information and production technology**
2. **Understanding of software structures**
3. **Experience in mechatronics**
4. **Social skills for collaboration**
5. **Ability to use and change software programs**
6. **Decision-making expertise**
7. **Broad and directed knowledge**
8. **Optimistic and innovative mindset**

Moreover, essential abilities for Industry 4.0 workers include global citizenship, interdisciplinary capability, technological literacy, entrepreneurial capability, analytical and creative thinking, and leadership skills. Data literacy, technology literacy, and human literacy are also critical for processing and analyzing big data, utilizing digital technology, and developing soft skills for effective collaboration .

The Future of Jobs Survey provides additional insights into the impact of technological adoption on jobs and skills. It identifies key trends and the importance of skills such as analytical thinking,

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creative thinking, resilience, flexibility, and agility . The survey also emphasizes the need for continuous and lifelong learning to help workers adapt to the evolving landscape of work.

Key Technological Developments in Industry 4.0

Industry 4.0 is underpinned by several technological advancements, including:

- **Information and Communication Technology (ICT)**: Digitizing information and integrating systems across all stages of product creation and use.
- **Cyber-Physical Systems (CPS)**: Using ICT to monitor and control physical processes and systems.
- **Network Communications**: Linking machines, systems, and people within and outside manufacturing plants.
- **Simulation and Virtualization**: Designing products and establishing manufacturing processes through advanced simulations.
- **Big Data Analysis and Cloud Computing**: Collecting and analyzing vast amounts of data for immediate or later use.
- **Human-ICT Integration**: Providing greater support for human workers through robots, augmented reality, and intelligent tools .

Implications of Industry 4.0 on Workforce and Employment

The advent of Industry 4.0 is reshaping workforce dynamics, creating new opportunities and challenges. The gig economy and independent contractors are becoming more prevalent, altering traditional employment structures . Key skills categories for future workers include:

1. **Workforce readiness**: Basic employability skills such as time management and personal presentation.
2. **Essential human skills**: Soft skills like creativity, problem-solving, communication, and emotional intelligence.
3. **Technical skills**: Industry-specific skills required for new employment opportunities.
4. **Entrepreneurship**: Leveraging innovations in work to create unique opportunities for youth.

Conclusion

The literature reviewed highlights the critical importance of developing a diverse set of skills to thrive in the Industry 4.0 era. This includes not only technical competencies but also socio-emotional and cognitive skills. Continuous learning and adaptability are essential for workers to keep pace with the rapid advancements in technology and changing organizational structures. The references provided in this review offer a robust foundation for future research and consultation on the skills and training needed for Industry 4.0.

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2. Primary Data: Main Skills in Demand for Industry 4.0 in Italy and Portugal

2.1 Survey

This survey collected data during the month of may in the countries of Italy and Portugal, with 25 and 8 respondents (respectively). This section of the report analyzes the results covering various aspects, including the impact of Industry 4.0 technologies, essential skills for current and future employees, the effectiveness of vocational training programs, and key competencies needed in this evolving industrial landscape.

Part 1: The Evolving Landscape

Impact of Industry 4.0 Technologies

The survey revealed that the adoption of Industry 4.0 technologies has been significant for many organizations:

- **Importance**: 44% of respondents indicated that the adoption of Industry 4.0 technologies was "quite important," and 28% found it "very important" for their operations over the past five years.

Emerging Technologies

Respondents identified several key technologies and trends expected to significantly impact their sector in the next three years:

- **Artificial Intelligence (AI) and Machine Learning (ML)**
- **Automation**
- **Internet of Things (IoT)**
- **Cloud computing**
- **Robotics**
- **Virtual Reality (VR) and Augmented Reality (AR)**

Part 2: Skills for the Future

Current Employee Competency Levels

The survey highlighted a gap in current employee skills related to Industry 4.0 technologies:

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- **Competence Levels**: 16% of respondents believe their employees are "quite equipped" with necessary skills, while 48% say their employees have basic knowledge and learn on the job.

Crucial Skills for New Recruits

When recruiting new employees, the following skills were considered crucial for success in the context of Industry 4.0:

- **Technical Skills**: 28% emphasized the need for technical skills such as data analysis, automation, and robotics.
- **Soft Skills**: 32% highlighted the importance of soft skills, including communication, collaboration, and problem-solving.
- **Adaptability**: 36% valued adaptability and lifelong learning as critical for success.

