OUTPUT 1

A research on innovative skills and best practices to enhance HE students employability, flexibility and transversal capabilities and develop effective digital workbased approaches

Case of Latvia

Authors:

Dr.sc.ing. Sintija Petroviča

M.sc.ing. Maija Strautmane

Dr.sc.ing., Dr.paed. Alla Anohina-Naumeca

2022

Digital Transformation, Industry 4.0 and Human Resources Management: Innovative skills to enhance HE students' employability, flexibility and transversal capabilities

Disclaimer

This document has been developed in the framework of the Project "Digital Transformation, Industry 4.0 and Human Resources Management: Innovative skills to enhance HE students employability, flexibility and transversal capabilities "/DigiWork/, Ref. No. 2021-1-PL01-KA220-HED-000032182.

The sole responsibility for the contents of this publication lies with the authors. Their opinion does not necessarily reflect that of the European Union. The European Commission is not responsible for any use that may be made of the information contained herein.

Please notify us immediately if you believe that this document harms any intellectual property right held by you as a person or as a representative of an entity.

The authors of this document have taken any available measure for its content to be accurate, consistent, and lawful. However, neither the project consortium as a whole nor the individual partners that implicitly or explicitly participated in the creation and publication of this document hold any sort of responsibility that might occur because of using its content.

TABLE OF CONTENTS

INTRODUCTION

This report describes the current situation of awareness and development of Industry 4.0 in Latvia. It covers aspects related to statistic and economic indicators of digitalisation level, national strategic planning documents, policies and law, educational events and projects relevant in the context of Industry 4.0, an overview of companies and best practices of digital transformation and implementation of Industry 4.0 concept. Moreover, the report summarises knowledge and skills that should be purposefully developed to support the successful introduction of Industry 4.0 into the economics and industrial competitiveness of the country.

The report is based on a systematic analysis of information sources published between 2017 and 2022. The following information sources were identified as being of interest for the current report:

- websites of companies, higher education institutions, government institutions, and projects;
- articles in the media;
- books;
- project reports;
- Latvian legal framework, decisions and policies adopted by the government;
- Scientific publications.

The search for information sources was performed on Google and in scientific databases such as IEEE Xplore, Science Direct, SCOPUS, and Web of Science. The report's authors used the combination of the terms "Industry 4.0" and "Latvia" as the main keyword for searching information sources. However, terms combinations that cover the main pillars of Industry 4.0 (Internet of things and Latvia, cloud computing and Latvia, robotics and Latvia, big data analytics and Latvia, augmented reality and Latvia, cyber security and Latvia, additive/advanced manufacturing and Latvia) were also used to extend search results.

The main text of the report is presented in the following eight sections. It represents conclusions made based on information collected from the information sources and represented in a structured way in the appendices of this report.

1. STATISTICS AND ECONOMIC INDICATORS ON DIGITALISATION AND DIGITAL SKILLS

In general, Latvia has highly advanced coverage of fast broadband and, as a result, almost all enterprises and most householders have access to the Internet. At the same time, Latvia ranked 20th among the 27 EU countries (below the EU average) in terms of digital skills at all levels, from basic to advanced levels, in 2021 [1]. Although an increasing number of Latvians engage in online activities, Latvia's level of digital skills is one of the lowest in the EU [2]. Only 43% of the population aged 16 to 74 have at least basic digital skills, versus the EU average of 56% [1]. According to [2], the lack of digital skills is identified as a factor hindering the introduction of innovations. Improving the population's digital skills is a precondition for creating and ensuring an environment conducive to digitalisation, improving business productivity and promoting Latvia's progress and investment in new digital technologies [3]. Also, the regions still have the unused potential for broadband optical internet access, providing a reliable and fast digital infrastructure for businesses and remote working possibilities for employees [4].

Regarding the integration of digital technologies in enterprises, Latvia ranks 23rd among EU countries, which is still well below the EU average level. The share of SMEs with at least a basic level of digital technologies is 42%, while the EU average is 60% [1]. The proportion of companies that acquire cloud services is 18%, only 9% of enterprises use big data, and only 19% have activities on social media [1]. Latvian enterprises have to adapt to the reality of "Industry 4.0" and should be able to integrate these new technologies. In order to succeed, it is necessary to overcome the limitations and have a clear strategy and vision of what is Latvian future high-tech manufacturing [5]. Currently, more significant efforts are needed to promote the use of digital technologies in small businesses. At present, Latvia is focusing on improving digital skills; however, there is a lack of a policy to expand the use of digital technologies in small businesses, as well as a strategy for the digitalisation of the private sector [6]. Significant factors limiting the international competitiveness of Latvian companies are administrative burdens (e.g., labour taxes) and general business costs (e.g., electricity costs, real estate taxes, and others). Also, the laws and regulations that govern the employment relationship are inappropriate today since they do not include information on remote work opportunities, temporary dismissal, downtime, and other modern trends [7]. Therefore, developing a comprehensive national digital strategy with adequate resources can help Latvia further increase the use of digital technologies by individuals, companies, government, and educational institutions [6].

Appendix 1 provides detailed information on statistics and economic indicators related to the digitalisation level and digital skills development in Latvia.

References:

1. European Commission. (2021). Digital Economy and Society Index (DESI) 2021: Latvia. Available at https://ec.europa.eu/newsroom/dae/redirection/document/80482
2. Helmane I. (2020). Ceļa karte Latvijas digitālajai transformācijai. LV portāls [in Latvian]. Available at https://lvportals.lv/norises/321428-cela-karte-latvijas-digitalajai-transformacijai-2020
3. Izglītības un zinātnes ministrija. (2021). Izglītības attīstības pamatnostādnes 2021.-2027.gadam "Nākotnes prasmes nākotnes sabiedrībai" [in Latvian]. Available at https://likumi.lv/ta/id/324332-par-izglitibas-attistibas-pamatnostadnem-2021-2027-gadam
4. Ekonomikas ministrija. (2021). Latvijas ekonomikas attīstības pārskats. [in Latvian]. Available at https://www.em.gov.lv/lv/media/12820/download
5. Menaker J., & Ozolina v. (2018). Latvian High-Tech Industry: Trends and Developments. Economics and Business, 32, 160-171. DOI:10.2478/eb-2018-0013
6. OECD. (2021). Going Digital in Latvia. OECD Publishing, Paris.
7. Ministru kabinets. (2021). Par Nacionālās industriālās politikas pamatnostādnēm 2021.-2027. gadam. Ministru kabineta rīkojums Nr. 93. [in Latvian]. Available at https://likumi.lv/ta/id/321037-par-nacionalas-industrialas-politikas-pamatnostadnem-20212027-gadam

2. NATIONAL STRATEGIC PLANNING AND REGULATORY DOCUMENTS

During the analysis of information sources, it was identified that national strategic planning and regulatory documents relevant to digitalisation and Industry 4.0 could be divided into two categories:

- Policy documents for the planning period 2021-2027 that set national strategic aims, priorities and actions for economic growth and transformation in the next seven years (National Development Plan of Latvia for 2021-2027, National Industrial Policy Guidelines 2021-2027, Digital Transformation Guidelines for 2021-2027, Guidelines for Science, Technology Development and Innovation 2021-2027, Research and Innovation strategy for Smart specialisation of Latvia, Implementation strategy of Platform "Industry 4.0", Cyber Security Strategy, Guidelines for the Development of Education for 2021-2027. Future Skills for the Future Society);
- Support programmes and initiatives that allow companies, government and local municipalities, business start-ups, public research organisations, merchants and others to get funding for digitalisation and innovation introduction initiatives (Latvia's Recovery and Resilience Plan, Norwegian Financial Mechanism, Innovation Motivation Programme, Business Incubators, Start-up support programmes, Innovation vouchers and support for attraction of highly-qualified specialists, Support for science result commercialisation, International competitiveness development, Support for staff training, Acceleration funds).

One of the priorities of the Ministry of Economics of the Republic of Latvia is to improve the business environment. The vision of the Ministry of Economics is to create an excellent business environment and move towards an innovative economic model. Therefore, five priority directions of action have been defined for further work on improving the business environment, and the digitalisation of public services and industry (Industry 4.0) is one of them [1]. Overall, several policy documents related to the Industry 4.0 have been approved mainly for the planning period 2021-2027. Digital transformation as a fundamental principle of Latvia's economic development is included in several state government planning documents for the next policy development period 2021-2027, for example, National Development Plan of Latvia 2021-2027, National Industrial Policy Guidelines 2021-2027, Digital Transformation Guidelines for 2021-2027 and other binding strategies and guidelines [2].

In general, innovation does not play a significant role in Latvian companies; however, Latvia is taking steps to increase the number of companies involved in innovation through regional and ERDF-funded programmes [2, 3]. Latvia uses different measures to support its growing start-up ecosystem. The law on aid for the activities of start-ups established a support programme to recruit highly skilled workers and provide personal income tax relief for start-up employees. In addition, subsidies and loans are available to business start-ups in rural areas to promote digital innovation or develop new products and services. The loans programme targets agricultural, rural and fisheries start-ups [4]. Furthermore, Latvia continues to use the

Competence Centre and other complementary programmes, such as the technology transfer programme to promote innovation in SMEs [2]. Other support measures for the digitalisation of enterprises include training programmes organised by the Latvian Information and Communications Technology Association and the EU co-funded development project for SME training in digital technologies and innovation. Furthermore, the Ministry of Environmental Protection and Regional Development and the Ministry of Economics have nominated two Digital Innovation Hubs [4]. The Latvian IT Cluster will focus on the digital transformation of enterprises using available digital solutions; the digital accelerator of Latvia will focus on R&D and innovative digital solutions. Both hubs, which involve public and private stakeholders, plan to be part of the network of European Digital Innovation Hubs and provide the infrastructure for prototyping [4]. The Latvian Investment and Development Agency (LIDA) plays an important role in managing support programmes for entrepreneurs [2]. The LIDA is the primary state agency for innovation and forms part of the Ministry of Economics. It manages innovation programmes funded by EU structural funds such as the Technology Transfer Programme, the Innovation Motivation Programme and the Business Incubators Programme. The LIDA's leading role is to support foreign direct investment (FDI), although FDI flows largely towards sectors that do not tend to invest in R&D [3]. There are also three digital innovation centres in Latvia intended to act as centres of digital excellence and single digital transformation contact points [2].

Appendix 2 lists national policies, plans, laws, initiatives and guidelines related to digitalisation and Industry 4.0 in Latvia.

References:

1. Ekonomikas ministrija. (2020). Latvijas ekonomikas attīstības pārskats. [in Latvian]. Available at https://www.em.gov.lv/lv/media/4061/download
2. Ministry of Economics. (2020). Economic development of Latvia. Available at https://www.em.gov.lv/en/media/4499/download
3. OECD. (2021). Going Digital in Latvia. OECD Publishing, Paris.
4. European Commission. (2021). Digital Economy and Society Index (DESI) 2021: Latvia. Available at https://ec.europa.eu/newsroom/dae/redirection/document/80482

3. EDUCATIONAL EVENTS RELATED TO INDUSTRY 4.0

Even though information on possible Industry 4.0 educational events for 2017-2021 is incomplete and includes only those events, information about which is available on the web, it can be concluded that opportunities for training in new technologies and developing an understanding of digitalisation processes are extensive. They include short, one-time local and international events (seminars, forums, conference sections, and others) and recurring exhibitions of technological achievements and long-term training programs within the framework of ERAF and ESF projects. Furthermore, educational events are offered to academic staff and staff of state institutions and enterprises in specific industries and any working or self-employed person. Some of the events examined in this report are dedicated to Industry 4.0 and digitalisation. In contrast, others focus on individual Industry 4.0 pillars such as cybersecurity, artificial intelligence and data analysis, cloud computing, and others.

In the context of education, it is worth mentioning that, according to [1], the Ministry of Economics developed an investment plan for 2021-2027 to improve the digital skills of company employees:

- Entrepreneurs will receive support in the form of a grant with an intensity of up to 70% of the total training costs.
- The total amount of investment is planned to be 30 million.
- Within the investment framework, it is planned to support at least 3,000 enterprises from the Latvia's recovery and resilience mechanism funding by 2027 and at least 1,273 enterprises by 2029 from the ERDF funding.
- It is planned to divide the investments into three parts:
    - Massive Open Online Courses on topics such as the basics of UX/UI, e-commerce, data analysis and visualisation, database development and maintenance, programming, and business intelligence system development;
    - European Digital Innovation Hubs offering advanced digital skills development through specialised training on topics such as cybersecurity, artificial intelligence and high-performance computing;
    - cooperation with industry associations to support the development of digital skills of employees in areas such as online information storage, use of websites/social portals, software configuration, online sales, image, video and audio processing, presentation preparation, basic programming skills.

Appendix 3 lists many educational events related to Industry 4.0.

References:

1. Ekonomikas ministrija. (2021). Latvijas ekonomikas attīstības pārskats. [in Latvian]. Available at https://www.em.gov.lv/lv/media/12820/download

4. INTERNATIONAL AND LOCAL PROJECTS ON INDUSTRY 4.0

Analysing local and international projects linked to Industry 4.0 and its main pillars where partners from Latvia are participating, a wide range of projects were found, and 38 of them are summarised in this report. All projects can be divided into five main categories, and some of them can be categorised in more than one of these categories:

1. Projects that aim at developing some **legal and regulatory framework** for the further progress of Industry 0.4 and related technologies by:
   o gathering best practices (4D4F[1], DIGINNO[2], INNO INNDUSTRY[3]);
   o generating policies (INNO INDUSTRY [3]);
   o formulating action plans (SKILLS+[4], DigiBEST[5], IoTXchange[6], AutoDrive[7]);
   o making guidelines (INTERFRAME[8]);
   o developing standards (ITSVET[9], AutoDrive[7], COMP4DRONES[30]);
   o issuing recommendations (DIGINNO[2], DCDS[10]).

2. Projects whose goal is to **raise awareness** and **level of knowledge** in topics related to Industry 4.0 through:
   o free access online courses (4CHANGE[11], IOT-OPEN.EU[12], BRACKET[13]);
   o study programs (ITSVET[9]);
   o demonstrators (TRINITY[14], VIZTA[23], AI4DI[34]);
   o educational events (DIGINNO[2]);
   o training and consultations (SKILLS+[4], i4.0 Baltics[15], WOMEN4IT[16], INforM[27], DCDS[10]);
   o tools for digitalisation assessment (DIGINNO[2], DINNOCAP[22], DigiBEST[5]);
   o framework of necessary skills for cybersecurity (SPARTA[31]).

3. Projects that aim at developing **specific technological solutions** and architectures that could bring Industry 4.0 to life:
   o various kinds of sensors and sensor networks (VIZTA[23], I-MECH[29], IIWS 1[36], IIWS 2[37]);
   o technologies for augmented reality headset (LEOPC[24], NGEAR 3D[25]);
   o technologies for building (ENACT[33]) and testing IoT (LEOPC[24]);
   o computer vision-based methods for traffic analysis (LEOPC[24], Real-time AI urban video analytics[26]) and manufacturing (LEOPC[24]);
   o optoelectronic system for analysing microbiological pollution (LEOPC[24]);
   o multiple robot cooperation software framework (LEOPC[24]);
   o methods for using computer vision and machine learning for automatisation of industrial processes (LEOPC[24]);
   o eCMR indexing prototype (DIGINNO-Proto[28]);
   o technologies for autonomous robots (LEOPC[24], IMOCO4.E[36], RONIN[18]);
   o autonomous microrobots (RoVam[35]);
   o integrated and modular architecture for drones(COMP4DRONES[30]);

- o communication systems for drones (COMP4DRONES[30]) and autonomous vehicles (AI4CSM[32], AutoDrive[7]);
- o autonomous vehicles and linked technologies (AI4CSM[32], PRYSTINE[21]).

4. Projects that strive to **implement** Industry 4.0 in a **particular field**:
    - o agriculture (AfarCloud[1], RONIN[18], 4D4F[1], AUMENTA[19], LEOPC[24]);
    - o food and beverage production (AI4DI[34]);
    - o food retail (LEOPC[24]);
    - o automotive industry (3Ccar[20], AI4DI[34]);
    - o industrial machinery (AI4DI[34]);
    - o transportation (AI4DI[34]).

5. Projects that create **communities, clusters and networks** for promoting Industry 4.0 (INNO INDUSTRY [3], i4.0 Baltics[15], SPARTA[31], AUMENTA[19], TRINITY[14]).

Most of the projects described in this report correspond to the categories of raising awareness and knowledge (17 projects) and developing specific technical solutions (16 projects). A few organisations from Latvia operate as partners in most of the projects described in this report: EDI- Institute of Electronics and Computer Science, LMT, and Lightspace technologies.

Out of 38 projects described in the report, 11 belonging to the first, second and fifth categories described before concentrate on Industry 4.0 as a whole. In comparison, other projects focus on one or several of its pillars. For example, there are 13 projects concerning the Internet of Things, 11 - autonomous robots, 9 - big data and analytics, 7 - cybersecurity, 4- augmented reality, 2 - horizontal and vertical system integration, 1 – additive manufacturing and 1- simulation.

Appendix 4 provides detailed information on international and local projects related to Industry 4.0 in which Latvian representatives participated or played a leading role.

References:

1. 4D4F https://4d4f.eu/
2. DIGINNO https://www.diginnobsr.eu/
3. INNO INDUSTRY https://projects2014-2020.interregeurope.eu/innoindustry/
4. SKILLS+ https://projects2014-2020.interregeurope.eu/skillsplus/
5. DigiBEST https://projects2014-2020.interregeurope.eu/digibest/
6. IoTXchange https://urbact.eu/iotxchange
7. AutoDrive https://autodrive-project.eu/
8. INTERFRAME https://www.lza.lv/aktualitates/projekti/content/82-projekti
9. ITSVET http://database.centralbaltic.eu/project/5
10. DCDS http://www.dcds-project.eu/about/
11. 4CHANGE http://www.change4industry.eu/

12. IOT-OPEN.EU https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2016-1-PL01-KA203-026471
13. BRACKET https://bracket.erasmus.site/
14. TRINITY https://cordis.europa.eu/project/id/825196
15. i4.0 Baltics https://si.se/en/projects-granted-funding/i4-0-baltics-developing-industrial-4-0-competence-centres-and-network-in-estonia-latvia-and-lithuania/
16. WOMEN4IT https://women4it.eu/
17. AfarCloud https://cordis.europa.eu/project/id/783221
18. RONIN https://www.zm.gov.lv/lauku-attistiba/statiskas-lapas/projekts-robotizetas-nezalu-ierobezosanas-iekartas-izveide-?id=19468#jump
19. AUMENTA https://www.itbaltic.com/single-post/aumenta
20. 3Ccar https://cordis.europa.eu/project/id/662192
21. PRYSTINE https://cordis.europa.eu/project/id/783190
22. DINNOCAP https://www.dinnocapbsr.eu/
23. VIZTA https://www.vizta-ecsel.eu/
24. LEOPC (Competence Centre of Electrical and Optical Equipment Production Sector of Latvia) https://www.leopc.lv/projekti/
25. NGEAR 3D https://lightspace3d.com/ngear-3d/
26. Real-time AI urban video analytics https://innovations.lmt.lv/projects/real-time-ai-urban-video-analytics/
27. INforM https://interreg-baltic.eu/project/inform/
28. DIGINNO-Proto https://www.diginnobsr.eu/diginno-proto
29. I-MECH https://cordis.europa.eu/project/id/737453
30. COMP4DRONES https://www.comp4drones.eu/
31. SPARTA https://www.sparta.eu/
32. AI4CSM https://ai4csm.automotive.oth-aw.de/
33. ENACT https://www.enact-project.eu/
34. AI4DI https://ai4di.eu/
35. RoVam https://www.edi.lv/en/projects/development-of-microrobot-based-on-visual-recognition-and-machine-learning-for-manipulation-of-individual-living-cells-rovam/
36. IMOCO4.E https://cordis.europa.eu/project/id/101007311
37. IIWS 1 https://www.edi.lv/en/projects/industrial-inertial-wireless-sensor/
38. IIWS 2 https://www.edi.lv/en/projects/industrial-inertial-wireless-sensor-iiws-part-2/

Co-funded by
the European Union

5. INDUSTRY 4.0 AND HIGHER EDUCATION

Unfortunately, at the moment, the concept of Industry 4.0 is poorly integrated into the discourse of higher education institutions in Latvia. Both the general search on Google and specific searches on the websites of Latvian higher education institutions yield almost no results. An exception is rare references to the professional growth of academic staff through their participation in various events (like conferences and mobility programs) covering some aspects of Industry 4.0, for example, [1, 2, 3]. The only university that addresses the necessity of educational changes in the context of Industry 4.0 is the Latvia University of Life Sciences and Technologies. It emphasises the need to modernise study programs of the Faculty of Information Technologies by including courses on Industry 4.0 and programs of other faculties by incorporating topics on Industry 4.0 in their courses [4]. An important factor that could indicate that higher education institutions are aware of the inevitable need to change their study programmes under the influence of Industry 4.0 is that, between 2017 and 2021, several higher education institutions developed new study programmes covering one or more pillars of Industry 4.0. A summary of these programs is given in Table 1 based on the register of study programmes of the Higher Education Quality Agency in Latvia [5]. At the same time, the Transport and Telecommunication Institute advertises two study programmes that are not included in the previously mentioned register but can be attributed to Industry 4.0. They both provide a double degree with the University of the West of England:

- Data analytics and artificial intelligence (academic master study programme) that includes courses on intelligent data processing, cybersecurity, machine learning, and data analytics [6];
- Artificial intelligence (academic bachelor study programme) that contains many courses related to developing intelligent systems and understanding the concept of artificial intelligence [7].

Furthermore, there are also two programs in Latvia offered by Riga Technical University that were developed more than ten years ago and seem relevant to the context of Industry 4.0:

- Smart Electronic Systems (professional master study programme, license year: 2009) that includes, among others, courses on signal processing systems, 5G wireless technologies, data transmission in wireless sensor networks [8];
- Intelligent Robotic Systems (academic bachelor's and master's study programme, license year: 2010), which mainly contains courses related to robotics [9].

Separate courses addressing pillars of Industry 4.0 can also be included in other study programmes as mandatory or free electives.

