Pinto, Rui; Žilka, Miroslav; Zanoli, Thalie; Kolesnikov, Mikhail V.; Gonçalves, Gil

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Enabling Professionals for Industry 5.0: The Self-Made Programme

Rui Pinto\textsuperscript{a,}\textsuperscript{*}, Miroslav Žilka\textsuperscript{b}, Thalie Zanoli\textsuperscript{c}, Mikhail V. Kolesnikov\textsuperscript{d}, Gil Gonçalves\textsuperscript{a}

\textsuperscript{a}SYSTEC-ARISE, Faculty of Engineering of the University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal
\textsuperscript{b}Department of Enterprise Management and Economics, Faculty of Mechanical Engineering, Czech Technical University in Prague, Karlovo Namesti 13, 121 35 Prague 2, Czech Republic
\textsuperscript{c}Univ. Grenoble Alpes, CNRS, G-SCOP, Génie industriel, 38000 Grenoble, France
\textsuperscript{d}Department of Electrical Engineering And, Automation, Aalto University, Espoo, 02150, Finland

Abstract

Education in the Industry 5.0 context emphasizes a combination of technical and soft skills, multidisciplinary learning, and lifelong learning to empower individuals to leverage advanced technologies and drive innovation in the evolving industrial landscape. One of the critical challenges in education for professionals in Industry 5.0 is the rapid pace of technological advancements and the associated skill gap. Moreover, considering the interdisciplinary nature of Industry 5.0, professionals need to possess a combination of technical, business, and interpersonal skills to succeed in this context. Addressing these challenges requires a collaborative effort between educational institutions and industry stakeholders, involving the development of flexible and responsive educational programs. In this work, we present the Self-Made Programme, a novel blended training program designed to equip professionals with the necessary skills and knowledge to thrive in the dynamic landscape of Industry 5.0. The pedagogical component of this program consists of four different learning paths, offered by a consortium from five different European hubs. On the one hand, the program’s focus lies in cultivating proficiency in Digitalization & Human-Centric Manufacturing, enabling professionals to navigate the convergence of physical and digital systems. On the other hand, the program equips professionals with essential skills in Data-driven Decision Making, enabling them to leverage vast amounts of data for strategic and operational insights. By combining theoretical foundations with practical applications, this training program empowers professionals to embrace the potential of Industry 5.0.

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Keywords: Industry 5.0; Educational Program; Upskilling; Self-Made; Digital Transformation; Human-in-the-Loop.

1. Introduction

Education in the Industry 5.0 (I5.0) context refers to the type of education and skills development needed to adapt to the rapidly evolving industrial landscape characterized by advanced technologies, automation, and human-
machine collaboration [15]. I5.0 represents a paradigm shift from the previous industrial revolutions by emphasizing the integration of human intelligence with smart machines. It recognizes the importance of human creativity, critical thinking, problem-solving, and adaptability in conjunction with technological advancements [8].

In this context, education needs to focus on developing both technical and soft skills. Technical skills encompass a broad range of disciplines, including collaborative robotics, Cyber-Physical Production Systems (CPPS), data analysis, Digital Twin, and Internet of Things (IoT), among others. Students should receive training in these areas to understand the underlying technologies and utilize them effectively in industry settings. Equally important are soft skills, which include creativity, complex problem-solving, collaboration, communication, and adaptability. These skills enable individuals to work alongside advanced technologies, understand their implications, and find innovative solutions to complex challenges. Emotional intelligence and intercultural competencies are also valuable, as I5.0 emphasizes global collaboration and cultural diversity [2]. Moreover, education in the I5.0 context should foster a multidisciplinary approach, integrating science, technology, engineering, arts, and mathematics (STEAM) [24]. This approach encourages cross-disciplinary collaboration, enabling individuals to explore creative applications of technology and find novel solutions. Furthermore, lifelong learning and continuous skill development are crucial in the I5.0 era. As technology evolves rapidly, individuals must adapt and upskill throughout their careers. Educational institutions and organizations should offer flexible learning opportunities, such as online courses, micro-credentials, and apprenticeships, to support professionals in acquiring new skills and staying relevant in the changing job market.

