

AN EXCELLENCE BASED CURRICULUM FOR THE IMPROVEMENT OF LEAN AND GREEN MANAGEMENT SKILLS IN SMEs

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Abstract

The globalized market, driven by the transition to Industry 4.0 and the emerging Industry 5.0 era, requires enterprises to continually adapt to rapid technological advancements, digital transformation, and sustainable business practices. This shift demands new skills and knowledge, presenting particular challenges for small and medium-sized enterprises (SMEs) striving to integrate digital and lean methodologies. To address these challenges, systematic methodologies capable of assessing current organizational maturity, identifying competence gaps, and supporting targeted learning interventions are needed. This paper presents a methodology that integrates a self-assessment approach based on the EFQM Excellence Models with a blended learning concept and an online digital learning platform. Developed through the ExCurS project, this methodology combines competence evaluation, automated training recommendations, and self-study modules to support continuous improvement and strategic capability development. The 12 core modules were pilot-tested by students and various companies. Evaluation results were analyzed to assess the methodology's effectiveness in enhancing understanding of digital transformation concepts. The analyzed results highlight the strengths of this approach and suggest potential areas for further improvement.

Keywords: ExCurS, self-assessment tool, self-learning I4.0 skills enhancement, digital transformation

1. INTRODUCTION

In recent years, global manufacturing has entered a phase of digital transformation, driven by the convergence of digital technologies, sustainability imperatives, and market volatility. What began as Industrie 4.0 in Germany in 2013 [1, 2] has evolved into a global movement characterized by the integration of cyber-physical systems, data-driven intelligence, and adaptive production networks. The aim is to address competitive pressures, shortened product life cycles, and fluctuating customer demand [2]. Companies are now expected to offer highly customized, sometimes even unique, products while keeping production costs nearly as low as those in mass manufacturing. This paradigm redefines both, organizational models and production strategies, emphasizing flexibility, interoperability, and data-driven processes [3].

Small and medium-sized enterprises (SMEs) are central to this transformation. Representing approximately 90% of global economic activity and more than half of total employment [4], SMEs are a cornerstone of industrial resilience and innovation. However, achieving high levels of digitalization and sustainability presents substantial challenges for SMEs. They must simultaneously manage technological integration, regulatory compliance, and resource constraints while remaining competitive in their core business within global value chains. The European Green Deal and the EU Industrial Strategy further increase these demands by setting ambitious targets for decarbonization, resource efficiency, and digital resilience [5]. Because SMEs account for a significant share of hazardous emissions worldwide, their adaptation is essential to achieving environmental goals.

The manufacturing landscape is shifting from traditional manual labor and, in some cases, automation to smart, interconnected ecosystems. Emerging information and communication technologies (ICTs) such as the Internet of Things (IoT), digital twins (DTs), cloud computing, big-data analytics, and collaborative robots (cobots) enable real-time connectivity among machines, processes, and humans. Combined with artificial intelligence, these technologies support predictive maintenance, process optimization, and agile supply-chain management. Addressing these concerns has led to the Industry 5.0 paradigm [6], which supplements the technology-centric focus of Industry 4.0 with a human-centric perspective. Industry 5.0 recognizes that workers remain essential in complex decision-making and creative problem-solving [7]. It envisions a future in which technology augments human potential rather than replacing it, ensuring that industrial progress aligns with broader societal and ecological objectives.

In this context, initiatives such as the ExCurS project (An Excellence based Curriculum for the Improvement of LEAN & Green Management Skills) have emerged to bridge the skills gap among SME employees by offering an online learning platform that integrates a self-assessment tool. The methodology used in this paper was developed as one of the core outcomes of the ExCurS project. It combines an EFQM-based self-assessment model, the concept of blended learning and iterative evaluation procedures. This approach directly supports SMEs in strengthening human resource capabilities and guides enterprises in implementing digital, lean, and green practices cohesively. It reflects the understanding that digital transformation cannot rely solely on technology adoption, it must also include cultural, organizational, and strategic change [8].

The objective of this paper is to present the project activities, achieved results, and piloting outcomes among a group of users. Building on the project's outcomes, the paper also evaluates the implementation and validation of 12 self-study learning modules designed to foster lean, green and digital competencies. The structure of the paper is as follows: Section 2 presents the theoretical framework and main intellectual components; Section 3 outlines the research methodology and presents the evaluation results; and Section 5 summarizes the key findings and future research directions.

