MC4.0 DEA CENTER: CONSOLIDATED EXPERIENCES AND INNOVATIVE DEVELOPMENTS

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1. Introduction

Several SMEs aim to achieve the ability to meet the varied and specific needs of their customers at an affordable price. In doing so, they can find a point of reference in the MC 4.0 approach, an approach that involves the ability to offer products tailored to the specific needs of various customers in a digital, efficient and fast way. Mass Customization (MC) is in fact defined as the ability of a company to offer customized products without penalizing performance in terms of cost, quality and time. When the MC is made by also adopting Industry 4.0 technologies, we speak of MC 4.0.

The INTERREG Italy-Austria project called MC 4.0 has pursued the objective of building MC 4.0 competencies in South Tyrol, Veneto, Friuli Venezia Giulia and Carinthia. In these territories many SMEs from different sectors are interested in improving their MC 4.0 capability, although they hardly use this term. This is particularly true for companies in the long, articulated and heterogeneous living supply chain, a supply chain that includes and serves the world of building and construction, the design and installation of systems, green energy applications, maintenance services, air conditioning systems, home automation, security, home and wellness appliances, furniture and garden products, and the design and production of components. This supply chain is present in these territories with particular excellences and characterizations and it is a particularly significant ground for the development of MC 4.0 because it asks to integrate different technologies and innovative, digitized and environmental friendly systems. This supply chain has been taken as a reference point for the MC 4.0 project. What has been developed in the project, however, goes far beyond this supply chain and can be applied to all SMEs in the area that face problems of product variety and customization.

This publication aims to present the most significant result achieved by the MC 4.0 project, i.e. the consolidated experience of the MC 4.0 DEA Centers (DEvelopment and Application) started since the beginning of the project and the activation of a cross-border network of MC 4.0 DEA Centers. The role that these centers play in the territories where they operate, both taken individually and as a whole, is explained here. Explaining the functioning and usefulness of these centers becomes the way to present what has been developed in the project and made available today through them. In this way, we do not present an administrative account of what has been done, but rather try to make it clear how to exploit the results obtained.

In the end, an international network of MC 4.0 expertise was built with deep roots in some local systems. The single centers and the whole network have been thought as open and in continuous evolution. This publication wants to make understand this evolutionary characteristic of this network so that companies, institutions, policy makers, professionals etc. can understand its nature and, if interested, can evaluate the possibility to connect to it.

2. Mass Customization 4.0: what it is and how it is achieved

Mass Customization (MC) is an approach developed to overcome the trade-off between variety-customization on the one hand and operational performance on the other. The goal of mass customization is to develop, produce, market and deliver affordable goods and services with sufficient variety and customization so that almost every target customer finds exactly what they want.

MC Levers	Definition
Standardization of components and subassemblies	Strong efforts to achieve commonality of components, subassemblies, etc., both across product variants and across product families
Product modularity	Achieve final product variants by recombining modules made in a limited number of variants with standardized interfaces
Product Platforms	Design a new product seeking to maximize commonality (of components, subassemblies, and manufacturing processes) with future generations of the same product
Group Technology	Grouping parts and products into families based on manufacturing similarities; manufacturing in cells
Fast equipment	Reduce machine downtime for product changes without increasing inventory levels
Customization of finished product at latest	Realization of differences between product variants at the end of the production process or even during the distribution process
Manufacture virtually on order	Possibility to plan and launch in production a specific product without having a defined customer order, and subsequently, when a customer order with similar characteristics to that product arrives, assign that product to that customer order, possibly modifying some characteristics of that product already launched in production
Commercial product configuration supported by software	Use of software applications to present product options, check consistency between chosen options, price product variants, and code product variants
Software-supported technical product configuration	Use of software applications for the automatic generation of bills of materials and/or production cycles for new product variants

Table 2-1 MC main levers

A company that takes this approach should be able to:

❖ provide a significant variety of products without sacrificing quality
❖ customize products on a large scale while maintaining high production volumes
❖ Keep switching costs low, and don't allow product variety to drive up costs: the efficiency of business activities and processes should not be sacrificed to customization.

Importantly, this approach also requires the company to:

❖ Quickly identify individual customer preferences
❖ Quickly adapt the product design according to the customer's needs.

Finally, to avoid cognitively and decisionally overloading customers by forcing them to evaluate and compare many product variants, a company that follows this approach should be able to effectively guide its customers through the product customization process.

There are many levers for achieving MC. The main ones are listed in Table 2-1. The order in this list does not imply an order of importance because there is no set order of importance that applies to all companies. The same lever, may have different importance for different companies. A lever that is of great importance to one company may be entirely marginal to another, depending on the type of product, the size of the company, the market, and so on.

