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TOWARDS TWIN TRANSITION FOR A MORE COMPETITIVE EUROPEAN INDUSTRY

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Abstract

The need for implementation of Industry 4.0 solutions is more pressing than ever due to the need for decentralisation of processes, remote working, and more flexibility after the pandemic period. The objective of this research is to develop new tools and equipping manufacturing small medium enterprises (SMEs) with comprehensive and flexible training package and thus raising their awareness on the need and benefits of twin (digital-ecological) transition. The methodology of the research consisted in development of value propositions, research and analysis of available standards for environmental impact auditing, collecting needs of the manufacturing SMEs through interviews, etc. The results of the project consist in the TWIN 4.0 Environmental impact audit tool, the TWIN 4.0 Transition training course, and the TWIN 4.0 Transition guidelines for VET providers. The TWIN 4.0 project results are beneficial for target group of manufacturing SMEs, consultants and other interested parties to evaluate their ecological impact– upon planning of introducing new digital I4.0 technology. It enables them to adapt a more environmentally responsible approach in the process of digital transformation and in general which is supported by training.

Key words: Industry 4.0, twin transition, digital, ecological, training

1. Introduction

COVID-19 made the business environment more complex than ever before [1]. It contributed towards revealing the flaws of established value and supply chains and existing business models, especially in manufacturing and thus made the need for digitalisation stronger than ever [2,3]. In the COVID context, digitalization and Industry 4.0 (I4.0) technologies have helped businesses and public services to keep functioning and have made sure that international trade could continue [4,5]. According to a McKinsey Global Survey [6] conducted among company CEOs across the world, 56% of the companies that hadn't implemented Industry 4.0 technologies prior to COVID-19 found themselves constrained in their ability to respond to COVID-19 in the absence of digital technologies to support them [7]. The need for decentralisation of processes, remote working, more flexibility and thus better reaction to crisis has made the need for implementation of I4.0 solutions more pressing than ever. The digital transformation has the potential to boost every process throughout the value chain however, if not combined with green practices, it may result in "unsustainable digitalisation". If adequately implemented, digitalisation and I4.0 has the potential to boost the application of circular economy principles, but at the same time they have their own considerable environmental risks [8]. General problems concern the respective technologies' needs for resources and energy [9].

For instance, ICT energy demand is essentially electricity based, any impact of its growth on carbon emissions is primarily related to the carbon intensity of electricity generation. A recent study suggests that the

ICT electricity demand will grow by 50% by 2030, reaching 3,200TWh [10].

At the same time, the EU manufacturing sector is already one of the biggest polluters being responsible for 11% of the total waste in the EU [11]. EU industry accounts for 20% of the total added value within the EU, 35 million jobs and 80% of exports [12]. 99% of the industry is represented by SMEs which face more issues compared to large companies in implementing I4.0 solutions due to lack of enough funding, awareness and training. Thus, the risk of unsustainable digitalisation among manufacturing SMEs is much higher compared to large companies especially in times when SMEs are pressed towards digitalisation and I4.0 transition to stay competitive in the long run [13].

Considering that manufacturing is one of the most polluting, but at the same time one of the most important sectors, it is of utmost importance to support SMEs towards not just digitalisation, but towards twin (green-digital) transition. Furthermore, in the short-term digitalisation may bring real industrial competitive advantage, but in the long term the only way for EU industry to stay competitive is to promote green-digital transition of the manufacturing sector to achieve higher industrial resilience [14].

A project consortium from 6 European countries have implemented in the period 2022-2024 the Erasmus+ project "Towards twin transition for a more competitive European industry", acronym Twin 4.0 [15]. The partnership consists in George Emil Palade University of Medicine, Pharmacy, Science and Technology of Targu Mures - Romania which is the promoter, Innogestiona Ambiental SL Badajoz - Spain, Ete Faros LTD Larnaca – Cyprus, Fondazione Fenice Onlus Padova – Italy, and Acta Foundation Sofia – Bulgaria.

The TWIN 4.0 project main aim was to boost the capacity of manufacturing SMEs for twin (green-digital) transition by equipping them with comprehensive and flexible training package and thus raising their awareness on the need and benefits of this transition.

The specific objectives of the project were:

- Enabling manufacturing SMEs management to adopt a responsible environmental approach in the process of digital transformation by supporting them in evaluating their environmental impact;
- Creating prerequisites for boosting green and digital skills and competencies of SMEs' managers/ employees/ consultants to enable smooth twin transition of manufacturing SMEs;
- Strengthening vocational education and training (VET) – business collaboration with regards to supporting twin transition through new educational offers based on the pressing labour market needs;

2. Material and Method

The Twin 4.0 objectives are directly focused on creating a tailored to the labour market needs multidisciplinary training course aimed to support manufacturing SMEs in the process of twin transition and thus contributing towards reducing their environmental impact in line with E+ priority focused on environment and climate change. The TWIN 4.0 training is aimed at promoting advanced digital and green skills that are considered essential for the post-pandemic industrial labour market and the fast economic recovery as well as to support the VET-business collaboration with regards to offering new VET offer to support twin transition and thus contributing for innovation and adaptation of VET to labour market needs.

