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Summary of training inputs coming from regional SME analysis

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1. Aim of the Report

The summary of training inputs coming from regional SME analysis mainly focuses on knowledge gains regarding the content and application of teaching cases that were achieved through various contributions from operational practice during the process of AVM capacity building in pilot trainings. Therefore, the aim of this report is to have a closer look at the actively contributed information from representatives of participating regional enterprises that can help to improve teaching cases and better approximate them to real-life challenges based on firms' AVM piloting experience. In doing so, a maximum of practicability for training participants in all regions is intended to be ensured. In addition to the overall purpose of evaluating pilot actions to identify typical development paths and key success factors of regional businesses (cf. D.T3.3.3 - final report on impact analysis of SME participating in pilot actions), this report also shows the potential of teaching cases as an effective training method in the AVM training program. This follows specifications made with respect to teaching cases within the deliverables D.T2.2.1 to D.T2.2.4 that are further linked to the deliverables of A.T2.3. Apart from this, the report is enriched by the lessons learnt during the testing of the pilot trainings. The training methods (cf. D.T2.2.6 to D.T2.2.10) have been adapted based on the findings from working with teaching cases in the pilot phase T3. By examining the impact on AVM capacity building in participating SMEs, this report gives implications for the further optimisation of the training programme.

2. Methodology

Before presenting the actual results on training inputs coming from regional SME analysis, this section will briefly describe which data has been used to obtain practice inputs for teaching cases and how the data has been subsequently consolidated and evaluated. Moreover, it will elaborate on teaching cases as training method (i.e. characteristics and purpose) and briefly outlines the procedure and general criteria for case selection, collection, development and application.

2.1. Data Sources and Evaluation Procedure

According to the jointly developed methodology and procedures for analysing the impact of pilot actions of the newly developed AVM training programme on participating SMEs in D.T3.3.2, questionnaires, semi-structured interviews and records of training activities from basic, advanced and practical trainings have been applied in the course of the impact analysis. In particular, open-ended questions within questionnaires and interview guides have been used to get a more personalised feedback from the participants. They were given the opportunity to openly reflect on training subjects as well as on training methods and were able to contribute further ideas and suggestions with regard to the pilot actions. Interim results and details have been reported in D.T3.3.5 - Mid-term report on impact analysis of basic courses / advanced webinars and D.T3.3.6 - Mid-term report on impact analysis of MF activities / Strategy camps. Moreover, participants' elaborations and discussions (e.g. own organisational challenges or proposed solutions for teaching and complex teaching cases) during the interactive parts of basic, advanced and practical trainings were mostly recorded and documented. More precisely, photo-protocols were made in the basic courses, whereas online webinars of the various advanced courses were recorded on video and are available in the respective advanced courses on the learning platform OPEN vhb. The collected training records were summarised within the corresponding reports D.T3.2.1 - "InnoPeer AVM Basic courses" implemented locally in all partner regions and D.T3.2.2 - "InnoPeer AVM Living Labs" - advanced online workshops based on teaching cases. Regarding the model factories and strategy camps, written assignments served as an instrument to collect additional feedback and document the inputs of attendees. For this, project partners collected information on varied participant-centred perspectives, focusing on key challenges, success factors and learnings from working with the CE mega case.

Along with the ongoing impact analysis, the information from these documents and the original data sources (e.g. written notes, video files and audio recordings) has been extracted and analysed systematically to ultimately gain practical input from practitioners for further developing the teaching case collection.

2.2. Teaching Cases as Training Method

Definition and Purpose

Teaching cases describe more or less complex real-world situations where a decision maker has to solve a particular problem under conditions of incomplete, conflicting, ambiguous, redundant and/or irrelevant information. Situations are often told from a manager's perspective, contain more than one challenge and thus represent day-to-day tasks of real-world managers who try to make sense of a complex and dynamic world and make decisions for an unpredictable future. In general, they are used to serve as illustrative examples to ensure problem-based learning as they make lectures more interesting and practice-oriented. Moreover, they provide the potential to initiate and facilitate discussion among participants and facilitate knowledge exchange.