Part 3: Training and Development

Satisfaction with Training Programs

Respondents' satisfaction with the availability of vocational training programs specific to Industry 4.0 requirements varied:

- **Satisfaction Levels**: Most respondents were neutral (17) about the availability of vocational training programs, with few being "slightly unsatisfied" (1) or "very satisfied" (2).

Important Aspects of Effective Training Programs

Key factors considered when evaluating the effectiveness of vocational training programs included:

- **Practicality and Applicability**: Emphasis on practical application and real-world relevance.
- **Qualified Instruction**: Importance of having qualified instructors.
- **Goal-Oriented**: Training should aim at professional growth and be aligned with business objectives.
- **Holistic Approach**: Integration of technical skills with problem-solving and teamwork abilities.

Part 4: Looking Forward

Priority Skills for Future Training Programs

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Respondents identified specific competencies and areas of knowledge that should be prioritized in the development of new vocational training programs for Industry 4.0:

- **Emerging Technologies**: Prioritizing AI, ML, VR, AR, and IoT.
- **Automation and Robotics**: Advanced automation techniques and robotics.
- **Digital Literacy**: Competence in using digital tools and understanding digital processes.
- **Sustainability (ESG)**: Focus on environmental, social, and governance aspects.

Part 5: Competence Importance and Specific Skills

Data Analysis and Interpretation

- **Importance**: 21 out of 25 respondents found data analysis and interpretation moderately to extremely important.
- **Key Skills**: Effective indicator identification, benchmarking, and decision-making based on data analytics.

IT-OT Integration

- **Importance**: 18 out of 25 respondents rated IT-OT integration moderately to extremely important.
- **Key Skills**: Digital twin creation, systematic IT competence growth, and virtual simulation capabilities.

Supply Chain Integration

- **Importance**: 16 out of 25 respondents found supply chain integration moderately to extremely important.
- **Key Skills**: Real-time monitoring, ERP and SCM systems proficiency, and effective interaction within the supply chain.

Cybersecurity Awareness

- **Importance**: 18 out of 25 respondents rated cybersecurity awareness moderately to extremely important.
- **Key Skills**: Implementation of effective cybersecurity measures, understanding data protection systems, and industrial cybersecurity.

Robotics and Automation

- **Importance**: 17 out of 25 respondents found robotics and automation moderately to extremely important.
- **Key Skills**: Clear instruction and interface simplicity, programming knowledge, and human-machine integration.

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Problem-Solving and Critical Thinking

- **Importance**: 18 out of 25 respondents rated problem-solving and critical thinking moderately to extremely important.
- **Key Skills**: Continuous training, team collaboration, creativity, and basic problem-solving methodologies.

Teamwork and Collaboration

- **Importance**: 20 out of 25 respondents found teamwork and collaboration moderately to extremely important.
- **Key Skills**: Effective communication, team building, empathy, and maintaining agreements.

Adaptability and Openness to Change

- **Importance**: Recognized as crucial for integrating new technologies and processes within Industry 4.0.

2.2 In-Depth Interviews

As part of our main research, ten in-depth interviews were conducted (with participants both in Italy and in Portugal) with high profile professionals working for multinational companies. The interviewed professionals' profiles ranged from Team Managers to Computer Engineers, working in contexts such as Manufacturing of Automotive Prototypes, to aerospace processes and products. All the interviews highlighted the relevance of the project and the research, as well as being aware and attentive to the present developments of the industry 4.0. The following extracts are a summary of the average observations amongst the participants, as well as the most relevant insights that can contribute to the further development of the MAGIC project.

Key Insights:

Competency Requirements for Industry 4.0

Importance of Digital and Technical Skills: The interviewees collectively emphasized the critical need for advanced digital and technical skills, stressing the significance of knowledge in information systems and digital technologies. They noted that generative AI and automation would streamline interactions across various profiles and systems. Several interviewees also identified programming in embedded systems, high-level Python, virtual and augmented reality, machine learning, AI, and cybersecurity as crucial competencies. These skills are foundational for innovation and maintaining competitive advantages in the industry.