Table 1. New Latvian study programs covering technologies related to Industry 4.0

Title	Higher Education institution	Study level	Licensing and accreditation	Study courses included
Cybersecurity Engineering [10]	Vidzeme University of Applied Sciences	Professional master study programme	License year: 2018	Courses cover different aspects of cybersecurity and corresponding technologies [11]
Cyber Security Engineering [12]	Riga Technical University	Academic master study programme	License year: 2020 Not included in accreditation yet	Courses cover different aspects of cybersecurity and corresponding technologies
Mechatronics [13]	Vidzeme University of Applied Sciences	Professional bachelor study programme	License year: 2017	Courses, among others, include Internet of Things and sensor networks, robots and robot control systems, sensors and their use [11]
Robotics [14]	Transport and Telecommunication Institute	Professional bachelor study programme	License year: 2018	Courses cover many topics related to the development of robotics systems
Smart Electronic Systems [15]	Riga Technical University	Professional bachelor study programme	License year: 2020 Not included in accreditation yet	Courses, among others, include Internet of Things technologies, signal processing, smart embedded systems
Smart Technologies and Mechatronics [16]	University of Liepāja joint programme with Ventspils University of Applied Science	Professional bachelor study programme	License year: 2021 Not included in accreditation yet	Courses, among others, include Internet of Things, artificial intelligence, robot control, cybersecurity, cloud computing
Virtual reality and smart technologies [17]	Vidzeme University of Applied Sciences	Professional master study programme	License year: 2018	Courses cover topics of machine learning, 3D graphics, virtual and augmented reality, computer vision [11]

DigiWork

Digital Transformation, Industry 4.0 and Human Resources Management: Innovative skills to enhance HE students' employability, flexibility and transversal capabilities

References:

1. Vasermane i. (2019). LiepU pētnieki paplašina kontaktu tīklu, piedaloties konferencēs, forumos un tīklošanās pasākumos. Liepājas Universitāte. [in Latvian]. Available at https://www.liepu.lv/lv/jaunumi/3530/liepu-petnieki-paplasina-kontaktu-tiklu-piedaloties-konferences-forumos-un-tiklosanas-pasakumos

2. Rēzeknes Tehnoloģiju Akadēmija. (2019). Erasmus+ programma sniedz iespēju pilnveidoties. [in Latvian]. Available at https://2021.rta.lv/aktualitates/1967/

3. Vidzeme University of Applied Sciences. (2021). Vidzeme University of Applied Sciences Organizes Scientific Conference. Available at https://va.lv/en/news-events/news/vidzeme-university-applied-sciences-organizes-scientific-conference

4. Rivža B., & Rivža P. (2019). Prezentācija "4.industriālā revolūcija: digitālā ekonomika un LLU studiju procesa izaicinājumi" [in Latvian]. Available at https://www.llu.lv/sites/default/files/2019-01/AK_2019_B_P_Rivza.pdf

5. Higher Education Quality Agency. (n.d.). Study programmes. Available at https://eplatforma.aika.lv/index.php?r=site%2Fprogram%2Flist

6. Transport and Telecommunication Institute. (n.d.). Double degree in computer science: Data analytics and artificial intelligence. Available at https://tsi.lv/study_programmes/double-degree-in-computer-sciencedata-analytics-and-artificial-intelligence/

7. Transport and Telecommunication Institute. (n.d.). Double Degree in Computer Science: Artificial Intelligence. Available at https://tsi.lv/study_programmes/computer-sciences-double-degree-artificial-intelligence/

8. Rīgas Tehniskā universitāte. (2022). Studiju programma "Viedās elektorniskās sistēmas". [in Latvian]. Available at https://stud.rtu.lv/rtu/spr_export/prog_pdf_lv.17

9. Rīgas Tehniskā universitāte. (n.d.). Intelektuālas robotizētas sistēmas. [in Latvian]. Available at https://www.rtu.lv/lv/studijas/visas-studiju-programmas/atvert/DBR?department=12000&type=P

10. Vidzemes augstskola. (n.d.). Kiberdrošības inženierija. [in Latvian]. Available at http://va.lv/lv/studijas/magistrs/kiberdrosibas-inzenierija/par-programmu

11. Vidzemes augstskola. (n.d.). VIA kursu reģistrs. [in Latvian]. Available at https://stud.rtu.lv/rtu/spr_export/prog_pdf_lv.176

12. Rīgas Tehniskā universitāte. (n.d.). Kiberdrošības inženierija. [in Latvian]. Available at https://www.rtu.lv/lv/studijas/visas-studiju-programmas/atvert/DMK?department=12000&type=A

13. Vidzemes augstskola. (n.d.). Mehatronika. [in Latvian]. Available at https://va.lv/lv/studijas/bakalaurs/mehatronika/par-programmu

14. Transport and Telecommunication Institute. (n.d.). Robotics. Available at https://tsi.lv/study_programmes/robotics/

15. Rīgas Tehniskā universitāte. (2022). Studiju programma "Viedās elektorniskās sistēmas". [in Latvian]. Available at https://stud.rtu.lv/rtu/spr_export/prog_pdf_lv.189

16. Liepājas Universitāte. (n.d.). Viedās tehnoloģijas un mehatronika. [in Latvian]. Available at https://www.liepu.lv/lv/1267/viedas-tehnologijas-un-mehatronika

17. Vidzemes augstskola. (n.d.). Virtuālā realitāte un viedās tehnoloģijas. [in Latvian]. Available at https://va.lv/lv/studijas/magistrs/virtuala-realitate-un-viedas-tehnologijas/studiju-programmas-saturs

Co-funded by the European Union

6. COMPANIES AND INDUSTRY 4.0

According to [1], the primary industries engaged in Industry 4.0 are telecommunications, electronics, logistics, smart mobility, and biotechnology, and some of the key networks involved in the Industry 4.0 innovation ecosystem are:

- IT Cluster;
- Latvian Information and Communication Technology Association (LIKTA);
- European Digital Innovation Hubs (EDIH);
- Annual Fifth-Generation Techritory, the leading fifth-generation ecosystem forum in Europe.

Companies from the IT, electronics and telecommunications sectors actively engage in digitalisation, automatisation, robotisation and data-driven analysis of business processes. They offer various services and solutions in data analytics and visualisation, intelligent automation, cybersecurity, the Internet of Things, cloud computing, artificial intelligence, and augmented reality for enterprises of different sizes and industrial fields. The most influential player is LMT, a mobile telecommunications operator and market leader in Latvia [2]. The enterprise participates actively in projects directed towards developing and introducing technologies of Industry 4.0 and collaborates with government, industrial and academic institutions. It is also involved in explanatory activities regarding Industry 4.0, its influence and requirements.

The Association of Mechanical Engineering and Metalworking Industries of Latvia greatly supports enterprises in the metalworking industry. It organises educational and experience exchange events, actively participates in projects related to Industry 4.0 and has also developed training materials in the Latvian language to implement Industry 4.0 in the metalworking industry (see Section 8).

Appendix 5 lists many companies that have introduced or supported Industry 4.0.

References:

1. United Nations. (2022). Industry 4.0 for Inclusive Development. Available at https://unctad.org/system/files/official-document/dtlstict2022d4_en.pdf
2. LMT. (n.d.). About LMT. Available at https://bizness.lmt.lv/en/about-lmt

7. DEMAND FOR SKILLS AND KNOWLEDGE IN THE CONTEXT OF INDUSTRY 4.0

The nature of many jobs will change due to digital innovations such as machine learning, big data and artificial intelligence. Concerning economic trends, the demand for labour in low-skilled occupations and occupations where routine activities can be automated is expected to decline [1]. Trends show that, on average, around 14% of existing jobs could disappear due to automation in the next 15-20 years, and the other 32% are exposed to significant changes in their job responsibilities due to the automation of individual tasks [2].

In [1], it was indicated that in the period until 2027, there will be a surplus of the labour force with secondary general education, basic education and a lower level of education, but a shortage of labour force with vocational secondary education, especially in engineering and manufacturing [1]. There is also a forecast of a shortage of highly qualified specialists in natural sciences, ICT and engineering (the shortage in the direction of STEM may increase to ~14 thousand). At the same time, a surplus of workforces with higher qualifications in the social sciences, business and humanities is projected by 2027 may increase to ~17 thousand [1]. Better literacy, numeracy and problem-solving skills are becoming essential for using the Internet effectively and determining the reliability of online information [3].

According to forecasts, the growth of the Latvian economy will be mainly determined by the use of new technological processes, digitalisation (concept "Industry 4.0") and process optimisation [1, 3]. Consequently, the fastest job growth is expected in high- and medium-high-tech sectors, such as ICT, as well as in high-skilled occupations, such as managers and senior professionals [1, 3]. Prospects for future professions are primarily based on the so-called "digital" and "human" factors, namely skills in working with data, artificial intelligence, new technologies, professional skills in technical fields, especially automation, robotics, control and programming of complex technologies [3, 4], as well as skills for successful process management and human interaction [1, 3]. Furthermore, skills such as creativity, problem solving, negotiation, critical thinking, teamwork, empathy and emotion management, intercultural communication and the ability to adapt and lead changes will be relevant [1, 5]. In a world where everything is connected, the ability to communicate successfully is also important; however, it can be considered one of the most difficult skills to develop [5]. Globally, the increased use of ICT has increased the demand for general and specialised ICT skills and additional skills such as online marketing and big data analysis [3]. In addition, the analysis of educational events allows concluding that knowledge and skills in the following fields are vital:

- general understanding of Industry 4.0 (opportunities, challenges, requirements, benefits, importance);
- latest technologies for digitalisation and automation (Internet of Things, artificial intelligence and machine learning, cloud computing, data analytics and cybersecurity).

In Latvia, employers' expenditure on employee training is low compared to other EU countries. The share of training expenditure in total labour costs in enterprises in Latvia is only 0.8%, but in the EU, on average – 1.7% [1]. The main obstacles to employees' growth are their inability to combine training with work schedules and insufficient employer support [1]. Investments in ICT skills in the workplace are low. Only 11% of Latvian companies provide training to their employees in ICT skills compared to the EU average (23%) [1].

It is necessary to strengthen the cooperation between universities and industry to improve the content of study programs and align it with the development needs of the industry, especially by promoting the acquisition of competencies necessary for the development of Industry 4.0 [1, 4]. One of the challenges for higher education is to reduce the shortage of ICT professionals, so there is a need to promote targeted investment in the ICT workforce specifically. Furthermore, with the digitalisation of different sectors and the emergence of new technologies and knowledge, higher education should be more flexible in transferring this knowledge and skills to the population [1]. Also, recently developed HEIs study programs indicate the need to develop skills in cybersecurity, robotics, artificial intelligence, smart technologies and virtual/augmented reality [4].

Skills and knowledge necessary for the current and future workforce largely depend on the employers' demand, willingness, and ability to adopt new ways of working. Three of the projects summarised in this report conducted studies to elicit companies' opinions regarding Industry 4.0 and intentions on digitalising their business. In 2019, the DIGINNO and Women4IT project conducted studies asking respondents about the importance of various digital technologies in their business. The sample is somewhat limited: the DIGINNO survey [6] had 18 respondents from Latvia, while the Women4IT survey [7] gathered responses from 34 companies. Nevertheless, both surveys reveal similar tendencies: Latvian respondents of the first survey indicated automation (3.4 out of 5 points), database (3.3), wireless (3.2), security and encryption (2.8) and cloud computing (2.8) technologies as most useful, while drones (1.1), blockchain (1.2), machine learning (1.4) and augmented reality (1.4) technologies were marked as less important. The Women4IT survey does not represent the data from Latvian respondents separately. However, from all respondents of this survey, 76% marked mobile services, 63% cybersecurity, 62% big data and analytics, 61% cloud technologies, 57% enterprise systems, and 56% IoT as very useful for their businesses. Only 3D printing was considered less useful - marked as very important by 22% of respondents.

Expected tendencies of the use of digital technologies in the nearest future (3-5 years) were studied in surveys conducted within the DIGINNO [6], Woman4IT [7] and the DigiBEST project. The DigiBEST project conducted a survey [8] on 2020 and got responses from 51 Latvian companies. Answers to this question in all three surveys coincide: companies express their intent to invest in wireless technologies, database, automation, security and encryption, cloud computing, big data and analytics, data visualisation technologies and robotics.

In preparing the report, several projects were found that strive to define sets of skills needed for specific areas. One of the deliverables of project ITSVET was a standard for ICT security specialists [9], which describes the knowledge and skills needed for such professionals in great detail. The standard demands professional as well as general skills. Professional skills necessary for such specialists include using the knowledge about future technologies to foresee appropriate security solutions, using the knowledge about secure infrastructure methodology, assessing security risks of ICT solutions and mitigating them, systematically scrutinising the environment for identification of vulnerabilities and threats and avert any breaches of ICT security. 4CHANGE project has created VET programs [10] for CNC machine operators of various qualification levels. These programs aim at developing such skills as ensuring cybersecurity at the workplace, operating, maintaining and troubleshooting additive manufacturing machines, and using wireless, big data and cloud computing technologies at the workshop, among others. The cybersecurity skills framework [11] developed during the SPARTA project describes skills needed for various roles at a company to ensure its cybersecurity. This framework is intended to provide a basis for a discussion between academia, industry, policymakers, specialists and others.

Therefore, specific skills and knowledge that will be demanded in future from employees depend mainly on company size (SME or large company) and targeted market (local or international), the company's digital maturity and the strategic vision of the business. However, the general trends indicate the necessity to develop the following skills and knowledge:

- general digital competence (effective use of software and hardware, searching and evaluating the reliability of information, and others);
- soft skills and transversal competences (creativity, problem solving, critical thinking, teamwork, intercultural communication, emotional intelligence, and others);
- general knowledge of Industry 4.0 (opportunities, challenges, requirements, benefits, importance);
- awareness of and skills in using the latest technologies for digitalisation and automation (Internet of Things, artificial intelligence and machine learning, cloud computing, automation, robotics, big data analytics and cybersecurity, smart technologies, and virtual/augmented reality).

References:

1. Izglītības un zinātnes ministrija. (2021). Izglītības attīstības pamatnostādnes 2021.-2027.gadam "Nākotnes prasmes nākotnes sabiedrībai" [in Latvian]. Available at https://likumi.lv/ta/id/324332-par-izglitibas-attistibas-pamatnostadnem-2021-2027-gadam
2. OECD. (2019).OECD Employment Outlook 2019. The future of work. Highlights. Available at https://www.oecd.org/employment/Employment-Outlook-2019-Highlight-EN.pdf
3. OECD. (2021). Going Digital in Latvia. OECD Publishing, Paris.

4. Ministru kabinets. (2021). Par Nacionālās industriālās politikas pamatnostādnēm 2021.-2027. gadam. Ministru kabineta rīkojums Nr. 93. [in Latvian]. Available at https://likumi.lv/ta/id/321037-par-nacionalas-industrialas-politikas-pamatnostadnem-20212027-gadam

5. Latvijas reitingi. (2019). Vai mileniāļi ir gatavi nākamajai industriālajai revolūcijai? [in Latvian]. Available at https://www.reitingi.lv/lv/news/darbs/127299-vai-mileniali-ir-gatavi-nakamajai-industrialajai-revolucijai.html

6. Diginno project. (2019). Diginno Business needs assessment. Available at https://www.diginnobsr.eu/_files/ugd/8cf6e6_f7e58cec3422452d8d0b3eaf99656cee.pdf

7. Women4IT. (2019). Study:Needs assessment at European and national levels. Available at https://women4it.eu/wp-content/uploads/2019/09/2.1-Needs-Assessment-updated.pdf

8. DigiBest. (2021). DigiBest regional study on the state of digital transformation and its impact on the regional businesses in Latvia. Available at https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1638609246.pdf

9. Itsvet. (2020). Informācijas sistēmu drošības speciālista profesijas standarts. [in Latvian]. Available at https://likta.lv/wp-content/uploads/2020/01/Inform%C4%81cijas-sist%C4%93mu-dro%C5%A1%C4%ABbas-speci%C4%81lista-profesijas-standarts.pdf

10. 4Change. (2019). Apprenticeship training plans. Available at http://www.change4industry.eu/uploads/Docs/doc1500/1581550605_4change-cnc-operator-training-program-2020.docx

11. Sparta. (2019). D9.1 Cybersecurity skills framework. Available at https://www.sparta.eu/assets/deliverables/SPARTA-D9.1-Cybersecurity-skills-framework-PU-M12.pdf

8. BEST PRACTICES FOR DIGITAL TRANSFORMATION AND IMPLEMENTATION OF THE INDUSTRY 4.0 CONCEPT

1	Best practice name:	Training materials in the Latvian language for the implementation of Industry 4.0 in the metalworking industry
2	Sector:	Metalworking industry
3	Organisation implementing/disseminating the practice:	The consortium of the Erasmus+ (Key Action: Cooperation for innovation and the exchange of good practices, Action Type: Sector Skills Alliances in vocational education and training) project No. 575813-EPP-1-2016-1-LT-EPPKA2-SSA "Industry 4.0 CHAlleNGE: Empowering Metalworkers for Smart Factories of the Future" (2016-2020). Partners from Latvia: Association of Mechanical Engineering and Metalworking Industries of Latvia, Zemgale Region Human Resource and Competences Development Centre, National Centre for Education Republic of Latvia.
4	The goal:	The project's main goal was to increase metalworkers' skills and prepare them for Industry 4.0 challenges. Therefore, the project addressed the problem of the lack of qualified employees and an inadequate level of employees' skills in the metalworking and mechanical engineering industry regarding introducing and developing Industry 4.0. [1,2]
5	Description / Focus:	The project developed an interactive e-learning platform (www.cnc4change.org) and training materials, among other results. [1,2]
6	Target groups:	The target groups of training materials are the following [1,2]: • workers in the metalworking and mechanical engineering industries; • CNC machine tool operators and adjusters; • engineers - technologists who develop CNC machine tool processing programs; • engineering students and learners in all types and levels of education and training; • academic staff. • all persons involved in computer-aided manufacturing solutions.

Co-funded by the European Union

7	Dissemination / implementation method:	The training materials as other project results were disseminated using the following channels [1,2]: • press articles in local/regional/special newspapers; • brochures printed and distributed to VET providers, associations, labour exchange, and the specialised public to spread the word about the project's added value and outcomes; • project website.
8	Results / impact with a focus on sector and individuals, like students or employees:	The developed training materials include [1,2]: • one model modular VET programme and four country-specific training programmes, which were specifically developed for youth, older people, unemployed, migrants, other adults, Qualification authorities, VET schools, and trainers; • set of assessment tests; • training material, which was developed for learners (youth, older people, unemployed, migrants, and other adults), includes one textbook for learners, one workbook for learners and one trainer manual for trainers; • a set of 3D posters representing processes in the metalworking industry visually. Therefore, the project provides the ready-to-use materials for education employees in the metalworking industry.
9	Sustainability:	Not specified
10	What were the obstacles?	Not specified
11	What innovative skills (if any) the described above best practice might have developed to enhance students employability?	Not specified
12	References:	1. https://erasmus-plus.ec.europa.eu/projects/search/details/575813-EPP-1-2016-1-LT-EPPKA2-SSA 2. https://www.masoc.lv/jaunumi/masoc-zinas/izdoti-jauni-macibu-materiali-industrijas-40-ieviesanai (in Latvian)

Co-funded by
the European Union

1	Best practice name:	SME Digital Maturity Recommender
2	Sector:	Any SME
3	Organisation implementing/disseminating the practice:	Latvian Information and Communications Technology Association, together with partners (Edisoft, Microsoft Latvia, Lursoft, Fitek, ELVA, VISMA, Bregards, Komercizglītības centrs, Baltic3d.eu), implemented a national initiative [1, 2, 3]
4	The goal:	The digital maturity test aims to allow SME management to assess the current state of use of IT solutions in companies and think about their further development and integration. [1, 2, 3]
5	Description / Focus:	The tool provides the following possibilities [1, 2, 3]: • answering questions about the use of IT solutions in the company's internal and external processes; • in-depth assessment of the company's digital maturity and comparison with competitors in the industry and the region; • recommendations on which IT solutions would help the company to work more efficiently. The tool measures digital maturity across ten business dimensions [1, 2, 3]: • digital transformation and competition; • financial data management; • human resources environment; • customer relationship management; • resource management; • communication and customer relations; • digitalisation of processes; • security policy and practices; • digitalisation in production; • innovation and growth perspectives.
6	Target groups:	Management of SMEs companies
7	Dissemination / implementation method:	The test is available on the web: https://www.diginnotool.eu/ It is promoted by the Latvian Information and Communications Technology Association and partners.