Considering education for professionals, it should prioritize upskilling, technical expertise, cross-disciplinary knowledge, innovation, collaboration, adaptability, ethics, and flexible learning approaches to empower professionals to succeed in a rapidly evolving industrial landscape. Thus, the main requirements related to education for professionals in the I5.0 context are:

- **Upskilling and Reskilling:** Professionals need to continuously update their skills to keep pace with technological advancements. Education programs should focus on providing opportunities for upskilling and reskilling in emerging technologies.
- **Advanced Technical Training:** Professionals should receive specialized technical training tailored to their specific industries and roles. Training could involve in-depth knowledge of industry-specific technologies, software, and tools, as well as understanding their practical applications and implementation.
- **Cross-disciplinary Knowledge:** I5.0 requires professionals to have a broad understanding of various disciplines and their interconnections. Educational programs should encourage professionals to acquire cross-disciplinary knowledge, combining technical expertise with a solid understanding of business, management, communication, and ethics.
- **Entrepreneurial and Innovative Thinking:** Education for professionals should foster an entrepreneurial and innovative mindset. Professionals need to be equipped with the skills to identify opportunities, think creatively, and develop new solutions. Courses on design thinking, problem-solving methodologies, and entrepreneurship can help cultivate these skills.
- **Collaborative Skills:** With I5.0 emphasizing human-machine collaboration, professionals should develop strong collaborative skills. Education programs can incorporate team projects, simulations, and real-world case studies to promote collaboration, effective communication, and teamwork.
- **Adaptability and Agility:** Education should instill adaptability and agility in professionals, as the rapid pace of technological change requires the ability to quickly learn and adapt to new tools and processes. Emphasizing continuous learning, critical thinking, and the ability to embrace change will help professionals thrive in dynamic environments.
- **Ethical and Social Implications:** I5.0 brings ethical and social considerations to the forefront. Education should address the ethical implications of emerging technologies, data privacy, cybersecurity, and the impact of automation on the workforce. Professionals should be prepared to navigate these challenges responsibly.
- **Blended and Flexible Learning:** Professionals often have time constraints and busy schedules. Education programs should offer flexible learning options, such as part-time or online courses, allowing professionals to balance their work commitments while acquiring new knowledge and skills. Blended learning approaches that combine online and in-person instruction can provide a balance between flexibility and interactive learning experiences.
In this study, we propose the Self-Made Programme, a blended training program offered to Small And Medium-sized Enterprises (SMEs). The Self-Made Programme aims to analyse SMEs’ current level of digital maturity to determine the activities and knowledge necessary to accelerate SME digital transformation. This is accomplished through a collaborative consulting and training journey with the individual SMEs, which is carried out through a series of co-design learning paths in the areas of Digitalization & Human-Centric Manufacturing, and Data-driven Decision Making. On the one hand, the Self-Made Programme relies on pedagogical content and training actions to support knowledge transfer, i.e., professional upskilling and reskilling. On the other hand, it enables an experimental ecosystem in which Teaching and Learning Factories (TLF) infrastructures are utilised to support SMEs’ digital transformation and technology adoption.

The paper is organized into three more sections. Section 2 provides the related work on education programs for professionals in the context of I5.0. Section 3 describes in detail the Self-Made Programme, more specifically the four co-design Learning Paths (LP) available. Section 4 explain in detail how the Self-Made Programme adds value to the literature and to the education sector as well. Finally, Section 5 concludes the paper, stating final remarks about the study performed while further discussing the proposed approach.

2. Related Work

Professional education in I5.0 stresses a blend of technical and soft skills, transdisciplinary learning, and continuous education to equip professionals to take advantage of emerging technology to foster innovation in an ever-changing industrial world. There are several types of education programs for professionals, such as Certificate Programs; Executive Education Programs; Professional Development Courses; Industry-specific Training Programs; Continuing Education Programs; Professional Associations and Societies; and Company-sponsored Training.

Many universities and institutions offer certificate programs that focus on specific skill sets or technologies. These programs are typically shorter in duration and provide targeted training in specific areas. Considering emergent technologies in the smart manufacturing context, the Politecnico di Milano in Italy offers a certificate program on building automation applications [23]. The Rhine-Westphalia Technical University (RWTH) of Aachen in Germany offers different certificate programs in the area of Robotics & Industry 4.0 [33]. Also, the Vlerick Business School in Belgium offers the Smart Factory and Digital Supply Chain certificate program, focusing on the transformation of operations with digital technologies [30]. However, many certificate programs focus on theory and lack practical application. They may not prepare professionals adequately for hands-on work.