Development of Teaching Cases

In the course of the InnoPeer project, the teaching cases were derived from real AVM-related problems and challenges of SME managers in the different partner regions by collecting empirical data through the conduction of interviews and using secondary sources, i.e. homepages, press releases, news articles from selected case firms (cf. D.T2.3.1 - selection of cases from CE SME identified in D.T1.1.2, basis for teaching case development). Additionally, some of the advanced teaching cases were developed by extending the set of basic teaching cases to include further and more complex information. Again, this was done in an iterative process of further data collection (i.e. interviews) and data analysis within the selected case firms. Based on the gathered information on the case firms, the project partners consequently prepared the teaching cases by describing each firm, its industry background, an ongoing or already completed AVM-related project, the challenges that firms encountered in its implementation as well as possible solutions to resolve the problems. Questions for discussion were prepared for each teaching case with respect to the relevant theoretical concepts and aim at giving training participants the opportunity to work on real-life problems in an applied fashion. In developing the CE Mega Case (D.T2.3.4), project partners from different regions worked together to develop a comprehensive storyline of different companies that are connected via a transnational value chain. For that purpose, the inputs of initial complex teaching case (see D.T2.3.7) were continuously widened using inputs from all participating SMEs and experts at different stages of T3 to build the CE Mega Case. More precisely, the specific interests and conditions of each region were incorporated in order to illustrate challenges of SME in a transnational AVM value chain.

A teaching case example for the HRM & organisation knowledge dimension is the case of a firm that wants to introduce automated work processes, but faces difficulties with employee resistance and skills. Therefore, the managers seek solutions for overcoming resistance in the process of introducing the new technology and for providing the skills needed for maintaining and further developing of the new processes. For each case, several training tasks were defined covering one or more of the Advanced Manufacturing (AVM) knowledge dimensions (i.e. technology, human resource management, organisation, business model development) at different levels of complexity. In this way, teaching cases were adapted for basic, advanced and practical training modules. Finally, all project partners cooperated to develop one "AVM Mega-Case" addressing complex challenges (i.e. trying to access transnational AVM value chains) faced by SME in the project region.

Whereas some cases focus only on one knowledge dimension (i.e. technology, HRM, organisation or business model development) others contain a mix of challenges and therefore allow linking technical & business issues in AVM. Apart from the existing experiences and expertise that can be shared among participants, teaching cases enable the practical application of taught concepts and the new knowledge acquired during the training programme. Additionally, participants gain meta-level competences necessary for any kind of

managerial decision-making. The method used for solving a teaching case (i.e. problem identification, development of alternative problem solutions, assessment of alternatives, selection of one alternative, development of implementation strategies) can be used as guiding principle for any kind of problem and therefore improves the capacity for analytical thinking and enhances decision-making and solution competence in complex settings. When teaching cases are used for the purpose of classroom discussion and/or group assignments, they also foster the competence for team decision making and allow for experience exchange among participants.

Application of Teaching Cases

In the course of the trainings, the participants were instructed in working with teaching cases. They received a quick methodological introduction as well as some information on how to start identifying and addressing problems. After this, participants were asked to engage with the teaching cases to develop solutions for the described issues. Questions that were added at the end of each teaching case intended to provide additional orientation and to support participants in developing (alternative) solutions to the identified challenges. Depending on the course mode (online vs. offline teaching) and individual preferences, participants worked on the assignments individually or in small groups. Results were then presented during the trainings. Precisely, to work with the basic teaching cases in the trainings, a five-step process can serve as a guideline for trainers and training participants:

