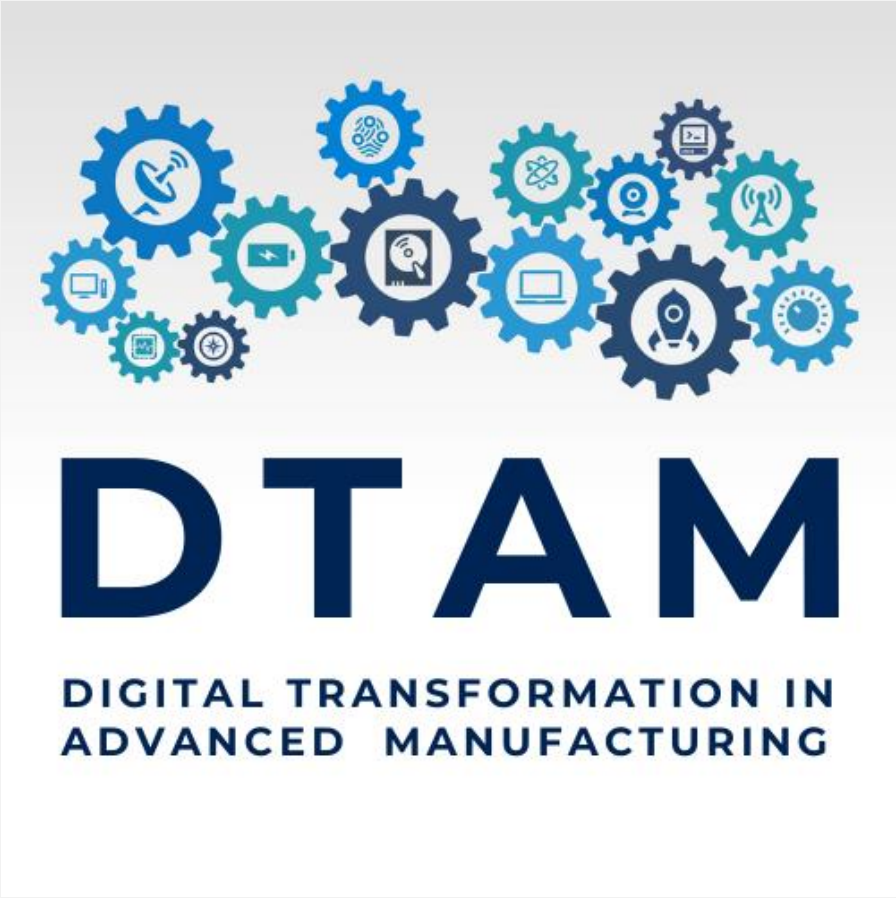

MODERNIZING AND EXPANDING THE EU VET OFFER: THE DTAM CASE

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This report is jointly published by the collaborative efforts of the ten organizations that form the consortium behind the DTAM project. These organizations, each contributing unique expertise and perspectives, have come together to share insights, findings, and recommendations for the improvement of the VET training offer across the EU, based on the Digital Transformation in Advanced Manufacturing (DTAM) project experience.

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1. Introduction (background)

"An Integral Training Curriculum for EU technicians to deploy and manage digital tools in Smart Manufacturing" or DTAM for short, is a 3-year international project financed under the Erasmus+ program of the European Union. It came as a result of the recognized need for initial and adaptive training for both operational and ICT technicians to face the emerging technological and digital transformation inherent in evolved manufacturing processes. Therefore, DTAM aims to deliver a new curriculum in digital transformation dedicated to the quality training of mid-high-level technicians in key enabling technologies for Advanced Manufacturing (AM). Our flexible multidisciplinary modular training with access for learners to a network of remote IoT labs will help grow a workforce of technicians capable of understanding, installing, configuring, monitoring, analysing, transferring data, and maintaining digital systems in advanced manufacturing environments.

Having that in mind, the DTAM partnership have created 7 main valuable resources to facilitate the aforementioned project goals:

1.1. Digital Transformation Competence Index (DTCI).

We invested quite a lot of internal and external resources and trying to find out the proper competencies for unique DTAM technician's VET profile. Hence, we gathered data from multiple-sources which include (a) formal public and informal messages (from Govt. bodies, Industry and VET stakeholders), at conferences, in policy directives and communications, (b) desk research input from relevant papers and EU sources as well as close research into previous project initiatives and (c) a series of direct round table regional sectoral discussions. It has been developed according to the needs for a type of qualification in the labour market (i.e. the need to deploy and manage digital tools in Smart Manufacturing) and it has been verified by industrial and digital transformation experts. The index forms the crux of the curriculum and provides an invaluable tool for learners/technicians and VET staff planning for skills training, upskilling or reskilling.

