

Interreg V-A Italia-Austria 2014-2020

Project ID ITAT1057 - MC 4.0

Subject: Final report of the results obtained on the validity of the AT1, AT2, and AT3 tools and on their optimal use

1 – Cross-national summary of the test

The tests of AT1, AT2 and AT3 have been performed with consistently different numbers in Italy and in Austria, but - for some aspects -with differences in methods we achieved the same overall result. The overall result is that all these tools are effective and meet the quality criteria needed to be trustworthy and useful. Hereafter we report more detailed information on the various tests performed and the obtained results.

2 – Testing objectives and method

The MC 4.0 project foresees the development and test of various tools to help SMEs to improve their MC 4.0 level. A first tool (AT1) intends to assess the MC 4.0 level of a given SME, both in terms of performance (<https://www.mc40-platform.eu/mass-customization>) and application of MC levers (<https://www.mc40-platform.eu/mc-levers>). A second tool (AT2) was intended to help a given SME to identify MC 4.0 related improvements, to define an individual path of initiatives to bring the SME a step further towards MC 4.0 and, in case of the possible inclusion of configurators among these initiatives, to assess their possible characterization and convenience. Finally, AT3 (the guide) constitutes a tool intended to provide information on MC 4.0 and to give guidance on how to use AT1 and AT2.

Given the prevailing differences in the manufacturing mindsets of the Italian and Austrian territories involved in the MC 4.0 project, the design and even more testing of these tools have been influenced by this manufacturing orientation. For example, the design of these tools was based on the consideration of the size and the characteristics of Italian SMEs. Finally, both in the design of the tools and in their test, a contingent approach has been followed. The idea behind these tools was not to push a given company towards configurators if the company was not in an appropriate business context or if this SME operated in an appropriate context but was not yet ready because of limited advancement in MC levers. The idea of AT1 was to define a company's high-

level profile to allow to understand what was the most appropriate second step for the specific company, if any. The same approach also guided the development of AT2.

The evaluations of the tools have been done differently, depending on the tools' characteristics, for two reasons. First, because the various tools had different objectives and, second, because the tools were designed to be used by persons with different roles and expertise.

AT1 has been first tested during its development mainly by the MC 4.0 project members. Once developed it has been tested in companies by MC 4.0 members interviewing company representatives. It has to be noted that AT1 was intended to be delivered in person by staff not compulsorily being MC 4.0 experts but at least appropriately trained. Additionally, during the project's development in Italy a non-academic experts and academic experts were involved. All of them had to report their evaluations of AT1 in a structured report. Finally, we exchanged opinions about AT1's effectiveness during its use (this has been a continuous activity not connected to a specific phase in the project). Since the test of AT1, due to the pandemic situation, took a lot of time, it has been possible to document its properties frequently and as a result, it was possible to adapt the way companies are approached to improve the tool's effectiveness.

AT2 underwent a thorough testing procedure. Generally, its test involved two experts for each company in Italy. This was necessary because of the related efforts. To use the tool is one task that fully occupies one person, to see how it works is another complex task. For one expert it was not possible to do both jobs in a satisfactory way in an Italian SME. Intellectually and relationally, it was very tiring for the experts. The test was predesigned to set a number of properties to be controlled in order to be able to collect all of these properties for each application. The outcome was that, in general, the resulting reports have been very detailed.

Actually, AT2 consisted of two tools. The first of them (AT2.1) considered all MC 4.0 levers. This tool has been almost always applied and deeply analyzed. Only in the last attempt to apply it in a company it turned out that it was better, in that case, to not use AT2.1 and to go to other approaches for the second phase. It emerged that in SMEs with an advanced management and in presence of an academic with a high level of expertise it is possible a different use of AT1 and it not needed to provide training to deliver unknown notions of MC 4.0. In such cases, it is not necessary to use AT2.1 after AT1, but immediately continue with AT 2.2. -The second tool (AT2.2) was designed for the assessment of the convenience to apply a configurator. This tool has been rarely used because SMEs preferred other more rewarding and affordable MC 4.0 initiatives.