1. **Read**
   - „Skim through the case“: Read the first paragraph and the headlines
   - Read the discussion questions at the end of the teaching case
   - Recall the contents of the theoretical input
   - Detailed reading of the teaching case
2. **Summarise individually**
   - What is the central topic of the case?
   - Which problems appear relevant for resolving the case?
   - What is the timely sequence of events?
   - Who are important actors and what are their roles? How are they related?
   - What is the essential information and where are the areas of ambiguity, contradictions, or areas where information is missing?
3. **Discuss in small groups**
   - Develop a common understanding of the problem
   - Critically discuss the discussion questions
   - Which parts of the theoretical input could be useful for answering the discussion questions?
   - Jointly find and agree on alternative solutions
4. **Document the results on flipcharts**
5. **Discuss the solutions in plenum**

Regarding the advanced training courses, working on teaching cases was organised via a previously scheduled online webinar in order to exchange solutions across various Central European regions. While participants developed solutions individually, the results were discussed in online plenums with trainers and other participants in view of their personal knowledge background and practical experience. This equally enabled a fruitful exchange across different regions and disciplines.

3. Results and Key Findings

Within and beyond the application of teaching cases in pilot trainings, profound input (i.e. experience from practice and feedback) of participants has been collected. The results in this section will be presented by following a systematic manner – following pilot training classification. Participants' contributions were used to adapt and extend the content and scope of the teaching cases and were finally applied to optimise the method for working with teaching cases respectively.

3.1. Basic Trainings: Feedback and Input from Participants

Teaching Cases constituted a relevant and important part of the basic trainings. More precisely, participants appreciated the interesting contents and confirmed to benefit from the examination of teaching cases by putting their theoretical knowledge into practice. For instance, they compared challenges and possible solutions within teaching cases to their respective companies and either got ideas for dealing with their concerns or were reaffirmed for actions they had already taken in their company. Although some of the challenges presented in the teaching cases did not directly relate to current hurdles that participants face in their firms, they were nevertheless able to derive valuable inputs to overcome current challenges in their organisations. During the discussion rounds, the participants discovered similarities and differences between the challenges that other companies are facing. While some of these challenges related solely to the technological aspects of Industry 4.0, some of them were, for example, concerned with regional conditions that improve or hinder access to certain technologies. Examples for such regional conditions were based on legal questions, the search for qualified personnel or the availability of expert counselling. Particularly these practical reflections and discussions with others were useful for participants. Moreover, participants' feedback emphasises the perceived positive impact of teaching cases that allowed participants to work on and apply their knowledge in an applied fashion.

In some cases, participants asked for real-life case examples that deal with the implementation of Industry 4.0 more extensively or that address the particular needs of participating SMEs more specifically. The intention behind this was to learn practical lessons that help to replicate such examples or have the potential to inspire changes. In this context, future jobs and new associated skills that will potentially be required for different business processes seemed to be relevant issues. Furthermore, some participants desired to have more time for the examination of the teaching cases and the possibility of sharing ideas, including more interaction, discussion and joint work with other participants and trainers. Participants also suggested to create a centre of competence regarding Industry 4.0 to foster the collaboration between companies and universities and to examine how the digital transformation can lead to an improved quality of life.

As already stated in D.T3.3.5 - Mid-term report on impact analysis of basic courses / advanced webinars, the basic trainings helped participants to realise how concrete and real Industry 4.0 already is and what potential it has. The teaching cases illustrated that each organisation has to find out individually what kind of technology and implementation strategy is most adequate and that external support is beneficial, especially when it comes to operatively introducing new technologies in organisations. Partly, this relates to the awareness that knowledge of different concepts and approaches as well as the sensitisation and training of new and existing staff is key. Furthermore, some participants reported that their perspective on Industry 4.0 has changed after the trainings. They have recognised the need to adapt to new technologies in order not to fall behind other competitors. Furthermore, teaching cases encouraged participants to explore and evaluate different perspectives of Industry 4.0. For instance, this refers to knowledge gains with respect to employees in 4.0 (e.g. managing resistance and increasing acceptance), the risks, future scenarios or consequences of Industry 4.0 (e.g. where and why Industry 4.0 leads to employment or unemployment), and AI-related aspects. Previous training improvements have taken into account the corresponding recommendations of the participants.