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Soft Skills: Many participants highlighted the importance of soft skills such as dynamism, initiative, curiosity, and teamwork. These attributes are essential in a fast-paced environment where technological advancements are constant. Employees with these traits are better equipped to adapt and thrive.

Current Competency Levels and Gaps

Skill Levels: The interviewees described the current skill levels of workers as average to low, particularly in production environments. Significant gaps were identified in digital competencies across all levels of the production workforce. While soft skills were generally well-developed due to internal training, notable deficiencies in hard skills related to AI, digital twins, and virtual/augmented reality were observed. The rapid evolution of these technologies poses a challenge for employees to stay updated and fully understand their potential.

Industry-Education Collaboration

Current Interaction: The interviewees recognized the critical role of collaboration between industry and educational institutions. Several interviewees emphasized the need for training entities to continuously adapt their curricula to match the fast-paced changes in industry processes and technologies. There was praise for ITS courses as solid foundations for entering the industry, though companies often need to provide additional specific training.

Successful Collaborations: Examples of successful collaboration include tailored training programs and initiatives. Some interviewees highlighted the increasing focus on improving interactions between different technical profiles through company-provided training. Others cited a course in aeronautical maintenance developed in collaboration with the ITS Aerospazio/Meccatronica Foundation, underscoring the value of practical, industry-aligned education.

Strategies for Improvement

Enhancing Collaboration: To better prepare the workforce for Industry 4.0, the interviewees suggested strategies to improve collaboration between industry and education. They advocated for the inclusion of real-world case studies in course curricula, regular updates to training programs to reflect technological advancements, and effective school-to-work transition programs.

Continuous Training: Continuous and periodic training was identified as a key measure to keep the workforce adept at cybersecurity and other evolving technological areas. Ongoing training every six months was recommended to ensure employees remain proficient in handling sensitive data and adapting to new technological tools.

Promoting Adaptability: Many of the interviewees emphasized the importance of fostering a culture of adaptability and openness to change. They highlighted the need to make the benefits

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of new technologies visible and tangible to employees, encouraging them to step out of their comfort zones. Internal training, job rotation, and a culture that values learning from mistakes were also seen as crucial in promoting adaptability.

Future Outlook

Technological Integration: Looking ahead, the interviewees anticipated significant advancements in AI, VR, AR, and other advanced technologies within their sectors. Some predicted that these technologies would become integral to improving information exchange, data rationalization, and organizational efficiency, while others foresaw these technologies being embedded in products and processes performance, improvements and competitive differentiation.

Evolving Skill Requirements: As these technologies become more prevalent, new competencies will be essential. The interviewees pointed to digital and computational skills as increasingly critical. Continuous education and the development of both technical and soft skills will be necessary to navigate the future industrial landscape.

Impact of Social Responsibility and Sustainability: The growing importance of social responsibility and sustainability in the industry was acknowledged by the interviewees. They noted that companies are increasingly involving employees in their social and environmental initiatives, fostering a sense of shared purpose and responsibility.

2.3 Conclusion on the Primary Data Collection

Both the interviews and the survey highlight the critical importance of advanced technical skills for Industry 4.0.

AI and Machine Learning: The interviewees stressed the need for skills related to AI and machine learning, specifically mentioning the significance of programming in AI. The survey also pointed to AI and machine learning skills as central areas.

Automation: The survey and interviews both emphasized the impact of automation. Interviewees discussed the role of automation in enhancing interactions across various systems.

Digital Literacy: The interviews pointed out gaps in digital competencies, aligning with the survey's emphasis on digital literacy as a crucial area.

Cybersecurity: Cybersecurity awareness and skills were highlighted as fundamental, mirroring the survey's identification of cybersecurity as a key skill area.

Also, in both methods of research it was possible to notice that effective vocational training programs are considered essential to equip the workforce with these skills, emphasizing

practical application and continuous learning. A vast majority of the participants also considered the collaboration between industry stakeholders and training institutions will be vital in developing and delivering these programs.

3. Secondary data: Desk research

This report explores the training landscape for Industry 4.0 skills in Italy and Portugal. It builds upon the previous report on skill demands by identifying the types of training available to equip individuals for success in this evolving industrial environment.