As you can see, there are both managerial and technological levers. These levers can concern the products, the productive as well as the commercial processes. They can be based on rationalizing the existing rather than devising future customizations to contain the complexity the company faces. When the levers used also include 4.0 technologies, such as product configurators and additive manufacturing, we talk about Mass Customization 4.0 (MC 4.0).

3. THE MC 4.0 DEA CENTER: what it is and how it works

An MC 4.0 DEA Center - MC 4.0 DEvelopment and Application Center - is a center that aims to increase the capacity of local systems to provide companies with services related to technical/organizational innovation for mass customization. It is made up of organizations present in a specific territorial area and it starts from their competences exploiting possible synergies between different skills to give assistance to regional companies.

Therefore, the DEA Center is not an entity with an autonomous legal personality, but it is a network entity made up of a set of structured collaborations between the different entities that compose it. An inter-organizational network as a facilitator of knowledge flow and innovation.

The interactive characteristics of collaboration necessary for the successful operation of the DEA CENTER are collaborative negotiation and management of processes, trust, communication, mutual understanding, shared decision-making and shared goals. Since these are relationships between different entities, they are forms of interaction that differ from hierarchical ones. In order to ensure the sustainability of these centers, a streamlined mode of collaboration is established that is based on coordination between organizations that remain absolutely independent and without changes in their organizational structures, while creating deep cooperation through identification in the people who are part of it, with shared goals for a lasting impact on the local community.

The essential goals of the DEA CENTER can be summarized as:

- raise the level of knowledge of local SMEs on the subject of MC 4.0
- support local SMEs in the use of MC 4.0 tools for greater competitiveness
- help local SMEs access funding to implement MC 4.0 tools.

The main territorial point of contact for SMEs and stakeholders is the MC 4.0 DEA Center, which appears as a territorial reference on the MC 4.0 Platform. However, all DEA Center partners can act externally as formal access points to the DEA Center, acting as conduits and coordinators of services that will then be delivered by the organizations specifically designated for each aspect. In fact, requests for information and services from companies are generally received in the first instance by the DEA Center, which critically evaluates them and, if deemed appropriate, refers them to the appropriate agency.

In the network of skills made available to companies, there are also those of external professionals. These are local resources that, if necessary, are involved by the partner that provides the service and contribute through specific ad hoc assignments. They can be, for example, experts in taxation and subsidized financing rather than consultants or temporary managers specializing in MC 4.0 or some of its specific aspects.

DEA Centers carry out ordinary communication activities on the web through the MC 4.0 platform and some animation activities on the territory through workshops, seminars, company visits and live demonstrations to facilitate networking and exchange of information within the business cluster (DEA Center plus companies). These activities are offered free of charge to local companies.

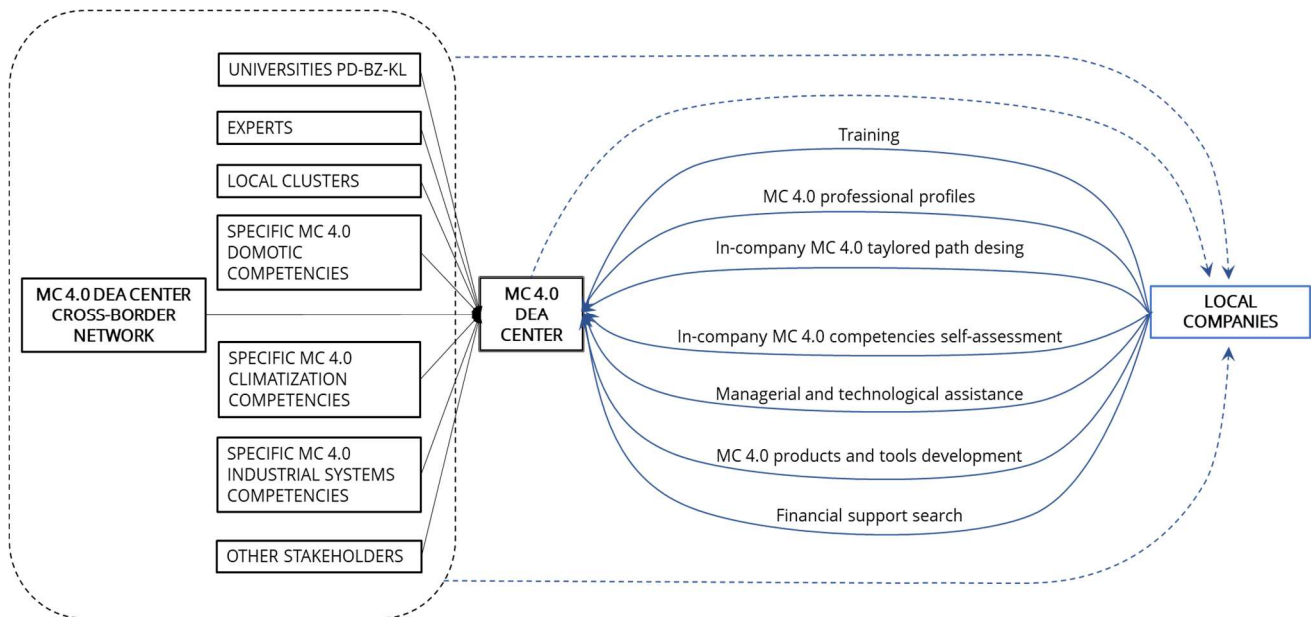Each DEA Center organizes at least two live events each year in addition to updating the platform services.

