Recommendations for the user's institution to ensure effective durability of the developed solution

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Task 6
Project „Metalworkers 4.0" (UDA-POWR.04.03.00-00-0117/18-00)

Topics

Introduction

Since roughly ten years, the concept of “Industry 4.0” has been introduced in industry. That means, each branch, each sector and each company should agree what Industry 4.0 means to them, since there is no single model. Since then, the definition as well as the technical and organization adaptation process with regard to Industry 4.0 was considered as a challenge by the entrepreneurs.

Although Germany was pioneering this concept, it was applied to other economies worldwide and became an important ideal model of future industries. Nowadays, the model has been widened by Artificial Intelligence (AI) and therefore by a new qualitative and quantitative impact on automation processes in industry (Krings et al. 2021). This is also true for other European cases like the Portuguese case, where huge scientific and political efforts have made to introduce the premises of the Industry 4.0 concept into the industrial sector (Moniz, Candeias and Boavida, 2022)

During the last decade, the vagueness of the Industry 4.0 concept makes it difficult to think about and to define new competences and skills with regard to the personnel in different hierarchical levels of the single organizations. Although the literature is full of general recommendations about the need for new skills and new qualifications in different working settings, each company has to figure out its specific Industry 4.0 model and – therefore - it’s specific organizational change with its needs and qualifications. There is a general agreement that the trade unions play an important role in the development and design of the Industry 4.0 model as well as in the introduction process, which should ideally be organized in a participative and constructive process. As described above neither the model, nor the implementation process are well defined, which means that organizational changes seem to be a learning process for all involved persons. This was also the case in the Polish project Metalworkers 4.0.

The general rule to be followed by innovative companies is the debate on the training strategy with the social partners, and not only defined in a top-down process. Usually, company managers assume that they must define and implement their training strategy without any negotiation. There is also a question of power and control in SME companies (regarding sensitive information) due to their dependency to larger companies, and in multinationals once their control center is not located in Poland. At the same time, middle-ranked managers and technicians and engineers may lose control of information that is important for them and for their role inside the organization, which often leads to behaviors of fear and refusal instead of curiosity and an individual engagement in cooperating within these processes and organizational dynamics.

From the very beginning, the trade unions were involved in the development of Industry 4.0 concepts in the present Metalworkers 4.0 use case. They were successfully stressing the organisation and social aspects of the implementation processes of Industry 4.0. They agreed

with the diagnosis included in the document and pointing to the risk of falling into the middle-income trap due to an insufficient level of innovation and digitalisation of the economy.

They also voiced a fundamental concern about whether employers will be willing to invest in innovative solutions and training their staff in the use of new technologies in the workplace. The unions emphasised the employers' excessive use of the competitive advantage in the form of lower labour costs and the need to compete, mainly, in terms of innovation and the quality of products/services. In Poland, trade unions criticised the Strategy for Responsible Development (SOR) for failure to show a path to reaching a more innovative and highly productive economy and to deal with the low level of expenditure on innovation (1% GDP annually) as a serious systemic barrier that can make it impossible to achieve the goals set in SOR [1]. But the general rule to be followed is the debate on the training strategy with the social partners, and not only defined in a top-down process.

There is also a question of power and control in SME companies (regarding sensitive information) due to their dependency to larger companies, and in multinationals once their control centre is not located in Poland. In the following, the authors are reflecting the process initiated by the project "Metalworkers 4.0" with the objective to provide some recommendations for whole process as well as for further activities. In sum, we consider the project as very successful with regard to the complexity of the processes as well as the fulfilment of the most important issues setting up processes (design, involvement of persons, resources, objectives). This seems specifically true by the feed back of the whole process by the participants.

[1] The SOR was adopted by the government in February 2017. See https://www.gov.pl/web/fundusze-regiony/strategia-na-rzecz-odpowiedzialnego-rozwoju

Conditions of success

During the development and adaptation processes towards Industry 4.0 models, the trade unions highlighted the need for safeguarding job stability in the process of transformation in Poland. According to them, these processes should be accompanied with substantial support around upgrading skills of the current and the new workers in the single organizations. Nevertheless, upgrading skills should be definitely the objective of the processes, not only because of saving jobs, but also because of the further technological and organisational development of working environment of industry work. Work shortage in industry becomes a central problem in nearly all European countries and in nearly all sectors. Thus, future options as well as the attractiveness of industrial work should also be taken into account when developing new organisational models like Industry 4.0.

As many projects regarding Industry 4.0 show, vocational education requires specific reforms at the post-secondary level once it should increase its effectiveness and harmonise it with the labour market. However, the competency gap is a problem of the entire education system and is also prevalent in higher education.