8	Results / impact with a focus on sector and individuals, like students or employees:	Any SME has a tool to assess it digital maturity and to decide which new technologies to introduce. It can raise the level of digitalization in the country
9	Sustainability:	Not specified
10	What were the obstacles?	Not specified
11	What innovative skills (if any) the described above best practice might have developed to enhance students employability?	Not specified
12	References:	1. https://digital-skills-jobs.europa.eu/en/inspiration/resources/diginno-tool-sme-digital-maturity-recommender 2. https://www.diginnotool.eu/ 3. https://likta.lv/digitala-brieduma-tests/ (in Latvian)

Co-funded by
the European Union

1	Best practice name:	"Introduction to the IoT: Coursebook in Latvian"
2	Sector:	Education
3	Organisation implementing/disseminating the practice:	The consortium of the Erasmus+ (Key Action: Cooperation for innovation and the exchange of good practices, Action Type: Strategic Partnerships for higher education) project No.2016-1-PL01-KA203-026471 "Innovative Open Education on IoT: improving higher education for European digital global competitiveness" (2016-2019). Four researchers of the Riga Technical University represented Latvia in the project and participated in developing the coursebook.
4	The goal:	The coursebook aims to introduce the Internet of Things, one of the pillars of Industry 4.0.[1,2]
5	Description / Focus:	The coursebook addresses such topics as a definition of IoT, enabling technologies, IoT hardware, networking basics, IoT security and others. It contains 352 pages. [1,2]
6	Target groups:	The book is targeted at [1,2]: • bachelor's and master's students; • technology enthusiasts; • engineers; • educators who are willing to expand their knowledge or develop a course on IoT; • adults for further development of previously acquired technical knowledge and skills.
7	Dissemination / implementation method:	The book is available on the web: https://ec.europa.eu/programmes/erasmus-plus/project-result-content/92252e46-43c8-4ccc-9935-590bdb8ba9fe/iot-open.eu-LV.pdf
8	Results / impact with a focus on sector and individuals, like students or employees:	Therefore, the project provides the ready-to-use materials to educate everyone interested in IoT technologies. It can raise the level of awareness of society about Industry 4.0.
9	Sustainability:	Not specified
10	What were the obstacles?	Not specified

Co-funded by the European Union

11	What innovative skills (if any) the described above best practice might have developed to enhance students employability?	Not specified
12	References:	1. http://iot-open.eu/download/iot-open-eu-introduction-to-the-iot-coursebook-in-latvian/ 2. https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2016-1-PL01-KA203-026471

1	Best practice name:	AR headsets
2	Sector:	Technology, engineering
3	Organisation implementing/disseminating the practice:	Lightspace Technologies
4	The goal:	The company has invented the world's first multi-focal technology - AR headsets - that uses multiple screens for eye accommodation that comes as close to natural viewing as possible [1,2]
5	Description / Focus:	The developed technology can be used in many fields (surgery, digital manufacturing, materials engineering, diagnostic imaging, and other files demanding high precision activities). The technology was developed and used in many projects (ERDF fund supported by the Ministry of Economics of Latvia project No. 1.2.1.1/18/A/006 No 1.16 "Development of integrated electronics for head position tracking and remote assistance functionality" and Project 1.2.1.1/18/A/006 No 1.22 "Precise positioning of the head-mounted display in industrial applications", as well as No. H2020-EIC-SMEInst-2018-2020-3 "Next Generation Enhanced Augmented Reality 3D Glasses for medical education, pre-procedural planning, intra-procedural visualisation, and patient rehabilitation") [1,2]
6	Target groups:	Professionals in surgery, digital manufacturing, materials engineering, diagnostic imaging, and other files demanding high-precision activities [1,2]
7	Dissemination / implementation method:	The technology is disseminated in marketing and technology events.
8	Results / impact with a focus on sector and individuals, like students or employees:	The company has developed a new tool for industry fields completing high-precision activities
9	Sustainability:	Not specified
10	What were the obstacles?	Not specified

11	What innovative skills (if any) the described above best practice might have developed to enhance students employability?	Not specified
12	References:	1. https://lightspace3d.com/products/ 2. https://cordis.europa.eu/project/id/960828

Co-funded by
the European Union

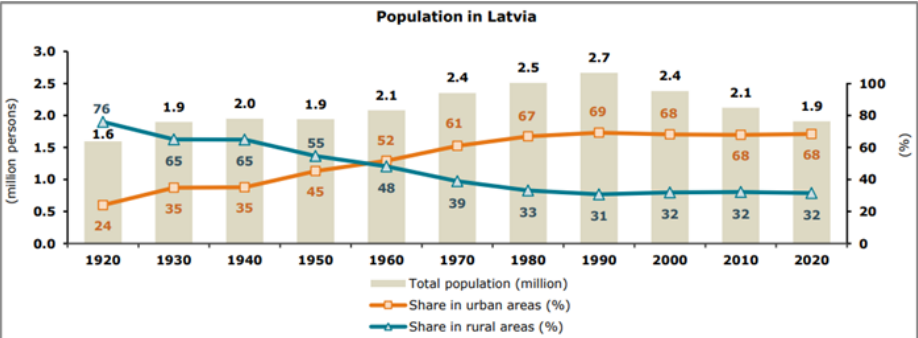| 1	Best practice name:	Energy Management System
2	Sector:	Energetic
3	Organisation implementing/disseminating the practice:	AdvanGrid
4	The goal:	The company provides an energy management system that, based on sensors, measures energy consumption on a machine level and stores the data in the energy management software platform for further analysis. Based on data, a specific action plan can be developed that helps to eliminate energy waste, boost efficiency and cut costs.[1]
5	Description / Focus:	The solution is used in many countries in Europe, North America, Australia, and Asia by more than 200 companies. On the website, many case studies are described. Users can use different plans to buy the solution.[1]
6	Target groups:	Any company that is interested in energy saving.
7	Dissemination / implementation method:	The company sells the system and its support based on different payment plans.[1]
8	Results / impact with a focus on sector and individuals, like students or employees:	Not specified
9	Sustainability:	Not specified
10	What were the obstacles?	Not specified
11	What innovative skills (if any) the described above best practice might have developed to enhance students employability?	Not specified
12	References:	1. https://www.advangrid.com/#3-steps-header

Co-funded by
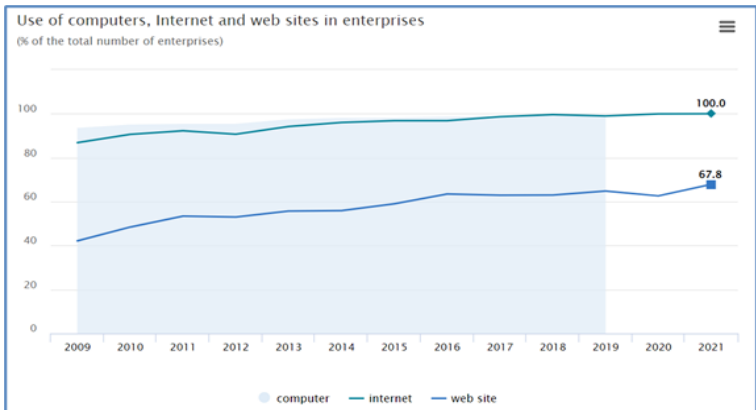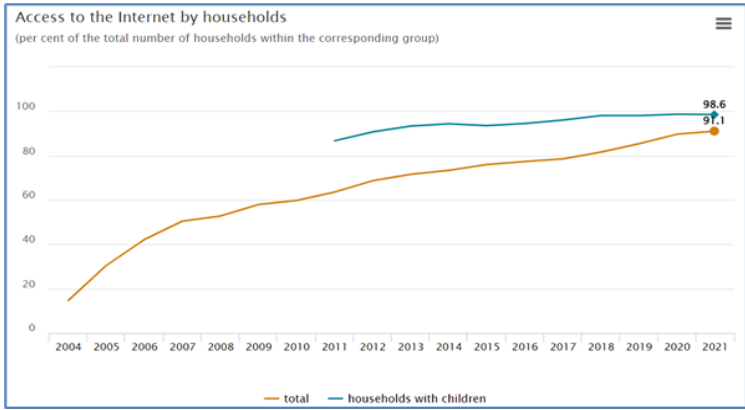the European Union

APPENDICES

Appendix 1: Statistics and economic indicators on digitalisation and digital skills
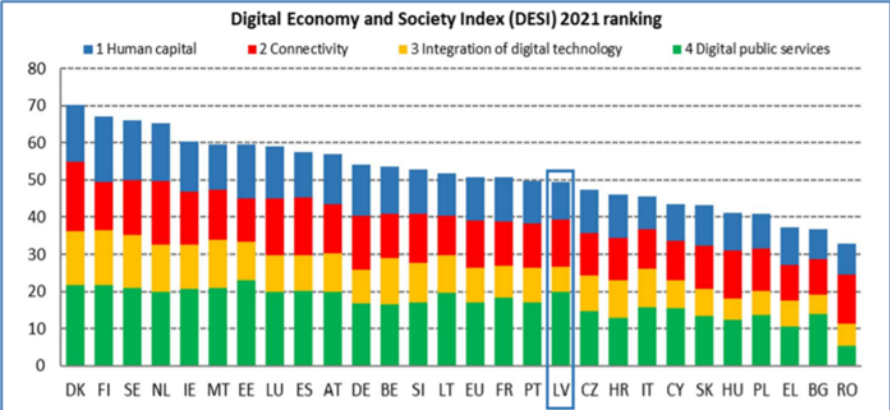
Geography and population

Title of the indicator:	Geographical characteristics of Latvia and population
Value:	The territory of Latvia comprises 64.6 thousand km^2, of which 62.2 thousand km^2 or 96 % is the territory of land, but 2.4 thousand km^2 or 4 % is the territory of inland waters. Protected natural areas take up 7.8 thousand km^2 or 12.1 % of the territory. Latvia has a land border with Estonia (343 km), Russia (2784 km), Belarus (173 km) and Lithuania (587 km) with a total length of 1387 km and a maritime border with a total length of 513 km [1]. Latvia is the fifth smallest country in the European Union. At the beginning of 2021, there were 1 million 894 thousand residents in Latvia, which is 13.9 thousand less than in the previous year. The majority (68%) of the Latvian population live in cities, almost half of this in Riga, while the rest (32%) are rural residents. The population of Latvia has been decreasing; since 1990, it has decreased by 760 thousand people or 29% in the last 30 years [1, 2]. (the figure is adopted from [1])
References:	1. https://admin.stat.gov.lv/system/files/publication/2021-05/Nr_03_Latvia_Statsitcs_in_Briefi_2021_%2821_00%29_EN.pdf 2. https://stat.gov.lv/en/statistics-themes/population/population-number/247-population-number-its-changes-and-density?themeCode=IR

Internet access

Title of the indicator:	**Access to the Internet in enterprises and households in Latvia**
Value:	In 2021, 100% of enterprises had access to the Internet. The access has increased by 1% compared to the situation before the Covid-19 pandemic. At the beginning of 2021, 67.8 % of enterprises had their websites, of which 95.5% were large enterprises, 87.3% were medium-sized enterprises and 63.5% - small enterprises [1, 2]. (the figure is adopted from [1]) In 2021, 91.1% of households had access to the Internet (an increase of 5.6% since 2019). At least 98.6% of households with children had access to the Internet [1, 2]. In the urban regions, access to the Internet is up to 92%, but in rural areas - 89% [3]. (the figure is adopted from [1]) The digital divide is still present despite investments in middle-mile connections in rural regions. The rural regions still have the unused potential for broadband optical internet access, providing a reliable and fast digital infrastructure for businesses and remote working opportunities [4, 5].

References:	1. https://admin.stat.gov.lv/system/files/publication/2021-05/Nr_03_Latvia_Statsitcs_in_Briefi_2021_%2821_00%29_EN.pdf
	2. https://stat.gov.lv/en/statistics-themes/information-technologies/computers-and-internet
	3. https://www.itu.int/en/ITU-D/Statistics/Documents/DDD/ddd_LVA.pdf
	4. https://ec.europa.eu/newsroom/dae/redirection/document/80482
	5. https://www.em.gov.lv/lv/media/12820/download

Digitalisation

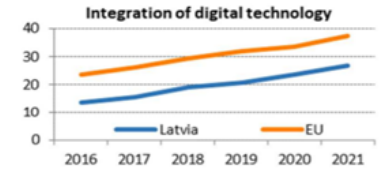| Title of the indicator:	**Digitalisation level in Latvia**
Value:	Regarding digitalisation, the Digital Economy and Society Index (DESI) report ranks Latvia in 17th place with a score of 49.5 across all EU member states in 2021. This score is below the EU average – 50.7 [1, 2]. According to the National Development Plan of Latvia for 2021-2027, the goal is to reach 15th place in the DESI ranking by 2024 and 13th place in 2027 [3].
	(the figure is adopted from [1])
	Currently, progress has been made in terms of connectivity (relatively high coverage and deployment of high-speed broadband networks) and digital public services (launch of the Latvian Open Data Portal, as well as a life-cycle approach to public service delivery) [4]. Latvia performs well in the provision of digital public services. The number of e-government users continues to increase, and the provision of online public services has further improved [2]. Latvia is a front-runner in broadband coverage and take-up and is well prepared for the introduction of 5G. The country's main strengths are the highly advanced coverage of fast broadband (93% against the EU average of 87%) and the fact that 39% of households subscribe to at least 100 Mbps broadband, compared to the EU average of 34% [2]. More and more people also use internet banking and e-government services, but half of them do not

	have digital skills, or their level is low [4]. While many indicators show a positive tendency, like job applicants' growing rates of using the Internet for job search or the growing share of enterprises making sales online, other indicators show a grimmer picture as the share of hired ICT specialists has decreased significantly in the past years [5]. Several reasons can be identified. Industry stakeholders have recognised that the key obstacle and challenge related to the take-up of digital technologies is a severe lack of qualified personnel [5]. Latvia's competitiveness is also significantly weakened by institutional shortcomings (regulatory shortcomings, inefficient bureaucracy, and others), insufficient quality of infrastructure, low innovation performance, and insufficient business development and quality [6]. Competitiveness is still largely based on relatively low labour costs, to a lesser extent on technological innovations [6]. Promoting innovation can help Latvian enterprises to improve their productivity, which is currently at a low level. This aspect could foster growth despite a shrinking population and increase salaries, which can help retain employees. In particular, digital innovations can overcome distance problems and help Latvia increase its exports [7]. The government, together with enterprises and the public, must take targeted measures to implement digital transformation measures, ensuring access to digital infrastructure that will strengthen the development of digital solutions in all sectors of the economy [6]. The government might be able to increase digitisation by making some digital aspects mandatory to guide the industry towards more significant investment in digitisation and personnel education [5].
References:	1. European Commission, "Questions and Answers: Digital Economy and Society Index (DESI) 2021," Nov. 12, 2021. [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/QANDA_21_5483 [Accessed: Mar. 5, 2022]. 2. https://ec.europa.eu/newsroom/dae/redirection/document/80482 3. https://komitejas.esfondi.lv/anm_rrf/Plnoanas%20dokumenti%20ANMRRF/Tematisk%C4%81s%20diskusijas/2021_gads/08.03.2021_tematiskas_diskusijas_(ANM_DP21-27_1_Digitalizacija)/3_EM_Digitalizacija_08032021.pdf 4. https://www.em.gov.lv/lv/media/12820/download 5. https://ec.europa.eu/information_society/newsroom/image/document/2019-32/country_report_-_latvia_-_final_2019_0D30BE44-054B-C822-C8DEFA25536D65B0_61211.pdf 6. Ministru kabinets, "Par Nacionālās industriālās politikas pamatnostādnēm 2021.–2027. gadam," Feb. 16, 2021. [Online]. Available: https://likumi.lv/ta/id/321037 [Accessed: Mar. 7, 2022]. 7. https://www.oecd-ilibrary.org/science-and-technology/digitalizacija-latvija_a58d1c1a-lv

Digital skills

Title of the indicator:	**Digital skills in Latvia**
Value:	According to DESI 2021, Latvia ranks 20th among the 27 EU countries for *Human capital*, below the EU average. Human capital is the DESI dimension characterised by the level of Internet user skills and advanced digital skills, as well as by the number of ICT specialists [1]. In Latvia, basic digital and advanced digital skills levels were much lower than the EU average: only 43% of the Latvian population had basic digital skills compared to 56% in the EU. One of the causes might have been the ageing population. However, even young people aged 16 to 24 lacked digital skills compared to the EU [1]. Moreover, the gap between Latvia and other EU countries is even more comprehensive regarding advanced or "above basic" digital skills. In Latvia, only 24% of the population possess above basic digital skills compared to the EU average level (31%) [1]. Latvia is also among those four countries, together with Romania, Greece, and Croatia, that suffer from a loss of talents with skills in advanced technologies since they primarily emigrate to the United Kingdom and Germany [2].

<table>
<thead>
<tr><th></th><th colspan="3">Latvia</th><th>EU</th></tr>
<tr><th></th><th>DESI 2019</th><th>DESI 2020</th><th>DESI 2021</th><th>DESI 2021</th></tr>
</thead>
<tbody>
<tr><td>1a1 At least basic digital skills
% individuals</td><td>48%
2017</td><td>43%
2019</td><td>43%
2019</td><td>56%
2019</td></tr>
<tr><td>1a2 Above basic digital skills
% individuals</td><td>27%
2017</td><td>24%
2019</td><td>24%
2019</td><td>31%
2019</td></tr>
<tr><td>1a3 At least basic software skills
% individuals</td><td>49%
2017</td><td>44%
2019</td><td>44%
2019</td><td>58%
2019</td></tr>
<tr><td>1b1 ICT specialists
% individuals in employment aged 15-74</td><td>2.6%
2018</td><td>3.1%
2019</td><td>3.7%
2020</td><td>4.3%
2020</td></tr>
<tr><td>1b2 Female ICT specialists
% ICT specialists</td><td>19%
2018</td><td>24%
2019</td><td>23%
2020</td><td>19%
2020</td></tr>
<tr><td>1b3 Enterprises providing ICT training
% enterprises</td><td>11%
2018</td><td>18%
2019</td><td>17%
2020</td><td>20%
2020</td></tr>
<tr><td>1b4 ICT graduates
% graduates</td><td>5.0%
2017</td><td>4.7%
2018</td><td>4.4%
2019</td><td>3.9%
2019</td></tr>
</tbody>
</table>

(the figure is adopted from [1])

Latvia's performance is above average regarding ICT graduates (4.7% against 3.8%) and female ICT specialists (23%, against 19% at the EU level). Latvia is also reducing the gap for ICT specialists, representing 3.7% of total employment versus the EU average of 4.3% [1]. However, the shortage of digital skills is a crucial obstacle to the more widespread use of digital solutions by the private sector; almost half of the Latvian companies (56%) that tried to fill vacancies for digital specialists encountered difficulties [1].

Improving the population's digital skills is a precondition for creating and ensuring an environment conducive to digitalisation, improving business productivity and promoting Latvia's progress and investment in new digital technologies [3, 4].

It is necessary to strengthen the cooperation between universities and industry to improve the content of study programs and align it with the

Co-funded by
the European Union

	development needs of the industry, especially by promoting the acquisition of competencies necessary for industry 4.0 [5]. With the digitalisation of different sectors and the emergence of new technologies and knowledge, the higher education sector should be more flexible in transferring this new knowledge and skills to the population, i.e., those in the labour market or entrepreneurs who already have one or more higher education but do not possess knowledge on the latest trends [5]. Currently, the Latvian government has identified the development of digital skills at all levels as a national priority [1]. In general, the rise of digital skills for various society groups (by age and education levels) has been included in several national development plans, e.g., National Development Plan 2021–2027 [6], Guidelines for Digital Transformation 2021–2027 [7] and National Industrial Policy Guidelines 2021–2027 [8]. In addition, other sectoral policies address the development of digital skills, such as the Implementation Plan on an Adult Education Governance Model, which is in force until 2023 and has also created the Adult Education Governance Board. Furthermore, since 2020, the Training Commission of the Ministry of Welfare has outlined broader 'Digital skills' among the priority fields for the courses organised by the State Employment Agency [1].
References:	1. https://ec.europa.eu/newsroom/dae/redirection/document/80482 2. https://ati.ec.europa.eu/reports/policy-briefs/meeting-sectoral-skills-challenge-advanced-technologies 3. https://www.em.gov.lv/lv/media/12820/download 4. OECD, Going Digital in Latvia. OECD Publishing, Paris, 2021. 5. https://www.izm.gov.lv/sites/izm/files/iap2027_projekta_versija_apspriesana_160720201_2.pdf 6. Saeima, "National Development Plan of Latvia for 2021-2027," Jul. 2, 2020. [Online]. Available: https://www.pkc.gov.lv/sites/default/files/inline-files/NAP2027__ENG.pdf [Accessed: Mar. 8, 2022]. 7. Ministru kabinets, "Par Digitālās transformācijas pamatnostādnēm 2021.–2027. gadam," Jul. 7, 2021. [Online]. Available: https://likumi.lv/ta/id/324715 [Accessed: Mar. 8, 2022]. 8. Ministru kabinets, "Par Nacionālās industriālās politikas pamatnostādnēm 2021.–2027. gadam," Feb. 16, 2021. [Online]. Available: https://likumi.lv/ta/id/321037 [Accessed: Mar. 8, 2022].

Advanced technologies in enterprises

Title of the indicator:	Advanced technologies used in Latvian enterprises
Value:	Latvian businesses can take more significant advantage of the opportunities offered by digital technologies. According to the DESI 2021, the country ranks 23rd for *integrating digital technology* by business, which is still well below the EU average in almost all categories. Integration of digital technology is the DESI dimension characterised by companies' ability to use digital technologies such as cloud services, big data, artificial intelligence and the spread of e-commerce [1].

3 Integration of digital technology	Latvia		EU
	rank	score	score
DESI 2021	23	26.8	37.6

(the figure is adopted from [1])

Latvian companies are adopting different technologies to enhance productivity in digital transformation, such as sharing internal information electronically or using RFID, e-Invoicing, social media and cloud technologies [2]. The share of SMEs with at least a basic level of digital intensity is 42%, while the EU average is 60%. Even though Latvian companies have increased their use of cloud services, the use of big data is progressing slowly. The share of companies using cloud services is 18%, a notable increase from 11% last year. However, only 9% of enterprises use big data, and only 19% have activities on social media, which is below the EU average. Regarding e-commerce, only 11% of SMEs sell online, and only 7% of SMEs' turnover is from e-commerce [1]. According to data by the Central Statistical Bureau of Latvia, in 2020, 24.3% of all enterprises used the Internet of Things (IoT). IoT was used by every second by 52.6% of large enterprises, 38.1% of medium-sized and 20.7% of small enterprises. IoT was mostly used in electricity, gas, steam and air conditioning supply, water supply, sewerage, waste management and remediation activities (for 47.3% of enterprises) [3]. According to the National Industrial Policy Guidelines 2021-2027, it is planned to reach 21st place by 2023 and 20th place by 2027 in the DESI dimension for integrating digital technology by business [4].

The Covid-19 crisis has accelerated the digitalisation of the economy and the automation of companies, so the new jobs and skills may be different from what it was before the crisis; however, it is also an opportunity to create and find new solutions for business development, creating innovative products. Latvia has improved in some categories but still performs below the EU average in all of them [4, 6]. In general, digital technologies are used more by large companies. The use of digital technologies has a direct relationship with the amount of added value. Employee productivity and salaries are also higher in more digitalised companies [5]. Considering the EC and Europe-wide

guidelines, Latvia pays special attention to integrating new technological solutions into Latvian manufacturing companies. Latvia intensifies its focus on updating digitisation activities by providing manufacturing companies with the opportunity to work with smart technology developers, mainly companies in the ICT industry, to collaborate on implementing new technologies and improving existing ones awarding the latest available technology and data processing capabilities [7].

| | Latvia | | | EU |
	DESI 2019	DESI 2020	DESI 2021	DESI 2021
3a1 SMEs with at least a basic level of digital intensity % SMEs	NA	NA	42% 2020	60% 2020
3b1 Electronic information sharing % enterprises	25% 2017	32% 2019	32% 2019	36% 2019
3b2 Social media % enterprises	13% 2017	19% 2019	19% 2019	23% 2019
3b3 Big data % enterprises	8% 2018	8% 2018	9% 2020	14% 2020
3b4 Cloud % enterprises	11% 2018	11% 2018	18% 2020	26% 2020
3b5 AI % enterprises	NA	NA	21% 2020	25% 2020
3b6 ICT for environmental sustainability % enterprises having medium/high intensity of green action through ICT	NA	NA	65% 2021	66% 2021
3b7 e-Invoices % enterprises	7% 2018	7% 2018	15% 2020	32% 2020
3c1 SMEs selling online % SMEs	10% 2018	11% 2019	11% 2020	17% 2020
3c2 e-Commerce turnover % SME turnover	5% 2018	5% 2019	7% 2020	12% 2020
3c3 Selling online cross-border % SMEs	5% 2017	7% 2019	7% 2019	8% 2019

(the figure is adopted from [1])

In general, the integration of digital technologies is mainly hampered by a lack of investment in R&D, a lack of digitally skilled employees and insufficient connectivity in rural areas [4, 8]. Latvia also has a high level of non-compliance with formalities, which can hinder the introduction of digital technologies. Failure to comply with formalities may hamper digitalisation because, unofficially, companies may want to stay small to avoid disclosure, but declaring reduced income may discourage banks from lending money. [6]. Almost half of the Latvian companies indicate that funding is a barrier to investment that can be a barrier to innovation [6]. There is a lack of targeted funding in ICT and other sectors to develop innovative ICT solutions based on the needs of companies. Also, cross-sectoral cooperation is too weak to generate ICT innovation throughout the product value chain. Adequate funding for innovative ICT solutions (big data processing, digitisation, 3D printing, artificial intelligence, visualisation, sensors, cloud computing, future plants, robotics, and others) is essential in this regard [9]. In order to promote digital transformation, Latvia should develop a strategy for the digitisation of SMEs, focusing on creating the conditions for SMEs to adopt digital technologies and invest in additional knowledge-based assets and digital security [6].