AT3 (the MC 4.0 guide for SMEs, a guide that includes indications on AT1 and AT2) was a way to essentially inform SMEs about what MC 4.0 is, what is its status of application in SMEs and what are and how AT1 and AT2 can be used. However, Italian SMEs in the territories of the project tend to prefer to learn through direct interactions. Therefore,

this document was more important for the project partners, such as API personnel, than for the SMEs. Consequently, it was tested by API employees who gave feedback to the researchers who developed the instrument.

In the following sections the results of the tests are reported.

3 – Results obtained on the validity of the AT1 tool

The tests of AT1 have shown that if a company is interested in the topic and understands its importance, to use AT1 is not a problem. For the companies more advanced in MC the use of AT1 is not difficult. However, for the companies less advanced it may become less easy to fill in the parts of AT1 appropriately. In addition, the companies' level of interest to use AT1 depends on the specific moment in which they are contacted. Finally, we realized that if an expert presents the questionnaire AT1 it takes more time to be filled in, because the company takes the opportunity to discuss and to learn. If, vice versa the expert is not present it takes less time (but probably the quality of data is lower). In general, filling AT1 takes from an absolute minimum of 30 minutes up to 90 minutes. The typical time for filling the AT1 was 50 minutes (media 50,25; median 50).

We had a number of companies that - even though initially interested - did not complete AT1 in a satisfactory way (in average 11.8% of missing data). This happened at the beginning of the project. In Bolzano and in Friuli Venezia Giulia where we performed the test of AT1 in a second iteration we had always a very accurate completion of all AT1 (in average 2.8% of missing data). However, we changed a little bit the contact strategy to avoid partially completed AT1. This took more time to get appointments and to visit the companies.

AT1 is a good tool to profile an SME in terms of customization context and MC 4.0 status. It is absolutely useful for the subsequent use of AT2. In fact, in all cases in which we decided to apply AT2 the context to apply AT2 was an appropriate one. This without any doubt confirms that AT1 performs its task - initially scanning a company - correctly.

The tests showed that AT1 should not be changed. For the Italian SMEs based on manufacturing it is OK. However, it is better to use it after a careful selection of SMEs and with well-trained interviewers.

Important note. The fact that some SMEs will have some difficulties in answering some questions is not an indication of ineffectiveness of AT1. Vice versa it indicates that either the considered SME does not have an appropriate level of customization and product variety (and in that case it has been wrongly selected) or that the SME does need to make big enhancements in understanding how to manage product variety and customization.

4 - Results obtained on the validity of the AT2 tool

AT2.1 has been tested in 18 SMEs in Italy. After a while the application of AT2 in further companies resulted in a saturation effect: the findings obtained in additional tests were not significantly changing the results obtained until that point.

The test took from 2,5 hours to 6,5 hours in each company with an average of 4,73 hours and a median of 4,92 hours (Criterion 3 - Table 1). The time invested to test AT2 has been much longer than expected. This has been due to the interest of most companies to deepen the discussion on the considered issues. This interest is also witnessed by the number of company participants (min 1, average 2,56, median 2, maximum 7 – C2 in Table 1). In most cases, we had an entrepreneur that participated in the meetings. As a result, the test of AT2.1 has been performed in almost all cases with high accuracy (C1 Table 1).

Very few problems have been faced (C4 Table 1). The most important has been the contextualization of the various levers in some specific contexts when the participants did not have enough insights on MC 4.0 levers. While in contexts of assembled products with the presence of configured products the contextualization resulted definitely easy, in the cases of installation services and in the cases of sub-contractors (conto terzisti) this task has been more difficult. In this case, the presence of MC 4.0 experts as well as the presence of open-minded people has been quite helpful.