Three to six month after the basic training some participants were interviewed again to examine which actions they have implemented (or are planning to implement) in their company after the training. They reported that working with the teaching cases delivered long-term support for identifying problems, inputs and learnings that are applicable to their own company. Again, it was suggested to add more real-life experience-based examples to the basic courses and, more precisely, best practices on how AVM has been successfully implemented. In this context, the topic of change management was perceived as important, also with regard to aspects like company size. Learning how to communicate the advantages of AVM to employees, how to get them on board with digitalisation and how to handle their concerns were considered relevant. Moreover, participants emphasised the legal aspects of integrating new technologies in SMEs and suggested to treat this issue more in depth.

"It was difficult to implement the knowledge in the entire company because of company size."
(Basic Training Participant)

In contrast, another participant stated that it was possible to realise improvements in the production process with the newly acquired knowledge. Another participant reported that the company's business model has been revised and some new ideas have been considered so far. Yet another company plans to provide trainings for employees to better exploit the use of AVM technologies in the future.

3.2. Advanced Trainings: Feedback and Input from Participants

In the advanced trainings, participants were provided with teaching cases that provide more complex SME challenges in the respective knowledge dimensions. The goal was to specifically enhance participants' knowledge through the described challenges and the additional questions asked. Apart from the cases, participants received a guideline that provided specific support in finding a solution individually or in small groups. They were encouraged to prepare answers to the questions and present their results in an online webinar. Each webinar was professionally moderated by a project partner and delivered not only additional input regarding the advanced teaching cases, but also stimulated a fruitful discussion and exchange between participants.

"I want to send my thanks to you and the team. I really enjoyed it. My highlight was definitely the case study webinar." (Advanced Training Participant)

Again, an evaluation survey was conducted. Participants indicated that teaching cases are particularly interesting and useful elements of the advanced trainings. Recommendations with respect to topics that could have been addressed additionally, more in depth or differently refer to the implementation of strategies, simulation, process optimisation and human resource management as well as to additive manufacturing processes, AVM materials and enterprise risk management. Moreover, participants suggested adding more practical examples and case studies to make the theoretical inputs more comprehensible. This indicates that teaching cases are a suitable method to convey theory in a practical way that promotes a deeper understanding of the organisation. Participants furthermore reported that the teaching cases positively influenced their ability to connect the theoretical and practical inputs from the advanced trainings with challenges as part of their daily business in the company and to initiate changes and improvements.

Some weeks after the completion of the advanced online trainings, participants were asked to take part in a second evaluation survey that investigates actions that have been triggered by the newly gained knowledge of participants in their organisations. Participants reported that they are planning various organisational changes (e.g. adaption of the business model, strategy, vision or recruitment). In this regard, teaching cases can be seen as an important component of the advanced trainings. They provided the opportunity to work with real cases, to exercise on practicable tools like the Business Model Canvas and thus, trigger improvements in participants' companies. One key take-away messages was that change is ubiquitous and that the implementation of changes is contingent on the specific circumstances a company faces. Participants therefore suggested extending the training to other platforms (e.g. internal company platforms) to reach a broader target audience.

3.3. Model Factories: Impact on Capacity Building and Implications for Teaching Case Development

The model factories enabled participating SMEs to get an overview of AVM/Industry 4.0 infrastructure implementation (cf. D.T2.2.10). They helped them to recognise the opportunities in terms of current challenges, such as strong competition on the market, a high variability of production or arising customer demands for shortened lead times. Showing the potential of AVM technologies, therefore, is as important as sharpening the view for relevant preconditions and possible technology-driven obstacles. Model factories served as a stimulus for a better understanding of how production plants can be digitally changed by designing, planning and managing the transition towards a new organisational model and new working processes – thereby contributing to SMEs' capacity building.