1.2. The DTAM training course

Based on our DTCI, we've developed a comprehensive training course with more than 25 training units on digital and transversal skills relevant for IT and OT technicians in AM environments. The training course consist of theory, guided examples and a series of challenges (practical exercises) – contained within a series of modules aimed at understanding key enabling technologies in major areas of Industry 4.0 like Big Data, Machine learning, Smart sensors, Cybersecurity and a dedicated module on Transversal skills. The training content is available in 6 languages: English, Bulgarian, Greek, Spanish, Italian and Dutch.

1.3. DTAM training methodology

To support the exploitation of the DTAM training course, we've developed a dedicated training methodology, offering practical and theoretical guidelines for delivering the DTAM curriculum in initial (IVET) and continuing (CVET) vocational education and training courses. The methodology is meant for both VET staff and other organizations delivering the DTAM curriculum.

1.4. DTAM Trainer's Manual

In order to facilitate the wider adoption of the DTAM training course, we've created an integral guide to the DTAM curriculum for future H/VET staff who would like to deliver the training as part of formal accredited training in IVET and CVET courses. The Manual incorporates summarised elements from the methodological guide with a focus in accompanying training staff on a flexible journey through the delivery of the DTAM course with appropriate pedagogical tools.

1.5. Digital self-evaluation tool

If we are going to teach digital transformation in advanced manufacturing in an effective way, it makes sense we needed a proper tool to assist us in establishing the learner's needs and possibly point out specific areas of improvement. Hence, the DTAM Digital self-evaluation tool. It is based on an interactive platform which includes several serious games and additional gamification elements. As a first step, by using the tool the students interested in DTAM, will run a self-diagnosis on

their soft and hard skills in order to check their knowledge status, and based on their results, to select the intensity of training for the rest of their education in the course.

1.6. Training platform

The interactive multilingual platform of the DTAM project, is an open-source tool for e-learning solutions, fully customized to the needs of the course. It hosts the curriculum training materials as well as modular materials and all other pedagogical tools necessary for a smooth learning experience.

1.7. IoT Hub

DTAM IoT Hub provides access to a developed IoT digital ecosystem with an aim to build on the e-learning experience. That includes our dedicated training platform and a special setup of 4 IoT labs build entirely for the purpose of the DTAM training course, integrating all necessary tools like raspberry Pi's and sensors to complete the DTAM training and learning experience. Remote learners with fewer resources have the opportunity to access these quality technologies and equipment via the e-learning platform. Users are connected directly to the project network of IoT labs upon registration and are encouraged in the DTAM Methodology to work together with other European students on specific digital challenges in the AM field.

Hence, we firmly believe, that the DTAM project stands as a transformative force in European VET, not only by addressing the immediate skills gap in Smart Manufacturing, but also by setting a precedent for collaborative, adaptive, and innovative approaches to vocational education and training tailored to the evolving needs of the workforce in the Fourth Industrial Revolution.

2. Current State of VET in the EU

The EU boasts a diverse range of VET programs catering to various industries and sectors. These programs are designed to provide practical skills and hands-on experience to learners.

Many EU countries have established strong partnerships between educational institutions and industries. This collaboration ensures that VET programs align with the current needs of the job market, increasing the employability of graduates. Several EU countries (e.g. Germany, Austria, the Netherlands, Sweden and Finland) have implemented quality assurance mechanisms for VET to maintain and enhance the standards of vocational education. This includes accreditation processes and continuous evaluation.

On the other hand, initiatives like Erasmus+ promote mobility among students and professionals, allowing them to gain international experience and exposure to different working environments. Some EU countries recognize and value non-formal and informal learning experiences, acknowledging that skills acquired outside traditional educational settings are valuable.

While the above-mentioned strengths are admirable, there are many weaknesses in EU VET systems yet to be tackled. In some regions for example, there persists a societal bias towards academic education over vocational paths. This perception is a rather old issue and a negative trend contributing to a lower uptake of VET programs and stigmatising vocational careers. Overcoming this bias is crucial for promoting the value and importance of vocational education and training across diverse regions and communities within the EU. Overcoming this challenge involves reshaping societal attitudes and highlighting the value and relevance of VET in providing practical skills for real-world employment, contributing to economic growth and innovation.