Similar to the Vlerick Business School, other business schools and universities often offer executive education programs designed for professionals. These programs cover a wide range of topics such as leadership development, strategic management, finance, innovation, and digital transformation. Advanced digital transformation and executive programs are available at the International Institute for Management Development (IMD) Business School in Switzerland [29, 28]. Leadership programs are also offered at Cranfield University in the United Kingdom [32]. Moreover, open programs of strategic management in manufacturing industries are offered at the European Institute of Business Administration (INSEAD) in France [17]. However, executive programs can be expensive and time-consuming, making them inaccessible to some professionals. They may also lack a focus on specific technical skills.

Various organizations and online platforms also provide professional development courses that cater to specific industries or professional roles. These courses cover a range of topics, including technical skills, soft skills, industry-specific knowledge, and emerging technologies. These include Coursera Professional Certificates [6], offered by universities and industry experts, and LinkedIn Learning Courses [21], covering various professional skills and software tools. However, these courses may lack depth and may not provide a comprehensive understanding of a subject. On the other hand, some industries have their own training programs or certifications. For example, in the field of information technology, one can find training programs for specific software or platforms like Microsoft Azure [22] or Cisco networking [3]. These programs may be too specialized and may not provide a broad skill set that professionals need to adapt to changing industry trends.

Many universities and other organizations offer continuing education programs that cater to professionals seeking to enhance their skills or transition to a new field. These programs may include part-time evening or weekend classes, online courses, or hybrid learning options. The Fraunhofer Academy offers several continuing education courses for professionals and managers [13]. However, traditional continuing education programs may not keep up with rapidly
evolving technology and industry changes. On the other hand, professional associations and societies, such as the Institute of Electrical and Electronics Engineers (IEEE) [16], often provide educational resources and training opportunities for their members. They may offer workshops, webinars, conferences, and access to industry-specific research and publications. While these organizations offer networking opportunities and resources, they may not provide comprehensive training programs.

Finally, some companies invest in training and development programs for their employees. These programs may be conducted in-house or in collaboration with external providers and can cover a wide range of skills and knowledge relevant to the company’s industry or specific roles. However, company-specific training may lack a broader perspective and may not be transferable to other organizations.

Within the research community, there are various research activities focused on creating and offering similar programs to meet the evolving needs of professionals in different industries. These research activities aim to identify emerging trends, skill gaps, and innovative approaches to education and training. These activities are often found in studies and research projects within universities and Research and Technology Organisations (RTO) to understand the changing demands of industries and the skills required by professionals. Usually, they collaborate with industry partners and stakeholders to identify areas for improvement and develop educational programs accordingly.

Considering European-funded projects, the FIT4FoF project [1] aimed to help the European workforce obtain skills to fit the factories of the future. It analysed present workers’ needs and technological trends in six industrial areas covering collaborative robotics, additive manufacturing, mechatronics and machine automation, data analytics, cybersecurity and Human-Machine Interface (HMI) [20]. This was used to promote new education and training requirements across European regions. More specifically, promote the early involvement of stakeholders in the process of industrial collaborative educational design to contribute to authentic and relevant upskilling of industrial workers [14]. More recent project are the Up-Skill [5] and BRIDGES 5.0 [4]. Both aim to enhance workforce skills for I5.0 in the areas of automation, organisational systems and sustainability.

On the other hand, the manufacturing community of the European Institute of Innovation and Technology (EIT-M) supports several education-related projects [9], such as FlexMan [11] and TURING [10]. These projects are proposing educational programs for professionals, targeting the digitalization of the manufacturing sector, which involves both knowledge and technology transfer to industrial companies.

While other education programs for professionals have their merits, a blended educational training program like Self-Made can be advantageous in addressing the literature gap by offering a comprehensive, flexible, and adaptable learning experience that combines theory with practical application and ongoing support. This approach can help bridge the gap between traditional education and the needs of professionals in rapidly evolving fields like Digitalization, Cyber-Physical Production Systems, Human-Centric Manufacturing and overall data-driven Decision-Making applications.