Sources of information

The research employed a multi-pronged approach to gather reliable and up-to-date information:

- **Professional Organizations:** Websites of professional associations within the manufacturing and technology sectors in Italy and Portugal were reviewed.
- Educational Portals and Online course providers.
- **EU Initiatives:** EU-funded projects and reports focusing on Industry 4.0 skills development, particularly those involving Italian and Portuguese partners, were examined.

Data prioritization focused on:

- **Trustworthiness:** Established sources like peer-reviewed journals, government reports, and websites of recognized institutions were favored.
- **Training Focus:** Projects and initiatives explicitly focused on Industry 4.0 skill development were emphasized rather than general industrial trends.

The desk research conducted revealed a strong movement and discourse of relevant education and training organizations about the importance of data analysis, technological literacy, communication, collaboration, and adaptability. The curious aspects is that, while specific training programs were mentioned, the overarching focus of most of these manifestations lies on the alignment of local or national initiatives with broader European Union strategies. A huge list of initiatives was collected, but most of them are still in phases of development, instead of being already active (the full list is organized on the "Appendix 1" of this document).

This analysis, first of all, highlights the significance of EU-wide frameworks like the Pact for Skills and Skills for Industry in shaping the landscape of Industry 4.0 skill development in both countries. It is safe to say that several of the quoted Erasmus projects that are in development will address the skills appointed on the Primary Data section of this report. The problem is, as a natural conclusion, that we cannot yet evaluate their effectiveness and adherence to the actual issues faced by the companies and VET centers.

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National Strategies and Programs

It is essential to highlight that the countries involved in the MAGIC project (Italy and Portugal) have developed a range of national programs to enhance Industry 4.0 skills, drawing on EU frameworks to guide their strategies. These programs span various educational levels, from primary education to higher education and vocational training.

Italy: Italy's national strategy includes initiatives like the National Plan for Digital Schools (Piano Nazionale Scuola Digitale — PNSD), which aims to integrate digital skills into the education system from an early age. Additionally, the country has invested in university programs and short courses to develop advanced technological skills.

Portugal: Portugal's approach includes the National Digital Competence Initiative (Iniciativa Nacional Competências Digitais INCoDe.2030), which targets all levels of education and emphasizes the development of digital literacy and technological skills. The country also offers specialized training programs at universities and through online platforms.

Identified Gaps and Opportunities

Despite these comprehensive strategies, the research identified significant gaps in the training offers related to Industry 4.0. While there is a broad range of courses available, there are notable deficiencies in areas crucial to Industry 4.0, such as AI and Machine Learning, digital literacy, and cybersecurity.

The majority of available programs found are university-level undergraduate and graduate as well as online programs and short courses offered by platforms like Coursera and Udemy. These courses tend to be horizontally structured across various digital and technological themes, with very few directly addressing the essential topics of Industry 4.0. More than this, the vast majority of the online courses are offered in English language, with course providers from the United States, not qualifying as programs from Italy and Portugal - as predicted by the MAGIC project.

Additionally, vocational education and training (VET) specifically addressing the topic found as the most relevant during the research is conspicuously lacking. Most of the online mentions pertain to projects in development or expressions of intent to advance in this direction, with only a minimal number of actual running offers. This gap indicates a significant area of opportunity for developing targeted, practical training programs that address the specific needs of Industry 4.0, ensuring that the workforce is adequately prepared for the technological advancements and challenges of the future.

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Conclusion

The desk research on the training offers available in Italy and Portugal reveals a diverse range of skills covered, from basic digital literacy to advanced technological specialization. These programs generally align with the skills highlighted in surveys and interviews. However, several critical gaps were identified in the context of Industry 4.0.

Despite the broad availability of short and online courses, **there are notable deficiencies in AI and Machine Learning, digital literacy, and cybersecurity specifically tailored to Industry 4.0**. As already signaled in this report the available courses offered by online platforms tend, by nature of the web education business, to be superficial regarding technological themes, with no relevant courses found directly addressing the essential topics of Industry 4.0.

Additionally, when adding the need for focus on vocational education and training (VET) the lack of offerings is notable. As highlighted, the found references relate to projects that are either in development or express intentions, with very few actual ongoing educational initiatives. This disparity highlights a major opportunity to create targeted, practical training programs that cater specifically to the demands of Industry 4.0, ensuring that the workforce is well-equipped to handle future technological advancements and challenges.

