



3T Industry4.0

Report IO1 for GERMANY

Version 1.0

13 March 2020

Erasmus+ KA2 - project/ 2019-FR01-KA202-062244

Project acronym: 3TIndustry4.0

Project title: 3TIndustry4.0

IO1:

National study: Germany

Written by Christopher Rogall (TUBS)



INDEX

1.	<i>Scope and analysis</i>	<i>4</i>
2.	<i>Literature research and questionnaires.....</i>	<i>5</i>
2.1	Resources.....	5
2.2	Training offer.....	8
2.3	Digital skills	10
2.4	VET trainers / teachers	13
2.5	In-company trainers.....	15
2.6	Focus group.....	17
2.7	Matrix Needs / Offer.....	17
3.	<i>Recommendations.....</i>	<i>19</i>
4.	<i>Conclusions</i>	<i>20</i>
	<i>Annexes.....</i>	<i>21</i>

1. Scope and analysis

The scope of the first working package of the project 3TIndustry4.0 is about a study of already existing training and the lack of skills in the area of students and in-company trainings.

The report will include the training needs and available trainings for vocational training in Germany and in-company trainings in Germany with the focus on Industry 4.0 contents. Overall the report will be the fundament for the development of the right training modules in IO2 and IO3.

The IO1 tasks are as follows:

- Search in bibliographic databases
- Analysis of technical documentation
- Examination of contents of official titles / qualifications of courses / trainings
- Interviews with stakeholders
- Creation of a database containing data from the situation of education and training to be used by all stakeholders in the field of Industry 4.0

Caar and *Mecanic Vallée* coordinate, transcript and summarise the research carried out by Aitiip and CMQ. TUBS will work on German data. The data collected for the realisation of the study will be uploaded on the project platform and into the database. For the general collection of the data was the software “MSForms” used. The personal information which was gathered has been written directly in MSExcel.

To evaluate the needs in Industry 4.0 training and detect gaps to recommend skills and content a few different phases were performed:

1. Study of publications
2. Existing trainings
3. Questionnaires and their analysis
4. Focus Group preparation
5. Reports and data collection

The objective for the whole report of each country divides into the following separation.

	SPAIN		GERMANY		FRANCE		TOTAL	TARGET PER COUNTRY
	excel	forms	excel	forms	excel			
COMPANIES QUESTIONNAIRE	6	7	11				24	10
VET TEACHERS QUESTIONNAIRE		12	5	3	20		40	5
EXECUTIVE EDU QUESTIONNAIRE		15	5		9		29	5
RESOURCES			15	8			23	12 (ARTICLES etc.)
WORKING GROUP		2	4		1		7	4
TRAINING OFFER		36	32				68	18 (6+6+6)

Figure 1: Number of questionnaires and deliverables per partner and country

For Germany it is noticeable that 11 questionnaires for digital skills in companies, 5 for VET teachers, 5 for executive educational have been performed. Also there are 15 resources and 32 training offers in Germany. The complete listing for every step and target of this research orientated program can be found in the following.

2. Literature research and questionnaires

This chapter implies the overview of the whole study on Industry 4.0 orientated training in Germany. This includes the resource and training offer study, as well as the in-company and VET training offers. Also the training which has been or is already performed is considered.

2.1 Resources

The specific resources for Germany in Industry4.0 training or general information in literature or brochures is restricted to very different contents. Some of the resources are focusing on the digitization itself others are very near to training and further education. In Germany the main focus is on qualification for the workers and not training the trainers. A very big part of the resources refers to digital skills and how to implement them in production context. The complete results of resources found is in Table 1.