Figure 3-2 MC 4.0 DEA CENTER: MC 4.0 circulation and skills building

Interested companies can also benefit from intensive services such as in-company audits, professional consulting, staff training etc. These services are on-demand and are provided by the partners on a fee-for-service basis or through the use of funding based on a specific agreement between the firm and the partner. The provision of these network services is devolved to a specific entity based on the types of services for which the entity has joined the network. The contractualization of the requested service is made between the SME user and the single entity not being the DEA Center endowed with legal personality. The economic and technical agreement is left to the free negotiation of the two parts.

In Vicenza the role of MC 4.0 DEA Center has been covered, since the beginning of the MC 4.0 project, by Apindustria Vicenza while in Klagenfurt it has been taken over by Energie Forum Kärnten. With the replication of the DEA Centers in Bolzano, Pordenone and Villach a cross-border MC 4.0 competence network has been established.

4. MC 4.0 DEA Center Network

Each MC 4.0 DEA Center is part of a network of MC 4.0 Centers (see Table 4-1) where knowledge about MC 4.0 is exchanged, experts are made available, ideas on MC 4.0 projects are shared, and joint projects and contacts between the companies that gravitate around the individual

centers are promoted. As a whole, these centers are connected to international networks specialized on MC 4.0 issues, such as the Mass Customization and Personalization - Community of Europe (MCP-CE) and the Configuration Workshop community (CWS). In this way, a cross-border network of MC 4.0 competencies has been created which, as can be seen, starting from the two pilot centers in Vicenza and Klagenfurt, has been extended to include the centers in Pordenone, Villach and Bolzano and is also opening up outside the program area with the contact point in Novi Sad (Serbia).

MC 4.0 DEA Center	Nature	Startup	Geographical Area
Vicenza	Pilot Center	Start 2020	Veneto *(Vicenza, Treviso, Belluno)*
Klagenfurt	Pilot Center	Start 2020	Carinzia *(Klagenfurt)*
Pordenone	Replication	End 2021	Friuli Venezia Giulia *(Pordenone, Udine, Gorizia, Trieste)*
Bolzano	Replication	Spring 2022	Trentino Alto Adige *(Bolzano)*
Villach	Replication	Spring 2022	Carinthia *(Villach)*
(Novi Sad)	(Point of Contact)	End of Spring 2022	Vojvodina *(Novi Sad)*

Table 4-1 the MC 4.0 DEA CENTER Network

Although the various centers do not operate in exactly the same way, they share the same spirit, values and objectives and, in the end, are quite similar. In all of these centers, with the exception of the contact point in Novi Sad which should be considered as a reference point for the future establishment of an MC 4.0 DEA CENTER, experimentation of the provision of various services was carried out with the support of the two pilot centers. In this experimentation 138 companies from the Italy-Austria cross-border regions were involved. With 34 of these (18 of the MC 4.0 DEA Center of Vicenza, 8 of that of Klagenfurt, 4 of that of Bolzano and 4 of that of Pordenone) we have tested the tools of assisted diagnosis and design of personalized paths of progress towards the MC 4.0. All the experiments carried out have allowed to break in the communication paths and especially to understand how to relate with the individual organizations involved and with the companies in the area. All this has led to a very important mutual knowledge and understanding of the situation in the companies in the area with regard to MC 4.0. For further information on the individual MC 4.0 DEA Centers, on their points of contact, on the organizations that compose them and host them, please refer to the MC 4.0 platform and more precisely to the page https://www.mc40-platform.eu/dea-center.