3. Self-Made Programme

The Self-Made project [31], co-financed by EIT-M, is a European initiative that aims to deliver innovative training courses and tailored technical consulting to SMEs, considering the need to improve current workforce skills and leverage disruptive scientific research results in real-world industrial applications. It relies on a 6-partner consortium from 5 different hubs, namely Portugal (Faculty of Engineering of the University of Porto - FEUP, and 4iTEC), Finland (Aalto University), Czech Republic (Czech Technical University - CTU), Lithuania (IntechCentras) and France (Grenoble Institute of Technology - Grenoble-INP).

The main output of this activity is the Self-Made Programme, which leverages a roadmap for SME digital transformation, supported by professional training and technology consulting. On the one hand, specific LPs are proposed by universities and RTOs for knowledge transfer. On the other hand, the same universities and RTOs will provide conditions for technology experimentation and transfer to the SME’s own manufacturing contexts. Focusing on the training component, the Self-Made Programme enables the exploitation of educational assets in topics such as Digitalization & Human-Centric Manufacturing and Data-driven Decision Making, as represented in Fig. 1.

The pedagogical offer consists of four different LPs within these two pillars. In the Digitalization & Human-Centric Manufacturing pillar, the Cyber-Physical Production Systems LP, coordinated by FEUP, includes topics such as Digital Twin (DT) and the IEC 61499 standard for Edge layer developments using a Model-Based Engineering
(MBE) approach [26]. Moreover, the Human-Machine Interaction LP, coordinated by Aalto University, focuses on topics of robotization in manufacturing, cobots, Operator 4.0, and human factors considering ergonomics [18].

On the other hand, in the Data-driven Decision Making pillar, we offer the LPs Equipment Life Cycle Assessment, coordinated by Grenoble-INP, and Tools to Support Managerial Decision-Making, coordinated by CTU [34]. These include topics in the circular economy regarding predictive analytics for equipment refurbishment and re-manufacturing, and manufacturing business intelligence for production operation economics.

Each one of the LPs considered consists of multiple sessions or modules targeting a specific topic. These sessions can be delivered online (self-paced and remote classes), TLF at the university facilities, or onsite (at the SME premises).

3.1. Cyber-Physical Production Systems

Within the I5.0 paradigm, where IoT and CPS technologies are perhaps the main innovations for digital business and the economic growth of the industrial fabric, the Cyber-Physical Production Systems LP, represented in Table. 1, encourages the creation of unique pedagogical conditions, which integrate several scientific areas that are now highly desirable in the profiles of professionals in the industry. At the end of the LP, the trainee will be familiar with the new technologies that transform the future of smart production, as it involves areas of knowledge transversal to computer engineering, namely the digital transformation of modern industrial production systems, where the intersection of Information and Communication Technologies (ICT) with Operational Technologies (OT) predominates. The trainee should be able to apply these technologies to several problems currently existing in the industry.

The main topics to be addressed are DT & Edge Computing, Sensorization & Control, and IEC 61499 & MBE. The LP starts with an introduction to Digitalization and key enabler technologies, such as DT, CPS and IoT. Then, the focus shifts to Python programming or Structured Text, as the coding languages to be used in the Edge layer. The trainee will also be exposed to the automation pyramid and standards to design, implement and control industrial systems, such as the recent IEC 61499. With this background, the trainee will know the benefits of MBE, and will be able to use these concepts in the DINASORE [25, 7] framework and Schneider Electric Ecostruxure Automation Expert, while deploying a developed solution in an industrial controller. Consisting in a 45-hour training program, with 15 hours of contact time, at the end of the LP, the users can:

1. Apply IEC 61499 for the design and development of CPPS.
2. Create Function Blocks (FB) using the DINASORE framework and Schneider Electric Ecostruxure Automation Expert.
3. Demonstrate how to develop and operate a DT in an Edge device.
Table 1. Outline of the Cyber-Physical Production Systems LP.