Table 1: Resources for training in Industry4.0 topics in Germany

TITLE	TYPE	AUTHOR'S NAME	LAST
VOCATIONAL AND TRAINING IN EUROPE: GERMANY	Report	Hippach-Schneider, U./ Huismann, A.	
Securing the future of German manufacturing industry Recommendations for implementing the strategic initiative INDUSTRIE 4.0 Final report of the Industrie 4.0 Working Group	Report	Kagermann, Henning/ Wolfgang/ Johannes Wahlster, Helbig,	
Digitalisierung in der Aus- und Weiterbildung und Augmented Reality für Industrie 4.0	Book	Thomas, Oliver/ Metzger, Dirk/ Niegemann, Helmuth	
Weiterbildung 4.0 - Digitalisierung als Treiber und Innovator betrieblicher Weiterbildung PDF Logo	Journal	Seyda, Susanne/ Meinhard, David B./ Placke, Beate	
Umsetzungsstand, Modernisierungs- und Unterstützungsbedarf in Betrieben	Report	Regina Flake / David B. Meinhard / Dirk Werner	
Digitalisierung Bildung Technik Innovation	Book	Wittpahl, Volker (Hrsg.)	
Digitalisierung: Herausforderungen für die Aus- und Weiterbildung in Deutschland	Report	Kruppe, Thomas et al. Birgit Vogel-Heuser / Thomas Bauernhansl / Michael ten Hompel (Hrsg)	
Weiterbildung und Kompetenzentwicklung für die Industrie 4.0 IN: Handbuch Industrie 4.0 Bd.1	Book/Chapter	Volker P. Andelfinger Till Hänisch Hrsg	
Auswirkungen von Industrie 4.0 auf das Anforderungsprofil der Arbeitnehmer und die Folgen im Rahmen der Aus- und Weiterbildung IN: Industrie 4.0	Book/Chapter	Volker P. Andelfinger Till Hänisch Hrsg	
Industrie 4.0 und die Folgen für Arbeitsmarkt und Wirtschaft: Szenario-Rechnungen im Rahmen der BIBB-IAB-Qualifikations- und Berufsfeldprojektionen	Report	Wolter et al.	
Industrielle Wettbewerbsfähigkeit, Digitalisierung und berufliche Qualifizierung	Working Paper	Klös, Hans-Peter; Meinhard, David B. Hammermann, Andrea Stettes, Oliver	
Qualifikationsbedarf und Qualifizierung: Anforderungen im Zeichen der Digitalisierung	Journal		

Industrie 4.0 und Herausforderungen für die Qualifizierung von Fachkräften IN: Hartmut Hirsch-Kreinsen, Peter Ittermann, Jonathan Niehaus (Hrsg.) Digitalisierung industrieller Arbeit	Book/Chapter	Daniela Ahrens, Georg Spöttl
Digitalisierung und betriebliche Bildung IN: Zwischen Provinzen und Metropolen: Stationen einer sozioökonomischen Reise	Book/ Chapter	Lutz Bellmann
Die zweite Säule des Erfolgs: Digitale Skills der Zukunft. In: So gelingt digitale Transformation!. Fit for Future	Book	Kristin Scheerhorn

The overall questionnaires and tables can be found in a separate document, which is also provided. For most of the resources there is no English translation. For this reason, the German titles were used and adapted to the table.

2.2 Training offer

The training offer in Germany is not restricted to VET or in-company training. For the national schedule every person can attend almost all kind of trainings. Especially in this context, 32 cases have been identified for training in Industry 4.0. Some of them are free to attend for professionals but most are correlated with high expenses. The table with all the identified training offers can be found below.