Coordination between educational institutions, employers, and policymakers can sometimes be lacking. This results in a mismatch between the skills acquired through VET programs and the actual demands of the labour market. The Fourth Industrial Revolution has brought about rapid technological changes. Adapting VET programs to these changes can be challenging, and there might be a lag in updating curricula to match emerging industry requirements. Addressing this weakness requires enhanced communication channels, regular feedback mechanisms, and closer

collaboration between stakeholders to ensure VET programs stay responsive to industry demands. Hence, a stronger collaboration between education, policy makers and education should be encouraged.

Access to quality VET programs can be unequal across different regions within EU countries, leading to disparities in skill development and employment opportunities. This issue creates disparities in skill development and employment opportunities. In certain cases, this is due to the fact that VET programs may suffer from inadequate funding and resources, limiting the quality of education and the ability to keep pace with rapidly evolving industries. Insufficient investment can lead to outdated facilities, outdated equipment, and an inability to keep pace with technological advancements. To tackle this particular challenge efforts are needed to ensure equal access to VET programs, particularly in rural or economically disadvantaged areas, while increasing both public and private funding to help VET programs be adequately resourced and equipped to deliver high-quality training.

Finally, VET systems across EU member states can be subject to complex and varied regulatory environments. Harmonising these regulations to facilitate smoother cross-border recognition of qualifications is still a major barrier in creating better coordination and validation of qualifications, programs and degrees obtained. Streamlining regulatory processes and fostering mutual recognition of qualifications holds an enormous potential in enhancing the mobility of VET graduates within the EU.

3. Key improvement aspects

3.1. Curriculum Development and Flexibility:

The need for modernised and flexible VET curricula is rooted in the rapidly evolving landscape of the modern workforce. As industries undergo profound transformations driven by technological advancements and changing economic demands, there is a critical imperative to ensure that VET programs are dynamic, relevant, and responsive to these shifts.

Modernization of VET is essential to equip learners with the skills and knowledge required in emerging industries, such as artificial intelligence, data analytics, and renewable energy. The Fourth Industrial Revolution necessitates a departure from traditional, static curricula to ones that embrace innovation and technological integration. Additionally, modernised VET curricula play a pivotal role in breaking down societal perceptions surrounding vocational education. By aligning closely with the needs of advanced industries and promoting cutting-edge skills, VET programs can attract a diverse range of learners and dismantle stereotypes associated with traditional career pathways.

Flexibility in VET is equally vital to accommodate the diverse needs of learners and the ever-changing requirements of industries. A flexible curriculum allows for the integration of new technologies, the inclusion of interdisciplinary skills, and the adaptation to evolving job market demands. It enables VET institutions to swiftly respond to emerging trends, ensuring that graduates are not only job-ready upon completion but also possess a skill set that remains relevant throughout their careers.

Moreover, a modern and flexible VET curriculum fosters an environment of lifelong learning. It encourages individuals to engage in continuous skill development, enabling them to navigate and thrive in a dynamic job market. This adaptability is particularly crucial as the nature of work continues to shift towards roles that demand a blend of technical expertise, problem-solving skills, and digital literacy.

Hence, the call for modernization and flexibility in VET curricula is a response to the imperatives of the contemporary workforce. It reflects a commitment to preparing learners not only for current industry needs but also for the uncertainties and opportunities presented by future advancements in technology and the evolving nature of work.

On the other hand, the imperative to update Vocational Education and Training (VET) curricula to encompass digitalization and Industry 4.0 skills is driven by

the profound transformations occurring in the global economy. As we transition into an era defined by advanced technologies and interconnected systems, the relevance of traditional skills is giving way to a demand for a new set of competencies. Integration of digitalization and Industry 4.0 skills into VET curricula is crucial due to the pervasive influence of technology across industries. Digital technologies, automation, data analytics, and the Internet of Things (IoT) are reshaping the nature of work. Therefore, it is essential that VET programs reflect these changes to ensure that learners are not only proficient in conventional skills but also adept at navigating the digital landscape.

The rapid evolution of industries towards smart manufacturing, data-driven decision-making, and interconnected systems necessitates that VET graduates possess a solid foundation in digital literacy. This includes the ability to work with emerging technologies, analyse data, and understand the implications of automation on various sectors. By updating curricula to embrace these skills, VET programs can produce graduates who are not only job-ready but also well-positioned to contribute to the innovation and efficiency of Industry 4.0. Moreover, incorporating digitalization and Industry 4.0 skills into VET curricula aligns with the broader goals of economic competitiveness. Nations and industries that lead in adopting and leveraging digital technologies are more likely to excel in the global market. By ensuring that VET graduates are equipped with the skills demanded by the current and future job market, countries can enhance their workforce's ability to contribute to economic growth and innovation.