<table>
<thead>
<tr>
<th>Session</th>
<th>Delivery Method</th>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>Online</td>
<td>Digitalization and key enabler technologies: DT, CPS and IoT.</td>
</tr>
<tr>
<td>Session 2</td>
<td>Onsite</td>
<td>Introduction to Python Programming or Structured Text.</td>
</tr>
<tr>
<td>Session 3</td>
<td>Online</td>
<td>Industrial automation and control: IEC 61499 vs 61131 standards.</td>
</tr>
<tr>
<td>Session 4</td>
<td>Onsite</td>
<td>Introduction to MBE: DINASORE Framework / Schneider Electric Ecostruxure Automation Expert.</td>
</tr>
<tr>
<td>Session 5</td>
<td>TLF</td>
<td>DINASORE / Ecostruxure – Part 2: FB creation, FB Pipeline design and implementation.</td>
</tr>
</tbody>
</table>

Users will address mainly Function Blocks-oriented programming (FBD), supported by the industrial standards IEC 61131 and 61499. There are many different methods and tools used in FBD programming for factory automation, and the specific tools and methods used can vary depending on the different applications and requirements of the system being developed. Both DINASORE and Schneider Electric EcoStruxure Control Expert [12] are used to program industrial automation controllers using FBD. The Schneider Electric EcoStruxure Control Expert tool is compliant with multi-vendor Programmable Logic Controllers (PLCs) and uses Structured Text to build automation systems. On the other hand, DINASORE enables FB implemented using Python, and default data communication using OPC UA.

The target group for this training would be professionals who are interested in learning about the latest developments in digitalization and its applications in industry, and who want to develop the skills and competencies necessary to design, develop and operate CPPS, create FBs using the DINASORE framework or Schneider Electric Automation Expert, and operate DTs in an Edge device.

3.2. Human-Machine Interaction

In a mass customized production, an upcoming I5.0 concept starts to introduce innovative ways of organizing Human-Centric production systems that allow enhancing flexibility, and effective task distribution between robotic agents and human labourers, enabling a high level of predictiveness considering individual aspects of a human worker.

The Human-Machine Interaction LP offers comprehensive pedagogical content that touches upon enablers of interaction and interplay between humans and machines on the shop floor, by focusing on collaborative production systems, IoT, wearables, DTs, virtual commissioning, and human-machine interfaces. It summarizes state-of-the-art solutions as well as modern practicalities for organizing collaborative production systems, Operator 4.0 [27], workplace ergonomics, and HMI that involve ergonomics, collaborative robotics, Automated Guided Vehicles (AGVs), DT, Virtual Commissioning, and Machine Learning technologies. At the end of the LP, the users can:

1. Cite the relevant robotization use cases in manufacturing.
2. Explain the relevant practicalities of collaborative robotics.
3. Show and compare how Message Queuing Telemetry Transport (MQTT) and OPC Unified Architecture (OPC UA) are used for the human-related ergonomic data flow.
4. Identify enabling factors for the assessment and optimization of ergonomic factors for an operator.
6. Conclude what are the most relevant scenarios where using DT of the Human Operator may benefit a business.

The Human-Machine Interaction LP consists of 5 sessions, as represented in Table. 2. It starts by introducing within the HMI session, human-machine interface technologies, cobots and AGVs. Regarding Human-Centered Production, it introduces Human-in-the-loop systems and IoT wearables. Then, it digs deeper into ergonomics aspects and human-related data management. It finalizes with demonstrations of Human-Centered Production Systems, such as human worker with AGVs and cobots.

The target group for Human-Machine Interaction LP would be professionals who are interested in learning about the latest developments in human-machine interaction and its applications in industry, and who want to develop the skills and competencies necessary to design and model DT for collaborative production systems that include collaborative robots and use human-related data flow in an IEC 61499 approach.
Table 2. Outline of the Human-Machine Interaction LP.

<table>
<thead>
<tr>
<th>Session</th>
<th>Delivery Method</th>
<th>Outline</th>
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</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>TLF/Online/Onsite</td>
<td>Introduction to HMI and Robotics.</td>
</tr>
<tr>
<td>Session 2</td>
<td>Online</td>
<td>Introduction to Human-Centered Production.</td>
</tr>
<tr>
<td>Session 3</td>
<td>Online</td>
<td>Covering Ergonomic Aspects on the Shop Floor.</td>
</tr>
<tr>
<td>Session 4</td>
<td>Online</td>
<td>Practicalities of using OPC UA and MQTT for Human Related Data Management.</td>
</tr>
<tr>
<td>Session 5</td>
<td>TLF/Online</td>
<td>Demonstration of Human-Centered Production System DT.</td>
</tr>
</tbody>
</table>