Co-funded by the European Union

References:	1. https://ec.europa.eu/newsroom/dae/redirection/document/80482
	2. https://ati.ec.europa.eu/reports/policy-briefs/latvia-national-industrial-policy-guidelines-2014-2020
	3. https://admin.stat.gov.lv/system/files/publication/2021-05/Nr_03_Latvia_Statsitcs_in_Briefi_2021_%2821_00%29_EN.pdf
	4. Ministru kabinets, "Par Nacionālās industriālās politikas pamatnostādnēm 2021.–2027. gadam," Feb. 16, 2021. [Online]. Available: https://likumi.lv/ta/id/321037 [Accessed: Mar. 8, 2022].
	5. https://likumi.lv/ta/id/321834-par-finansu-sektora-attistibas-planu-20212023-gadam
	6. OECD, Going Digital in Latvia. OECD Publishing, Paris, 2021.
	7. https://ec.europa.eu/information_society/newsroom/image/document/2019-32/country_report_-_latvia_-_final_2019_0D30BE44-054B-C822-C8DEFA25536D65B0_61211.pdf
	8. https://www.em.gov.lv/lv/media/12820/download
	9. https://likumi.lv/ta/id/322858-par-latvijas-atveselosanas-un-noturibas-mehanisma-planu

Appendix 2: National strategic planning and regulatory documents

Policy documents for the planning period 2021-2027

National Development Plan of Latvia for 2021-2027

Program name:	National Development Plan of Latvia for 2021-2027
Designed for the sector:	Society as a whole (including citizens and entrepreneurs)
Period:	2021-2027
Aid amount:	Funding differs for each priority and direction. For example, the priority "Business Competitiveness and Material Well-being" has 3,53 billion euros.
Focus on:	NDP2027 contributes to implementing a human-centred, long-term concept approved by the Saeima (Parliament) - "Growth model for Latvia: People first". It outlines sectoral policies and key reforms, public investments from the state budget, local government budget, European Union (EU) funds and other financial sources (including foreign and national funds and programmes). This plan is realistic because ambitious goals are feasible and in line with available resources [1].
Short description: (100-200 words)	The National Development Plan for 2021-2027 (NDP2027) is Latvia's highest national-level medium-term planning document that defines the strategic aims planned to be achieved in Latvia by 2027 [1]. One of the priorities of NDP2027 is "Business Competitiveness and Material Well-being", which includes direction "Productivity, innovation and export" related to Industry 4.0 [1]. The goal of this direction is the growth and competitiveness of companies based on their ability to create and sell high-tech, knowledge-intensive goods and services and to integrate into ever higher value-added global chains. Smart specialisation, innovation, technological development and modernisation, and targeted investment in human capital are the basis for productivity growth [1]. Indicative funding for this direction is 797.78 million EUR. In addition, one of the tasks of this direction is promoting digital transformation (digitisation, automation, robotisation, artificial intelligence, and others) in business [1].
References:	1. Saeima, "National Development Plan of Latvia for 2021-2027," Jul. 2, 2020. [Online]. Available: https://www.pkc.gov.lv/sites/default/files/inline-files/NAP2027__ENG.pdf [Accessed: Mar. 8, 2022].

National Industrial Policy Guidelines 2021-2027

Program name:	National Industrial Policy Guidelines 2021-2027
Designed for the sector:	Public (administrative institutions), private (companies) and academic (HEIs) sectors
Period:	2021-2027
Aid amount:	The financing of the activities set up in the National Industrial Policy Guidelines (NIP) is ensured by both the public and private sectors despite initial hesitation from the private sector to invest [1]. For the digitalisation priority, 179 million euros are allocated [2].
Other indicators:	The NIP guidelines aim to increase exports to € 22 billion in 2023 and € 27 billion in 2027. In addition, the sub-objective of the NIP is to increase spending on R&D activities to EUR 300 million in 2023 and EUR 600 million in 2027 [1].
Focus on:	The NIP guidelines are a medium-term policy planning document that covers all sectors of the economy and sets out goals and directions for growth for the next seven years, both locally and internationally [1]. These guidelines offer a clear vision for reallocating public resources in favour of more productive growth of future sectors, industries and ideas [3].
Short description: (100-200 words)	NIP guidelines highlight the national approach to the transformation of the economy into an innovative and knowledge-based economic model, using the development of Smart specialisation strategy (RIS3) value chain ecosystems. It will be based on structured dialogue and coordinated action between all stakeholders (a network of private, public and academic cooperation partners), thereby promoting the development of new products and services, knowledge transfer in the national economy and increasing private investment in research and development [3]. Promoting digital transformation (digitisation, automation, robotisation, artificial intelligence, and others) in business, including the manufacturing industry, is also one of the main challenges in the NIP guidelines [1]. In terms of Industry 4.0, one of the directions of this plan is "Infrastructure", which includes several tasks, e.g., Support for the introduction of digital solutions, automation, modernisation, new decarbonisation technologies, investment programs for the automation of production processes. Another direction, "Innovations", focuses on new products, technologies, and digital transformation. This direction includes tasks related to the financial support and promotion of digital transformation and deploying technology-intensive solutions, including artificial intelligence solutions, in the private and public sectors. This direction also involves closer cooperation between research and industry to develop infrastructure and ensure accessibility [1].

Co-funded by
the European Union

References:	1. Ministru kabinets, "Par Nacionālās industriālās politikas pamatnostādnēm 2021.–2027. gadam," Feb. 16, 2021. [Online]. Available: https://likumi.lv/ta/id/321037 [Accessed: Mar. 7, 2022].
	2. https://lddk.lv/wp-content/uploads/2021/04/Ropazi21042021_compressed.pdf [Accessed: Apr. 11, 2022].
	3. https://www.em.gov.lv/en/media/4499/download

Digital Transformation Guidelines for 2021-2027

Program name:	Digital Transformation Guidelines for 2021-2027
Designed for the sector:	The guidelines set out a common policy for the digital development of public administration, the economy and society [1].
Period:	2021-2027
Aid amount:	The implementation of the guidelines will take place mainly by attracting EU funds and private financing, as well as financing from the state budget. The overall funding is 951 million euros [1].
Focus on:	The Guidelines are a medium-term policy planning document that sets out Latvia's digital transformation (information society development) policy, covering the period from 2021 to 2027 [1]. The Digital Transformation Guidelines aim to develop unified digital solutions and introduce new efficient, publicly available services and infrastructures in line with the goals of the global information society and the evolution of the EU's digital single market [2].
Short description: (100-200 words)	The guidelines expand the digital transformation policy's goals, directions and tasks approved in the National Development Plan 2021–2027 [3]. The digital transformation strategy for the country's digital transformation defined in the Latvian Digital Transformation Guidelines 2021-2027 covers ICT education and skills, internet access, modern and efficient public administration, e-services and digital content for society [4]. The guidelines define the development of digital skills for society, from basic skills to day-to-day communication to the skills needed for deploying digital technologies in manufacturing, services, innovation and commercialisation [5]. Overall, the guidelines provide for action in five directions and cover all key aspects of the digital societal breakthrough [6]: ● Digital skills and education ● Digital security and credibility ● Access to telecommunications services ● Digital transformation of the economy (incl., "public administration") ● Information communication technology (ICT) innovation development, and commercialisation, industry and science.

Co-funded by the European Union

References:	1. Ministru kabinets, "Par Digitālās transformācijas pamatnostādnēm 2021.–2027. gadam," Jul. 7, 2021. [Online]. Available: https://likumi.lv/ta/id/324715 [Accessed: Mar. 8, 2022]. 2. Ministru kabinets, "Par Nacionālās industriālās politikas pamatnostādnēm 2021.–2027. gadam," Feb. 16, 2021. [Online]. Available: https://likumi.lv/ta/id/321037 [Accessed: Mar. 7, 2022]. 3. https://lvportals.lv/norises/321428-cela-karte-latvijas-digitalajai-transformacijai-2020 4. https://ec.europa.eu/newsroom/dae/redirection/document/80482 5. https://www.varam.gov.lv/en/article/latvian-digital-transformation-guidelines-2021-2027-accellation-digital-capacities-future-society-and-economy 6. https://unctad.org/system/files/information-document/CSTD2021-2022_Issues01_Industry4.0_en.pdf

Guidelines for Science, Technology Development and Innovation 2021-2027

Program name:	Guidelines for Science, Technology Development and Innovation 2021-2027
Designed for the sector:	HEIs, scientific institutions, enterprises, state and local governments
Period:	2021-2027
Aid amount:	Total financial support - 1.14 billion euros [1]
Other indicators:	Main results to be achieved by 2027 [2]: ● Investment in research has increased to 1.5 % of gross domestic product (currently 0.64 %). ● At least 1% of employment in Latvia is in science (currently 0.67%). ● Latvia's position on the European Innovation Scoreboard has risen from 24th to 22nd. ● The contribution of companies to state scientific institutions has reached 10% (currently 6%).
Focus on:	Guidelines emphasise the need to invest fully in the human capital of research, scientific excellence, international cooperation, and technology transfer, contributing to developing a smart, technologically advanced, and innovative society in Latvia [2].
Short description: (100-200 words)	The guidelines set out the main principles, objectives, priorities, action directions, and tasks to be carried out according to the Latvian National Development Plan 2021-2027 supporting the priority "Knowledge and skills for personal and national growth" [1, 2].

Co-funded by
the European Union

	The guidelines are based on a detailed analysis of the current situation, global trends, and opportunities for developing the research and development system. Their content is based on two monitoring reports of the Smart Specialisation Strategy of Latvia and two studies of the Policy Support Facility of the European Commission, as well as other national and international studies [1, 2]. Guidelines determine the strategic goals to be achieved in Latvia by 2027, outline the directions of action and main reforms of the science and technology development policy, as well as the directions of public investment from the state budget, EU funds and other financial sources for investment in the development of the R&D system [1].
References:	1. https://likumi.lv/ta/id/322468-par-zinatnes-tehnologijas-attistibas-un-inovacijas-pamatnostadnem-2021-2027-gadam 2. https://labsoflatvia.com/en/news/directions-for-science-technology-and-innovation-development-and-support-established-for-following-years

Research and Innovation strategy for Smart specialisation of Latvia

Program name:	Research and Innovation strategy for Smart specialisation of Latvia
Designed for the sector:	Private, public and academic sectors
Period:	2021-2027
Focus on:	Latvia's Smart Specialization Strategy (RIS3) is a strategy of economic transformation towards higher added value, productivity and more efficient use of resources. The strategy of economic transformation ensures changes and growth in the structure of production and exports of traditional industries, as well as promotes the development and growth of existing and new high-value-added products and services sectors [1].
Short description: (100-200 words)	The smart specialisation strategy (RIS3) for Latvia was developed in 2014 to concentrate public R&D investment in programs that create future domestic capability and interregional comparative advantage [1]. This conceptually new and complex strategy provides a balanced and complementary support tool kit to strengthen the innovation capacity of the Latvian economy [2]. Furthermore, the strategy aims to restructure export by inducing change and growth in [2]: ● Production and export structure in traditional sectors of the economy. ● Future growth of sectors in which exist or may be products and services with high added value. ● Sectors with significant horizontal impact and contribution to the transformation of the national economy.

Co-funded by
the European Union

	The priorities of the Strategy, among others, include facilitation of the production of higher-value-added products, development of new products and industries with high development potential, development of a modern ICT system, development of a modern and future-focused education system, and developed science base [3]. In addition, the strategy has outlined seven investment priorities to induce change and growth and defined five specialisation areas. The investment priorities are [2]: 1. High added value products; 2. Productive Innovation System; 3. Energy Efficiency; 4. Modern ICT; 5. Modern education; 6. The knowledge base; 7. Polycentric development. The knowledge specialisation areas are Knowledge-intensive bio-economics; Biomedicine, medical technologies; Bio-pharmacy and biotechnologies; Smart materials, technologies and engineering systems; and Information and communication technologies (ICT) [2].
References:	1. Ministru kabinets, "Par Nacionālās industriālās politikas pamatnostādnēm 2021.–2027. gadam," Feb. 16, 2021. [Online]. Available: https://likumi.lv/ta/id/321037 [Accessed: Mar. 7, 2022]. 2. https://www.izm.gov.lv/en/smart-specialisation-strategy 3. https://sciendo.com/pdf/10.2478/eb-2018-0013

Implementation strategy of Platform "Industry 4.0."

Program name:	Implementation strategy of Platform "Industry 4.0."
Designed for the sector:	The platform envisages interaction between the scientific sector, the state and industry.
Period:	From 2019
Aid amount:	According to the government, the Industry 4.0 platform will be formally launched through the Digital Europe Program (2021-2027), which proposes to make available 9.2 billion euros in areas such as supercomputing, artificial intelligence and the creation of a European network of digital innovation centres and strengthening [1].
Focus on:	To promote similar projects and expand them to other sectors, the government, together with several centres of excellence and the AHK-German-Baltic Chamber, has signed a memorandum of cooperation on developing and implementing the Industry 4.0 platform [1, 2].

Co-funded by
the European Union

Short description: (100-200 words)	Platform Industry 4.0 aims, in particular, to strengthen cooperation and coordination between stakeholders by advising Latvian companies on new technologies in the manufacturing sector and developing policies to promote digital technologies [1]. In order to promote digital transformation in Latvian companies, a guide for the development of industrial digitisation in Latvia and a strategy for implementing the Industry 4.0 platform are being developed [3]. The government aims to use Digital Innovation Hubs as a physical platform to implement Industry 4.0. Such centres would act as a single point of contact for companies, in particular SMEs, as well as public sector organisations to access services related to testing, attracting investors, skills and training, networking and the innovation ecosystem [1].
References:	1. OECD, Going Digital in Latvia. OECD Publishing, Paris, 2021. 2. https://ec.europa.eu/information_society/newsroom/image/document/2019-32/country_report_-_latvia_-_final_2019_0D30BE44-054B-C822-C8DEFA25536D65B0_61211.pdf 3. https://www.zemeunvalsts.lv/documents/view/35051070e572e47d2c26c241ab88307f/Latvijas%20ekonomisk%C4%81s%20att%C4%ABst%C4%ABbas%20p%C4%81rskats%202019.pdf

Cyber Security Strategy

Program name:	Cyber Security Strategy
Designed for the sector:	Government, including national and municipal administrations, the private sector and individuals
Period:	2019-2022
Aid amount:	The total financing required for the implementation of the strategy is 29.8 million euros [2]
Focus on:	The main digital security policy initiative in Latvia is the Cyber Security Strategy of Latvia (2019-2022), which replaces the Cyber Security Strategy of Latvia (2014-2018). Prepared by the Ministry of Defence in cooperation with other ministries and the National Information Technology Security Council, this document sets out the national priorities for digital security policy in Latvia and identifies upcoming challenges [1].
Short description: (100-200 words)	The first Cyber Security Strategy of Latvia (2014-2018) took stock of the digital transformation and marked a shift towards a more strategic and whole-of-government approach to digital security. The second Cyber Security Strategy of Latvia (2019-2022) continues this trajectory, with a greater emphasis on risk management, resilience, public awareness, and the need to balance digital security with openness, prosperity and human rights [1]. The

	goal of the cyber security policy for the period 2019 to 2022 is to strengthen and improve digital security capabilities by increasing resilience to cyber attacks and enhancing public awareness of threats in cyberspace [1, 2]. Cyber Security Strategy relies on a "vision of cyber security policy as a secure, open, free and reliable cyberspace that guarantees the safe, reliable and continuous receipt and delivery of services essential to the state and society, and respects the individual's human rights in a physical and virtual environment". The strategy also acknowledges that "Latvia needs to take advantage of the digital environment to ensure economic and social welfare, while at the same time reducing the overall level of cybersecurity risk without unnecessarily limiting the flow of technology, communications and data" [1]. The new strategy also recognises the development of cyber-physical systems and the need to move beyond the virtual-physical dichotomy [1].
References:	1. OECD, Going Digital in Latvia. OECD Publishing, Paris, 2021. 2. https://www.mod.gov.lv/sites/mod/files/document/kiberstrategija.pdf

Guidelines for the Development of Education for 2021-2027. Future Skills for the Future Society

Program name:	Guidelines for the Development of Education for 2021-2027. Future Skills for the Future Society
Designed for the sector:	Educational institutions, society
Period:	2021-2027
Aid amount:	The overall aid amount for all goals and action directions is 4.49 billion euros [1].
Focus on:	The overarching goal of guidelines is to provide quality educational opportunities for all Latvians to promote the development and realisation of their potential throughout their lives and to build their ability to change and responsibly manage constant change in society and the economy [1].
Short description: (100-200 words)	The guidelines set the current goals and directions for education development for the next seven years. Given that the educational process affects everyone, the guidelines cover all types and levels of education [2]. By implementing the goals of education development, it will be possible to achieve the following results of the education policy for 2021-2027 [1]: 1) qualitative and quantitative generation of teachers and academic staff, 2) quality and modern education, 3) everyone has access to support for their growth, 4) sustainable and efficient management of the education system and resources.

	Major horizontal changes also cover digitalisation [1]: ● priority development of digital skills as a cross-cutting competence in society; ● increase of the e-learning offer in vocational, higher and adult education, including education of interests; ● development and integration of digital learning management platforms, digital learning resources and support materials into the learning process, thus creating high-performance digital education ecosystems. The guidelines also set out key changes in adult learning, such as increasing participation in adult learning, improving the quality of adult education, and developing a sustainable and socially responsible funding system for adult education [1].
References:	1. https://likumi.lv/ta/id/324332-par-izglitibas-attistibas-pamatnostadnem-20212027-gadam 2. https://www.izm.gov.lv/sites/izm/files/iap2027_projekta_versija_apspriesana_160720201_2.pdf

Support programmes and initiatives

Latvia's Recovery and Resilience Plan

Program name:	Recovery and Resilience Plan
Designed for the sector:	Companies, government and local municipalities
Period:	2021-2026
Aid amount:	1,82 billion EUR in total (Digital transformation: 365 million EUR) [1]
Focus on:	Within the Recovery and Resilience Plan framework, the faster recovery of the Latvian economy after the Covid-19 pandemic includes four directions of action - reduction of regional inequalities, digitisation of enterprises, climate change, economic transformation and productivity [2].
Short description: (100-200 words)	The Recovery and Resilience Plan is a new budget program managed centrally by the EC, in addition to the EU's multiannual budget for the 2021-2027 programming period [3]. Latvia's Recovery and Resilience Plan is a response to the economic and social situation and strengthens Latvia's growth potential by tackling the main digital challenges [4]: - Lack of digital skills by training public officials, students, teachers, professionals and ICT specialists. - Investments and reforms in the Digital Infrastructure Transformation to address the insufficient rural connectivity with investments in last-mile connectivity and physical infrastructure in 5G corridors. - Targeted measures in the Digital transformation and innovation of businesses to enhance digitalisation capacities through a broad spectrum of actions. - Measures in the Digital transformation of public administration, including municipalities, to maintain and improve Latvia's performance. Measures to promote digitisation include investment in training to improve digital skills and the use of digital opportunities, tools and e-services. At the same time, it is planned to increase the efficiency of the state and local governments and introduce unified ICT solutions for communication with the public. In total, 20% of the total funding will be invested in digitisation activities, including support measures for the provision of 5G infrastructure and the development of citizens' basic digital skills, development of public platforms and national IT systems, as well as 140 million euros for the digital transformation of business and digital skills. improvement [1, 3]. It is planned to provide support for developing digital skills of enterprises for training at least 3,000 small and medium-sized enterprises, providing 20 million euro funding for this purpose [3].