Furthermore, the inclusion of digital skills in VET curricula is integral to addressing the skills gap. Many industries face a shortage of workers with proficiency in digital technologies. By preparing VET students with these skills, educational institutions contribute to filling this gap, providing industries with a skilled workforce that can drive productivity and foster competitiveness.

The DTAM project, with its emphasis on modular training units, reflects a recognition that the landscape of smart manufacturing and Industry 4.0 is continually evolving. Adaptability is a cornerstone of effective VET programs,

particularly in the face of rapid technological changes. The call for modular and adaptable programs is a call for education systems to be agile, responsive, and capable of integrating new developments seamlessly. It aligns with the understanding that the traditional model of static, long-term educational structures may struggle to keep pace with the dynamic needs of Industry 4.0.

Hence, advocating for the adoption of similar modular structures in VET programs encourages a proactive response to emerging technologies and changing industry requirements. These modular approaches enable swift adjustments to curricula, ensuring that learners are equipped with the latest skills demanded by the job market.

3.2. Capacity building of teachers and trainers in VET

The well-known need for capacity building of teachers and trainers in VET is undeniable in the face of rapidly evolving educational landscapes and technological advancements. In a dynamic job market where the skills demanded by industries are continually changing, educators in VET play a pivotal role in shaping the competencies of the future workforce. Capacity building ensures that teachers and trainers are equipped with the latest pedagogical methods, industry insights, and technological expertise. It empowers them to integrate cutting-edge technologies into their teaching practices, fostering a learning environment that mirrors the demands of contemporary workplaces. Moreover, capacity building enables educators to stay abreast of emerging trends and advancements in various industries, allowing them to provide relevant and up-to-date guidance to students.

Therefore, encouraging and incetivizing teachers to actively participate in Erasmus+ projects such as DTAM is vital part of their capacity building. The latter includes deeper integration of project management into the professional development plans of teaching staff, while also encouraging them to develop their knowledge using innovative tools.

In the case of the DTAM project, such is the case for the Da Vinci College (Dordrecht, the Netherlands) teachers who worked on the development of one of the training modules of the DTAM training course. Their feedback was that

doing so was a nice opportunity to work with new hardware like discovering the Raspberry Pi Pico, Arduino and the various sensors. Another such use case was that some of the teachers involved in the DTAM project, who are also teaching “Python programming” and “PHP programming”, have now started to use exercises from the DTAM curriculum in their other lessons.

In the case of another partner in the DTAM project - the Apro Formazione VET school (Alba, Italy), the installation of the new IoT laboratory and the knowledge gained from the DTAM project has enabled Apro to grow in the world of advanced manufacturing. Furthermore, it was possible to use the resources as a development base for other international projects (e.g. www.thinkerlab.eu), thus creating new synergies with other entities possibly interested in using DTAM resources. In addition, for the involved teachers from Apro, the DTAM project has been an excellent opportunity for capacity building on IoT topics, in the specific application of integration with industrial devices such as PLCs, HMIs and motor drivers. Connecting these devices to the system developed with the DTAM project made it possible to introduce data collection and analysis into the EQF4 courses offered for 'Industrial Automation Technicians', giving students the chance to broaden their horizons.

Another crucial aspect of the successful capacity building was especially thanks to the experience gained from the skill competition organised between Apro Formazione (Alba, Italy) and Politeknika Txorierri (Derio, Spain) students. Working on a project by bringing both teachers and students together, from other backgrounds and from different countries gave great added value to the DTAM pilot phase. The skill competition system should definitely be repeated in the coming years involving more and more students from all over Europe. Furthermore, such kind of exchange and experiences are definitely an effective tool to facilitate the attractiveness of VET programs and promote capacity building of both students and teachers.

Ultimately, investing in the professional development of teachers and trainers in VET is an investment in the quality and relevance of education, enhancing the overall effectiveness of vocational training programs and better preparing

students for the challenges and opportunities of the modern workforce.

3.3. Public-Private Partnerships

Public-private partnership (PPP) is a model of cooperation in which government entities and private companies work together to provide services or develop projects of public interest. One of the sectors where this collaboration is particularly relevant is education and especially vocational training centres.