Moreover, practical examples to explain the implementation process and the technical aspects of the solutions to be adopted were used as central elements of the model factories. This concerns, for example, the question of setting up an IoT-based monitoring system of production lines from the acquisition of inputs to the storage of the final products. Besides, the identification of proper suppliers and partners as well as the establishment of supportive networks were considered relevant.

Deepening knowledge on how to put Industry 4.0 solutions into practice for making production and logistics more efficient and effective is an urgent matter of participating SMEs. Apart from the technical issues, getting insights into the role of data seems to be particularly important as well as learning

- how to implement Industry 4.0 solutions at production level by exploiting expertise in ICTs and by integrating such expertise with the core production know-how of the company,
- how to interact with external experts (e.g. research centres, start-ups, technology integrators) to implement Industry 4.0 solutions and
- how to implement digital transformation within their companies by following a standardised roadmap.

"My company started the I4.0 process already 4 years ago. Now, the whole InnoPeer AVM programme, the covered subjects and teaching case application allowed me to evaluate and confirm previous choices."
(Model Factory Participant)

Participants highlighted the practical relevance of further technologies and organisational issues and expressed the need for continuous capacity building in these areas. Figure 1 presents a collection of the most interesting topics in this regard.

value stream mapping, production planning tools, machine connectivity, AVM process planning, mass customised production, business model upgrade, organisation structure change, HRM planning, additive manufacturing, 3D-printing, IoT, AVM quality control, software support, workflow redesign, data management architecture, process digitization, data collection systems, productivity gains, training, employee involvement, data processing

Figure 1 Collection of Interesting Topics

The feedback and inputs of participants in the model factories are a valuable source for the further development and extension of teaching cases, although teaching cases have not been applied there. As with the model factories, teaching cases trigger vivid discussions and exchange regarding the presented challenges and beyond. The case-based discussion about the change of products or optimisation of plants by using Industry 4.0 solutions is likely to spread over to real-life examples and subsequently provide an "impetus to act". The individual and collective examination of a case study further contributes to build awareness with respect to the implementation of AVM solutions and required changes that go beyond purely technical functionalities like legal, economic or environmental factors as well as shifts in strategy.

3.4. Strategy Camps: Feedback and Input from Participants

The strategy camps aimed at working with AVM-related challenges in the context of a transnational value chain. To do so, participants were working with the CE Mega Case (D.T2.3.4) that has been developed to reassemble real problems and dynamics within a trans-European manufacturing value chain that spans across various companies operating in different regions. In total, five interconnected strategy camps in the Central European (CE) project regions took place. The approach of the CE Mega Case enabled participants to apply methods and instruments from the basic and advanced trainings and to more holistically deepen their theoretical knowledge with practical inputs. Since participants found overlaps between the case-specific change management problems and their actual ones, working on the CE Mega Case helped them to reflect the present situation, e.g. regarding involvement of the top-management, engagement of internal teams or integration of new knowledge and competences in their organisations.

In D.T3.3.6 - the Mid-term report on impact analysis of MF activities / Strategy camps, participants' AVM-related challenges and key success factors for the implementation of AVM solutions are presented. From this, the following aspects appear to be particularly relevant with respect to the improvement of the teaching cases:

- Participants acknowledged that there is an undeniable necessity for change. Hence, they see a major learning in having received a toolbox of theoretical inputs on certain methods that can be used to trigger certain practical changes within their organisations. Particularly, the Business Model Canvas and the competency map helped participants to get a better understanding how to start dealing with digitalisation challenges. Therefore, the use of these tools was perceived as particularly beneficial in working with the CE Mega Case.
- Participants expressed their wish for more time to work on the CE Mega Case, while the case itself received very positive feedback as being both informative and educational. This reveals the importance of the CE Mega Case as educational tool for more holistically designed knowledge acquisition processes and learning transfers. In this regard, two major benefits can be highlighted:
  - Working with the CE Mega Case allowed participants to apply their knowledge of AVM-related strategies that is needed to address challenges going beyond the boundaries of the company itself and spanning across transnational value chains.
  - Since many challenges are associated with a lack of AVM-related knowledge, the examination of the CE Mega Case contributed to better recognise and handle challenges, such as uncertainty among employees and the adaption of business models in continuously changing environments.