Table 2: Training offer in Germany

DEGREE NAME	KIND OF DEGREE	ORGANISATION
Certified Information Manager CA	Professional Certificate	CA Controller Akademie
Certified Business Data Scientist	Professional Certificate	Controller Institut (A)/Munich Business School
Advanced Analytics & BI Professional	Professional Certificate	Hochschule Ludwigshafen/Horváth & Partners
Digital Transformation Programs	Professional Certificate	IMD Business School (CH)
Digital & Corporate Transformation	Professional Certificate	WHU Executive Education
Management 2030: Digitalisierung, Trends und Herausforderungen“, „Decoding Digital: Building a Digital Strategy“ oder „Data Analytics for Decision Making	ESMT Postgraduate Diploma in Management – a university-level certificate	ESMT Berlin
Digital Business Analytics & Digital Strategies	Professional Certificate	MCI Unternehmerische Hochschule
Strategie & Governance für Business Intelligence und Analytics (BIA)“	Professional Certificate	The Data Warehousing Institute“ (TDWI e. V.),
Data Scientist Basic Level	Professional Certificate	Fraunhofer-Allianz Big Data und Künstliche Intelligenz
Künstliche Intelligenz (KI) in der Produktion – eine Einführung	Non Degree Training	Mittelstand 4.0, mitunsdigital, Hannover, Produktionstechnisches Zentrum Hannover
Unterwegs in virtuellen Welten – Einsatzmöglichkeiten von Augmented und Virtual Reality in der Produktion	Non Degree Training	Mittelstand 4.0, mitunsdigital, TU Braunschweig
Ausreichend geschützt?! IT-Sicherheit in der Produktion	Non Degree Training	Mittelstand 4.0, mitunsdigital, Hannover, Hochschule Hannover Fakultät 1 - Elektro- und Informationstechnik

Aus Analog mach Digital – Modernisierung der Produktion mit Retrofit	Non Degree Training	Mittelstand 4.0, mitunsdigital, Kreishandwerkerschaft Cloppenburg
DATEN BEHERRSCHEN LERNEN – POTENZIALE VON BIG DATA UND DATA MINING	Non Degree Training	Mittelstand 4.0, mitunsdigital, Hannover, Institut für Integrierte Produktion
DIGITALISIERUNG IN DER PRODUKTION – EINE EINFÜHRUNG	Non Degree Training	Mittelstand 4.0, mitunsdigital, AKADEMIE der DR. JÜRGEN UND IRMGARD ULDERUP STIFTUNG
WERDEN SIE SCHLANK! LEAN PRODUCTION TRIFFT INDUSTRIE 4.0	Non Degree Training	Mittelstand 4.0, mitunsdigital, Hannover, Produktionstechnisches Zentrum Hannover
INTELLIGENTER MATERIALTRANSPORT MIT FAHRERLOSEN TRANSPORTSYSTEMEN (FTS)	Non Degree Training	Mittelstand 4.0, mitunsdigital, Hannover, Institut für Integrierte Produktion
MEHR ALS NUR TECHNIK – ANFORDERUNGEN DER DIGITALISIERUNG AN ARBEIT UND ORGANISATION	Non Degree Training	Mittelstand 4.0, mitunsdigital, Lüneburg, IHK Lüneburg-Wolfsburg
Train the Trainer (IHK)	Professional Certificate	IHK Braunschweig
Datenschutz-Coaching für Einsteiger	Non Degree Training	IHK Hannover
Industrie 4.0 - Digitalisierung, Innovationsmanagement und Führung	Professional Certificate	TÜV Süd
Information Security Foundation	Professional Certificate	TÜV Süd
BIM Basics	Professional Certificate	TÜV Süd
3D-Druck - Modul 1: Industrielle Anwendungsmöglichkeiten des 3D-Druckes	Non Degree Training	TÜV Süd
Instandhaltung 4.0	Non Degree Training	TÜV Süd
Lean Order Management 4.0	Professional Certificate	TÜV Süd
Robotik - Automatisierung und Industrie 4.0	Non Degree Training	TÜV Süd
Instandhaltung 4.0 in der Windenergie	Non Degree Training	TÜV Süd
Various Trainings and Consulting Offers	Professional Certificate	DGQ Germany GmbH
Kommunikationssysteme für Industrie 4.0	Non Degree Training	VDI Germany
Data Analytics - Grundlagen der Datenanalyse	Non Degree Training	VDI Germany
Intelligente Sensoren in der industriellen Anwendung	Non Degree Training	VDI Germany

Noticeable is especially the fact that most of the trainings are being held by the big institutions in Germany like the TÜV, VDI or DGQ. There are also some minor schools for special training in further education for professionals. Most important is to stand out the free training offer in rising digital technologies of the cluster “Mittelstand 4.0 – mitunsdigital” in the northern part of Germany. Especially in Lower Saxony with the focus on SMEs there is a lot of offers free to attend in this concept.