3.3. Equipment Life Cycle Assessment

In today’s industry, many challenges are increasingly impacting SMEs, such as recruitment of personnel, the supply of raw materials, the adaptation of fluctuating demand and compatibility with the environment, and the new digital uses to move towards a digital transition. In order to meet these challenges, topics such as Life Cycle Assessment (LCA), Equipment Refurbishment and Reconditioning, Sustainable Industry and Circular Economy become essential in the design of a new product or service within a company. The Equipment Life Cycle Assessment LP, represented in Table. 3, offers 5 training sessions on the use of an LCA tool with an example of application in the industry, circular economy and critical materials guided by examples and practical exercises. Also, workshops and serious games will be given on the theme of sustainable industry with different topics to raise the awareness of the trainee on the various impacts on the industry. Finally, additional training will be presented on equipment refurbishment and reconditioning according to the needs of the SME or trainee on this specific topic. Thanks to this LP, the participant can:

1. Compare and recommend Life Cycle Extension Strategies in the equipment and machinery sector.
2. Develop and apply fault diagnosis techniques to find abnormal behaviours that deviate from the normal process for equipment monitor of health status and refurbishment.
3. Select and classify an additive manufacturing process.

Table 3. Outline of the Equipment Life Cycle Assessment LP.

<table>
<thead>
<tr>
<th>Session</th>
<th>Delivery Method</th>
<th>Outline</th>
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</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>Online</td>
<td>LCA and societal challenges.</td>
</tr>
<tr>
<td>Session 2</td>
<td>Onsite</td>
<td>Serious games (&quot;Fresque du climat&quot; or &quot;Fresque de l'économie circulaire&quot; or &quot;Fresque du numérique&quot;).</td>
</tr>
<tr>
<td>Session 3</td>
<td>Onsite</td>
<td>Data science project for manufacturing.</td>
</tr>
<tr>
<td>Session 4</td>
<td>Onsite/Online</td>
<td>Circular Economy and critical materials.</td>
</tr>
<tr>
<td>Session 5</td>
<td>Online/Onsite</td>
<td>Flexible prototyping and production: additive manufacturing tools.</td>
</tr>
</tbody>
</table>

The trainee will be able to set up innovative solutions with the knowledge of the previously mentioned topics. He will be able to face the new problems of his company with simple tools and be able to apply his new knowledge in different situations. The target group for this LP would be professionals who are interested in learning about the latest developments in industrial transformation and its applications in industry, and who want to develop the skills and competencies necessary to design, develop and operate new technologies in terms of circular economy, Equipment Refurbishment & Remanufacturing and LCA.

3.4. Tools to Support Managerial Decision Making

The industrial sector is constantly evolving in the digitization era, and managers need to stay ahead of the curve to ensure that their production processes are efficient, cost-effective, and profitable. To do so, they require a solid understanding of production economics and business intelligence tools to support their decision-making.

The Tools to Support Managerial Decision Making LP is designed to provide a comprehensive overview of key managerial tools supporting decision-making in the area of production economics. This LP is also focused on building
skills in the use of business intelligence tools, specifically Microsoft Power BI [19], to transform production and economic data into management dashboards as decision support tools. At the end of the LP, trainees can:

1. Apply key managerial tools such as business planning, budgeting, costing, and investment evaluation that are crucial to understanding production economics.
2. Use business intelligence tools like Power BI to transform data into actionable insights that drive decision-making.
3. Identify and explain the principles, methods and concepts learned in the courses to apply in the daily decision-making process thanks to the comprehensive interactive training using the Business Navigation Game.

Overall, the LP provides a comprehensive and interactive approach to developing the knowledge and skills needed to excel in the industrial sector. Participants will leave the program equipped with the tools and competencies necessary to make informed decisions that support production economics and business intelligence, while also being able to practice and refine their decision-making abilities in a safe and interactive setting through the Business Navigation Game. An outline of the LP is represented in Table 4.