References:	1. https://www.esfondi.lv/upload/anm/atjaunos_meh_finmin_800x600-ppt-eng_short.pdf
	2. https://www.em.gov.lv/lv/atveselosanas-fonds
	3. https://www.em.gov.lv/lv/jaunums/uznemumu-digitalizacijai-un-digitalo-prasmju-uzlabosanai-paredzets-ieguldit-140-milj-eiro-no-eiropas-atveselosanas-fonda
	4. https://ec.europa.eu/newsroom/dae/redirection/document/80482

Norwegian Financial Mechanism

Program name:	Norwegian Financial Mechanism's 2014-2021 Programme "Business Development, Innovation and SMEs" grant for "Application of green industry innovation and ICT products and technologies"
Designed for the sector:	Entrepreneurs registered in Latvia who comply with the status of a small (micro), small or medium-sized enterprise will be able to receive support. Entrepreneurs can also attract project partners, who can be any public or private legal entity registered in Norway or Latvia and with the appropriate competence to help introduce new products into production [1].
Period:	The project shall be implemented within two years from the date of commencement of the eligibility of the project expenditure specified in the project contract, but not later than 30th April 2024 [2].
Aid amount:	The total amount of funding available for the call is EUR 8 495 389, of which EUR 5 847 694,50 is available for green industry innovation projects, while the available funding for the ICT projects is EUR 2 647 694,50. Support for a single project is between EUR 200 000 and EUR 600 000 [1, 2].
Other indicators:	The maximum aid intensity for small-sized enterprises shall be 55% of the project's total eligible costs and 45% for medium-sized companies [1].
Focus on:	The support is given to project promoters for [2]: ● application of new products and technologies with reduced environmental impact in the area of green industry innovation; ● application of ICT products in the production process ensuring digitalisation or automation of the manufacturing processes in the area of ICT.
Short description: (100-200 words)	The objective of the grant is to increase competitiveness for Latvian enterprises within the focus areas of green industry innovation and ICT [3]. These areas include creating more environmentally friendly and energy-efficient materials and products, intelligent mobility, clean transport, water management, automation, robotics and sensor solutions, next-generation mobile technologies, artificial intelligence solutions and other high-value-added products and technologies [1]. Grant supports the purchase of new equipment, software, licenses and patents, as well as activities related to introducing a new product and technology into production [2]. This funding will support the creation or modernisation of at least 15 new plants, making production processes

	more automated and environmentally friendly while creating at least 50 new jobs and boosting the turnover and exports of the supported companies [1].
References:	1. https://www.em.gov.lv/lv/mazajiem-un-videjiem-uznemumiem-pieejams-atbalsts-jaunu-produktu-un-tehnologiju-ieviesanai-razosana 2. https://eeagrants.lv/en/2021/04/14/the-open-call-application-of-green-industry-innovation-and-ict-products-and-technologies/ 3. https://www.em.gov.lv/en/media/4499/download

Innovation Motivation Programme

Program name:	Innovation Motivation Programme
Designed for the sector:	The programme's target group is potential business start-ups, self-employed persons, natural persons (authors of business ideas), associations and foundations, pupils and students of educational institutions, entrepreneurs, universities, scientific institutions, municipal institutions, and society in general [1].
Period:	2018-2023
Aid amount:	The total eligible funding for implementing the Innovation Motivation Program is 5,3 million euros, including the European Regional Development Fund (ERDF) funding - 4,5 million euros and the state budget resources - 795 590 euros [1].
Other indicators:	The maximum eligible amount of ERDF funding does not exceed 85% of the total eligible funding of the project [1].
Focus on:	Within the framework of the programme, well-known activities will be implemented, such as the competition of innovative business ideas "CUP OF IDEAS", events within the program "Student Learning Companies", and new - a multi-day event with foreign experts and master classes to promote technological interests and creativity, management innovation training course for entrepreneurs and others. Also, in cooperation with other organisations, a series of events will be organised for different target groups - networking seminars, discussions, master classes, new product creation workshops (hackathons), and others [1].
Short description: (100-200 words)	The Innovation Motivation Program aims to inform and encourage the public to start an innovative business, using awards as a promotion mechanism. It is also planned to inform the public about the developments related to innovations and their potential, thus encouraging the public and entrepreneurs to focus on the development and use of innovative solutions, as well as increase the share of innovative entrepreneurs in the economy and motivate start-ups in the specialisation priorities or areas [1].
References:	1. https://www.liaa.gov.lv/lv/programmas/inovaciju-motivacijas-programma

Business Incubators

Program name:	Business Incubators
Designed for the sector:	Support for business start-ups and development for individuals and new businesses [1].
Period:	2016-2023
Aid amount:	The planned financing of the project is 30.8 million euros, which consists of the European Regional Development Fund financing of 26 198 233 euros and the state budget financing of 4 623 217 euros [1].
Focus on:	Support programs include [1]: ● *Pre-incubation* suitable for idea authors - individuals and companies who want to develop a business model and test the viability of a business idea. ● *Incubation* suitable for start-ups that need support for faster growth. (A company may not be registered in the Commercial Register of the Republic of Latvia for more than three years at the time of joining).
Short description: (100-200 words)	The project aims to support the establishment and development of new viable and competitive businesses in the regions of Latvia by providing small (micro), small and medium-sized businesses (SMEs) with the necessary consultations, training and events on entrepreneurship, general business issues, mentor support, environment (premises) and grant co-financing for the operating costs of businesses [1]. There are 11 regional business incubators, nine support units throughout Latvia, and a Creative Industries Incubator in Riga, which specialises in providing support to creative industries companies [1].
References:	1. https://www.liaa.gov.lv/lv/programmas/biznesa-inkubatori

Start-up support programmes

Program name:	Start-up support programmes
Designed for the sector:	Start-up Companies
Period:	2017-2023
Aid amount:	The aid is achieved under de minimis conditions, i.e. up to EUR 200000 over three years
Other indicators:	The implementation period of support programs is up to 12 or 24 months.
Focus on:	Start-up support programmes include [2]: ● Aid Programme for Attracting Highly Qualified Employees ● Tax Relief Related to Aid Programmes ● Aid Programme for Fixed Payments
Short description: (100-200 words)	The goal of the support is to promote the establishment of new companies in Latvia to promote research and the use of innovative ideas, products or processes in economic activities [1]. The expected result is to create Latvia's success stories - innovative, globally competitive products. It is planned that as a result of the operation of the support programs, at least 30 start-ups will emerge in Latvia each year, attracting approximately 160 highly qualified employees [3].

References:	1. https://www.liaa.gov.lv/lv/programmas/jaunuznemumu-atbalsta-programmas
	2. https://likumi.lv/ta/en/en/id/287272-law-on-aid-for-the-activities-of-start-up-companies
	3. https://www.facebook.com/atbalstsuznemejiem/photos/infografika-ko-nosaka-jaunuz%C5%86%C4%93mumu-darb%C4%ABbas-atbalsta-likums/1818584285022963/?_rdr

Innovation vouchers and support for the attraction of highly-qualified specialists

Program name:	Innovation vouchers and support for the attraction of highly-qualified specialists
Designed for the sector:	Company registered in the Commercial Register of the Enterprise Register of the Republic of Latvia [1].
Period:	The innovation Voucher is valid for 12 months starting when a support contract with LIAA is signed. The service contract must be signed within two months after a support contract, but no later than 30 June 2022 [3].
Aid amount:	The program offers three types of vouchers that are worth between EUR 5,000 and EUR 25,000, depending on the type of voucher [2]. Voucher support is granted following the De minimis Regulation (max support EUR 200,000 over the last three years) or EU Regulation No 651/2014 conditions [3].
Other indicators:	Eligibility criteria [1, 3]: 1. The company can prove that innovation contributes to the company's competitiveness and productivity. 2. The company has a business plan for a new product/technology that considers the development process up to introduction and production.
Focus on:	Innovation Voucher is a government financial support tool offered by the Investment and Development Agency of Latvia to drive collaboration between industry and the research community. It is available to all-size companies (including start-ups) registered in Latvia which seek to innovate their existing product/technology or develop a new one [2].
Short description: (100-200 words)	The support aims to promote innovation activity in enterprises with technology transfer and highly qualified employees by supporting the development of new or significantly improved products or technologies that contribute to the achievement of the goals of the Latvian Smart Specialization Strategy [1]. The same company can apply for several Innovation Vouchers within different business idea development. However, one project at a time is possible [3]. Products created during the Innovation Voucher support program shall be owned exclusively by the companies. Business development of a new product/ technology should be reasonable and well thought through [3].
References:	1. https://www.liaa.gov.lv/lv/programmas/inovaciju-vauceri/apraksts 2. https://startuplatvia.eu/innovation-voucher 3. https://startuplatvia.eu/files/resources/editor/a4-innovation-vouchers-programme.pdf

Support for science results commercialisation

Program name:	Support for science results commercialisation
Designed for the sector:	Public research organisations - higher education institutions and scientific institutes
Period:	2017-2023
Aid amount:	The total funding available is 15,9 million euros, made up of funding from the European Regional Development Fund and the national budget. The maximum funding for one technology transfer project is € 300,000, and the aid intensity is up to 90% [1].
Focus on:	The purpose of the support is to contribute to achieving the goals of the Latvian Smart Specialisation Strategy by supporting the commercialisation of research results owned by research organisations both in Latvia and abroad to increase research organisations' income from commercialisation [1].
Short description: (100-200 words)	Technology transfer projects aim to bring the technology to a practical demonstration or prototyping stage as a result of industrial research and experimental development and to carry out further commercialisation activities, the resulting benefits of which are transferred to a third party in the form of a registered patent or license, incl. establishing a new, technology-oriented company in a research organisation [1]. Eligible actions include carrying out feasibility studies, preparation of commercialisation strategy, industrial research, experimental developments, participation in various activities for commercialisation of developed technologies and intellectual property, strengthening industrial property rights, preparing a commercialisation offer, and others. [1].
References:	1. https://www.liaa.gov.lv/lv/programmas/atbalsts-petniecibas-rezultatu-komercializacijai 2. https://startuplatvia.eu/science-commercialization

International competitiveness development

Program name:	Promotion of International Competitiveness (business)
Designed for the sector:	merchants, cooperative societies in which at least three companies are associated, farms or fish farms, individual enterprises, associations of at least five merchants or cooperative societies, foundations, where the founders and members include at least five merchants or cooperative societies, local governments, port authorities [1].
Period:	2016-2023
Aid amount:	The total amount of aid is € 60.6 million [2]. Financial support is awarded following de minimis terms and conditions, support for a group of related companies for three fiscal years – EUR 200 000; support for beneficiaries who are involved in the

	primary production of agricultural products – EUR 25 000; support for beneficiaries in fishing and aquaculture industry – EUR 30 000. In a calendar year, financial support for associations and foundations, local governments, planning regions and port authorities shall not exceed EUR 66 666 [1].
Focus on:	The support program aims to promote the competitiveness of industries by supporting entrepreneurship and entering foreign markets, ensuring the operation of Latvia's foreign economic representations [2].
Short description: (100-200 words)	Support is granted to the following activities: participation in national stands at international exhibitions or in trade missions abroad, export support activities, including developing websites, online stores, digital applications and virtual communication platforms for the export market [1].
References:	1. https://www.liaa.gov.lv/lv/media/6255/download 2. https://business.gov.lv/atbalsta-programmas/starptautiskas-konkuretspejas-veicinasana-uznemejdarbiba

Support for staff training

Program name:	Event "Support for staff training"
Designed for the sector:	Merchants
Period:	2016-2023
Aid amount:	The total funding available for the event is 7,9 million euros. The maximum amount of support per merchant is 200 000 euros. At least one non-unique person is trained for every 8 000 euros in support [1].
Focus on:	Focus on companies that develop products, technologies or services in one of the areas specified in the smart specialisation strategy or a new competitive niche identified by the industry [1]. The project provides support for small and micro ICT skills development and implementation in the fields of digital technology, digitalisation of internal processes and digital tools for manufacturing and development of services [2].
Short description: (100-200 words)	The aim is to promote the productivity, export capacity and work efficiency of micro, small, medium and large enterprises by increasing the qualifications and skills of employees [1]. Through this project, people can update their skills to handle new technologies [2]. The aim is to facilitate the transformation of enterprises in line with global trends, ensure maximum export capacity and increase the production of high-value-added products to attract investors [1]. By the end of 2019, more than 1,200 companies had been involved in the project, and more than 3,900 training events had been organised [3].
References:	1. https://www.liaa.gov.lv/lv/programmas/atbalsts-darbinieku-apmacibam/apraksts 2. https://ec.europa.eu/newsroom/dae/redirection/document/80482 3. https://www.em.gov.lv/en/media/4499/download

Acceleration funds

Program name:	Acceleration funds offered by Development Financial Institution "Altum"
Designed for the sector:	Start-ups
Period:	2018-2023
Aid amount:	In total, 15 million euros [1]
Focus on:	Creation and development of innovative start-ups [2].
Short description: (100-200 words)	Latvia has three accelerators - Buildit, Commercialization Reactor and Overkill Ventures. Overkill Ventures focuses on start-ups offering software for business-to-business, while BuildIT focuses on hardware and the Internet of Things [3]. Altum has provided € 5 million of European Regional Development Fund funding for each of them out of € 15 million [1, 3]. Funding is initially available for business model research and initial concept development - costs for patent registration, market research, compensation of employees, and others. Additional funding is available for the product and prototype development. [2]. Includes [1]: ● An Acceleration Programme focusing on IoT and hardware start-ups from all over the world. ● An Acceleration Programme focusing on deep-tech start-ups. ● An Acceleration Programme focusing on work environment efficiency and automation start-ups from Central and Eastern Europe that will work in the fields of environment efficiency and automation for B2B companies. ● An Acceleration Programme focusing on B2B SaaS, CyberNorth and Fintech start-ups.
References:	1. https://startuplatvia.eu/acceleration-funds 2. https://www.em.gov.lv/lv/atbalsts 3. https://www.oecd-ilibrary.org/science-and-technology/digitalizacija-latvija_a58d1c1a-lv

Appendix 3: Educational events related to Industry 4.0

Short or one-time events

Title of the event:	Conference Industrie 4.0 in Riga and beyond "Getting Ready for INDUSTRIE 4.0: Transformations Needed"
Date:	December 1, 2017
Place:	Kipsala International Exhibition Centre BT 1
Organiser:	German-Baltic Chamber of Commerce and the Association of Mechanical Engineering and Metalworking Industries of Latvia (MASOC) in cooperation with the Ministry of Economics of Latvia and the Riga City Council
Target audience:	Representatives of manufacturing, electronics, IT, mechanical engineering
Short overview:	The conference was devoted to the opportunities and requirements that Industry 4.0 brought about
Information on the event is taken from:	https://www.masoc.lv/data/pielikumi17/Industry%204.0%20in%20Riga%20and%20Beyond_provizorisk%C4%81%20programma.pdf

Title of the event:	II European-Latvian Forum "Industrial revolution 4.0: Digital Economics, Data protection and Compliance Best-Practice"
Date:	September 7-8, 2018
Place:	Latvian Academy of Sciences
Organiser:	Institute of Economics of the Latvian Academy of Science and LMT enterprise
Target audience:	Entrepreneurs and potential investors, scientists, politicians, representatives of local governments and ministries, representatives of embassies, journalists
Short overview:	The main aims of the forum were: ●Great attention must be paid in all areas of the economy to future information and communication technologies (ICT), to European resources in the age of digitalisation and globalisation to promote and establish Latvia's leading position as a 'smart country'. ●The scientific potential and the transfer from research and teaching to business to determine new profiles and achievements for the development of entrepreneurial activities, to observe and stimulate trends of globalisation and digitisation in the economy of the 21st century. ●With the practice established in the I Economic Forum, we want to continue and use the Forum as a platform for the exchange of experience and cooperation of scientists, entrepreneurs and politicians and to promote and accompany innovation and investment of foreign and national investors in Latvia's innovative national economy as a 'smart country'.
Information on the event is taken from:	● https://2018.economicforum.lv/ ● https://2018.economicforum.lv/wp-content/uploads/2019/10/conference_program_en.pdf

Co-funded by
the European Union

Title of the event:	The international conference "Digital Transformation of the Engineering Industries in the Baltic Sea region" in the framework of Techn Industry 2018
Date:	November 30, 2018
Place:	Kipsala International Exhibition Centre BT 1
Organiser:	Latvian Information and communication technology association (LIKTA), Association of Mechanical Engineering and Metalworking Industries of Latvia (MASOC) with financial support by "#R050 DIGINNO of Interreg Baltic Sea Region" (DIGINNO) project, Ministry of Economics of Latvia and Riga City Council
Target audience:	Not specified
Short overview:	The conference discussed the current status and trends of the digitalisation in the engineering industry sector in the Baltic Sea Region as well as introduced the latest technologies for industry digitalisation, automation, and optimisation
Information on the event is taken from:	https://likta.lv/en/digital-transformation/

Title of the event:	Seminar "3D printing - work environment aspects: risks and solutions"
Date:	December 3, 2018
Place:	Rīga Stradiņš University Medical Technology Education Center
Organiser:	Rīga Stradiņš University, Institute of Occupational Safety and Environmental Health
Target audience:	Senior occupational safety specialists, competent occupational safety specialists, entrepreneurs, doctors of occupational diseases and health care, and others interested in the topic
Short overview:	The seminar provided information on 3D printing technologies and materials used, their potential risks and impact on the work environment, health and safety
Information on the event is taken from:	https://www.rsu.lv/seminars-3d-druka-darba-vides-aspekti-riski-un-risinajumi

Title of the event:	Section "Industry 4.0: Opportunities and Challenges" of the 78th International Scientific Conference of the University of Latvia
Date:	February 7, 2019
Place:	Faculty of Business, Management and Economics of the University of Latvia
Organiser:	Faculty of Business, Management and Economics of the University of Latvia
Target audience:	Students, lecturers and researchers from all Latvian universities and scientific institutions, representatives of companies and organisations, as well as foreign guests
Short overview:	University conference with the presentations addressing Industry 4.0
Information on the event is taken from:	https://www.bvef.lu.lv/index.php?id=69384

Title of the event:	Digitalisation and Innovation Forum DIG-IN
Date:	February 15, 2019
Place:	RISEBA Architecture and Media Center H2O
Organiser:	Ministry of Economics (Latvia)
Target audience:	Representatives of the various manufacturing sectors
Short overview:	The forum highlighted and analysed the smart specialisation sectors of the Latvian economy. It addressed the promotion of digitalisation potential within Industry 4.0, its opportunities and benefits for the introduction of new technological solutions in companies
Information on the event is taken from:	https://www.em.gov.lv/lv/about https://lvportals.lv/dienaskartiba/302011-digitalizacija-uznemejdarbibas-inovacijas-produktivitates-un-konkuretspejas-pamats-2019

Title of the event:	Business delegation trip "Industry 4.0 - Insider T(r)ip to East Westphalia-Lippe"
Date:	March 14-15, 2019
Place:	Trip from Latvia to Germany
Organiser:	German-Baltic Chamber of Commerce in Estonia, Latvia, Lithuania
Target audience:	Not specified
Short overview:	The trip included visits to the world's leading German companies and production facilities, providing an understanding of Big Data use in the manufacturing sector, machine intelligence, digital platforms and future jobs, smart systems in the agricultural sector and Industry 4.0 in steel processing
Information on the event is taken from:	https://www.ahk-balt.org/filehub/deliverFile/d3a02b17-3fdf-4c0f-9480-b3c9ee34ddff/802741/PDF_Programmentwurf_Industrie_4.0_Stand_14.01.19_Flug_Paderborn.pdf

Title of the event:	Seminar "Innovative technologies in animal husbandry"
Date:	April 12, 2019
Place:	Exhibition complex "Rāmava"
Organiser:	Farmers' Association
Target audience:	Livestock farmers and others who are interested
Short overview:	The seminar focused on the Implementation of innovative solutions on farms to improve production efficiency and economic performance
Information on the event is taken from:	https://zemniekusaeima.lv/calendar/zsa-seminars-inovativas-tehnologijas-lopkopiba/

Title of the event:	Professional Competence Development Courses "Industry 4.0 Challenges in the Work of a Vocational Education Teacher in the Metalworking Industry"
Date:	June 6-7,2019
Place:	Not specified
Organiser:	ERASMUS + program project "Training of metalworking workers to work with smart technologies according to the needs of Industry 4.0" (Project No. 575813-EPP-1-2016-1-LT-EPPKA2-SSA)
Target audience:	Vocational teachers in the field of mechanical engineering
Short overview:	During the course, the participants were introduced to the teaching and methodological tools developed in the Erasmus + project "Preparing employees in the metalworking industry to work with smart technologies according to the needs of Industry 4.0" and their practical application in the learning process. Teachers had the opportunity to work in the interactive learning environment developed in the project, take knowledge tests and test the environment's functionality. Teachers were introduced to the development of the mechanical engineering and metalworking industry, the possibilities of "Industry 4.0" and implementation trends in Latvia, as well as learned about the possibilities of robot operation and the use of 3D printers in metalworking industry.
Information on the event is taken from:	https://zrkac.lv/event.php?id=5763

Title of the event:	3rd Mechanical Engineering and Metalworking Business Forum
Date:	November 25-26, 2020
Place:	Virtual
Organiser:	Association of mechanical engineering and metalworking industries of Latvia, together with the Investment and Development Agency of Latvia
Target audience:	Foreign and local enterprises in the industry
Short overview:	The forum included presentations of industry experts about the future of mechanical engineering, Industry 4.0, robotics and supply chains in Latvia
Information on the event is taken from:	https://zemniekusaeima.lv/calendar/zsa-seminars-inovativas-tehnologijas-lopkopiba/

Title of the event:	Online meeting "DIH as a facilitator of digital transformation of SMEs"
Date:	April 15, 2021
Place:	Online
Organiser:	Institute of Electronics and Computer Science
Target audience:	Any entrepreneur of SMEs
Short overview:	The event addressed the development, impact and importance of Industry 4.0 in today's business, as well as support mechanisms of the Digital Innovation Center - funding, experience stories, competitiveness and other topics
Information on the event is taken from:	https://kraslava.lv/zinas/pilns-raksts/tiessaistes-pasakums-uznemumiem https://talsunovads.lv/zinas/uznemejdarbiba/notiks-seminars-uznemumiem-par-digitalajam-inovacijam/

Title of the event:	Training seminar "Development of technologies, their application in the study process and business environment"
Date:	August 26, 2021
Place:	Online
Organiser:	Rīga Stradiņš University and BA School of Business and Finance
Target audience:	Researchers, academic staff
Short overview:	There were several presentations related to modern technologies. One was "Industry 4.0 - Production Automation", which highlighted current issues in machine learning, applications of artificial intelligence algorithms and researchers' experience in production automation and international European projects (VIZTA, AI4DI).
Information on the event is taken from:	https://www.edi.lv/edi-petnieki-un-eksperte-uzstajas-tehnologiju-seminara/

Title of the event:	Educational campaign "Smart Latvia"
Date:	Started in 2019
Place:	No specific place
Organiser:	Latvian Information and Communication Technology Association, together with ICT companies Edisoft, Microsoft Latvia, Lursoft, VISMA and ELVA
Target audience:	SMEs
Short overview:	The "Smart Latvia" campaign is organised to educate the managers of Latvian medium and small companies about the latest IT solutions, encouraging them to implement them in their companies and providing them with the necessary information support.
Information on the event is taken from:	https://www.gudralatvija.lv/par

Co-funded by
the European Union

Recurring events

Title of the event:	Business Technology Exhibition and Conference RIGA COMM
Date:	Annually in October
Place:	International Exhibition Center in Kipsala
Organiser:	International Exhibition Company BT1
Target audience:	Anyone interested in the topics of the conference
Short overview:	The conference typically includes sub-conferences related to machine learning, the Internet of Things, smart HR systems, use of artificial intelligence in different fields
Information on the event is taken from:	https://rigacomm.com/en

Title of the event:	International Exhibition "Tech Industry"
Date:	Annually
Place:	International Exhibition Center in Kipsala
Organiser:	International Exhibition Company BT1
Target audience:	Anyone interested in the topics of the conference
Short overview:	The exhibition demonstrates achievements in the fields of Mechanical Engineering, Metalworking, Automation, Electronics and Electrical Engineering
Information on the event is taken from:	http://www.techindustry.lv/

Long-term training

Title of the event:	Training of ICT professionals for promotion of innovation and development of the industry
Date:	June 1, 2016 – March 31, 2019
Place:	N/D
Organiser:	The Latvian Information and Communications Technology Association (LIKTA), using ERAF funding
Target audience:	Working ICT professionals
Short overview:	The project aimed to increase the qualification of working ICT professionals through training and, in this way, to promote technical innovations and increase productivity, which will increase the number of innovative businesses, the export share of ICT, and the overall growth of the ICT field [1]. The project supported entrepreneurs in training and rising qualification of ICT professionals in the following fields, among others, innovative applications of ICT for specific fields, big data and knowledge infrastructure, information security and cybersecurity. The source [2] reports that 1630 persons used the training opportunities offered by this project.
Information on the event is taken from:	1. https://likta.lv/ikt-profesionalu-apmacibas/ 2. https://likta.lv/wp-content/uploads/2020/05/Apmacibu-izmaksas-07.2016-03.2020.pdf

Title of the event:	Training of small and micro-entrepreneurs for the development of innovations and digital technologies in Latvia
Date:	December 2016 - December 2023
Place:	N/D
Organiser:	The Latvian Information and Communications Technology Association (LIKTA), using ERAF funding
Target audience:	Employees of small and micro enterprises as well as the self-employed persons
Short overview:	The project aims to promote entrepreneurs' understanding of innovations and raise the qualification of self-employed persons and employees of small and microenterprises, promoting the adoption of technological innovations and raising efficiency and productivity [1]. It is planned to train more than 6200 managers and employees of small and microenterprises and self-employed persons through this project[1]. Furthermore, training offers trainees an opportunity to try out new ICT tools and technologies [1]. According to [2] project offers training in several thematic blocks: 1. Digital technologies; 2. Digitalisation of enterprise's internal processes; 3. Digital tools for the development of manufacturing and services. A list of the courses offered is published in [2], and it includes training in cloud services and security. According to [3], before January 13, 2020, 3931 persons had already been trained from more than 1200 enterprises. The most demanded courses are "Data analysis and preparation of reports" and "Data gathering and processing".
Information on the event is taken from:	1. https://likta.lv/mmu-kursi/ 2. https://www.mmu.lv/Lapas/Apmacibas.aspx 3. https://likta.lv/mmu-kurusu-rezultati/