During the AT2.1 test meetings, the interest has been almost always very high (C5 Table 1). The discussion has always been very focused and structured. At the end of the test, this property of the AT2 has been underlined in almost all cases and has been appreciated by company participants (C7 Table 1). The researchers too recognized that AT1 plus AT2 are an effective set of tools that together can correctly profile SMEs in terms of customization context and MC 4.0 status (C10 Table 1). However, the effort in doing this profile is much higher than expected. The reason for this is that in order to identify specific improvement opportunities, the company's context has to be understood by the researchers/experts too, which is not a simple task. In any case, most SMEs expressed their interest to continue the involvement with future initiatives (C6 Table 1).

One of the objectives of the test was to comprehend the understandability of the grid and assert whether there was any need to change it (C11 Table 1). In general, the grid's understandability turned out to be high (C8 Table 1). However, it clearly emerged that experts have to be prepared to present examples to help participants to grasp in more detail the meaning of some concepts (C9 Table 1). Except for this aspect, no other relevant issues emerged. Noticeably, before using AT2.1 it is important to have: a) analyzed carefully AT1, b) visited the company's website, and c) have an agreement with some company coordinators on the company participants. In most cases, the training events were enough to set appropriate expectations for AT2.1 and for identifying the most appropriate participants. However, these training events were not enough to

prepare all participants, also because for many of them it would have been too time-consuming to participate in the training events. So those who conduct the use of AT2.1 should be prepared to redo some training on the need basis.

The AT2.1 capability of recognizing the MC 4.0 status has been demonstrated (C12 Table 1). Both researchers and company participants agreed on that. So even this aspect of the test has been passed without any limitations.

Finally, in terms of the capability to help SMEs to define MC 4.0 improvement plans, AT2 has been very effective (C13 Table 1). In all companies, except two improvement plans have been identified. Most of them included 7 initiatives, but in some cases 11 initiatives have been identified (C14 Table 1). It has to be underlined that in many cases company representatives participated actively but did not take notes. This has been highly different from company to company. In those companies in which participants do not take notes it is the expert's role to take notes on the initiatives that have emerged. Writing down these initiatives in a detailed way took a considerable amount of the experts' time, but is valuable to capitalize what has been done. This task was not foreseen before the test.

Finally, it should be remarked that in the majority of the cases the use of the grid showed the opportunity to perform a number of improvements different from configurators. Even though the configurator approach has been appreciated in several companies, the effective evaluation of the convenience of adopting a configurator has been rarely performed. It has also to be underlined that a number of alternative support tools and mechanisms for specific configuration tasks are already implemented in the involved companies. When it was indicated to evaluate the convenience of adopting a professional configurator it has been useful to start from the final table of the AT1. However, the situations are quite different from case to case. To properly guide SMEs in this direction the expert should pay attention because the variety of digitalization possibilities is very high and many SMEs are skeptical about the real benefits they can get. Therefore, an incremental approach is in most cases the appropriate means to bring SMEs at a level in which they can really benefit from a product configurator.

Finally, some words on AT2.2. Essentially AT2.2 deepens the last table of AT1 going to assess for each row how much gain an improvement in a support by a configurator would provide. We did not have enough tests to be able to provide specific properties of this tool. However, the collected evidence is positive.

5 – Summary of MC 4.0 tool application in Austria

In general, the application of the AT1 and AT2.x. tools revealed comparable results as in the Italian sample. AT1 was used together with 20 companies, the different parts of AT2 with 8. The core difference to the Italian sample was that the percentage of