The full result for in-depth analysis can also be found in the complete document, which is also provided.

2.3 Digital skills

Eleven questionnaires were completed:

Six OEM

Two TIER1, large companies

Two TIER 3

and one with a consultant for digital skills.

The questionnaire based on the project CARDEMY was used, which will allow this project to compare the results with those of two years ago and look for any evolution. The distinction of educational levels of the vocational training system has been eliminated to focus only on the number of workers involved.

The objective was to evaluate the content and volume of training that our organizations have received in enablers / technologies / skills

However, as the objective of the business interview is literally “... to identify key technologies that are key enablers...” these questions have been slightly modified:

15.- Is there any other technologies based on digitalisation that we have not previously included, that is critical for your company?

For this:

15.- Is there any other technologies not included in the previous list based on digitalisation that you identify as a key enabler for your industry transition in the future?

The objective is to focus the questionnaire more on this project. The spirit of the question is similar, and we believe that the answers can be equated

For the design of the whole questionnaire see the attached files / pdfs.

In the following the main answers of this questionnaire for digital skills are pointed out. The production background of each company can be found in Figure 2. Noticeable is, that the main

processes are assembling and machining. But also some other actions are performed. The “others” tab is mostly resulting out of the focus of the partners. One part was also a more consulting operator and a logistics company.

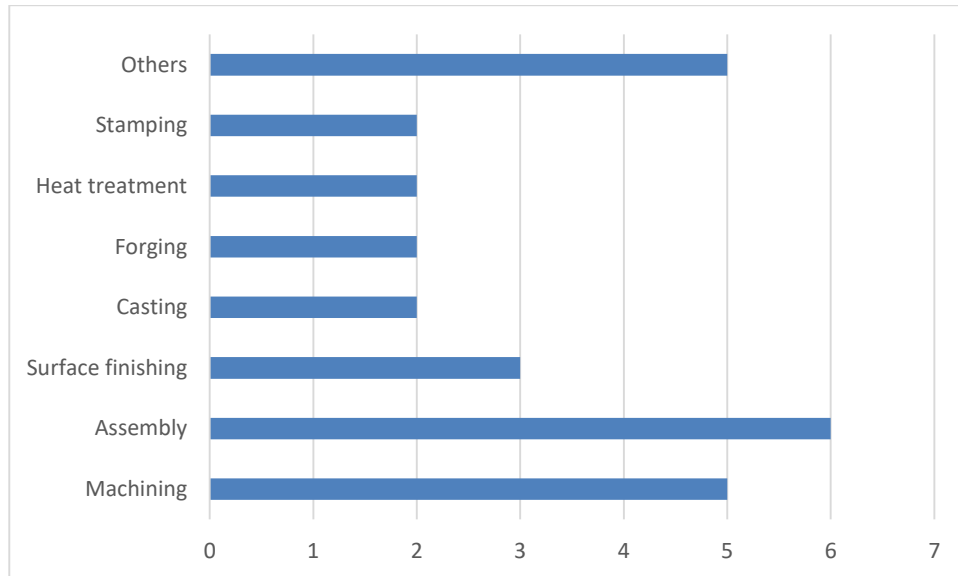


Figure 2: Production background of the 11 companies in the questionnaire

In Figure 3 it is confirmed that most of the company’s focus is on Machining. Moreover, some of the companies are deep in the topics of Automation and robotics or Production scheduling.