Title of the event:	Training for ICT professionals
Date:	April 27, 2020– December 31, 2023
Place:	N/D
Organiser:	The Latvian Information and Communications Technology Association (LIKTA), using ERAF funding
Target audience:	Working ICT professionals
Short overview:	The aim of the project, as stated in [1], is "to increase the qualification of working ICT professionals through training and in this way to promote technical innovations and increase of productivity, which in turn will increase the number of innovative businesses, export share of ICT, and the overall growth of the ICT field. Planned results are reported in [1]. They include training at least 1400 ICT professionals from at least 51 enterprises in several training programmes, including computer systems, data analysis, IT security, engineering science and technologies.
Information on the event is taken from:	1. https://likta.lv/projekts-ikt-profesionalu-apmacibas/

Title of the event:	Improvement of professional competence of employed persons
Date:	January 1, 2017 - December 31, 2023
Place:	N/D
Organiser:	State Education Development Agency, together with municipalities, educational institutions and National Employment Agency (ESF project)
Target audience:	Working and self-employed persons, including those at social risk
Short overview:	The project aims to improve the professional competence of employed persons to timely eliminate the mismatch of the labour force's qualification with the labour market's demand, promote the competitiveness of employees and increase labour productivity [1]. The project offers several courses in business analytics, data analysis, digital transformation, IT and cybersecurity, the Internet of Things, cloud computing, artificial intelligence, and others.
Information on the event is taken from:	1. https://www.macibaspieaugusajiem.lv/par-projektu?tab=collapse-82

Appendix 4: International and local projects on Industry 4.0

Title:	**Data Driven Dairy Decision for Farmers**
Acronym (if any):	**4D4F**
Website:	https://4d4f.eu/
Period:	01.03.2016 – 28.02.2019
Source of funding:	H2020-EU.3.2.
Partners: (Latvian partners in bold)	• Innovation for Agriculture (United Kingdom)- coordinator • Flanders research institute for agriculture, fisheries and food (ILVO) (Belgium) • The Estonian University of Life Sciences (Estonia) • **Latvian Academy of Sciences (Latvia)** • The University of Agronomic Sciences and Veterinary Medicine of Bucharest (Romania) • The Royal Swedish Academy of Agriculture and Forestry (KSLA) (Sweden) • The Zuidelijke Land- en Tuinbouworganisatie (ZLTO) (Netherlands) • Wim Govaerts & Co (Belgium) • Knowledge Information Market (KIM) (Spain) • Paragon Europe (Malta, Belgium) • Van Hall Larenstein University of Applied Sciences (Netherlands) • Institute for Food and Agricultural Research and Technology (IRTA) (Spain) • Liba (Beligium) • DeLaval International AB (Sweden) • Porphyrio NV (Belgium) • KU Leuven (Belgium)
Short overview:	From [1]: "The Data Driven Dairy Decisions for Farmers (4D4F) thematic network will focus on the role which dairy animal and environmental sensors can play in collecting real time information to help make more informed decisions in dairy farming. The network will develop a Community of Practice (COP) comprised of farmers, farm advisors, technology suppliers, veterinarians and researchers who work together to debate, collect and facilitate the co-creation of best practice on data and sensor technology."

Main results in regard to Industry 4.0:	From [2]: "The EU-supported 4D4F network was established to help dairy farmers base management decisions on data, such as that gathered by **sensing equipment**, leading to best practices for more sustainable dairy farming.
	[..] virtual resource known as the Warehouse of Technology, (comprising an overview of, and comparisons between, all of the current technology)"
	Series of Standard Operating Procedures [3] have been developed to "help to make a decision on what to do when a certain alarm shows up when using sensors on cattle".
References:	1. https://4d4f.eu/content/about 2. https://cordis.europa.eu/article/id/241023-sharing-data-and-experience-to-benefit-sustainable-dairy-farming 3. https://4d4f.eu/content/standard-operating-procedures

Title:	**Latvijas valsts un sabiedrības izaicinājumi un to risinājumi starptautiskā kontekstā** **(Challenges and solutions of the Latvian state society in an international context)**
Acronym (if any):	**INTERFRAME-LV**
Website:	https://www.lza.lv/aktualitates/projekti/content/82-projekti
Period:	Planned: 01.12.2018–30.11.2021, Extended till: 30.06.2022
Source of funding:	VPP (Administration of Studies and Research of the Republic of Latvia)
Partners: (Latvian partners in bold)	• **Latvian Academy of Sciences- coordinator** • **Latvia University of Life Sciences and Technologies;** • **Riga Stradiņš University;** • **Institute of Agricultural Resources and Economics;** • **University of Latvia.**
Short overview:	Project objectives as stated in [1]: • Assess the relevance of the economic and societal model in the context of global and European processes. • To formulate the characteristics of the desired economic and public model, which deals with Latvia's internal and external security, guaranteeing the sustainability of its existence. [..] • To provide guidelines for further sustainable development of Latvia in the perspective, highlighting the main patterns of action in global changing processes, the impact of which cannot be avoided by the country."

Co-funded by the European Union

Main results in regard to Industry 4.0:	Results of the project are reported in Yearbooks 2020 and 2021 of Latvian Academy of Sciences: • Analysis of structural changes in the economy [3] • Analysis of digitalisation of the national economy • and society [3] • Sociological surveys to identify public opinions on changes (including digitalisation) in the public life[3]. • 5 regional forums for exchanging of views between scientists and practitioners [4] • Monograph "Latvian Sustainability Perspectives: Challenges and Opportunities" summarises both the conclusions of the research and provide further guidelines for the balanced development of the country from the perspective of scientists (to be published) [4]. • 68 reports on the INTERFRAME-LV project presented at international conferences.
References:	1. https://socialsciences.llu.lv/en/projects/challenges-and-solutions-latvian-state-society-international-context 2. https://www.lza.lv/aktualitates/projekti/content/82-projekti 3. https://www.lza.lv/images/Annual_reports/Yearbook_2020.pdf 4. https://www.lza.lv/images/Annual_reports/YearBook_2021_articles/pages_13_19.pdf

Title:	**Industry 4.0 CHAlleNGE: Empowering Metalworkers For Smart Factories Of The Future**
Acronym (if any):	**4CHANGE**
Website:	http://www.change4industry.eu/
Period:	01.12.2016–29.02.2020
Source of funding:	Erasmus +
Partners: (Latvian partners in bold)	• Vilnius Jerusalem Labour Market Training Centre, VJDRMC (LITHUANIA)- coordinator • Engineering Industries Association of Lithuania, LINPRA (LITHUANIA) • Education Network for the Northern German Metal and Electrical Industries, NORDBILDUNG (GERMANY) • **Association of Mechanical Engineering and Metalworking Industries of Latvia, MASOC (LATVIA)** • Federation of Estonian Engineering Industry, EML (ESTONIA) • North Technical Academy, TAN (GERMANY) • **Zemgale Region Human Resource and Competences Development Centre, ZRKAC (LATVIA)**

	• Tallinn Lasnamae School of Mechanics, TLMK (ESTONIA) • Qualifications and Vocational Education and Training Development Centre, KPMPC (LITHUANIA) • **National Centre for Education, VISC (LATVIA)** • Baltec CNC Technologies JSC, BCT (LITHUANIA) • MTS Mathematical Technical Software Development JSC, MTS (GERMANY)
Short overview:	The overall goal of the project is to tackle skills gaps of metalworkers by addressing the following objectives: to design and deliver a new targeted VET programme based on the current and future skills demand in the metalworking sector, and to develop a self-adaptive work-based learning system in combination with coaching [1].
Main results in regard to Industry 4.0:	As is said in [2], one of the results of this project is development of E-learning platform. "[That] will act as an on-line training tool for learners, trainers, VET institutions, manufacturing enterprises and individuals aiming at acquiring metalworkers profession. It is established as an Open Education Resource system with a focus on accessibility and easy sharing." Address of this platform: https://cnc4change.org/ Analysis of current and future skills demand in the metalworking sector described in [2] includes such skills: • Advanced technology and digital skills due to increased need for engineers instead of manual workers; • Robotics and CNC operation skills due to technology- driven innovation; • Social and entrepreneurial skills due to need for highly motivated work-force to stay competitive; • Green skills due to promotion of energy efficiency.
References:	1. http://www.change4industry.eu/en/pages/home.html 2. http://www.change4industry.eu/uploads/Presentation4change.pdf

Title:	**Digital Innovation Network**
Acronym (if any):	**DIGINNO**
Website:	https://www.diginnobsr.eu/
Period:	01.09.2017–31.12.2020
Source of funding:	Interreg Europe
Partners: (Latvian partners in bold)	• Ministry of Economic Affairs and Communications of Estonia (Estonia) • Estonian Association of Information Technology and Telecommunications (Estonia) • Foundation Tallinn Science Park Tehnopol (Estonia) • DIMECC Ltd. (Finland) • Polish Chamber of Commerce of Electronics and Telecommunications (Poland) • **Latvian Information and Communications Technology Association (Latvia)** • **Ministry of Environmental Protection and Regional Development of Latvia (Latvia)** • Engineering Industries Association of Lithuania LINPRA (Lithuania) • Association INFOBALT (Lithuania) • RISE AB (Sweden) • Aalborg University (Denmark) • WITHDRAWAL (31/10/2018):The Ministry of Transport and Communications of the Republic of Lithuania (Lithuania) • The Brønnøysund Register Centre (Norway) • Ministry of the Economy and Innovation of Republic of Lithuania (partner as of 1.04.2018) (Lithuania)
Short overview:	A unique network for innovative solutions in public-private co-operation to speed up the process towards the Baltic Sea Region digital single market [1]. From [2]: "With DIGINNO we are focusing on three challenges: ● promoting uptake of ICT in the business sector, ● developing innovative digital public services and ● facilitating DSM [Digital single market] related policy discussions on BSR [Baltic Sea Region] level."

Main results in regard to Industry 4.0:	Planned results of the project are described in [3]:
	"The DIGINNO project will also produce a number of workable results that are closely related to the MEPRD's ICT Policy:
	1. Identified and analysed cross-border e-services to be developed, 4 concepts of pilot projects developed.
	2. An instrument has been created for enterprises to identify their maturity in the use of ICT opportunities (Industry 4.0 maturity), developed national industry 4.0. communities, transnational cooperation.
	3. A compendium of good practices and recommendations for policy makers on cross-border eservices and Industry 4.0. promotion.
	4. Information campaign on the Baltic Sea Region, including Latvia's role as a forerunner in the implementation of cross-border e-cooperation. "
	Tool for evaluating company's digital maturity: https://www.diginnotool.eu/home
References:	1. https://www.diginnobsr.eu/ 2. https://www.diginnobsr.eu/about 3. https://ec.europa.eu/information_society/newsroom/image/document/2019-32/country_report_-_latvia_-_final_2019_0D30BE44-054B-C822-C8DEFA25536D65B0_61211.pdf

Title:	**Digital Innovation Capacity Building**
Acronym (if any):	**DINNOCAP**
Website:	https://www.dinnocapbsr.eu/
Period:	01.01.2021-31.12.2021
Source of funding:	Interreg Europe
Partners: (Latvian partners in bold)	• Ministry of Economic Affairs and Communications of Estonia (Estonia)- coordinator • Aalborg University (Denmark) • Association INFOBALT (Lithuania • Estonian Association of Information Technology and Telecommunications (Estonia) • The Brønnøysund Register Centre (Norway) • **Latvian Information and Communications Technology Association (Latvia)**

	• Polish Chamber of Commerce of Electronics and Telecommunications (Poland) • Engineering Industries Association of Lithuania LINPRA (Lithuania) • RISE Research Institute Sweden AB • Association of SMEs Support Centres in Kaliningrad Region
Short overview:	Source [2] sums up the aim of the project like this: "The project supports small and medium sized enterprises (SMEs) around the Baltic Sea to update digital solutions faster. In this way, the project facilitates the transition to a digital single market in the region. Based on tools developed in DIGINNO, the project DIGINNOCAP works on improving digitalisation methods and their practical use." in [1] it is stated that: "DINNOCAP is an extension project of DIGINNO which was a digital collaboration project for the BSR carried out 2017-2020: https://www.diginnobsr.eu/. DINNOCAP will support the implementation of innovative ICT tools, cross-border e-services solutions, and policy recommendations developed in DIGINNO. These are: 1. Business needs assessment of ICT in SMEs in BSR 2. SME Digital Maturity Recommender Tool 3. Digital Assessment Toolkit for SME's 4. Four show-case models of G2B cross-border e-service 5. DIGINNO Policy White Paper"
Main results in regard to Industry 4.0:	In [3] the long term impact of the project has been stated: "A considerable amount of SMEs in the BSR region will be familiar with the digitalization and digital awareness tools, enabling them to increase their digitalization capacity and uptake of ICT, a.o. inspired by approaches and practices in the neighboring countries. In the long term, this will improve the innovation capacities of SMEs and encourage SME digitalization based on transnational learning. This will enhance the competitiveness of SMEs and the BSR industry sectors. [..]" From [1]: "The overall output of DINNOCAP will be a set of innovative digital transformation instruments to support capacity enhancement among SMEs, industry associations, and policymakers."
References:	1. https://www.dinnocapbsr.eu/ 2. https://interreg-baltic.eu/project/dinnocap/ 3. https://www.dinnocapbsr.eu/outcomes

Title:	**Improving innovation delivery of policies within 4.0 industry in Europe.**
Acronym (if any):	**INNO INDUSTRY** **(INNO4.0 in** https://clustero.eu/inno4-0-inno-industry/**)**
Website:	https://projects2014-2020.interregeurope.eu/innoindustry/
Period:	01.08.2019 – 31.01.2023
Source of funding:	Interreg Europe
Partners: (Latvian partners in bold)	• Regional Development Agency Posavje (RDA Posavje) (Slovenia) • Ecoplus. The Business Agency of Lower Austria (Austria), • Innovative business association of furniture manufacturers and related in the Murcia Region – AMUEBLA (Spain), • **Ministry of Economics of the Republic of Latvia (Latvia),** • Business and innovation Centre of Beira Interior (Portugal), • Romanian Cluster Association – CLUSTERO (Romania), • RISE Research Institutes of Sweden AB (Sweden), • Slovak Business Agency (Slovakia), • Buckinghamshire Business First (United Kingdom)
Short overview:	INNO Industry project aims to increase rate of clusters that develop activities to support the transformation towards Industry 4.0 by 2022 through the improvement of regional and national policies [1].
Main results in regard to Industry 4.0:	Planned results are described in [1]: "INNO Industry proposes to establish a strategic work group with the aim to share best practices related with cluster activities and the promotion of Industry 4.0 to develop a European Blueprint as a policy guide towards clusters 4.0. The development of INNO Industry will achieve as key outputs a SWOT analysis in 10 EU regions, the identification of at least 30 best practices related with clustering and industry 4.0, one European Blueprint towards clusters 4.0 and 10 action plans to introduce improvements in addressed policy instruments."
References:	1. https://projects2014-2020.interregeurope.eu/innoindustry/

Title:	**Boosting a novel and innovative training approach of Key Enabling Technologies**
Acronym (if any):	**BRACKET**
Website:	https://bracket.erasmus.site/
Period:	01.11.2018 – 30.04.2021
Source of funding:	Erasmus+
Partners: (Latvian partners in bold)	• Institute for Development and International Relations (IRMO) (Croatia) • Danmar Computers LLC (Poland) • University of Thessaly (Greece) • ASOCIACION EMPRESARIAL DE INVESTIGACION CENTRO TECNOLOGICO DEL MUEBLEY LA MADERA DE LA REGION DE MURCIA (Spain) • **Biedrība Eurofortis (Latvia)** • Ljudska univerza Rogaška Slatina (Slovenia) • InnoRenew CoE (international research centre estblished with funding from the H2020 WIDESPREAD-2-TEAMING programme)
Short overview:	Objectives of the project are described in [1]: "[T]he main objective of this project was to transfer KETs [Key Enabling Technologies, here specifically nanotechnology, biotechnology and advanced materials] to Vocational Education and Training (VET) through the development of innovative and open learning content in terms of KETs. High capacities cannot be developed and implemented in the markets if students and workers do not have the necessary competences and/or skills, both technical related to chemistry, computer sciences, etc., and non-technical skills as entrepreneurship, innovation, etc. To this end, the BRACKET Consortium defined the following specific objectives (SO): • SO1. To study and analyse the incoming trends regarding KETs and competences necessaries to foster its implementation and work in VET. • SO2. To design and develop a Joint Curriculum (JCV) for developing and fostering new skills on VET students (initial or continued VET) with the participation of stakeholders, experts and Universities with experience in these enabling technologies as well as in non-technical skills. • SO3. To deliver the JCV on e-learning OER platform and protect it under open licenses. • SO4. To break boundaries among VET students, workers and experts in KETs, creating common procedures and defining skills.

	It will be developed during the execution of the four Intellectual Outputs. • SO5. To equip VET users and other target users with the right skills and knowledge about KETs from today and tomorrow and to foster a sustainable and innovative development. • SO6. To create new job opportunities for people with the necessary skills in the field of KETs."
Main results in regard to Industry 4.0:	Developed course book [2] includes a chapter on Industry 4.0 explaining basic concepts and their linkage to KETs. "Key Enabling Technologies represent advanced technologies, which are in fact Industry 4.0 technologies, offering opportunities for the European industry to grow in services and products for the future benefit. Therefore, I4.0 has its place in KETS, especially the Internet of Things (IoT) which is generally used to refer to the connection between consumer goods, but in this respect, it is a network that connects physical devices (appliances, smart solutions, vehicle systems etc.) so that they are able to share data."
References:	1. https://bracket.erasmus.site/more-about/ 2. https://ec.europa.eu/programmes/erasmus-plus/project-result-content/4d47557a-f780-4aa5-be4d-a384058cf472/BRACKET%20Coursebook%205%20units.pdf

Title:	**Vision, Identification, with Z-sensing Technologies and key Applications** (Z-uztveres tehnoloģija redzei un identifikācijai)
Acronym (if any):	**VIZTA**
Website:	https://www.vizta-ecsel.eu/
Period:	01.05.2019-31.10.2022
Source of funding:	Horizon 2020 (ECSEL Joint Undertaking (JU))
Partners: (Latvian partners in bold)	• STMicroelectronics Crolles (France)- coordinator • Alter Technology TÜV Nord (Spain) • Applied Materials (France) • Ayming (International) • Beamagine (Spain) • Beamagine (Spain) • CEA (French Alternative Energies and Atomic Energy Commission)(France) • DFKI (German Research Centre for Artificial Intelligence) (Germany) • **EDI (Institute of Electronics and Computer Science) (Latvia)**

	• Eurecat (Spain) • Idneo (Spain) • IBEO (Germany) • IDEMIA (France) • IEE (Luxembourgh) • III-V LAB (France) • ISD (Integrated Systems Development S.A.) (Greece) • QUANTEL TECHNOLOGIES & KEOPSYS INDUSTRIES (France) • Semilab (Hungary) • ST (STMicroelectronics) (France) • TRUMPF Photonic Components (Germany) • UPC (Universitat Politècnica de Catalunya) (Spain) • Veoneer (Sweden)
Short overview:	VIZTA aims at developing innovative technologies in the field of optical sensors and laser sources for short to long-range 3D-imaging and to demonstrate their value in several key applications including automotive, security, smart buildings, mobile robotics for smart cities, and industry4.0 [1].
Main results in regard to Industry 4.0:	From [2]: "Technology developments of sensors and emitters are carried out by leading semiconductor product suppliers (STMicroelectronics, Trumpf, III-V Lab) with the support of equipment suppliers (Amat, Semilab) and CEA Leti RTO. VIZTA project also includes the development of 6 demonstrators for key applications including automotive, security, smart buildings, mobile robotics for smart cities, and industry4.0 with a good mix of industrial and academic partners (Ibeo, Veoneer, Ficosa, Beamagine, IEE, DFKI, UPC, Idemia, CEA-List, ISD, BCB, IDE, Eurecat)." EDI (Latvia) is involved in developing WP3- development of short range 3D imaging systems which can be used for: "[..] Face recognition, Gesture control, Driver monitoring, Industrial control, [..] Smart buildings, Mobile robots, Drones, Security, [..] Security of transport with LIDARs (Light based radars with much higher resolution) [3]"
References:	1. https://www.vizta-ecsel.eu/ 2. https://www.vizta-ecsel.eu/in-a-nutshell/objectives/ 3. https://www.vizta-ecsel.eu/in-a-nutshell/general-questions-answers/

Co-funded by
the European Union

Title:	**Competence Centre of Electrical and Optical Equipment Production Sector of Latvia (Latvijas elektrisko un optisko iekārtu ražošanas nozares kompetences centrs)** **Project 1.2.1.1/18/A/006**
Acronym (if any):	N/A
Website:	https://www.leopc.lv/projekti/
Period:	2019-2022
Source of funding:	ERAF
Partners: (Latvian partners in bold)	• **Competence Centre of Electrical and Optical Equipment Production Sector of Latvia- coordinator** • **LEITC SIA (Latvia)** • **Hansamatrix Innovations SIA (Latvia)** • **Hansamatrix Ventspils SIA (Latvia)** • **Mondot SIA (Latvia)** • **EDI (Institute of Electronics and Computer Science) (Latvia)** • **Robotic Solutions SIA (Latvia)** • **Riga Technical University (Latvia)** • **Lightspace Technologies SIA (Latvia)** • **SAF Tehnika AS (Latvia)** • **RIMI Latvia SIA (Latvia)** • **Conelum SIA (Latvia)** • **Apply SIA (Latvia)**
Short overview:	"Competence Centre of Electrical and Optical Equipment Production Sector of Latvia unites companies and research institutes with the aim to increase their competitiveness and to advance cooperation between industrial and research sectors in order to develop innovative products and technologies. Research projects are implemented in the fields of electronics, electrical engineering and optics by implementing Smart Strategy (RIS3) of Information and Communication Technologies – Hardware Engineering (Electronics)." https://www.leopc.lv/projekti/ Most relevant sub-projects/research activities: 1. Pētījums Nr. 1.1 "Elektromagnētiskās savietojamības testēšanas sistēmas izpēte un izstrāde, frekvenču diapazonā 1MHz-6GHz lietu interneta (IoT) testēšanai" ("Research and development of testing system of electromagnetic compatibility for a IoT in the frequency range 1MHz-6GHz") https://www.leitc.lv/lv/about-us#zinatne 2. Pētījums Nr. 1.2 "Vadības elektronikas shēmas izstrādes pētījums multifokālās papildinātās realitātes galvas displejam"