VET centres are crucial in preparing individuals for the labour market and success in their careers. PPP in VET can lead to a greater diversity of curricula, resources and opportunities for students. Public institutions can partner with private companies to offer training programs that are aligned with real labour market needs. This not only ensures that graduates are better prepared for employment, but can also encourage innovation and investment in education.

The public administration plays a key role in regulating and overseeing these PPP programs, ensuring that high quality standards are maintained and public interest objectives are met. In addition, through tax incentives and financing, the government can stimulate private sector participation in VET.

Companies, for their part, benefit from PPP by having access to a better trained workforce tailored to their specific needs. This can increase competitiveness and productivity, which in turn contributes to economic development.

In the case of the DTAM project, such a company is Atlantis Engineering Srl. (Thessaloniki, Greece). Atlantis is deeply engaged in fostering strong partnerships with VETs, universities, and industry players. The close collaboration with VET providers has proven instrumental in tailoring training programs to meet the dynamic demands of the local and international workforce. Their relationships with universities further enhance this synergy, creating a knowledge-sharing network that benefits both academia and industry. Atlantis encourages the exploration of incentives that promote and reward collaboration between VET providers and businesses. These incentives can take various forms, including, recognition programs, and resource-sharing initiatives. Atlantis and VET centres work closely together, teaming up on

various proposals and sharing knowledge. With the help of DTAM, an SME like Atlantis Engineering have expanded their connections to clients in the manufacturing industry, informing them about the project, which in terms helped reaching even more manufacturing and VET centres and expanding their network. Therefore, DTAM has proved to be a valuable tool for collaboration and growth in the case of Atlantis Engineering.

3.4. Accessibility of VET

Digital technologies support the inclusion of diverse student groups in education in a number of ways including **enhancing accessibility** of educational content, **increasing personalisation** and providing distance learning opportunities. DTAM is no exception in this relation. The dedicated online Training Course coupled with a standalone Digital Self-Evaluation Tool of hard and soft competences, aim to help students assess the levels of their current knowledge in relevant topics, so that they can then make choices that best fit their educational needs and preferences. The DTAM training course is accompanied by quizzes, exercises and challenges that help students monitor their progress and make the course more motivating. In addition, the developed Training Methodology and Trainer's Manual assist teachers (and basically anyone else interested in exploiting the DTAM training course), in implementing the DTAM curricula in their own environment i.e. classrooms. Finally, the fact that the DTAM course has been made available in six different languages also makes it more accessible to even greater number of stakeholders potentially around the whole of Europe.

Another aspect of accessibility achieved within the DTAM project has to do with the open-access feature of the online training course, thus providing equal flexible and personalised learning opportunities. Furthermore, remote learners with fewer resources also have the opportunity to access quality technology and equipment via the multilingual DTAM IoT Hub: made of 4 IoT labs equipped with various tech and sensors, serve as a practice point of various technologies related to what users have been learning about as part of the DTAM course. On the other hand, the DTAM IoT Hub also serves as a collaboration hotspot e.g. to

organise relevant workshops, and informational sessions to highlight the benefits of VET and to encourage participation from underserved communities.

The DTAM course offers flexibility in addition to accessibility, as it can be part of an official training provision, but it can also be universally accessed by anyone and a Certificate of Achievement listing the competences gained can be automatically provided via the online training environment. These future qualified learners will be able to show that they have acquired the skills needed to compete in the job market, thus reducing the gap in employment opportunities between different socioeconomic groups.

Hence, DTAM exists to once more advocate for investing in technology and online learning platforms to make VET education attractive and accessible to those who may have limitations in attending physical classes, representatives from underserved or underdeveloped regions, but also adults who would like to upskill their competences. Most of the time these are possible through digital education policies, but it is also very important to partner with entities outside education, including private businesses, as already pointed in the *Public-Private Partnerships* section.

3.5. Digital Learning Infrastructure

In the dynamic educational environment, we are living today, investing in new digital tools is essential for VET centres to prepare students for the challenges of the modern workplace, especially by applying practical approaches used in real-life scenarios. We are in the age of technology, where digitization and automation are rapidly transforming various industries. Therefore, VET centres must adopt a proactive mindset and use digital tools as allies in the educational process.

One of the key areas where this investment will make a difference is online education. Being well aware of this fact, the partnership behind the DTAM project, has invested significant resources in developing such an output in line with the online learning trends. Virtual learning platforms, online courses, and interactive simulations give students the flexibility to access educational

resources anytime, anywhere. This format not only addresses the needs of students, but also prepares future professionals for a workplace that values autonomy and the ability to continuously learn.