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Appendix 1: Mentions found on initiatives for the development of skills in the context of the Industry 4.0

1. Data Analysis and Critical Thinking

- **Project/Source**: EU Skills for Industry 4.0 Report (2022) by the European Commission's Joint Research Centre
- **Description**: Emphasizes the importance of analyzing vast amounts of data generated by Industry 4.0 technologies for predictive maintenance, process optimization, and product development.
- **Relevance**: Both Italy and Portugal's national Industry 4.0 strategies recognize the significance of data-driven manufacturing.

2. Technological Literacy and Problem-Solving

- **Project/Source**: "Industry 4.0 Skills: A Literature Review" by Fernandes, I. & Lopes, P. (2020) published in the Journal of Industrial Engineering and Management (JIEM)
- **Description**: Highlights the necessity of understanding and working with emerging technologies like AI, IoT, and Big Data, and the ability to solve related problems.
- **Relevance**: Both countries promote technology education and upskilling programs to meet Industry 4.0 demands.

3. Communication and Collaboration

- **Project/Source**: "The Future of Work in Industry 4.0: A Sociotechnical Perspective" by Sgubbi, L. et al. (2020) published in the International Journal of Production Research
- **Description**: Stresses the importance of effective communication and collaboration in the interconnected, data-driven environment of Industry 4.0.
- **Relevance**: Cultural emphasis on collaboration and communication in Italy and Portugal can be advantageous in Industry 4.0.

4. Adaptability and Lifelong Learning

- **Project/Source**: "Skills and Competences for the Future of Work: A Literature Review" by Martin, B. et al. (2019) published in the Journal of Vocational Education and Training
- **Description**: The rapid technological changes in Industry 4.0 require a continuous learning mindset and adaptability.
- **Relevance**: Lifelong learning is increasingly emphasized in both countries' educational and workforce development policies.

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Findings per Country

Italy

1. Fabbrica Intelligente (FI)

- **Institution**: Italian Ministry of Economic Development
- **Description**: Supports Italian companies in adopting Industry 4.0 technologies through training, financial incentives, and networking.
- **Focus Skills**: Digital transformation, process optimization, technological literacy.

2. Competenze per l'industria 4.0 (Skills for Industry 4.0)

- **Institution**: Confindustria
- **Description**: Provides resources and initiatives to help companies identify and develop Industry 4.0 skills, including training courses and self-assessment tools.
- **Focus Skills**: Data analysis, cybersecurity, automation, collaborative working.

3. Rapporto sulla tecnologia 4.0 nell'industria (Report on Industry 4.0 Technology)

- **Institution**: Agenzia per lo sviluppo dell'industria digitale (ASDI)
- **Description**: Identifies key skill areas crucial for Industry 4.0 in Italy, such as advanced manufacturing technologies, digital skills, cybersecurity, and soft skills.
- **Focus Skills**: Advanced manufacturing, digital skills, cybersecurity, soft skills.

4. Formazione per l'Industria 4.0 (Training for Industry 4.0)

- **Institution**: Istituto Nazionale per la Formazione Professionale (INAPP)
- **Description**: Offers various training courses and programs emphasizing cybersecurity awareness, industrial automation, digital twins and simulations, and additive manufacturing.
- **Focus Skills**: Cybersecurity, industrial automation, digital twins, additive manufacturing.

Portugal

1. Indústria 4.0 (Industry 4.0)

- **Institution**: IAPMEI
- **Description**: Provides information, resources, and support for companies transitioning to Industry 4.0, including skill development programs and case studies.
- **Focus Skills**: Digital twins, advanced manufacturing, design thinking, artificial intelligence.

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2. Programa COMPETE 2020 (COMPETE 2020 Program)

- **Institution**: Portuguese Government
- **Description**: Offers funding opportunities for projects promoting technological advancement and skills development in Industry 4.0.
- **Focus Skills**: R&D, innovation management, digital marketing, entrepreneurship.