The research methodology consisted in development of an impact audit tool, a transition training course and a transition guidelines for VET providers.

3. TWIN 4.0 Environmental impact audit tool

A series of research activities were carried out by the consortium which consisted in the development of value proposition & templates for TWIN 4.0 environmental impact audit tool and methodology. This document served as direction of the efforts of all partners towards developing the TWIN 4.0 audit tool.

Then the research and analysis of available standards for environmental impact auditing was performed. It was focused on analyzing and systemizing environmental regulations and standards both on EU and on national level in the partner countries with regards providing solid legal and theoretical basis for project activities. Next, the needs of the manufacturing SMEs were identified through a series of interviews conducted in all partner countries with SME owners, managers, head of production units, etc. As a result of the interviews carried out, a series of conclusions were drawn about their current situation.

Then it was developed of TWIN 4.0 environmental impact audit tool and methodology. It provides a step-by-step methodology on how companies can evaluate their current and potential (upon implementation of certain technologies) environmental impact at every stage of their digital transition. Thus, manufacturing SMEs will be able to adopt a more sustainable approach towards digitalisation.

4. TWIN 4.0 Transition training course

The results were achieved through implementation of activities that consisted in development of value proposition, templates for module development and learning outcomes (skills, knowledge, attitudes). Partners researched in specialized scientific databases, on the web, publications, company prospectuses, statistical situations, scientific articles from journals, etc. in the field of circular economy, digitalization, Industry 4.0, twin transition. The output of the activity served for the development of the 19 planned modules.

The next activity consisted in desk research of real case examples, practical and theoretical resources for content development.

The partners explored in the documentary research real cases presented in different information sources (web, specialized publications, company prospectuses, statistical situations, scientific articles from journals, etc.), through which they created practical and theoretical resources for the development of the contents of the planned modules. At final in the list was included 209 resources. The technical development of the online portal which host the training course is posted under the main website of the project [15].

5. TWIN 4.0 Transition guidelines for VET providers

The research started with the development of the value proposition and structure for the TWIN 4.0 guidelines which reveal the strategic aims to be achieved, main results of the guidelines, qualitative and quantitative indicators for transition guidelines and expected results of the activities.

It was followed by the analysis of developed TWIN 4.0 materials and research on effective training techniques which highlight the most effective training techniques as regards overall considerations, the choices, classroom or instructor-led training, advantages, disadvantages, interactive methods (quizzes, small group discussions, case studies, active summaries, Q&A sessions, question cards, role-playing, participant control, demonstrations), hands-on-training (cross-training, demonstrations, coaching, apprenticeships), computer-based training – CBT (text-only, CD-ROM, multimedia, virtual reality), online e-learning (web-based training, tele-or video conferencing, audioconferencing, web meetings, online colleges, collaborative documents, e-mail), how to use a blended learning approach, list of training methods.

6. Results

Type your main text in 10 pt Times New Roman, single-spaced. Do not use double-spacing. All paragraphs should be indented 0,5 cm first line. Be sure your text is fully justified—that is, flush left and flush right. Please do not place any additional blank lines between paragraphs.

The first result of the project is the TWIN 4.0 environmental impact audit tool, which is a simple, easy-to-understand tool that enable companies to understand their environmental impact and take an environmentally responsible approach to implementing improvements and meeting their legal responsibilities. It was developed two products: (1) The TWIN 4.0 environmental impact audit tool–calculation files representing an easy to understand and use environmental impact audit tool especially designed for manufacturing SMEs to enable them to evaluate, regularly monitor and potentially reduce their environmental impact, which is edited in excel and contains 8 pages: Water footprint, Data water, Carbon footprint, Calculations, Fuel type, Countries, Biomethanable potential, Data biometanable (Fig.1).

Fig. 1: The TWIN 4.0 environmental impact audit tool–calculation files.

The second product is (2) TWIN 4.0 environmental impact audit tool – methodology which serves as a guide that gives specific and specialised information on how to use the TWIN 4.0 environmental impact audit tool –calculation tools.

The 2 results are implemented on the project website, where user may access directly the Carbon footprint calculation tool, Biogas potential calculation tool, and Water footprint calculation tool and the methodology.

The second result of the project is the TWIN 4.0 transition training course, which consist in 5 modules (Fig.2). Module 1 entitled Introduction to twin transition & Johnson's 4 Boxes Business, contents 2 units. Module 2 is Value Proposition: Enhancing Client and Partner Relationships through Digital Solutions, and contents 4 units. Module 3 is entitled Key Operations: Optimizing Key Processes through Digital & Green Transformation and is composed of 5 units. Module 4 is Key Resources: Sustainable Resource Management through Industry 4.0 and is structured in 5 units. And finally, module 5, Profit Formula: Economic Benefits of Twin Solutions for Manufacturing Businesses, contents 3 units. Additionally, we developed 10 case studies with practical industrial examples for easy understanding of training content.