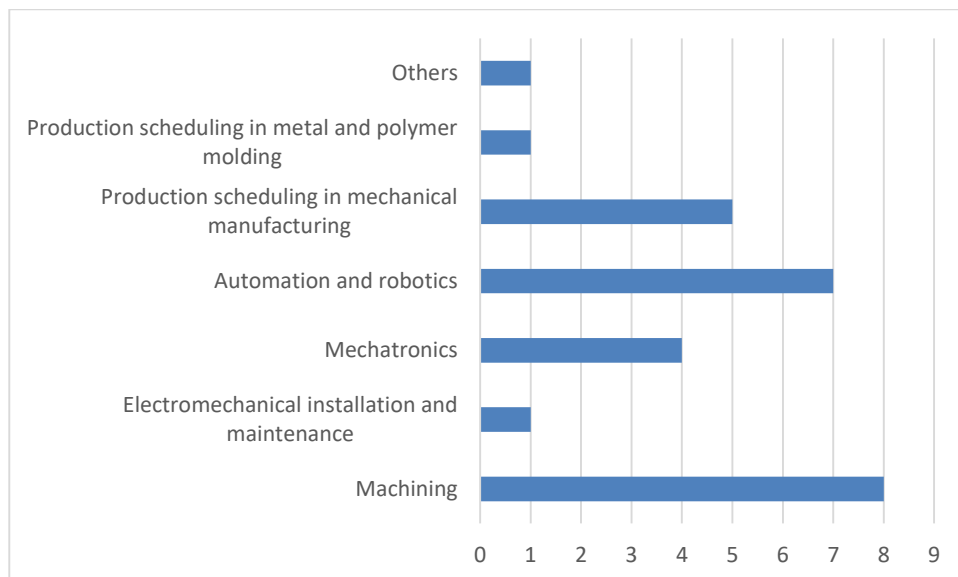


Figure 3: Production processes per company

Most important for this topic is nevertheless the question 12 of the questionnaire on digital skills. Here the subjective opinion is asked on which technologies are being rated as the most important for the future on a scale from 1 to 5. For the German report this is the main scope of the digital skills report to identify the right needs for trainings in the next project work packages.

Table 3: Importance of rising technologies for the companies

Big Data analysis for predictive maintenance and other productive applications: 6 sigma, quality, ...	5	3	5	3	2	5	1	5	5	1	1
Cloud computing for data production storage	5	3	5	5	5	5	1	5	5	1	5
Cibersecurity in production area	3	1	1	5	4	1	1	3	3	1	3
Internet of things: tablets smart phones on the job, personal data capture systems, RFID products control, internet connected machines ...	5	5	5	4	5	5	3	3	5	4	5
3D printing for Prototyping	3	5	3	3	3	1	1	2	3	4	1
3D printing for Additive manufacturing	3	5	3	3	4	1	1	1	3	5	1
Augmented realty and smart glasses	2	3	3	2	1	1	1	1	5	1	5
Cobots: collaborative robots	4	1	4	5	4	1	2	1	5	2	5
Drones	1	1	1	3	3	5	1	1	1	1	1
Bin Picking	1	1	1	4	3	5	1	1	1	1	1

Recognizable is that most of the important strategies are in correlation with data and analysis. So for example Big Data and Cloud computing has a high importance according to those surveyed. In addition to this the Internet of things has also a high value. Also 3D-printing and Mixed-Reality such as Augmented is focused. There are also technologies with a fewer importance like Cybersecurity in production and Drones or Bin picking. This could be correlated to the fact that only specialized companies have been asked.

2.4 VET trainers / teachers

For the questionnaire of VET teaching training a number of 5 teachers have been asked, to get a brief overview of the situation in Germany. In total there is a variety of Studies and specialty areas of these teachers. Most of them come from the field of mechanical engineering and production technologies, while others are from industrial management and engineering. The total age average is 45,4 years. 80% of the teachers are from public institutions or schools while the other 20% are from private institutions.