5. THE PLATFORM MC 4.0

The MC 4.0 web platform is the DEA Centers' primary communication tool on the web. It is a tool managed by the network of local DEA Centers. The platform contains informative and

technical content on Mass Customization 4.0, demonstrators and configurators, a database of the companies that are part of the local clusters, a list of experts on MC 4.0 with their contacts and news and events from all the local DEA Centers. It serves as a collaborative working tool between the different DEA Centers.

The partners of the local DEA Centers have signed an agreement that regulates the adequate and sustainable management of the platform, committing themselves to keep it updated for the parts of their competence. Based on the particular network configuration, each DEA Center determines what content each entity will need to update.

The MC 4.0 PLATFORM provides key evidence of the MC 4.0 cross-border skills network. The most visible evidence is shown below:

- provides selected information on MC 4.0 capabilities present in SMEs located in the Italy-Austria cross-border territory and related to the living sector. It also provides selected information on MC 4.0 levers and their adoption in the same SMEs. Finally, it provides key information on MC 4.0 acquired through a series of focus groups conducted with various experts, managers and entrepreneurs operating in the various territories. This scientifically validated knowledge has been reported in the platform in an easy-to-read but still rigorous way;
- provides a database of SMEs (based in the target territories) implementing MC 4.0 and offering mass customized products. These companies are companies interested in MC 4.0, in many cases they are examples of excellent or at least good practices in MC 4.0. The choice made was to provide the essential information about them: company name, main products/activities/sector, link to the website. In this way a visitor can consult all the companies belonging to the clusters of SMEs MC 4.0 DEA Center and can search by the names of the products he is interested in performing the normal searches that are done on a web page (i.e. simply using CTRL F). This choice allows a quick and complete consultation of the companies on the network and does not require any particular maintenance, thus avoiding the risk of becoming obsolete;
- provides contacts and points of contact for each of the MC 4.0 DEA Centers. Directly on the MC 4.0 platform or through links to the various DEA Centers, anyone can access the services provided by the various centers. It should be borne in mind that among the services provided are those supporting the definition of personalized paths towards MC 4.0 and the identification of funding to support these paths. So these services support the creation of MC 4.0 capacity in SMEs
- Provides a range of MC 4.0 experts working in cross-border target territories. It shows the specific skills and specializations of each MC 4.0 expert. Please note that clicking on an expert will take you to the MC 4.0 DEA Center reference that is in close contact with

that expert. The choice to go through the MC 4.0 DEA Center of reference aims to make each DEA Center a point of concentration of specialized knowledge and contacts. To support MC 4.0 skills development, it is important to know what aspects of MC 4.0 SMEs are interested in and why. It is also important to get information on how these companies are interested in acquiring this knowledge. This type of learning is important for the entire network;

- provides guidance on what individual competencies a worker should emphasize when approaching an MC 4.0 company. This is because research has shown that there are specific individual skill requirements in MC 4.0 companies. SMEs that participated in the project highlighted with particular emphasis the difficulty of finding staff and especially personnel with appropriate characteristics;

- In order to convey to the companies some important information on the choice of configurators for MC 4.0, the platform communicates in a simple form the most important messages emerged from the research conducted during the MC 4.0 project on the desirable features for online configurators. For more detailed guidance, SMEs should contact one of DEA's MC 4.0 Centers who will connect the SME with the appropriate expert;

- For an introduction to configurators, the platform provides two demonstrators developed in the MC 4.0 project. One demonstrator presents a B2B configurator and the other a B2C configurator. In the same platform there are also two configurators, which use the same B2B and B2C distinction, in the field of air conditioning and home automation respectively.

6. BEYOND THE ESTABLISHED EXPERIENCES

What has been reported up to this point concerns the experiences that have been consolidated during the MC 4.0 project. Now we conclude the communication with a look into the future, a look that not only considers what is already planned as a sustainable continuation but also considers possible innovative developments.

6.1 Research and innovation

Studies conducted during the MC 4.0 Project have found that in recent years, an ongoing trend in many SMEs has become even more pronounced: product families have increased (and thus also the heterogeneity of knowledge related to them) and specialties have become more specialty (with aggravation of technical departments). While this is a sign of innovation, it can also put SMEs in difficulty if they do not implement methods to overcome the trade-off that

exists between product variety and customization on the one hand and operational performance in time, cost and quality on the other. With the onset of Industry 4.0 innovations, new opportunities for expansion in product and service customization are opening up and new ways to overcome the aforementioned trade-off are being generated.