The trade unions propose a change in the approach to the method and school curricula in the entire education system, including higher education and supplementing SOR with the following three elements:

1) to increase participation in lifelong learning among workers;
2) to increase the share of vocational education in the education system and improve its quality and capability to meet the needs of the labour market; and
3) to adapt higher education to better match the needs of the labour market.

It seems there are no agreements, contracts or other forms confirming cooperation of social partners in the bilateral or trilateral formula for Industry 4.0 in Poland. The main source of this condition is the fact that the industrial policy in this country - including the one addressing the issue of Industry 4.0 - is only marginal in nature and is left to the initiative of market forces. For this reason, project Metalworkers 4.0 became so important while provided determinant information about the features of technology requirements and the organizational principles that provide the potential possibility for competence and knowledge development of the employees in work environments.

In our former report (Krings, Boavida and Moniz, 2021) [2], we have proposed that the **training modules** should be reconsidered as follows:

- **the 'philosophical' module should be renamed as „psycho-social factors" module** – it would approach the nature of human-machine interactions, psychological and social consequences of digitization, the implications into labour market, the artificial intelligence and machine learning, and the human-centred systems.

[2] Entitled "Some training recommendations for metalworkers in the context of technology changes in Poland", CICS.NOVA

- **case studies module** – it should integrate examples of Industry 4.0 implementation in several sectors and different countries with illustrative material. It should reflect the diversity of situations and not only the standards.

In fact, the Metalworkers 4.0 project organised the training modules around the following topics:

→ **Psychosocial factors module** - approaching the nature of human-machine interaction, psychological and social consequences of digitization, implications for the labor market, artificial intelligence and machine learning, and human-centric systems;

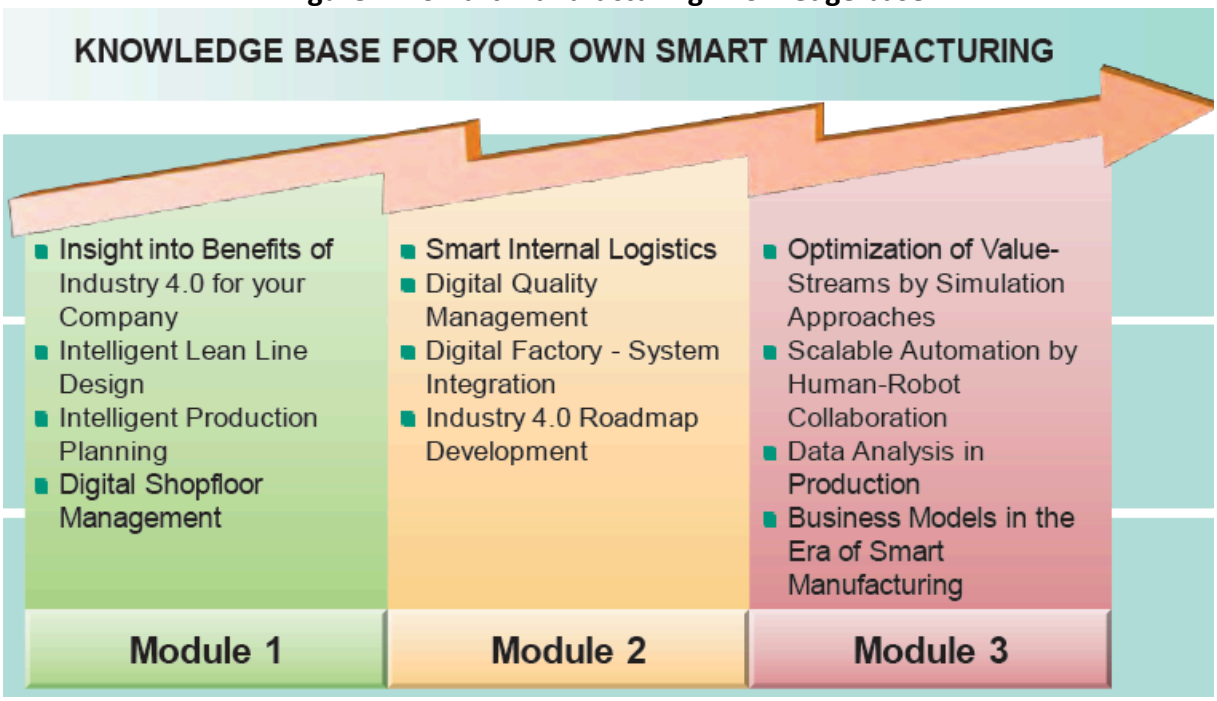
→ **Case studies module** – should include examples of Industry 4.0 implementation in several sectors and different countries, along with illustrative material. It should reflect the diversity of situations, not just standards;

→ **Motivational module** - coaching stimulating the awareness of the need for training and self-development.