2. EXCURS PROJECT SCOPE

An Excellence based Curriculum for the Improvement of LEAN & Green Management Skills in SMEs (ExCurS) project focuses on lifelong learning and the development of an excellence-based curriculum to enhance lean and green management skills in small and medium-sized enterprises [9]. Funded by the Erasmus+ program, the project aims to create a vocational training program centered on lean and green management skills for European SMEs. The project was conducted over a 36 month period, from 2022 to 2025. Six organizations from five different European countries and various sectors collaborated to develop the results briefly presented in this paper. The project is coordinated by Gaia (Spain), the Knowledge and Technology Industries Association, which represents more than 300 companies in the ICT sector. Two partners are from the academic community: the University of Reutlingen (Germany) and the University of Split (Croatia), while the remaining three are from the business community: IBK Management Solutions (Germany), Irish Work Study Institute (Ireland) and Mindpedia (Romania).

The project centers on the development of three key intellectual outputs, developed sequentially during the project's duration (Figure 1): a self-assessment tool, a blended learning concept and an online platform.

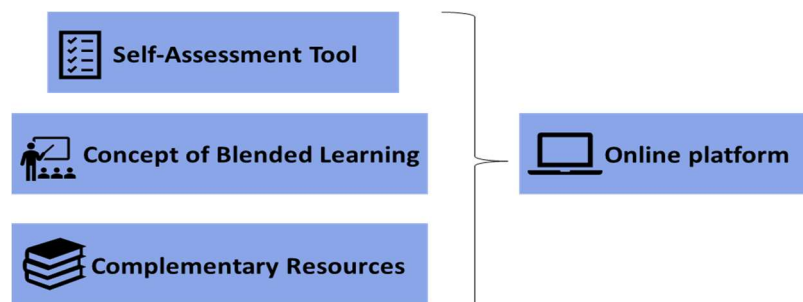


Figure 1. – Expected outcomes of the ExCurS project

2.1 Self-assessment tool

The self-assessment tool was developed based on the EFQM 4.0 Excellence Model (European Foundation for Quality Management, EFQM) according to the six areas of the Excellence Framework Europe. By gathering the individual knowledge and experience of people involved in an organization regarding their work situations and processes, it provides accumulated insights into the current status and potential improvement for both individual processes and the organization as a whole. Figure 2. shows the iterative improvement process developed for individual employees and groups of employees.



Figure 2. – The improvement process developed by the project

Although this tool cannot improve companies' processes and organization by itself, it provides clear guidelines for prioritizing improvements and training needs based on the current state evaluation. It is not limited in the number of iterations. It allows groups of employees to update evaluations as soon as improvements are made. By providing insight into all assessors' self-assessment completions and visualized results (Figure 3), the implementation of identified improvement opportunities can be perused promptly and actively.



Figure 3. – Self-assessment dashboard and visually presented results

Based on the score achieved in each of the six central topics shown in Figure 3, the assessment report, partially shown in Figure 4, includes a list of recommended self-learning training modules to improve the skills needed to address each item, and its specific aspects. The list is developed using the accumulated scores for each criterion shown in Table 1.

Table 1 – Decision making according to the accumulated score per criterion

Score	Category	Training modules suggested from the learning platform
< 40	Strongly recommended	Available in: Croatian, English, German, Romanian, Spanish
40-65	Recommended to consider	Available in English only
>65	Additionally to consider	Also consider other management support techniques

The recommendations are clustered according to the six areas of the Excellence Framework Europe and are based on achieving the required score in each topic area. Based on the results of one of the pilot assessments, the report presents a list of the recommended self-learning modules for all areas. Figure 4 shows an example list for area 4., titled “Creating added value”.

4. Creating added value	
<i>Based on the calculated score, the following training modules should be considered:</i>	
<u>Introduction trainings available in language Croatian, English, German, Romanian, Spanish:</u>	
- Customer requirement matrix (QFD)	- KPI Analysis - Key Performance Indicators
- Digital Assistant systems	- Predictive maintenance
- Digital Human Resource Management	- Stress Management
<u>Introduction trainings available in English:</u>	
- Communication Analysis	- Measurement of processes
- Data driven decision making	- Time (self) management
- Financial Risk Management	- Track and trace
- Integrated transparent value chain	
<u>Management tools and techniques you might also consider:</u>	
- Cost Comparison	- Organisational agility
- Customer Relationship Management	- PDCA Cycle with CIP
- Critical thinking	- People Development
- Customer satisfaction analysis	- People Plans
- Digital Marketing	- Persuasion: influencing without authority
- Digital Supply Chain Management	

Figure 4. – Example of assessment report suggestions for area 4. “Creating added value”

2.2 Self-study modules integrated into the online platform

The online platform integrates the self-assessment tool, self-study modules and resources to further support the application and customization of the developed tools in real business and educational contexts. Additional resources include a library, a glossary, guidelines for trainers and other important documents. The blended learning concept, initially based on over 50 self-study modules, was refined to 12 core modules (Figure 5) and provided to student groups and various companies.