In the second evaluation round which took place three to six months after the training, participants stressed the importance of an interesting and rich discussion with other participants and, again, the joint application of different tools while working on the CE Mega Case. By applying tools such as the Persona Method, SWOT-analyses or competency maps, participants could use their theoretical knowledge in an applied fashion. Some participants of the strategy camps even realised that they are able to update the value proposition of their company by applying new technologies. They remarked teamwork and the interdisciplinary exchange with other participants as very useful and added that such an exchange of ideas triggers the development of new perspectives. Moreover, the significance of team building and productive teamwork was emphasised. One of the main objectives of the strategy camps was achieved by giving companies the opportunity to test the complexity and the potential of a corporate transformation towards Industry 4.0 through a hands-on, small-scaled, and controlled experience. This not only increased the awareness, but also the motivation to implement corporate change in the own company.

"I have learned that change-related interventions are only possible with the awareness and commitment of the management." (Strategy Camp Participant)

4. Conclusion

The training methods for all AVM InnoPeer pilot trainings have been refined and further optimised on the basis of the findings from working with teaching cases. The details of the methodological adjustments are presented in the deliverable reports D.T2.2.6 to D.T2.2.10.

In this report, training inputs coming from regional SME analysis were summarised and a collection of topics for the further development and extension of teaching cases was presented. Besides, company representatives who participated in the pilot trainings provided insights from practice and extensive feedback regarding teaching cases. Based on this feedback, four major categories that reflect the importance of teaching cases in the InnoPeer AVM training curriculum were identified.

1. **Thematic Relevance**

   Thematic relevance addresses the degree to which the content of teaching cases seems to be connected, appropriate and useful to what participants are interested in due to their personal and professional background, e.g. their function and responsibility within their organisation. Teaching cases were found to be highly relevant in terms of the covered issues and challenges. The relevance of the teaching cases in enhancing the understanding of AVM-related issues was mainly reflected in participants' positive feedback regarding the significance and usefulness of the dealt subjects.

2. **Practical Applicability**

   Practical applicability refers to the presence of a suitable link between theoretical explanations and real-life context. This is, providing a target-oriented way to withdraw learnings from teaching cases to implement changes or foster concrete actions in the respective organisations. Teaching cases facilitated the transfer of theories and methods learned in pilot trainings to organisational practice. Against the background of present organisational states and challenges (business strategy, maturity level, competitiveness, etc.), they helped to build understanding and trigger practical changes. Although the teaching cases do not always take into account the idiosyncratic characteristics of participating SMEs, e.g. company size or industry sector, they are designed to generalise solutions to broader contexts.

3. **Interdisciplinary Knowledge Exchange**

   Interdisciplinary knowledge exchange is understood as the systematic or situation-based sharing of tacit knowledge that has been acquired by participants coming from different fields or disciplines in the course of their working life. The main purpose is to connect practitioners so they can discuss and learn from each other. Forming diverse working groups and jointly working on teaching case solutions allowed insights into multiple perspectives. Thus, participants could benefit from the real-life (work) experience of other participants and share their own knowledge.

4. **Creativity Enhancement**

   Creativity enhancement focuses on increasing participants' capability to imagine new ideas or to think about given facts or existing concepts from a different perspective. It is closely linked to a fruitful exchange and creative solution seeking process. In this way, teaching cases fostered outside-the-box thinking and idea generation through joint solution development and discussion.

All in all, teaching cases are a highly-valued educational element of the InnoPeer AVM training programme and contributed significantly to an exchange-based learning as well as to a practice-oriented depiction of Industry 4.0 challenges and its possible solutions. In a nutshell, participants perceived working with teaching cases as enriching and highly important in dealing with Industry 4.0 and other AVM-related issues.