Intelligent manufacturing and employee qualification

As we have mentioned in the previous document by Krings, Boavida & Moniz (2021) that, in 2020, the Sino-German Company Working Group on Industry 4.0 and Intelligent Manufacturing (AGU) Expert Group Training 4.0 published a guideline on the "Employee Qualification as Key Success Factor in Digitalised Factories". There, they presented several examples from experiences of application in China under the cooperation with Germany. They have proposed for one case a model of training process very similar to the one proposed in the project "Metalworkers 4.0".

Figure 1 – Smart manufacturing knowledge base

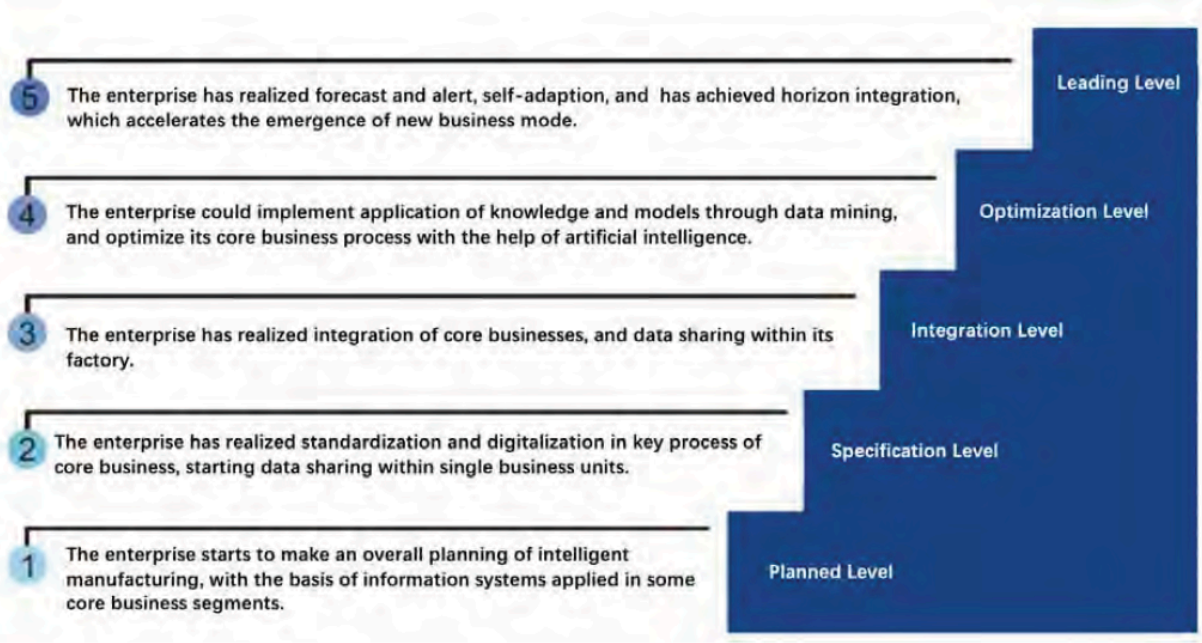


It was also proposed a model for self-assessment of company development of Intelligent Manufacturing capacity, and the training needs to improve it. According to the same guideline, a possibility to develop the Intelligent Manufacturing capability in a company can consider the existence of five levels of development:

1) Plan
2) Specification
3) Integration
4) Optimisation
5) Leading

The higher the level a company reaches, the higher the maturity of the Intelligent Manufacturing capability needs to be. The Intelligent Manufacturing level is obtained compared with the actual situation of the company. This will be conducive to find the gaps in the organisation. It will also allow the combination of the level with the corporate Intelligent Manufacturing strategic goals to develop improvement programs. This development can be understood with the following model.

Figure 2 - Intelligent Manufacturing Capability Maturity



Source: GIZ/CCID (2020)