However, Industry 4.0 also brings new threats to SMEs that offer product variety and customization. With these new technologies larger companies may be able to efficiently occupy market segments that were previously too small for them, thereby eroding market space for smaller ones. In addition, SMEs find themselves lacking the skills to adopt Industry 4.0 technologies. Finally, while the Mass Customization approach has been known for some time, guidelines for its implementation are lacking, especially in the SME context. And what little is available does not consider Industry 4.0 technologies. With the MC 4.0 project, a little has been done in this direction, but much remains to be done.

SMEs in the program area need simple and lightweight tools to help them in embarking on a path towards Mass Customization that takes advantage of Industry 4.0 (MC 4.0) technologies. These tools should allow for knowledge transfer, self-diagnosis or diagnosis assisted by individual consultants, and the involvement of company personnel who then need to put in place the transformational actions towards MC 4.0. Furthermore, given that not only is there no MC 4.0 model in the literature that is considered valid in all contexts but, indeed, given that the need to adapt MC initiatives to specific business contexts is recognized, there is a need to offer living examples of MC 4.0, examples from which to draw inspiration through comparison.

Along these lines, the themes identified for the development of the MC 4.0 DEA Centers and the local Clusters that revolve around them are:

- increase in the level of comparison between companies in the MC 4.0 cluster, companies that are pursuing paths towards MC 4.0 and are willing to compare themselves with others
- stimulus to the development of software products (configurators) also through an exploitation plan of what has been developed during the project
- Applied research related to training and accompanying activities and aimed at all SMEs.

6.2 Training and consulting

It is desirable to build individual MC 4.0 skills as there is a shortage of such skills in the program area. In order for these individual skills to be exploited and grow with use, they need to be built around the operational needs felt by the individual firm. It is therefore necessary to have training that is both shared between firms and specific to the individual firm.

This training must be accompanied by actions of applied research for the development of the missing pieces (tools of diagnosis and guide towards MC 4.0, cluster of MC 4.0 companies) and by actions of accompaniment to the practical application in the single company.

This line of activity involves the development of three types of interventions:

1) training and accompaniment in the individual company (training and consulting/accompaniment modules in an individual company);

2) inter-company training with short interventions, usually involving people from different functions and levels because MC 4.0 requires great vertical and horizontal integration;

3) training of young graduates for the preparation and insertion in the company of User Interface Expert for Configurators and Configuration Manager profiles. Long-term training consisting of classroom training and internship in the company.

These actions are based on the exploitation of project results: professional profiles "User Interface Expert for Configurators" and "Configuration Manager" and research on skills for MC 4.0.

Training courses are organized by individual DEA Centers. Various training funding tools or tax credits may be used or activities will be offered in a paid catalog for local businesses.

Within the DEA Center of Vicenza, Centro Produttività Veneto and Apindustria Vicenza develop a joint planning of catalog courses for companies. The courses can be offered individually by each of the two entities or jointly. The University of Padua, on the other hand, has activated a course in Italian entitled Management of Product Variety and one in English entitled Digital Customization starting from the 2021/22 academic year. These courses are offered as part of the Master's degree in Management Engineering and can also be followed as individual courses by people who are already working in the company.

6.3 Dissemination on territories and network development

The actions planned are traditional: workshops, seminars, company visits and live demonstrations to facilitate networking and information exchange within the business cluster.

The network has been conceived as open and therefore it is possible that new centers could be activated also outside the program area. Similarly, the network can also develop with the insertion of further experts, with the inclusion of further companies etc. Although welcome, it is not the numerical objective that the network aims at. What to which it points is the to carry ahead the lines of increase of competences MC 4.0 outlined in the present document following

closely the requirements of the PMI. Innovative developments in terms of research, transfer, training should be evaluated and selected according to this perspective in order to contribute to the quality of life and medium-term competitiveness of the target territory of this MC 4.0 project.

Appendix

Project Summary:

The MC 4.0 PROJECT was born with the aim to improve the innovation base of smart living SMEs (broadly understood including also the relevant supply chains) in the program area in order to face the new challenges of competition and INDUSTRY 4.0. The project has created local skills bases and supports to increase the ability of SMEs to meet the specific needs of individual customers at affordable costs thus following the Mass Customization (MC) approach through digitized customization processes (4.0), which bring the customer closer to the SME production chain, lowering costs, speeding up time and ensuring product quality. To achieve these results in the MC 4.0 project, more than 120 Italian and Austrian SMEs were directly involved in order to examine the current situation in the management of product variety and customization and to test the tools and initiatives to support towards MC 4.0. A partnership representing scientific and technological knowledge, the needs of SMEs and industrial realities was also established.

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