	("Development of electronics for multifocal augmented and virtual reality displays") http://www.hansamatrix.com/hmx-launches-multifocal-electronics-project.html 3. Pētījums Nr. 1.5 "Efektīvs modulis automātiskai cilvēku un transporta detektēšanai ar Video novērošanas kamerām" ("An effective module for automatical detecting of people and transport using video from surveilance cameras") https://www.mondot.lv/jaunumi/params/post/3757775/mondot-petniecibas-projekta-efektivs-modulis-automatiskai-cilveku-un-transp 4. Pētījums Nr. 1.9 "Iekštelpu navigācijas risinājums dažādu funkciju autonomiem robotiem" ("Indoor navigation solutions for autonomous robots with various functions") https://www.squad-robotics.com/eu-funds 5. Pētījums Nr. 1.16 "Integrēta elektronikas risinājuma izstrāde galvas displeja pozīcijas noteikšanai telpā un attālinātās palīdzības funkcionalitātes nodrošināšanai" ("Development of integrated electronics for head position tracking and remote assistance functionality") hansamatrix.com/hmx-launches-tracking-peripherals-development-project.html https://lightspace3d.com/development-of-integrated-electronics-for-head-position-tracking-and-remote-assistance-functionality/ 6. Pētījums Nr. 1.21 "Caurspīdīgas stikla taras un tās elementu analīze un detekcijas metožu izpēte universālai defektoloģijas analīzei" ("Analysis of translucent glass packaging and it's elements and research of detection methods usable for universal analysis of defects") https://www.applyit.lv/en/competence-center-glasscon 7. Pētījums Nr. 1.22 "Galvas displeja pozīcijas precīza noteikšana industriālos pielietojumos" ("Precise positioning of the head-mounted display in industrial applications") https://wp.lightspace3d.com/precise-positioning-of-the-head-mounted-display-in-industrial-applications/ 8. Pētījums Nr. 2.1 "Elektronisko bezvadu sensoru mērījumu lielu datu apjoma (Big Data) apstrāde izmantojot mākoņa (Cloud) risinājumu, un tā pielietojums pārtikas mazumtirdzniecības uzņēmumiem" ("Processing of large volumes (Big Data) of readings from electronic wireless sensors using cloud solutions and it's application to food retail enterprises") 9. Pētījums Nr. 2.2 "Conelum EloVIEW" https://www.leopc.lv/projekts/petijums-nr-2-2-conelum-eloview/
Main results in regard to Industry 4.0:	1. According to [1] system for testing Internet of Things in 1MHz-6GHz frequency has been developed. 2. "Small-size light-weight electronics driver for multifocal augmented and virtual reality displays and headsets. [..] control algorithms, schematics capture, layout development in flexi-board technology,

	manufacturing of prototypes, validation of functionality of the developed board in actual multifocal augmented reality headset." [3] 3. As stated in [11] effective computer vision based methods for video analysis for detecting and counting of members of traffic have been developed. Experimental prototype uses original machine learning based method for detecting objects using Recurrent Neural Network-based virtual detection line. 4. According to [5] existing indoors positioning methods and their technical implementations were compared in a laboratory setting. As a result proposals for improving and combining several methods were developed. 5. "[..]small-size light-weight electronics board that implements absolute position tracking for the head mounted display within a room and also implements a remote assistance functionality. The actions of the proposed project include development of SLAM algorithms, integrateable devices, electroncis module development and sample production run."[6] 6. Current results according to [8]: research of algorithms for determining the position and orientation of empty glass packaging and identification of various zones (i.e. bottom, bottle-neck etc) of glass packaging using the power of AI computer vision. Planned results according to [8]: to make detection of deffects of translucent empty glass packaging more more affordable and easier to install. 7. Expected result: "[..] to create a solution for tracking position of the head-mounted display in 5 x 5 m large industrial-like room, thus enabling the industrial use cases with Lightspace AR[Augmented reality]] headsets." [9] 8. Source [10] reports that: temperature sensors have been deployed in 130 Rimi Latvia stores. Centralised system for monitoring temperature in glass-cases in all stores has been developed using cloud for storing and analysing data. Machine learning module for detecting temperature anomalies based on sensor data has been developed to detect potential defects preventively. 9. The aim of the subproject 2.2. in [12] is described as development of wide field of vision opto-electronic modular system EloVIEW that allows completely automatic analysis of microbiological pollution for any industry. This subproject has created innovative approach that allows significantly speed up the microbiological pollution analysis process and to count animate cells in less than hour (traditionally it takes 3-7 days).
References:	1. https://www.leopc.lv/projekti/ 2. https://www.leitc.lv/lv/about-us#zinatne 3. http://www.hansamatrix.com/hmx-launches-multifocal-electronics-project.html

Co-funded by
the European Union

	4. https://www.mondot.lv/jaunumi/params/post/3757775/mondot-petniecibas-projekta-efektivs-modulis-automatiskai-cilveku-un-transp 5. https://www.leopc.lv/projekts/petijums-nr-1-9-iekstelpu-navigacijas-risinajums-dazadu-funkciju-autonomiem-robotiem/ 6. http://www.hansamatrix.com/hmx-launches-tracking-peripherals-development-project.html 7. https://lightspace3d.com/development-of-integrated-electronics-for-head-position-tracking-and-remote-assistance-functionality/ 8. https://www.applyit.lv/en/competence-center-glasscon 9. https://wp.lightspace3d.com/precise-positioning-of-the-head-mounted-display-in-industrial-applications/ 10. https://www.leopc.lv/projekts/petijums-nr-2-1-elektronisko-bezvadu-sensoru-merijumu-lielu-datu-apjoma-big-data-apstrade-izmantojot-makona-cloud-risinajumu-un-ta-pielietojums-partikas-mazumtirdzniecibas-uznemumiem/ 11. https://www.leopc.lv/projekts/petijums-nr-1-5-efektivs-modulis-automatiskai-cilveku-un-transporta-detektesanai-ar-video-noverosanas-kameram/ 12. https://www.leopc.lv/projekts/petijums-nr-2-2-conelum-eloview/

Title:	**Competence Centre of Electrical and Optical Equipment Production Sector of Latvia (Latvijas elektrisko un optisko iekārtu ražošanas nozares kompetences centrs)** **Projekts Nr. 1.2.1.1/16/A/002**
Acronym (if any):	**N/A**
Website:	https://www.leopc.lv/projekti/
Period:	2016-2018
Source of funding:	ERAF
Partners: (Latvian partners in bold)	• **Competence Centre of Electrical and Optical Equipment Production Sector of Latvia- coordinator** • **Robotic Solutions SIA (Latvia)** • **Rīgas Tehniskā universitāte (Latvia)** • **EDI (Institute of Electronics and Computer Science) (Latvia)**
Short overview:	"Competence Centre of Electrical and Optical Equipment Production Sector of Latvia unites companies and research institutes with the aim to increase their competitiveness and to advance cooperation between industrial and research sectors in order to develop innovative products and technologies. Research projects are implemented in the fields of electronics, electrical engineering and optics by implementing Smart Strategy (RIS3) of

	Information and Communication Technologies – Hardware Engineering (Electronics)." https://www.leopc.lv/projekti/ Most relevant sub-projects: 1) Pētījums Nr. 9 "Daudzu robotu sistēmas pielietojumiem lauksaimniecībā" ("Multi-robot systems for applications in agriculture") https://www.leopc.lv/projekts/petijums-nr-9-daudzu-robotu-sistemas-pielietojumiem-lauksaimnieciba/ 2) Pētījums Nr. 11 "Pētījums par datorredzes paņēmienu attīstību industrijas procesu norises automatizācijai" (DIPA) ("The research on the development of computer vision techniques for the automation of industrial processes") https://www.edi.lv/projects/petijums-par-datorredzes-panemienu-attistibu-industrijas-procesu-norises-automatizacijai-dipa/

Main results in regard to Industry 4.0:	1) Results of subproject "Multi-robot systems for applications in agriculture" are reported in [1] and they are:
	   a) development of multiple robot cooperation software framework that allows getting out of dead ends and for robots to replace each other if necessary.
	   b) Development of methods for merging maps, planning routes, fusing sensor data and other purposes.
	   c) Development of a prototype of multiple feed-pushing robots system.
	2) A set of methods for automation of various processes in industry have been developed using visual information (2D and 3D computer vision) and it's processing with machine learning methods (neural networks, deep learning, etc.), reports [2]. Source [3] describes created model of industrial process for data gathering and processing. It gathers data using Kinect V2 sensors, processes data to detect objects of interest in a chaotic pile, processes data to determine the orientation of the picked-up object. Architecture of a modular system has been created that includes sensors, cameras, stereo modules, robotic manipulators, etc. This architecture allows using components from various producers with only minor changes necessary. Modularity has been achieved trough the usage of ROS-Robot Operating System.

References:	1. https://www.leopc.lv/projekts/petijums-nr-9-daudzu-robotu-sistemas-pielietojumiem-lauksaimnieciba/ 2. https://www.edi.lv/projects/petijums-par-datorredzes-panemienu-attistibu-industrijas-procesu-norises-automatizacijai-dipa/ 3. https://www.edi.lv/wp-content/uploads/2019/07/2017.08.-Prezentacija-publicitatei.pdf

Co-funded by the European Union

Title:	**Next Generation Enhanced Augmented Reality 3D Glasses for medical education, pre-procedural planning, intra-procedural visualization, and patient rehabilitation**
Acronym (if any):	**NGEAR 3D**
Website:	https://cordis.europa.eu/project/id/960828 https://lightspace3d.com/ngear-3d/
Period:	01.07.2020–30.06.2022
Source of funding:	Horizon 2020
Partners: (Latvian partners in bold)	**SIA Lightspace Technologies (Latvia)**
Short overview:	"Augmented reality (AR) technology offers great possibilities for advanced tools to be used in medicine to improve diagnostics and efficiency in surgical planning and tasks, heralding a new level of modern healthcare. However, the highly anticipated VR/AR 3D display glasses are not yet not suitable for close work, due to the focal rivalry of the stereoscopic 3D image and the real world, which results in eye strain and pains. To solve this problem, the EU-funded NGEAR 3D project supports the development of the state-of-the-art multifocal-accommodating AR headset that eliminates all adverse effects of existing headsets and outputs holographic-look 3D images." [1]
Main results in regard to Industry 4.0:	"Augmented Reality Glasses that can visualize high-quality 3D images at stretched arm's distance (0.3m –2.0m)." [2] "Augmented Reality headset and glasses prototype validation with strategic partners:in healthcare – with market-leading medical AR application company, cardio surgeons from two hospitals; in digital manufacturing – with global leading car manufacturer[..]"[2]
References:	1. https://cordis.europa.eu/project/id/960828 2. https://lightspace3d.com/ngear-3d/

Co-funded by
the European Union

Title:	**Innovation Framework for Challenge Oriented Intelligent Manufacturing**
Acronym (if any):	**INforM**
Website:	https://interreg-baltic.eu/project/inform/
Period:	January 2019 – December 2021
Source of funding:	Interreg Europe
Partners: (Latvian partners in bold)	• Tallinn University of Technology (Estonia)- coordinator • Innovative Manufacturing Engineering Systems Competence Centre (Estonia) • Machine Technology Center Turku Ltd. (Finland) • Lappeenranta University of Technology (Finland) • Odense Robotics (Denmark) • **Vocational education and training center "Liepajas State Technical school" (Latvia)** • Lithuanian Innovation Centre (Lithuania) • Klaipeda Science and Technology Park (Lithuania) • Torun Technology Park (Poland)
Short overview:	"The INforM project provides support to small and medium sized mechatronics and mechanical engineering companies in the ongoing digital transformation process. The continuous digitalisation of value chains called Industry 4.0 brings with it great challenges for smaller companies. The project plans to enable companies to benefit from the trend towards smart factories, which operate mainly based on intelligent, IT and web-based processes."[1]
Main results in regard to Industry 4.0:	"The project INforM creates a cross-sectorial Innovation Support Digital Framework to support small and medium sized enterprises (SMEs) in the digital transformation process. The Framework develops and implements customised smart engineering and educational solutions responding to the actual needs of the enterprises around the Baltic Sea in order to ensure their competitiveness and productivity." [1]
References:	1. https://interreg-baltic.eu/project/inform/

Title:	**Developing Industrial 4.0 competence centres and network in Estonia, Latvia and Lithuania**
Acronym (if any):	**i4.0 Baltics**
Website:	https://si.se/en/projects-granted-funding/i4-0-baltics-developing-industrial-4-0-competence-centres-and-network-in-estonia-latvia-and-lithuania/
Period:	30.06.2016 – 31.03.2017
Source of funding:	Baltic Sea region seed funding
Partners: (Latvian partners in bold)	• Eesti Plastitööstuse Liit (Estonia) • **Latvian Chamber of Commerce and Industry (Latvia)** • Public Entity Intechcentras (Lithuania)
Short overview:	"The i4.0 Baltics project focuses on small and medium size companies in the Baltic Sea region and their preparedness for the fourth industrial revolution. According to the i4.0 Baltics project, many small and medium size companies in the Baltic Sea region are not prepared for the fourth industrial revolution, Industry 4.0 or i4.0, a development that implies full digitalization of industries. Many of these companies only operate locally. They lack the requisite specialist staff to prepare for the changes that Industry 4.0 will require, according to this project. Also, some of the companies have a sceptical attitude towards a technology strategy they are not familiar with. The project wants to integrate these small and medium size companies into global value networks. The idea of is to create a network among leading companies, small and medium size companies and organizations in the Baltic Sea region. The network will serve to enhance the understanding of the implications and challenges of the fourth industrial revolution. Also, it will discuss strategies and methods to take advantage of the development." [1]
Main results in regard to Industry 4.0:	"One activity is to find local i4.0 consultants in Estonia, Latvia and Lithuania. Moreover, the project will arrange factory visits in Sweden and hold a 2-day training in i4.0."[1]
References:	1. https://si.se/en/projects-granted-funding/i4-0-baltics-developing-industrial-4-0-competence-centres-and-network-in-estonia-latvia-and-lithuania/

Co-funded by
the European Union

Title:	**An interregional cooperation project for improving SME competitiveness policies**
Acronym (if any):	**SKILLS+**
Website:	https://projects2014-2020.interregeurope.eu/skillsplus/
Period:	01.04.2016 – 31.03.2021
Source of funding:	INTERREG Europe
Partners: (Latvian partners in bold)	• Ministry for Regional Development and Transport of SaxonyAnhalt (Germany) • Kainuun Etu Ltd. (Finland) • **Ministry of Environmental Protection and Regional Development of the Republic of Latvia (Latvia)** • University of Western Macedonia (Greece) • Malopolska Regional Development Agency (Poland) • Trondelag County Authority (Norway) • Zadar County Rural Development Agency (Croatia) • Bulgarian Chamber of commerce and Industry (Bulgaria) • Ministry of Culture and Tourism of Castilla y Leon Regional Government (Spain) • Pannon Novum WestTransdanubian Regional Innovation Nonprofit ltd. (Hungary) • **University of Latvia (Latvia)** • Technical University of Ostrava (Czech Republic)
Short overview:	"SKILLS+ aims at advancing public policies promoting information and communication technologies (ICT) skills among SMEs in rural areas helping them seize fully the opportunities offered by a digital single market and benefits of a digital economy." [1] "The project was aimed at raising productivity, innovations and increasing the long-term competitiveness of small and micro enterprises by teaching them how to effectively apply ICT technologies and e-skills. The planned activity will directly train on the opportunities provided by ICT, how to design and develop a future corporate strategy using ICT that further contributes to the OP's [Operational Program] goal." [2]
Main results in regard to Industry 4.0:	"Support is provided for small and micro-enterprises, self-employed persons in training thematic blocks: 1. Digital skill and ICT solutions for productivity; 2. The use of ICT tools for SME's competitiveness and development; 3. Use of ICT solutions for business efficiency and export development."[2] 11 action plans to promote SME digitalisation in rural areas [3]. More than 5000 businesses expected to benefit from implemented actions directly and many more from the spillover effect [3].

References:	1. https://projects2014-2020.interregeurope.eu/skillsplus/
	2. https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1576241987.pdf
	3. https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1553072485.pdf

Title:	**Digital Business EcoSystem Transformation**
Acronym (if any):	**DigiBEST**
Website:	https://projects2014-2020.interregeurope.eu/digibest/
Period:	01.08.2019– 31.07.2023
Source of funding:	Interreg Europe
Partners: (Latvian partners in bold)	• **Ministry of Environmental Protection and Regional Development of the Republic of Latvia (Latvia)- coordinator** • Trøndelag fylkeskommune (Norway) • **University of Latvia (Latvia)** • Sviluppo Basilicata Spa (Italy) • Austria Wirtschaftsservice Gesellschaft mbH (Austria) • Comunidade Intermunicipal do Tâmega e Sousa (Portugal) • Diputación Provincial De Granada (Spain)
Short overview:	"The overall objective of the project is to support and promote SMEs competitiveness through digital transformation of SMEs in rural European territories by proposing solutions to enhance their capacity to use advanced technologies and new innovative business approaches for promoting smart, sustainable and inclusive growth in Europe and its regions." [1]
Main results in regard to Industry 4.0:	Planned outcomes of the project according to [3] are: ● SMEs digital transformation barrier and solution analysis for each partner country. ● Development of enterprise digitalisation self-assessment tool; ● Development of road-maps for promotion of enterprise digitalisation. ● Development of action plan based on roadmaps for promotion of enterprise digitalisation.
References:	1. https://projects2014-2020.interregeurope.eu/digibest/ 2. https://keep.eu/projects/21526/Digital-Business-EcoSystem--EN/ 3. https://www.lu.lv/cets/research/euproject/digibest/

Title:	YOUNG-ICT WOMEN: Innovative Solutions to increase the numbers of EU vulnerable girls and young women into the digital agenda
Acronym (if any):	WOMEN4IT
Website:	https://women4it.eu/
Period:	01.09.2018 – 31.01.2023
Source of funding:	Grant from Iceland, Liechtenstein and Norway through the EEA and Norway Grants Fund for Youth Employment
Partners: (Latvian partners in bold)	• **LIKTA – The Latvian Information and Communications Technology Association (Latvia)- coordinator** • BETI – Baltic Education Technology Institute (Lithuania) • Tech.mt – Tech.mt - Malta Leading Through Innovation (Malta) • CRETHIDEV – Creative Thinking and Development (Greece) • ICS Skills – Training and Certification Body of the Irish Computer Society (Ireland) • PLAN International – Advancing children's rights and equality for girls (Spain) • Fundatia EOS – Educating for an Open Society (Romania) • ECWT – The European Centre for Women and Technology (Norway) • DIGITALEUROPE – The voice of the digital technology industry in Europe (Belgium)
Short overview:	"In the context of the structural transformation towards a digital economy, there are significantly fewer women than men on the European market. Left unaddressed, this digital gap will lead to loosing-out on the female talent, innovation and entrepreneurship – and further widen the gender gap. The ambition of the project partners is to develop the digital competences of young women who are at risk of exclusion from the labour market, by improving their employability." [1]
Main results in regard to Industry 4.0:	Key outcome indicators of the project as stated in [4]: • 10,000 Number of youth reached by digital career awareness activities • 350 Number of employers introduced to innovative solutions • 1,000 Number of young girls and women assessed by the profiling tool • 700 Number of target group enrolled in education and training, including work. Project's webpage [2] offers to choose between 8 Job profiles, including Data analyst, Data protection officer. As is stated in [3] till 21.08.2020 200 young women had registered in the training platform and tested their skills and 102 had signed up for training.