Fig. 2: The TWIN 4.0 0 transition training course.

TWIN 4.0 transition training course supports manufacturing SMEs on taking the leap towards digital

and green business models and provides their current and future staff with necessary technologically-advanced and green skills, but also theoretical and practical knowledge to operate in the context of a highly competitive and dynamic I4.0 environment.

The third result of the project is the TWIN 4.0 transition guidelines for VET providers. It supports VET providers on building their training offer on twin transition for business, effectively apply the TWIN 4.0 training results and thus create prerequisites for strengthening the potential for joint VET-business cooperation (Fig.3).

The TWIN 4.0 transition guidelines for VET providers reveals the importance of transition for the manufacturing sector by presenting the Twin 4.0 environmental impact audit tool and the Twin 4.0 transition training course with didactic scenarios for the 19 learning units.

Fig. 3: The TWIN 4.0 0 transition guidelines for VET providers.

The transition guidelines are indispensable resources for VET providers as they navigate the dynamic terrain of education and vocational training, particularly within the framework of the TWIN 4.0 initiative. These guidelines not only serve as navigational aids but also offer a comprehensive roadmap, providing strategic insights and practical recommendations to facilitate a gradual transition towards the adoption of digital and environmentally sustainable practices in the manufacturing sector.

7. Discussion

TWIN 4.0 transition guidelines for VET providers cumulatively with the other results the TWIN 4.0 environmental impact audit tool and the TWIN 4.0 transition training course contribute towards achieving the specific objective of the project by creating prerequisites for boosting green and digital skills and competencies of SMEs' managers/ employees/ consultants to enable smooth twin transition of manufacturing SMEs [16,17].

TWIN 4.0 project is innovative because of its focus and content of results. There are many initiatives across Europe promoting the implementation of I4.0 and IT solutions: Fabbrica Intelligente (IT), Industrie 4.0 (DE), etc [18]. However, they focus on the effective application of I4.0 technologies. Sustainable implementation in a way enabling both digital and green transition remains peripheral [19]. Horizon 2020 offers funding for twin transition but it aims to support the actual development and application of an identified digital technology in a sustainable manner. The preparation of such proposals requires time, investments and know-how that most manufacturing SMEs lack. TWIN 4.0 aims to equip manufacturing SMEs with an accessible and free training materials & tool to inform them on the possibilities of sustainable digitalisation and in evaluating their current and potential environmental impact [20]. In this sense, TWIN is a steppingstone for manufacturing SMEs towards twin transition as such materials are lacking.

As regards the content of TWIN 4.0 results the TWIN 4.0 environmental impact audit tool help manufacturing SMEs evaluate their current and potential environmental impact to take informed decisions on twin transition investments and to monitor & control their environmental impact. Such tools aren't available for free, usually assessments are carried out by environmental consultants and require additional funds hence SMEs rarely perform them.

On the other hand, the TWIN 4.0 transition course shows manufacturing SMEs how to apply I4.0 and IT solutions in a sustainable manner to reduce their carbon and environmental footprint. Most courses focus either on just I4.0 and ICT ignoring the environmental aspect or only on CE and green practices, but not how both concepts can be combined to achieve sustainability in the long term. The TWIN 4.0 guidelines for VET providers facilittae the design and application of new training offer to support twin transition in the manufacturing sector.

In line with the Green Deal main targets as well as the European Industrial strategy, the TWIN 4.0 project contributes towards faster recovery of manufacturing SMEs across Europe through a package of tools to support their digital and green transition [21,22]. The nature of the project core topic not only requires partners with complementary experience in various fields (IT, environmental engineering and assessment, automation & robotisation, training design and development, etc.), but also a pan-European effort is needed. Twin transition represents a narrative for the implementation of various digital and I4.0 based technologies in a sustainable manner considering green practices and circular economy principles. With the processes of globalisation and digitalisation, today's manufacturing SMEs are just a part of global

value chains which go way beyond their national borders and only through shared knowledge and efforts this transition can be adequately supported [23].
Furthermore, the project consortium created synergy and prerequisites for knowledge exchange between different partner countries combining some of the leaders in Europe like Italy and Spain in green manufacturing practices application with countries like Romania and Bulgaria that are lagging.

8. Tables

The TWIN 4.0 project results, namely the environmental impact audit tool, the transition training course and the transition guidelines for VET providers are beneficial for target group of manufacturing SMEs, consultants and other interested parties to evaluate their ecological impact – current and potential – upon planning of introducing new (digital/I4.0) technology and after, and thus, enabling them to adapt a more environmentally responsible approach in the process of digital transformation and in general which is supported by training.

The TWIN 4.0 transition training course, that is composed of 19 units, also accompanied by 9 case studies are appreciated by end users as being of very good quality and useful for them. Practical implantation is facilitated by various training scenarios that are detailed in the TWIN 4.0 guidelines for VET providers.

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