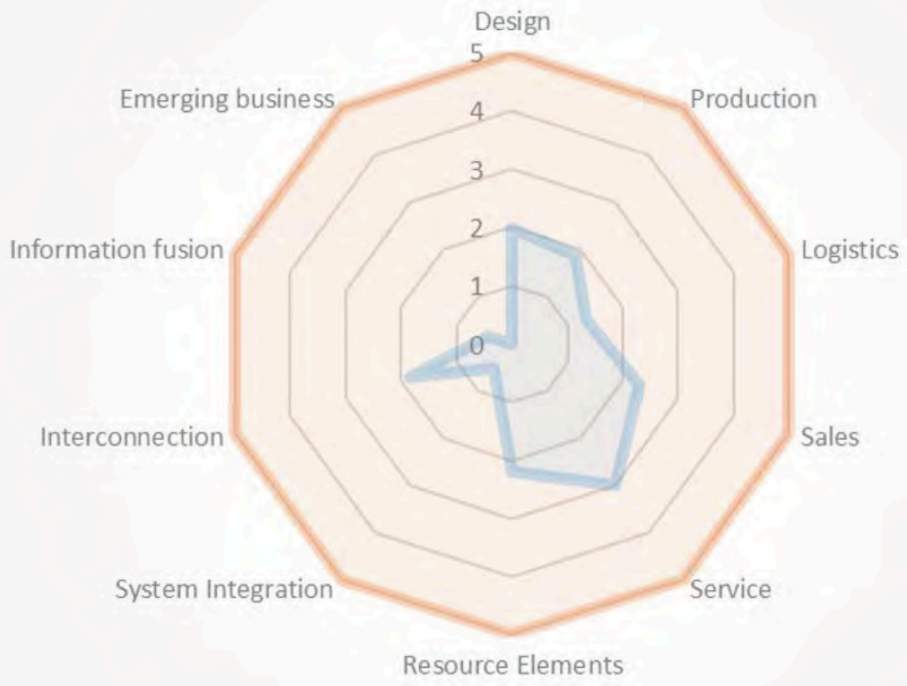
New collective abilities

In order to set up the processes mentioned above, it should be possible to create a self-assessment scoreboard from the mentioned five levels of development considering the collective abilities in each organisation. These abilities are defined by each sector inside the company that is proceeding a self-assessment of the capability maturity. The abilities can be as follows:

a) Design
b) Production
c) Logistics
d) Sales
e) Service
f) Resource element
g) System integration
h) Interconnection
i) Information fusion
j) Emerging business

For each ability the sector members should assess the level of maturity in their one sector. Finally, a complete company assessment can be reached considering the whole sectors assessments. An example is presented in the following figure where is assessed the abilities understood by the company, which provides the basis for a wider understanding of the strongest and weaker abilities to perform an Industry 4.0 strategy.

Figure 3 – company ability towards Intelligent Manufacturing



Source: GIZ/CCID (2020)

This graphical representation can easily illustrate the capacity of a company for the development of an Intelligent Manufacturing strategy adopting Industry 4.0 concepts. With such self-assessment companies can develop their qualification to succeed with such strategy and further recommendations can be defined, as for example, in relation to training.

Final recommendations

Recommendations for Companies

- Further development of employees' skills and qualification should be a key success factor of the transformation towards an Industry 4.0 model.
- Make use of negotiation and feedback culture during the transformation processes (assessment of problems, needs & improvements).
- Install training programs to led participate and to led cooperate employees within the transformation processes (use their expertise).
- Make effective use of existing self-assessed maturity indexes to help identify and analyse existing skill gaps in a clear and systematic way.
- Manage the change by creating a work environment and culture, where life-long learning and agility to adapt promptly to new development are embedded.
- Make use of supporting training units and corresponding training courses once the action fields regarding workforce development are determined (in case when own training capabilities and resources are not sufficient).
- Investment should imply resources (money) and time for learning courses outside the organisations (create learning situations where the needs of the employees (participation, re-creation, learning issues etc.) are taken into consideration).

Recommendations for Training Providers

- Shift the focus from showcasing to real learning (platforms & learning by doing).
- Provide practical and case-specific trainings that are closely in alignment with the Industry 4.0 concept.
- Improve the qualification of trainers by facilitating the Train-the-Trainer concepts.
- Be aware of the training environment (location, resources, time, quality of trainings etc.)
- Be aware of new training methods (teamwork, common and non-hierarchical development of solutions etc.), which may be innovative with regard to the increasing engagement of the employees.

Policy Recommendations

- Facilitate the development of a maturity model that focuses on the workforce in the age of digital transformation and support companies in self-assessing their workforce's readiness and finding capacity development measures.
- Standardise such maturity levels, promote general acceptance in the industry and better enabling companies to determine the qualification of their employees and implications for future recruitments (see the European Foundation for Quality Management EFQM model as a reference [3]).

[3] https://efqm.org/the-efqm-model/

- Encourage companies / institutions to cooperate on establishing regional Intelligent Manufacturing training centres / innovation centres while facilitating the use of existing training units.
- Formulate standards for Intelligent Manufacturing training centres.
- Allocate funds with a focus on establishing actual training units and Train-the-Trainer concepts instead of technological showrooms.
- Provide training subsidies to companies that support the training of their employees at Intelligent Manufacturing training centres.
- Provide financial support for training centres based on the number of trainings conducted, providing that these training centres meet the quality standards.
- Developing standards for further education curricula for the existing workforce is helpful and necessary.

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