Figure 5. – A total of 12 core modules selected from the 51 initially developed modules

3. METHODOLOGY AND RESULTS

To ensure the effectiveness of the developed tools and their relevance to the real business environment, they were disseminated to various student and employee groups through pilot activities. A total of 75 participants took part in the evaluation process using an online questionnaire, resulting in a substantial sample of responses. The participants evaluated the modules in terms of usage and relevance (Figure 6), and competence development (Figure 7). Figure 6 shows that most participants found the modules helpful and practically relevant, indicating that the learning content aligns well with user needs. Figure

7 confirms that all modules contribute to expanding knowledge in sustainability, lean management, and digitalization, with sustainability receiving higher average scores. The consistent scores across the three areas demonstrate that the modules have effectively supported competence development in line with project objectives.

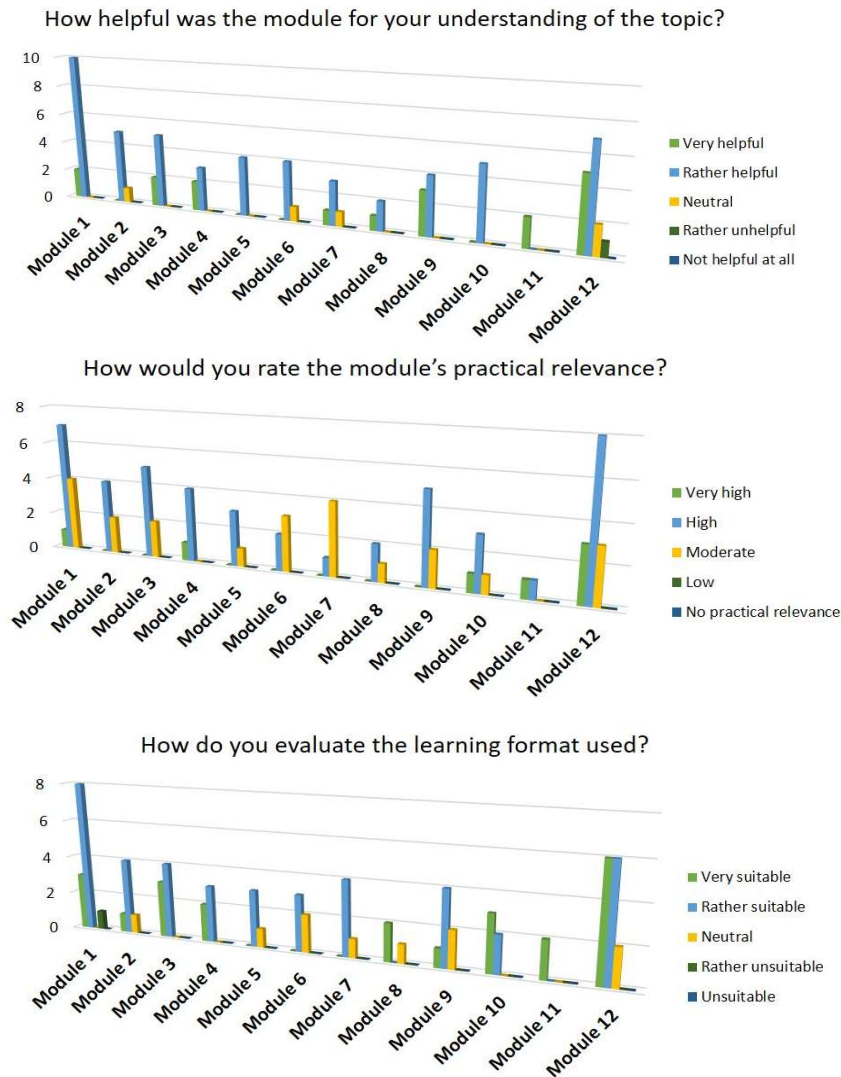


Figure 6. – The understanding, the practical relevance and the learning format of self-study modules