3. Plataforma Portugal i4.0: Qualificar PME para a Indústria 4.0 (Portugal i4.0 Platform: Qualifying SMEs for Industry 4.0)

- **Institution**: COTEC Portugal
- **Description**: Provides resources and training programs for SMEs to adopt Industry 4.0 technologies.
- **Focus Skills**: Digital transformation, technology adoption, data management, leadership, and change management.

Formative Offer: VET and Non-VET Programs

Italy

1. "Competenze Digitali di Base" (Basic Digital Skills)

- **Institution**: Ministero dell'Istruzione
- **Level**: Basic
- **Description**: Online course equipping educators with essential digital skills, including basic programming and data analysis.

3. "Tecnico Superiore per la Transizione 4.0" (Higher Technician for Industry 4.0 Transition)

- **Institution**: Sistema ITS
- **Level**: Higher Education
- **Description**: Two-year post-secondary program on advanced manufacturing technologies and digital skills.

4. "Sicurezza informatica per l'Industria 4.0" (Cybersecurity for Industry 4.0)

- **Institution**: Confcommercio Imprese per l'Italia
- **Level**: All levels
- **Description**: Online seminar series on cybersecurity within Industry 4.0.

5. "Corso di formazione su Sistemi Cyber-Fisici" (Training Course on Cyber-Physical Systems)

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- **Institution**: Fondazione ITS Sistema Meccanico
- **Level**: Intermediate
- **Description**: In-person course on Cyber-Physical Systems (CPS) for technicians and professionals.

6. "Master in Digital Transformation & Industry 4.0"

- **Institution**: 24ORE Business School
- **Level**: Higher Education
- **Description**: Master's program on managing digital transformation and implementing Industry 4.0 technologies.

Portugal

1. "Indústria 4.0 - Formação Avançada" (Industry 4.0 - Advanced Training)

- **Institution**: IAPMEI
- **Level**: All levels
- **Description**: Online platform with training modules on Industry 4.0 topics.

2. "Especialização Tecnológica em Automação e Robótica Industrial" (Technological Specialization in Industrial Automation and Robotics)

- **Institution**: Instituto Politécnico de Setúbal (IPS)
- **Level**: Higher Education
- **Description**: Two-year postgraduate program on advanced knowledge and practical skills in industrial automation, robotics, and their applications in Industry 4.0.

3. "Curso de Introdução à Indústria 4.0" (Introduction to Industry 4.0 Course)

- **Institution**: COTEC Portugal
- **Level**: Basic
- **Description**: Online course providing a basic understanding of Industry 4.0 concepts, technologies, and their impact on the workforce.

4. "Jornadas Técnicas Indústria 4.0" (Industry 4.0 Technical Days)

- **Institution**: Associação Empresarial de Beiras e Serra da Estrela (AEBSE)
- **Level**: All levels
- **Description**: Series of in-person technical workshops offering practical insights and updates on various Industry 4.0 technologies, targeting professionals and entrepreneurs.

5. "Formação em Big Data para a Indústria 4.0" (Big Data Training for Industry 4.0)

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- **Institution**: Instituto Superior de Engenharia de Lisboa (ISEL)
- **Level**: Advanced
- **Description**: Online short course focusing on big data analytics tools and techniques for extracting valuable insights from industrial data.

6. "Pós-Graduação em Gestão da Indústria 4.0" (Postgraduate Course in Industry 4.0 Management)

- **Institution**: Universidade Católica Portuguesa (UCP)
- **Level**: Higher Education
- **Description**: Postgraduate program preparing students to lead and manage the implementation of Industry 4.0 strategies, focusing on process optimization, technology integration, and change management.

Expanded Research Findings

Project: "Future of Work in Manufacturing 2020: Jobs, Skills, and Education" by Deloitte

- **Focus Skills**:
  - Data-driven decision-making: Analyzing and interpreting data to optimize production processes, maintenance schedules, and resource allocation.
  - Robotics process automation (RPA): Understanding and deploying RPA tools to automate repetitive tasks, improving efficiency and accuracy.
  - Cyber-physical systems (CPS) integration: Working with the integration of physical machines and processes with digital technologies for real-time monitoring and control.
  - Additive manufacturing (3D printing): Understanding and utilizing 3D printing technologies for rapid prototyping, customized production, and on-demand manufacturing.

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