For instance, technologies such as IoT, AI, Virtual reality (VR) or Augmented Reality (AR) are technologies that are revolutionising training in various fields. Another such technology is Data analytics tool - yet another valuable tool for VET centres, as it is becoming the new innovation fuel for companies. VET students need to understand how they can manage and interpret this data in order to support the digital transformation, with a special focus in the industry applications, where normally there are companies missing this approach.

At a training level it is also valuable to use these digital tools in order to obtain the data of the VET environment. By collecting and analysing student performance data, educators can customise instruction to meet individual needs. This ensures more effective learning and allows students to progress at their own pace. The **Digital Self Evaluation Tool** from DTAM project is one of the examples of this, as it allows students to identify their hard and soft skills and it supports them in finding out which training and job profiles suit them better. In addition, hands-on learning via the dedicated project-based learning tasks (challenges), students can exploit the DTAM IoT labs as another digital tool facilitating their educational needs.

In summary, investing in new digital tools is not only a necessary adaptation for the current times, but also an investment in the future success of the students. VET centres which utilise innovative technology, not only improve the quality of the education they provide, but also contribute to the development of highly skilled professionals adapted to the needs of the labour markets. Finally, it also supports them to provide better and more effective training with a more practical approach for their students.

3.6. Monitoring and Evaluation

The success of any new or improved VET training offer, greatly depends on the effective monitoring and evaluation. In the dynamic realm of VET programs, the journey begins in the design phase, where the curriculum is meticulously

crafted to mirror the skills demanded by enterprises. This well-thought-out content is then handed over to VET teachers and trainers during the application phase. Their task is to transform this curriculum into engaging training activities, imparting knowledge, skills, and competence to eager learners.

The ultimate goal of this phase is to witness the successful transition of learners into employment or their seamless progression within the education system. These outcomes, like a compass, guide the subsequent updating phase. Here, the actual learning outcomes of the VET program are scrutinized against the original targets. Depending on the alignment, the curriculum should undergo revisions to stay in sync with the evolving demands of the labour market.

Quality assurance, a crucial facet of this process, doesn't always necessitate formal procedures. Immediate feedback from end users, especially employers, plays a pivotal role. This direct interaction is most effective in decentralized VET systems, such as Denmark's, where close ties between educational institutions and employers facilitate real-time adjustments to training programs.

To safeguard the effectiveness of policies promoting work-based learning (WBL), diligent monitoring and evaluation are indispensable. Monitoring involves continuous data collection, while evaluation zooms in on specific problems over a defined period. Yet, evaluating the impact of interventions poses challenges, demanding reliable data on training programs and learners' labor market statuses.

Recognizing the diverse perspectives of stakeholders—ranging from VET policy makers to educational institutions, employers, and learners—a balanced analytical framework is crucial for WBL evaluation. The latter includes encompassing input, process, output, and outcome components, which can indeed act as a guiding structure for this intricate journey.

Throughout the implementation of DTAM project, all project results and activities were monitored according to Quality Assurance Guidelines & Risk Management Plan following the EQAVET model and the EQAVET quality assurance cycle, i.e. Planning, Implementation, Evaluation and Review. This

methodology proved to be very efficient and allowed the development of final deliverables of high quality and tailored to the needs of the end users.

As regards impact it was evaluated **internally** in terms of:

a) professional development of the staff members of the partner organisations and
b) impact on the capacity of the participating organisations.

Impact was also evaluated **externally** through the pilot implementation and reported in detail for every stakeholder (IVET students, CVET trainers, Companies) as part of the project Impact Report. The DTAM Steering Committee and the whole partnership share great interest in the exploitation of the results and has already stated its intention to build further on them. On those grounds the committee in cooperation with IDEC SA, as Quality Assurance leader, has set an action plan with the following guidelines considering monitoring and evaluation of the impact of the project's outcomes. For the following 5 years a KPI monitor will be set and will be updated annually by the committee in order to measure qualitative and quantitative indicators in the following sectors in line with the application submitted:

	ADAPTED VET CURRICULAR OFFER IN LINE WITH SKILLS NEEDS	UPDATED TECHNOLOGICAL AND METHODOLOGICAL CAPACITY	KNOWLEDGE FLOW ECOSYSTEMS: LONG TERM CHANGE MANAGEMENT STRATEGIES	INCREASED COMPETITIVENESS AND SUSTAINABILITY