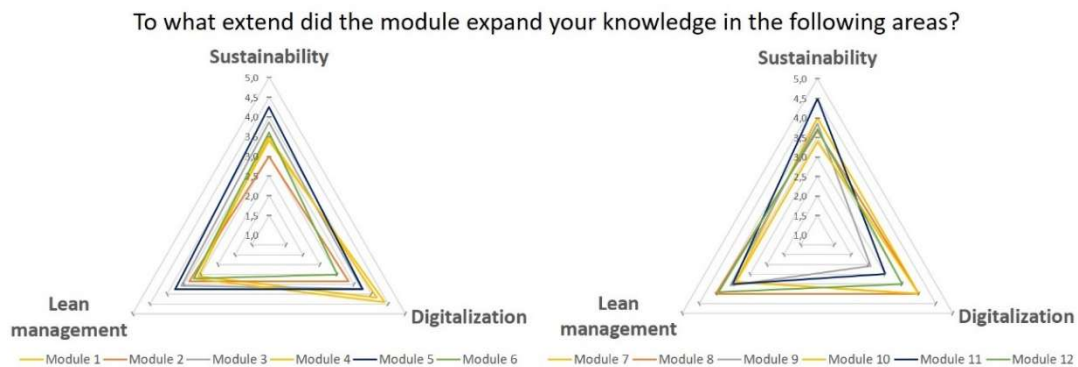


Figure 7. – Acquiring of knowledge on sustainability, digitalization and lean management

Additionally, three questions were asked for free-form textual feedback: “What was the greatest added value of the module content-wise for you?”, “What additional aspects should be improved?”, and

“Further comments and/or suggestions?”. In summary, participants appreciated the modules’ practical orientation. However, a clear pattern emerged: many requested more practical case studies, more real-life examples, and additional multimedia materials (videos, links, or online resources). Some found certain modules too short or too complex, while others praised the engaging and interactive nature of the sessions. Among the responses, there were 66 mentions of a desire for: more case studies, practical examples, and real-life situations and 31 mentions that the Module was considered sufficient and appropriate for the topic.

4. CONCLUSIONS

This paper presents the development of three key intellectual outputs of the ExCurS project, which were developed sequentially during the project: the self-assessment tool, the concept of blended learning and the online platform. Additionally, the evaluation of 12 self-study modules presented was based on responses from 75 participants collected through a questionnaire. Regarding understanding of specific topics, the modules were mostly rated as “Rather helpful” or “Very helpful”. Most participants rated the modules practical relevance as “High” or “Moderate”. For the learning formats used in the modules, most participants rated them as “Rather suitable” or “Very suitable”. The competence development evaluation showed that every module helped participants acquire above-average knowledge in sustainability, digitalization, and lean management. The lowest average score was 2,571 out of 5 for acquiring knowledge about digitalization in Module 9: Benchmarking/Continuous Improvement. It can be concluded that the ExCurS project self-study modules have been successfully validated and achieved a very good level of participant satisfaction. Further research will include a larger number of participants, and a new round of questionnaires after the modules are improved based on the analyzed feedback.

5. ACKNOWLEDGMENTS

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6. REFERENCES

- [1] Kagermann, H., W. Wahlster, and J. Helbig. 2013. Recommendations for Implementing the Strategic Initiative INDUSTRIE 4.0. Berlin: Heilmeyer und Sernau.
- [2] Thoben, K. D., S. A. Wiesner, and T. Wuest. 2017. “Industrie 4.0” And Smart Manufacturing – A Review of Research Issues and Application Examples.” *International Journal of Automotive Technology* 11 (1): 4–16. doi:10.20965/ijat.2017.p0004.
- [3] Kosasih, W., Pujawan, I.N., Karningsih, P.D., 2023. Integrated Lean-Green Practices and Supply Chain Sustainability for Manufacturing SMEs: A Systematic Literature Review and Research Agenda. *Sustainability*, 15, 12192.
- [4] Das, M., Rangarajan, K., 2020. Impact of policy initiatives and collaborative synergy on sustainability and business growth of Indian SMEs. *Indian Growth and Development Review*, 13, 607-627.
- [5] Parker, C.M., Redmond, J., Simpson, M., 2009. Review of Interventions to Encourage SMEs to Make Environmental Improvements. *Environment and Planning C: Politics and Space*, 27, 279-301.
- [6] Klein, V.B., Todesco, J.L., 2021. COVID-19 crisis and SMEs responses: The role of digital transformation. *Knowledge and Process Management*, 28, 117–133.
- [7] Kahveci, E., 2025. Digital Transformation in SMEs: Enablers, Interconnections, and a Framework for Sustainable Competitive Advantage. *Administrative Sciences*, 15(3), 107.
- [8] Kosasih, W., Pujawan, I.N., Karningsih, P.D., 2023. Integrated Lean-Green Practices and Supply Chain Sustainability for Manufacturing SMEs: A Systematic Literature Review and Research Agenda. *Sustainability*, 15, 12192.
- [9] ExCurS – An Excellence based Curriculum for the Improvement of LEAN & Green Management Skills in SME, official website, 2025