In this case, table 4 shows the overall result of the survey. First there is the description of technologies which are already included in the classes. Second the emerging technologies which are considered by the teachers and last the essential training needs for these trainers.

Table 4¹: VET teacher / trainer questionnaire

Technologies which are included in classes	Emerging technologies	Essential training for these VET trainers
Cloud computing	Virtualisation, intelligent technologies	Change of platforms, digital transformation
CNC	Additive manufacturing	techniques to promote informal learning
Internet of things: tablets smart phones on the job, personal data capture systems, RFID products control, internet connected machines ...	Artificial Intelligence	Cloud Computing; generally the IT subjects
Cloud computing for data production storage; Augmented reality and smart glasses; Cobots: collaborative robots	Driverless transport systems	Programming
Sig Sigma; Project management; Production Management 4.0	Digitalized Quality Management	Mixed-Reality training

Noticeable is a wide variance of technologies included in the classes. These are from Data analytics to Six Sigma and project management. Important are the emerging technologies, which are mostly about virtualisation and AI (artificial intelligence). Nonetheless also driverless transport systems are mentioned. Overall there is essential training for VET teachers and trainers in the last column. If any answer is translated to the field of the corresponding

¹ Table headings have been adopted and shortened for reading purposes

technology, one can assume that the most lack of skills is in the field of programming. Especially the cloud and AI programming can be assumed. Nevertheless, Mixed-Reality is also mentioned. A very interesting topic of the VET teachers questionnaire is the fact of the train the trainer courses. The question “Do you receive train the trainers courses or workshops from I4.0 equipment providers?” is answered as seen in Figure 4. Therefore 4 of 5 teachers do not receive training in specific Industry4.0 topics. The train the trainer courses of equipment providers is mostly zero according to this survey. This is also a point to focus on in the following discussion of Work package 2 and 3 and also the specific training modules.

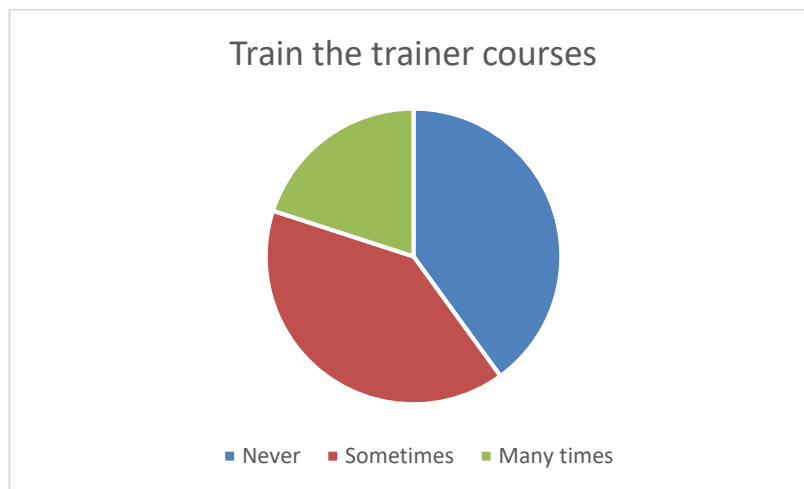


Figure 4: Train the trainer courses or workshops

For the design of the whole questionnaire see the attached files / pdfs.

2.5 In-company trainers

For the questionnaire of in-company teaching and training a number of 5 trainers have been asked, to get a brief overview of the situation in Germany. In total there is a variety of Studies and specialty areas of these teachers. Most of them come from the field of management technologies and software programming, while production consulting and branch management is also represented. The total age average is 35,2 years.