<table>
<thead>
<tr>
<th>Session</th>
<th>Delivery Method</th>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>Online/Onsite</td>
<td>Building the Foundation in Production Operation Economics 1.</td>
</tr>
<tr>
<td>Session 2</td>
<td>Online/Onsite</td>
<td>Building the Foundation in Production Operation Economics 2.</td>
</tr>
<tr>
<td>Session 3</td>
<td>Online/Onsite</td>
<td>Industrial BI - Introduction.</td>
</tr>
<tr>
<td>Session 4</td>
<td>Online/Onsite</td>
<td>Industrial BI - Advanced.</td>
</tr>
<tr>
<td>Session 5</td>
<td>Online/Onsite</td>
<td>Business Navigation Training.</td>
</tr>
</tbody>
</table>

The sessions for building the foundation in production operation economics will focus on basic economic functions, types of costs, entities and the corporate management system, creating an annual plan, budgeting, costing, and investment evaluation. Moreover, the industrial BI sessions will rely on concepts of data analysis, KPIs in manufacturing, data formatting, dashboard creation, power query, Data Analysis Expressions, and visualization. Finally, the last session relates all the previous topics to support effective business decision-making. The LP is ideal for production specialists and managers who do not have a broad education in the field of economics, but whose daily decisions in the field of production have major economic consequences.

4. Research Implications

There are several education programs for professionals that have advantages and can be effective in various contexts. However, they also come with certain limitations and challenges. The Self-Made Programme is a comprehensive and well-structured educational blended approach for professionals, combining training sessions and continuous consulting to ensure effective technology transfer. On the one hand, there is flexibility in delivery methods, i.e., online delivery for convenience and accessibility, allowing participants to learn from anywhere; onsite delivery for a personalized touch of training, especially for companies looking for in-house skill development; TLF to enable training in a simulated industry environment, providing participants with hands-on experience. On the other hand, the value of continuous coaching and technical consulting reinforces the learning from training sessions and facilitates technology transfer. Training sessions and consulting are designed to complement each other. Participants will have the opportunity to apply what they learn in the training sessions directly to their projects during the consulting phase. This integrated approach ensures a more holistic and practical learning experience.

Overall, the Self-Made Programme offers a well-rounded education that combines theory with practical application, ensuring professionals acquire both knowledge and skills. Also, by being a blended program, it offers the flexibility of in student's learning journal, while emphasising hands-on experience and real-world projects, bridging the gap between theory and practice. Moreover, it is tailored to address specific industry gaps and learner needs, providing a
more personalized learning experience. Finally, the inclusion of coaching and consulting components ensures ongoing support and guidance for professionals to adopt the technology later.

Despite not being tested yet, in terms of added value, the Self-Made Programme has the potential to: I) Address a critical skills gap, considering the growing demand for professionals skilled in Industry 4.0 technologies; II) Enhance blended learning models, providing insights into effective blended learning models in manufacturing; III) Inform industry-academia collaboration, by fostering mutually beneficial partnerships; IV) Promote lifelong learning, based on the program’s adaptability and continuous coaching component in rapidly evolving fields. V) Set standards and best practices for Digitalization & Human-Centric Manufacturing and Data-driven Decision Making education.

5. Conclusion

The industry is evolving at an unprecedented rate, driven by emerging technologies. As a result, there is a growing misalignment between the skills possessed by professionals and the skills demanded by I5.0. The traditional education system often struggles to keep pace with these technological advancements and the changing needs of industries. Many professionals may lack the necessary knowledge and expertise in areas such as digitalization, data analytics, human-machine collaboration, and the integration of physical and digital systems. This gap hinders their ability to effectively navigate and contribute to I5.0 environments.

Moreover, the education system often struggles to provide holistic training programs that encompass the diverse skill sets required, making it difficult for professionals to bridge the gap between different domains and effectively contribute to multidisciplinary teams. Furthermore, continuous learning and upskilling are critical in I5.0, as technologies and practices evolve rapidly. However, traditional education models may not adequately support lifelong learning and ongoing professional development, resulting in professionals struggling to stay updated with the latest advancements and best practices.

The Self-Made Programme is proposed as an educational program for professionals, which results from a collaborative effort between European academic institutions and RTOs. This program aims to foster interdisciplinary skills, incorporate emerging technologies, and prioritize continuous learning in areas such as CPPS, HMI, Equipment LCA, and Tools for Managerial Decision-Making. Ultimately, the Self-Made Programme enables knowledge transfer, experiential learning, and the development of curricula in professionals that reflect the real-world needs of I5.0.

Acknowledgements

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