companies producing also standardized goods is very low. Only one company produces standard concrete parts, the rest of the sample consists of suppliers of custom solutions (wood constructions, window/door suppliers, prefabricated houses) or installers /planners which would indicate the use of configuration technology. However, in many cases the companies have the access to configurators from the producers or wholesale and do not see the need of having configurators on their own. What is a common denominator is the low level of integration of tools in the company, which was not so clear to them before, but crystallized out in the course of the AT1 and AT2.x consultations. A typical example is one company which is producing custom furniture has a web representation with only contact information. Potential clients have to get in contact and meet physically to negotiate the piece they want, prices and shipment conditions. The result is entered in the company's digital tools, which is a spreadsheet program for specification, an accounting tool for calculation and a CAD program for planning. The transfer of data and information is done manually. In this regard the MC 4.0 AT tools have turned out to be good guidelines to emphasize the state of the art of the company in regard to MC 4.0 and what are the potentials and where companies could invest efforts to increase their MC 4.0 level. In general, companies are on a low level of MC 4.0 and – similar to the situation described for the Italian sample before – have difficulties to find a match between their status and the enhancement possibilities of MC 4.0. The key data of the evaluation activities themselves are similar to the Italian sample. The accuracy of provided data of the company was very good for around 30% of the companies, another 50% provided information in an average / satisfactory quality, the remaining 20% of company provided information with partly big areas of missing data. The latter typically argued that because of their business orientations the questions do not apply. In the case of AT2, evaluated with 8 companies, the quality of data was very high in all cases. The companies reflected on the provided information categories in high details and provided new insights in situations of companies (mainly in the customized product supply domain) - such as how to deal with the situation of having to use a third-party configurator – which fertilized the further processes and developments in MC 4.0.

Table 1 Summary of the AT2 evaluation in Italy

Criterion		Scale	Mean	Median	Mode	Min	Max
N.	Name						
1	Accuracy	1 bad accuracy 2 poor accuracy 3 sufficient accuracy 4 good accuracy 5 excellent accuracy	4,78	5	5	4	5
2	Number of company participants	Integer	2,56	2	2	1	7
3	Time	Minutes	283,89	295	300	150	390
		Hours	4,73	4,92	5	2,5	6,5
4	Problems	1 many serious problems	4,67	5	5	4	5

		2 some serious problem 3 no serious problem 4 some minor problems 5 no problem					
5	Interest during test	1 bad interest 2 little interest 3 sufficient interest 4 good interest 5 very good interest	4,83	5	5	3	5
6	Interest to prosecute with other initiatives	1 bad interest 2 little interest 3 sufficient interest 4 good interest 5 very good interest	4,44	5	5	2	5
7	Judgement on AT2	1 bad 2 poor 3 sufficient 4 good 5 excellent	4,89	5	5	4	5
8	Understandability	1 bad 2 poor 3 sufficient 4 good 5 excellent	4,67	5	5	3	5
9	Need to explain concepts	1 very low 2 low 3 medium 4 high 5 very high	3,00	3	3	2	4
10	Grid suitability for a SME	1 bad 2 poor 3 sufficient 4 good 5 excellent	4,78	5	5	3	5
11	Need to improve the grid	1 null 2 low 3 medium 4 high 5 very high	1,17	1	1	1	3
12	Capability to evaluate the MC 4.0 status of a SME	1 bad 2 poor 3 sufficient 4 good 5 excellent	4,89	5	5	4	5
13	Capability to help definition of a feasible MC 4.0 improvement plan	1 bad 2 poor 3 sufficient 4 good 5 excellent	4,50	5	5	3	5
14	Number of initiatives generated	Integer	6,11	6	7	0	11

6 - Results obtained on the validity of the AT3 tool

The guide AT3 is essentially the presentation of what is MC 4.0 and how can be used AT1 and AT2. This guide has been tested by API personnel: this personnel being every day in contact with SMEs had the competence to evaluate AT3. In Austria it has been tested by Energieforum personnel being experts in communication to the companies representing the Austrian target group of MC 4.0.

In the end we discovered that Italian SMEs, except in rare cases, don't like to read documents. They prefer to learn directly from interactions. So it becomes important that the content of the guide is absorbed by the person who has to present the MC 4.0 services offered by the MC 4.0 DEA Centers. The same applies to the majority of Austrian companies. Most of them were willing to meet for an interview or discussion rather than reading documents, filling in questionnaire or consulting some web resources.

In addition and as a result, the main messages present in the guide AT3 have been reported in the MC 4.0 platform so that the interested companies can access the basic information in a very easy and fast way. The guide on the other hand can be useful for companies that participated to test AT1 and AT2, as a summary of the process followed and the theoretical notions used. For this reason, the guide has been sent to SMEs after their participation in evaluating AT1 and AT2. A shorter version (without indications for AT2) was provided to those having participated only in the evaluation of AT1.