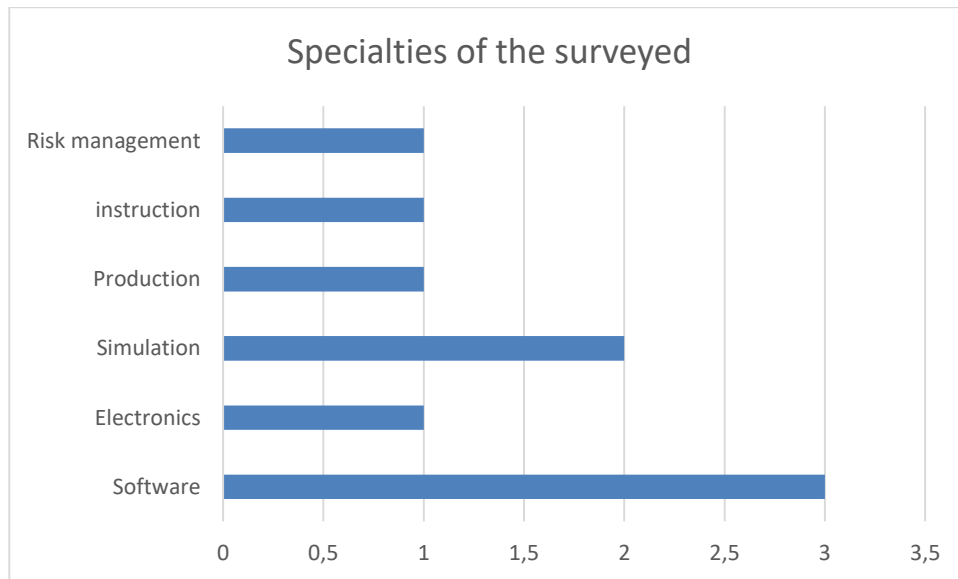


Figure 5: Specialties of the surveyed people

In this case, Table 5 shows the overall result of the survey. First there is the description of technologies which are already included in the classes. Second the emerging technologies which are considered by the teachers and at third the essential training needs for these trainers. At last the question if training the trainer courses have been already applied is asked.

Table 5²: In-company teachers / trainers questionnaire

Technologies which are included in classes	Emerging technologies	Essential for these in-company trainers	Already received training on these topics?
3D printing	Group related Visualisation	Electronic and Software coding	Others Yes, I received it through the offer of administration / center / company
Big Data; Data analytics, Cloud computing, Six Sigma	digital teambuilding	Software training and teaching training	No, I have not received training in these subjects.
Big data for predictive maintenance, Six Sigma, Bin picking, E-commerce data storage	teaching elder people the use of information technology	software	
3D printing	-	Programming	No, I have not received training in these subjects.
Cloud computing, 3D printing, logistics systems digitized	Business Interruption Analysis	Data acquisition and data handling	I have received training in both previous modalities

Recognizable for this survey is that the most mentioned technology is 3D printing, which is also already included in current trainings. Nevertheless, also in this survey is the most mentioned technology about data analytics and big data. Moreover, the emerging technologies are group related topics. A big factor is also the teaching of older workers who cannot use the current emerging digital applications.

Essential for exactly these trainers are programming skills and software building abilities. Most of the trainers did not receive trainings on these topics yet.

For the design of the whole questionnaire see the attached files / pdfs.

² Table headings have been adopted and shortened for reading purposes

2.6 Focus group

The focus group in Germany will be performed after the results of IO1 have been identified. This results of the different approaches per country.

While in the other focus groups the meetings took place before the completion of IO1, in this one or possibly several meetings of the focus group will take place after the completion of IO1. This serves the purpose of a review or validation of the results achieved, not only looking back at the national results but also comparing them with international results. This allows a scientific critical evaluation of the results and guarantees sustainable results of the overall project.

2.7 Matrix Needs / Offer

The Matrix for the needs / offers in Germany in educational and in-company training is found in the figure below. Basically, the training offer consists of the digitization of companies in Germany. Mostly, the offer is restricted to data analytics and other topics regarding this issue. Therefore, the knowledge is based on data as well. The skills which are offered, are more from the programming and implementation side. Out of this the competencies are generated, which result in Big Data and programming experts.