QUANTITATIVE INDICATORS	• Number of partners that will continue offering part or the whole DTAM training course. * It should be highlighted that some of the DTAM partners e.g. Da Vinci College (the Netherlands) has already integrated part of the course in its official curriculum.	• Investment in new technology in the 4 IoT labs; • No of IoT labs joining the International Hub; • N° of visits to the IoT hub and registered users; • N° of student groups using the IoT labs; • N° of new learning challenges designed; • N° of students in WBL in AM companies; • N° of self-learners registering to use the DTAM course;	• N°. of active participants in partner regional Communities of Practice; • N° of updates to DTAM curriculum (Skills Index etc.); • N° of new curricular initiatives	• Reduction in skills mismatch Employability data
QUALITATIVE INDICATORS	Satisfaction rate by end users (students, trainers, AM companies)	Regular renewal of technology, Expression of satisfaction with DTAM learning challenges from feedback loops	Expression of satisfaction from sectoral representatives in education (H/VET), business and Industry	Stakeholders (e.g. employers and policymakers) satisfaction rate
METHODOLOGY	Questionnaires-interviews	Questionnaires for the responsible staff of IoT Labs	Establishment of annual meetings with regional Communities of Practice.	To be monitored through the DTAM alumni the employability and satisfaction of employees regarding the skills.

Based on the feedback provided through the above-mentioned activities, the DTAM steering committee will meet annually to discuss the evaluation results and plan adjustments and updates, if needed. Ultimate aim of monitoring and evaluation activities after the lifetime of the project is to provide open educational resources (OER) of high quality to end users, multiply the end users, the feedback loops with stakeholders and respond to the emerging needs of VET and AM sectors.

The establishment of the DTAM alumni along with the continuation of interaction with the regional Communities of Practice will significantly impact VET and AM Sector and relevant stakeholders. Simultaneously the DTAM model will provide a policy recommendation for policy makers in terms of connecting the VET sector with the labour market and effectively addressing skills mismatch through the establishment of communication channels.

The DTAM model acts as a springboard to the benefit of the trainees as future workforce, of the quality and effectiveness of IVET and CVET and of the industry sector and therefore can be used as a blueprint for the development of future VET offers.

4. Conclusions

In order to realize these ambitious recommendations aimed at transforming VET in the European Union, it is crucial to delineate practical steps and mechanisms for their effective implementation. These steps need to address specific areas such as:

- the modernization of curricula
- integration of digitalization and Industry 4.0 skills
- adoption of modular and adaptable programs
- capacity building of teachers
- fostering public-private partnerships
- ensuring accessibility and
- investing in digital learning infrastructure.

Each facet demands a tailored approach, collaboration with stakeholders, and dynamic methodologies to keep pace with the rapidly evolving workforce landscape.

Herein, we outline actionable steps to facilitate the successful execution of the so far mentioned recommendations, paving the way for a transformative impact on VET in the EU.

1. **Being proactive:** VET centres need to **initiate collaboration** with **industry experts to identify emerging skills demand and** thus establish an agile review process for curricula updates, incorporating real-time industry feedback. As the latter holds the actual potential transformation of VET education, there also the need for the establishment of a centralized database available for the multitude of stakeholders in need of it, especially policy makers.

2. **Strategic Overhaul of Curricula:** There is a need of the development of a **centralized comprehensive strategy** for the modernization and flexibility of VET curricula. This should involve a systematic review of existing programs, identifying outdated elements, and integrating dynamic content relevant to emerging industries. The establishment of a **task force** to guide the transition, ensuring alignment with technological advancements and economic shifts, could enhance this process, as it will help emphasize the **need for industry collaboration** to inform curriculum updates and challenge societal stereotypes.

3. **Digital Skills Integration Framework:** We would like to advocate for the **development of a dedicated framework** for the seamless integration of digitalization and Industry 4.0 skills into VET curricula. However, in order to create a lasting and sustainable effect, this needs to be **created on EU level**, by forming a working group comprising industry experts, educators, and policymakers to define the core digital competencies required. The framework should have **a phased implementation plan** that includes teacher training, resource allocation for technology integration, and ongoing assessments to track progress. Finally, it should allow **fostering collaboration** with industry partners to provide real-world insights and ensure curriculum relevance.

4. **Adopting Modular Training Approaches:** Based on the presented DTAM project case, but also previous similar experiences, our partnership also

advocates for the **adoption of modular structures in VET programs**, including **microlearning**, allowing for agile responses to emerging technologies and evolving industry needs. Erasmus+ is very strong tool in achieving results in this area. However, there's the **need for continued support** on an EU level, for successfully implemented Erasmus+ projects. For example, the respective National agencies and/or appointed EU commission officers, can **evaluate the realistic applicability of a newly created curriculum** and **provide support** with its integration on a national/international scale. That can be for example by setting a final evaluation "admittance" threshold of a certain points for completed projects, to get into a possible **follow-up pilot program** with select institutions to test the effectiveness of modular training offer in other VET centres and scenarios.

5. **Investing in Educator Capacity Building:** There's a need in prioritizing the **professional development of VET teachers and trainers** by incentivizing participation in projects such as Erasmus+. Establishing a structured national or EU framework for ongoing capacity building, integrating project management skills and exposure to innovative trends can become a significant tool in achieving better results in this area. Furthermore, creating **a feedback mechanism** for educators involved in projects to share insights and best practices and by exploring partnerships with industry experts to provide specialized training aligned with the latest industry trends can also be a strong tool in facilitating the capacity building of educators in VET.

6. **Fostering Public-Private Partnerships:** There is a need to facilitate better formation of public-private partnerships (PPPs) to enhance VET programs. **Introducing incentives**, such as tax benefits, to encourage private sector participation in VET initiatives can help promote PPSs and showcase successful case studies in VET to be replicated by other stakeholders. A valuable PPP collaboration example could **the establishment of a digital learning ecosystem** for VET centres to prepare students for the modern workplace. That could facilitate the integration of emerging technologies, such as IoT, AI, VR, AR, and data analytics, into VET programs. Furthermore, this could provide an initial boost to **encourage partnerships with technology companies** to provide resources, mentorship, and real-world industry insights for existing and future VET offers.

7. **Improved Accessibility Through Technology:** Implementing a **technology-driven approach to enhance the accessibility of VET** is also imperative as advocated previously. VET centres need to invest in digital infrastructure, including online learning platforms, virtual labs, and interactive simulations. A very bold, but necessary step in this direction could be the development a **centralized digital hub for VET resources** accessible in multiple languages, such as the DTAM IoT Hub. The latter, can facilitate PPPs and the collaboration with private businesses to provide technology resources for underserved communities. On the other hand, promoting **policies that support digital education and inclusivity**, and ensuring VET remains accessible to diverse student groups, is equally important and should be prioritized via the common EU agenda.
8. **Robust Monitoring and Evaluation Practices:** Having **indicators to oversee VET processes is essential** for any quality assurance system. While there's a multitude of indicators available, the **key lies in achieving consensus** among all stakeholders regarding these indicators, their policy rationale, and their utility.

5. Final remarks

In embarking on the practical steps and mechanisms for implementing the recommended policy changes in VET, a crucial initial action involves national and regional VET authorities collaborating to conduct a comprehensive review of existing curricula. This review should be informed by industry insights and consider the evolving demands of the job market. Leveraging findings from innovative projects like the DTAM initiative can provide a valuable blueprint for curriculum modernization. The DTAM project, with its Digital Transformation Competence Index (DTCI) and modular training units, offers a tested model for integrating key enabling technologies into VET curricula. Implementation steps should prioritize collaboration between educational institutions, industry experts, and policymakers to ensure alignment with contemporary workforce requirements.

While envisioning a paradigm shift in VET, securing adequate funding and fostering collaborations are pivotal aspects. Important actors such as governments, employers, and individuals could share the responsibility to create a collaborative effort in covering the costs of VET programs. To successfully implement the recommended policies, identifying and tapping into diverse funding sources is imperative. This includes exploring EU funding avenues, engaging with national resources, collaborating with the private sector, partnering with NGOs and foundations, and establishing international alliances. These partnerships not only bring financial support but also offer a collaborative ecosystem where knowledge, expertise, and resources can be shared.

To secure the necessary funding for implementing transformative changes in VET, engaging with EU funding programs such as Erasmus+ is paramount. The DTAM project serves as a noteworthy example, having received support from the Erasmus+ program. Building on this success, VET stakeholders can tap into dedicated Erasmus+ initiatives, emphasizing the integration of digital tools in smart manufacturing training. Additionally, fostering collaborations with private sector entities, provides not only financial support, but also ensures the alignment of VET programs with industry needs.

Finally, collaborative efforts with foundations and NGOs, leveraging the success and insights of the DTAM project and similar projects in the future, can further enhance the financial sustainability and effectiveness of VET reforms.

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