GAP MATRIX				TRAINING NEEDS		
TRAINING OFFER				KNOWLEDGE	SKILLS	COMPETENCE
TRAINING OFFER REFERENCE	KNOWLEDGE	SKILLS	COMPETENCE	Artificial intelligence, sensor installation (hands-on), Programming on software and visualisation for production technologies, new production technologies	Programming skills, application of visualisations (like VR/AR), 3D-printing application for series production	Programming, sensor usage, use the right visualisations, use 3D-printing for production
Digitization, AI, Data analytics, Lean management, Sensors	Data knowledge, Big data analysis, Cloud computing	Programming, IT-Skills, Production 4.0 skills	Big data experts, Programming experts	Visualisation (VR/AR), Internet of Things (sensor hands-on), 3D-printing		

Figure 6: Matrix Needs in comparison to offer for Germany

The training needs on the other side are focused on more emerging technologies. One big factor is the visualisation of data in Mixed-Reality environments and the development of skills in general. The skills and competencies are generated out of these topics as well.

Therefore, the Needs to Offer Matrix gives a wide overview on the Industry 4.0 topics which have to be taught in the future. In this case these are:

- Visualisations (VR/AR)
- Internet of things (sensor integration, hands-on)
- 3D-printing for prototyping and series production
- (Big data)

3. Recommendations

This part the consortium should work as a team to agree on the content. At the end of this phase we will obtain **two reports and a database with the relevant information**.

After the correct assumptions the work on IO2 and IO3 can begin. Nevertheless, it is very important to have an overall report for the international needs and not only for each country.

For the training needs there can be recommendations given regarding the development of Industry 4.0 skills in companies and also for VET areas. A question in the questionnaire about the soft skills for this development gave an interesting insight of digital education. Basically, the survey results in a few more important factors. Therefore, leadership, communication and initiative are the most important values for the development of Industry 4.0 skills. On the other hand, almost no problem solving, negotiation or financial skills are demanded. This question of the survey results in the recommendation for Germany that the soft skills should not be forgotten. Even if the training modules of this project are not focussing on these topics, it should be considered.



Figure 7: Development of soft skills for implementation of Industry 4.0 topics

Overall the recommendations for the training modules are, after the comparison, obvious. The whole conclusion of the right topics for Germany and also other points will be found in the following.

4. Conclusions

In this report the lack of skills in companies and educational institutions in comparison to the needs of trainings in Industry 4.0 topics is discussed. The report contains an overview over the available resources, training offer and trainings itself. Simultaneously, the in-company training and VET teaching and training is more closely examined. Overall the digital skills of both of these areas are compared. Also a definition for the focus group is given and the results are displayed in a matrix, which covers the needs and offers.

This matrix basically gives the required information about the future training and the general needs in Germany. The comparison of the training offers, which are already existing and the needs for the industry and the teaching, gives the right instructions on the following work packages of this project. Therefore, the needs for the industry and the teaching in Germany for the continuous development of skills in Industry 4.0 are structured as follows:

- Visualisation and Virtualisation (Mixed-Reality: Virtual Reality and Augmented Reality)
- Internet of things (sensor integration for continuous data management, hands-on “how to develop a concept for sensors?”)
- 3D printing for prototyping and for series production (especially last because of the general lack of competencies in the series production of 3D printed objects)

There is also a fourth need, which can be considered. Big Data and data analytics are a big topic in Germany already and have been mentioned in many trainings at the moment. Nevertheless, the needs in this area are much higher than the offer is momentarily. Especially topics like artificial intelligence and machine learning need to be addressed even more.

Annexes

Workbook for

- Digital Skills
- In-Company Trainings
- VET teaching
- Resources
- Training offers

PDF for

- Questionnaires