Co-funded by the European Union

References:	1. https://women4it.eu/about-us/ 2. https://digitaljobs.women4it.eu/ 3. https://likta.lv/sakusas-projekta-women4it-pilota-aktivitates-latvija/ 4. https://women4it.eu/our-impact/

Title:	**DIGITAL COMPETENCE DEVELOPMENT SYSTEM**
Acronym (if any):	**DCDS**
Website:	http://www.dcds-project.eu/about/
Period:	01.01.2018 – 31.12.2020
Source of funding:	Erasmus+
Partners: (Latvian partners in bold)	• ALL DIGITAL (Belgium)- coordinator • Hellenic Open University (HOU), DAISSy Research Group (Greece) • Centro Studi Foligno (CSF) (Italy) • Associazione Emiliano-Romagnola Centri Autonomi di Formazione (AECA) (Italy) • Fundación ESPLAI (Spain) • **LIKTA (Latvia)** • EOS Foundation (Romania) • European Association for the Education of Adults (EAEA) (Belgium)
Short overview:	"The DCDS project aims to establish a framework that will provide the low-skilled adult European population with the basic digital and transversal competences needed for employment, personal development, social inclusion and active citizenship. The project will develop an open, innovative multilingual Digital Competences Development System (DCDS) and use it to provide non-formal training to low-skilled adults in different European countries. DCDS is completely aligned to the European Digital Competence Framework for Citizens – DigComp and thus promotes its adoption in Europe." [1]
Main results in regard to Industry 4.0:	Outputs from [1]: ● Digital Competences Development Methodology(DCDM): for the development of digital competences and related transversal skills of adults; ● Digital Competences Development Environment(DCDE): Consisting of a self-assessment tool, online management tools, online learning application, multilingual digital open educational resources, validation & certification of digital competences; ● Personalised blended non-formal training: composed by training modules which combine online learning with face-to-face support sessions by e-facilitators

Co-funded by the European Union

	● Handbooks and course guides: for implementing the methodology to assist the trainers and the training providers in planning and delivering flexible and modular training offers ● Policy Influence Toolkit: which includes policy recommendations on e-Inclusion, Adult Education and Digital Skills Agenda. Learning outcomes for basic digital competence in [2] have been defined in accordance with DigComp 2.1framework. List of skill covered in this project includes: 4.1 Protecting devices 4.2 Protecting personal data and privacy 5.3. Creatively using digital technology (Involves ability to simply explain what new tools and services are such as: online collaboration environments, augmented/virtual reality, robots, voice commands, intelligent assistants, drones, 3D printing, internet of things.)
References:	1. https://eaea.org/our-work/projects3/dcds/ 2. http://www.dcds-project.eu/wp-content/uploads/2019/02/D6_DCD-Methodology-_v1_revised.pdf

Title:	**ICT Security in VET**
Acronym (if any):	**ITSVET**
Website:	http://database.centralbaltic.eu/project/5
Period:	01.12.2015 – 31.03.2019
Source of funding:	Interreg (Central Baltic Programme)
Partners: (Latvian partners in bold)	• The Technology Education Support Foundation (Igaunija)- coordinator • BCS Koolitus AS (Igaunija) • Tallinn Polytechnic School (Igaunija) • **Riga Technical College (Latvija)** • Helsinki Business College (Somija) • **The Latvian Information and Communications Technology Association – LIKTA (Latvija)** • Foundation Innove (Igaunija)
Short overview:	"The project ITSVET aims at developing a model for providing ICT security skills on the vocational education level. Reports show that demand for ICT security professionals has grown faster over the past five years than demand for other ICT jobs. Thus, the objective of the project is to meet the needs of the region's employers through developing a VET model for the ICT security specialists to reduce the skill gap of the labour market in the Central Baltic region. The consortium brings together ICT employers,

	vocational education institutions and vocational education regulatory bodies." [1]
Main results in regard to Industry 4.0:	The results of this project [1]: 1) Competence Standard (based on the analysis of ICT Security skills needs on the labour market); 2) Curricula in four languages (english, estonian, finnish, latvian) 3) Learning resources (in estonian, latvian and finnish); 4) Skilled and competent VET institution teachers for teaching ICT security; 5) Curriculums teaching plan (teaching methods, relevant resources and methodologies.) 6) Piloted and evaluated curriculum (in all three partner schools)
References:	1. http://database.centralbaltic.eu/project/5

Title:	**Speeding up network internationalization of food, ICT Industry 4.0 clusters and their SMEs towards strategic third countries beyond Europe in field of emerging industries and Fast Moving Consumer Goods (FMCG 4.0)**
Acronym (if any):	**AUMENTA**
Website:	https://www.itbaltic.com/single-post/aumenta
Period:	01.09.2020 – 01.03.2022
Source of funding:	European Union's small and medium-sized enterprises (SMEs) competitiveness program "COSME"
Partners: (Latvian partners in bold)	• **Latvian IT Cluster (Latvia)- coordinator** • Agrofood and Bioeconomy Cluster (Poland) • SMART food cluster (Lithuania) • **Food Products Quality Cluster (Latvia)** • Asociación Cluster Granada Plaza Tecnologica y Biotecnologica (Spain) • Morocco • Georgia • Uruguay
Short overview:	From [1]: "The Project's overall aim is to implement and test joint internationalization strategy aimed at supporting SMEs to identify growth opportunities worldwide, increase the internationalisation of SMEs, augment business and cooperation opportunities with strategic partners in third countries beyond Europe and facilitate their integration into global value chains. [..] The project interconnects of five relevant and complementary partners from four countries (ES, PL, LT, LV) uniting high technology

	clusters (ICT/ Industry 4.0) with traditional sectors (food) towards jointly and consciously selected third countries beyond Europe:

Morocco - as a strategic gate to North African/ South-Mediterranean (MEDA) markets;

Georgia - as a strategic gate to Caucasus & post-URSS markets;

Uruguay - as a strategic gate to Latin American markets

to lead international cluster cooperation in field of emerging industries:

- Food 4.0.
- Industry 4.0 applied to agrofood industry
- Fast Moving Consumer Goods (FMCG 4.0) and development of international commerce and eCommerce." |
| Main results in regard to Industry 4.0: | Expected results published in [2] are:

● Number of cluster organisations and business networks from different COSME participating countries having benefited from the supported actions – 5
● Number of cooperation agreements resulting from the supported actions – 15
● Number of business agreements resulting from the supported actions – 20
● Number of events (workshops/ matchmaking events/ working group meetings) organised – 12
● Number of cluster and business matchmaking meetings supported – 48
● Number of SMEs having directly or indirectly benefited from the supported actions, resulting in cooperation projects – 30
● Increase in the percentage of the turnover from international activities, and employment in Europe, of the SMEs having benefited directly and indirectly from the supported actions, as measured through a survey by the end of the action – 5%
● Impact of the supported actions in terms of number of resulting cooperation projects between international cluster and business network partners – 3 |
| References: | 1. https://www.itbaltic.com/single-post/aumenta
2. https://clustercollaboration.eu/eu-cluster-partnerships/escp4i/speeding-network-internationalization-food-ict-industry-40-clusters-and-their#section-5 |

Title:	**Integrated Components for Complexity Control in affordable electrified cars**
Acronym (if any):	**3Ccar**
Website:	**https://cordis.europa.eu/project/id/662192**
Period:	01.06.2015 – 31.10.2018
Source of funding:	Horizon 2020
Partners: (Latvian partners in bold)	INFINEON TECHNOLOGIES AG (Germany)- coordinator **Institute of Electronics and computer science (EDI) (Latvia)** and 45 more partners from Austria, Belgium, Czech Republic, Finland, France, Germany, Italy, Lithuania, Netherlands, Romania, Spain, Taiwan, United Kingdom
Short overview:	"3Ccar's impact is maximizing pragmatic strategy: Use semiconductor technology innovations to manage functionality & complexity increase. This leads also to cheaper, efficient, robust, comfortable, reliable and usable automotive systems. This strengthens Europe as a whole (OEM, Tier1, Semiconductor) generating economic growth and new jobs in Europe. The impact of 3Ccar is driven vertically by innovations and horizontally enabling growth and deployment in the industry based on what we see as European Values. We recognized that European engineers develop for highest efficiency, convergence and manageable complexity. [..] The technologies developed in 3Ccar will be commercialized all over the world while giving advantages to Europe's OEMs willing to manufacture in Europe. 3Ccar will be involved in standardization needed to ensure that large vertical supply chains can be established." [1]
Main results in regard to Industry 4.0:	As a result, 32 systems and products are being introduced to the market and/or being prepared for market introduction in the years 2018- 2025 [2].
References:	1. https://cordis.europa.eu/project/id/662192/results 2. https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5be166d82&appId=PPGMS

Co-funded by
the European Union

Title:	**Internet of Things as a policy instrument for the city change**
Acronym (if any):	**IoTXchange**
Website:	https://urbact.eu/iotxchange
Period:	02.09.2019–13.05.2022
Source of funding:	URBACT
Partners: (Latvian partners in bold)	• Fundão (Portugal)- coordinator • Razlog (Bulgaria) • Dodoni (Greece) • Åbo Akademi University (Finland) • Nevers Agglomération (France) • **Jelgava Local Municipality (Latvia)** • Ånge (Sweden) • Kežmarok (Slovakia)
Short overview:	"Internet of Things as a policy instrument for the city change. It encourages the creation of a network of European partners committed to the **design of digitalization plans based on Internet of Things (IoT) solutions** to increase the quality of life in small and medium sized EU cities. URBACT methodology based on transnational cooperation between cities and engagement of local groups offer to our network of 9 cities the conditions to each develop an Integrated Action Plan that will guide us through a new age of digital transformation." [1]
Main results in regard to Industry 4.0:	Planned results of a project as can be found on [2]: "Develop an action plan for municipality how it can use the Internet of Things for creating a smart city. Action plan covers various areas like administration, safety, health, education, enterpreneurship etc. (As stated in [3]: the period for action plan is 2022-2032.)
References:	1. https://urbact.eu/iotxchange 2. http://www.jelgavasnovads.lv/lv/pasvaldiba/projekti/paslaik-istenosana/interreg-iii-urbact/15275/lietu-internets-ka-politikas-instruments-parmainam-pasvaldiba-iotxchange/ 3. https://www.facebook.com/IoTXchange.URBACT

Title:	**Innovative Open Education on IoT: improving higher education for European digital global competitiveness**
Acronym (if any):	**IOT-OPEN.EU**
Website:	https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2016-1-PL01-KA203-026471
Period:	01.09.2016 – 31.08.2019
Source of funding:	Erasmus+
Partners: (Latvian partners in bold)	• Politechnika Slaska (Poland) • Universita Degli Studi Di Messina (Italy) • Itt Group (Estonia) • Tallinna Tehnikaulikool (Estonia) • **Rigas Tehniska Universitate (Latvia)** • Saint Petersburg National Research University Of Information Technologies, Mechanics And Optics (Russia)
Short overview:	"IOT-OPEN.EU project is aimed at bridging the gap between what higher education offers and what the European labor market needs in the field of Internet of Things - one of the most fast growing and promising areas in the world of information and communication technologies. [..] The IOT-OPEN.EU project offers students and teachers an array of possibilities to discover how digitalisation of education can bring significant quality improvements and make learning outcomes more relevant to the labour market needs. The project introduces virtual remote laboratories and open e-learning materials within one innovative multidisciplinary teaching module on the Internet of Things. It will allow students from Bachelor's to Master's levels and adult learners to experience capabilities of the Internet of Things devices both in theory and in practice." [1]
Main results in regard to Industry 4.0:	"IOT-OPEN.EU delivers content for classical IOT courses held at the universities or companies, MOOC online courses available through the web and provides access to the physical devices so-called VREL distant/remote access IoT laboratories." [2] Open access course book on Internet of Things (available in Latvian here: https://ec.europa.eu/programmes/erasmus-plus/project-result-content/92252e46-43c8-4ccc-9935-590bdb8ba9fe/iot-open.eu-LV.pdf) On 17.04.2020 it was reported that: "we've already hit far over 10K students, studying IOT-OPEN.EU content from virtually all over the world at the moment."[3]

Co-funded by
the European Union

References:	1. https://robolabor.ee/et/content/13-iot-open
	2. https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2016-1-PL01-KA203-026471
	3. https://www.linkedin.com/pulse/project-iot-openeu-innovative-open-education-iot-higher-di-pietro

Title:	**Advancing fail-aware, fail-safe, and fail-operational electronic components, systems and architectures for fully automated driving to make future mobility safer, affordable and end-user acceptable**
Acronym (if any):	**AutoDrive**
Website:	https://autodrive-project.eu/
Period:	01.05.2017 - 30.06.2020
Source of funding:	Horizon2020 ESCEL
Partners: (Latvian partners in bold)	• INFINEON TECHNOLOGIES AG (Germany)- coordinator • **Institute of Electronics and Computer Science (EDI) (Latvia)** • In total 58 partners from 13 countries: Germany, Austria, Spain, Italy, Latvia, Norway, Belgium, Czech Republic, Netherlands, Taiwan, Sweden, Finland, Lithuania
Short overview:	"Automated driving is a disruptive technology which opens the door to future multi-billion markets providing business opportunities to value chains in automotive and semiconductor industry. The European industry has leading competitive strength in the development and manufacturing of highly reliable electro-mechanical systems. In order to preserve this capability Europe needs to setup European standards for high level control such as real-time computing or big data processing. In order to respond on the global challenge AutoDrive has gathered Europe's leading semiconductor companies, suppliers, OEMs, and research institutes committed to create a pan-European eco-system, which has the critical mass to initiate standards and provides the components and subsystems for automated driving. [..] AutoDrive aims for the design of (i) fail-aware (self-diagnostics), (ii) fail-safe, (iii) fail-operational (HW and SW redundancy) electronic components and systems architecture that enable the introduction of automated driving in all car categories. AutoDrive results will significantly contribute to safer and more efficient mobility. It will raise end-user acceptance and comfort by supporting drivers in highly challenging situations (active safety) as well as in regular driving situations."[1] " AutoDrive is a European project focusing on the development of connected, electric and highly automated vehicles with special focus on safety. [..]

	With diverse background of all the partners, AutoDrive aims to find synergies among different aspects of autonomous driving. From the development perspective, it covers the whole development lifecycle from requirement analysis to validation and Test. From the product perspective, it includes most of the automotive functional components for automated driving such as perception, communication, decision, control and the electrical powertrain. From the technical perspective, it considers software, hardware, system architecture and safety."[4] Source [5] summarises **main aims** of the project: ● Fully automated driving and flying systems targeting SAE level; ● Highly automated driving SAE Level 4; ● Cooperative active safety for automated driving; ● Fail-operational 800V automotive powertrain ● Safe, secure and low latency communication ● Acquisition, 360° sensing, perception, and environmental awareness; ● Embedded intelligence and systems for automated driving; ● Fail aware components and health prediction.
Main results in regard to Industry 4.0:	It was concluded that during project 102 described, standardization and commercial exploitation results with exploitation routes were established. Whereas 83 scientific publications were released! 63 events attended! 36 project videos produced [..][3] The main results of the project are mentioned in [6]: ● 2 free assembled product prototypes (Shuttle Pod and Aircraft); ● Automated bus; ● Improved road scanning; ● Developed new active safety features (Cooperative automated emergency brake assistant, Fault tolerant lateral controller); ● New automotive power chain (Fail-operational, 800V, Stochastic drift model, weakness monitor); ● New reliable v2x communication system; ● Certification and standardization of automated driving systems (2 draft regulations: cybersecurity engineering and Software-update OTA [Over The Air update]); ● Traffic simulation tool;
References:	1. https://cordis.europa.eu/project/id/737469 2. https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5cfda8446&appId=PPGMS 3. https://autodrive2.automotive.oth-aw.de/news/201-autodrive-s-super-final-review-accomplished 4. https://www.kth.se/mmk/mechatronics/current-projects/autodrive-1.779888 5. https://autodrive2.automotive.oth-aw.de/images/dissemination/AutoDrive_Poster_EFECS2018.pdf 6. https://autodrive2.automotive.oth-aw.de/videos

Title:	**DIGINNO-Proto e-CMR prototype**
Acronym (if any):	**DIGINNO-Proto**
Website:	https://www.diginnobsr.eu/diginno-proto
Period:	July 2019 - December 2020
Source of funding:	Nordic Council of Ministers
Partners: (Latvian partners in bold)	• Ministry of Economic Affairs and Communications (Estonia)-coordinator • Associative partners: • **Latvian Information and Communication Technology Association (LIKTA) (Latvia)** • Lithuanian Information and Communication Technology Association (INFOBALT) (Lithuania) • Polish Chamber of Commerce for Electronics and Telecommunications (KIGEIT) (Poland) • **LMT (Latvia)** Alongside LMT, the pilot project participants from Latvia were the Latvia State Radio and Television Centre, Latvian Information and Communications Technology Association, the Ministry of Transport of Latvia, State Revenue Service, Freeport of Riga, Road Transport Administration, logistics companies, and other representatives of both private and public sector [4].
Short overview:	"DIGINNO-Proto project is a sub-project supporting and extending the DIGINNO project activities. [..] DIGINNO-Proto project was initiated to demonstrate one of these show-cases (eCMR) through prototyping."[1] "The prototype objective was to create an eCMR indexing prototype for paperless international logistics. It aimed to allow the service providers to index their active eCMRs and the controlling institutions to check the availability of CMR transport documents of the foreign road carriers driving through their territory in a secure and trustful way. With the use of the indexing service and the indexing number of an eCMR, the appointed government institutions of the involved country would be able to see where the eCMR is stored and receive agreed available data."[2]
Main results in regard to Industry 4.0:	The project partners developed a common cross-border indexing scheme – from the principles to the working prototype which was tested with cross-border test cases and against live eCMR service providers [2].

Co-funded by
the European Union

	The prototype will allow a regional shift from paper CMR to eCMR – an opportunity for both businesses and authorities to gain efficiency and transparency through digitalization [2].
	The prototype will enable businesses to manage their supply chain more effectively and simplify communication with public authorities: once the eCMR document is created, it can be shared electronically with the necessary authorities or business partners [2].
	Cross-border prototype testing was carried out across all participating countries – Estonia, Latvia, Lithuania, Poland - in August and September 2020 in cooperation with governmental institutions (Tax and Customs Board, Police, Road Administration, etc.) together with private sector eCMR service providers and road carriers [3].
References:	1. https://www.diginnobsr.eu/diginno-proto 2. https://www.diginnobsr.eu/ecmr 3. https://www.diginnobsr.eu/ecmr-testing-results 4. https://innovations.lmt.lv/projects/e-cmr-documentation-digitization/

Title:	**Real-time AI urban video analytics**
Acronym (if any):	N/A
Website:	https://innovations.lmt.lv/projects/real-time-ai-urban-video-analytics/
Period:	in development
Source of funding:	Unknown
Partners: (Latvian partners in bold)	• **LMT (Latvia)** • Fyma (Estonia)
Short overview:	Using AI to transform urban data into valuable information that ensures increased road safety and traffic optimization [1].
Main results in regard to Industry 4.0:	"LMT has partnered with Fyma, an Estonia-based company that offers a GDPR-compliant computer vision solution that turns any CCTV camera into an intelligent analytics tool. LMT plays a crucial role in delivering the real time AI video analytics solution to its potential users. We set up, configure, and provide maintenance for certified network cameras, and securely send the video stream via the 4G network to Fyma servers. There, the stream is analyzed using multiple neural networks to obtain actionable data. LMT can provide reliable analytics in locations that lack infrastructure, and without our input and support the real time AI video analytics wouldn't be so widely available.

	Only the necessary data points obtained from the video stream are saved (no video footage or photos are saved in any format), ensuring data privacy and full compliance with GDPR regulations."[1]
References:	1. https://innovations.lmt.lv/projects/real-time-ai-urban-video-analytics/

Title:	**Intelligent Motion Control Platform for Smart Mechatronic Systems**
Acronym (if any):	**I-MECH**
Website:	https://cordis.europa.eu/project/id/737453
Period:	01.07.2017 – 31.05.2020
Source of funding:	Horizon2020 EU.2.1.1.7.
Partners: (Latvian partners in bold)	• SIOUX TECHNOLOGIES BV (Netherlands)- coordinator • **Institute of Electronics and Computer Science (EDI) (Latvia)** • and 30 more from Chech Republic, Netherlands, Spain, Greece, Portugal, Belgium, Italy, France, Ireland
Short overview:	"The I-MECH target is to provide augmented intelligence for wide range of cyber-physical systems having actively controlled moving elements, hence support development of smarter mechatronic systems. They face increasing demands on size, motion speed, precision, adaptability, self-diagnostic, connectivity, new cognitive features, etc. Fulfilment of these requirements is essential for building smart, safe and reliable production complexes. This implies completely new demands also on bottom layers of employed motion control system which cannot be routinely handled by available commercial products. On the ground of this, the main mission of this project is to bring novel intelligence into Instrumentation and Control Layers mainly by bridging the gap between latest research results and industrial practice in related model based engineering fields. Next, I-MECH will deliver new interfaces and diagnostic data quality for System Behavior Layer. It strives to provide a cutting edge reference motion control platform for non-standard applications where the control speed, precision, optimal performance, easy reconfigurability and traceability are crucial. The high added value of I-MECH reference platform will be directly verified in high-speed/big CNC machining, additive manufacturing, semicon, high-speed packaging and healthcare robotics. In these sectors, the main project pilots will be validated. However, the platform will be applicable in many other generic motion control fields. The project outputs will impact on the entire value chain of the production automation market and, through envisioned I-MECH center, create sustainable proposition for future smart industry."[1]
Main results in regard to Industry 4.0:	"The EU-funded I-MECH project developed a framework to employ advanced control solutions in industrial settings. The chosen approach is

	known as model-based systems engineering. The project developed 11 building blocks that (among other functions) monitor or control industrial processes to find incremental improvements.[..]

The team applied its building blocks to five pilot applications, which use machinery developed by project partners. The applications include a generic substrate carrier, which is the conveyor component of large-format inkjet printers, and a 12" wafer stage of semiconductor manufacture. The remainder cover a teabag machine, a computer numerical control (CNC milling machine) and a healthcare robot that moves an X-rays system around patients that lie on a table.

In each case, the systems received upgrades identified by the building blocks. Eventually, all building blocks, and an entire toolchain, will be available for industrial customers, who will be able to select just the building blocks they need for their specific application." X3ъ

As reported in [2] EDI (Latvia) in this project is developing smart wireless sensor networks and algorithms for real-time mechatronic systems. |
| References: | 1. https://cordis.europa.eu/project/id/737453
2. https://www.edi.lv/projects/intelligent-motion-control-platform-for-smart-mechatronic-systems-i-mech/
3. https://cordis.europa.eu/article/id/422568-embedded-algorithms-design-faster-and-more-accurate-industrial-and-health-care-equipment |

Title:	**Programmable Systems for Intelligence in Automobiles**
Acronym (if any):	**PRYSTINE**
Website:	https://cordis.europa.eu/project/id/783190
Period:	01.05.2018 – 31.10.2021
Source of funding:	Horizon 2020 ECSEL Joint Undertaking
Partners: (Latvian partners in bold)	• INFINEON TECHNOLOGIES AG (Germany)-coordinator • **Institute of Electronics and Computer Science (EDI) (Latvia)** • And 59 other partners from: Italy, Israel, Netherlands, Austria, Spain, Turkey, Greece, Finland, Romania, Lithuania, Germany, Belgium, Sweden
Short overview:	"The ambition of PRYSTINE is to strengthen and to extend traditional core competencies of the European industry, research and universities in smart mobility and in particular the electronic component and systems and cyber-physical systems domains. PRYSTINE's target is to realize Fail-operational Urban Surround perceptION (FUSION) which is based on

Co-funded by
the European Union

	robust Radar and LiDAR sensor fusion and control functions in order to enable safe automated driving in urban and rural environments. Therefore, PRYSTINE's high-level goals are: 1. Enhanced reliability and performance, reduced cost and power of FUSION components 2. Dependable embedded control by co-integration of signal processing and AI approaches for FUSION 3. Optimized E/E architecture enabling FUSION-based automated vehicles 4. Fail-operational systems for urban and rural environments based on FUSION."[1]
Main results in regard to Industry 4.0:	The main results of PRYSTINE project are novel Radar sensors, innovative embedded control and E/E architectures, pioneering sensorfusion approaches and AI-controlled vehicle demonstrators.[2] As reported in [2] EDI (Latvia) in this project is developing and implementing progressive AI algorithms for CPU/SOC/GPU based system. These algorithms are aimed at fusing data from LiDAR, stereo-camera and radar, detection and classification of objects, prediction of motion and decision-making with an emphasis on precision, reliability, safety and cost efficiency.
References:	1. https://cordis.europa.eu/project/id/783190 2. https://www.academia.edu/57339103/Programmable_Systems_for_Intelligence_in_Automobiles_PRYSTINE_Final_results_after_Year_3

Title:	**Aggregate Farming in the Cloud**
Acronym (if any):	**AfarCloud**
Website:	https://cordis.europa.eu/project/id/783221
Period:	01.09.2018 – 30.11.2021
Source of funding:	H2020-ECSEL
Partners: (Latvian partners in bold)	• UNIVERSIDAD POLITECNICA DE MADRID (Spain)- coordinator • **LATVIJAS UNIVERSITATES MATEMATIKAS UN INFORMATIKAS INSTITUTS (Latvia)** • And 60 more partners from: Spain, Germany, Belgium, Austria, Portugal, Norway, Sweden, Finland, Czechia, Poland, Italy and Greece
Short overview:	"AFarCloud will provide a distributed platform for autonomous farming that will allow the integration and cooperation of agriculture Cyber Physical Systems in real-time in order to increase efficiency, productivity, animal health, food quality and reduce farm labour costs. This platform will be integrated with farm management software and will support monitoring and decision- making solutions based on big data and real time data mining techniques.

	The AFarCloud project also aims to make farming robots accessible to more users by enabling farming vehicles to work in a cooperative mesh, thus opening up new applications and ensuring re- usability, as heterogeneous standard vehicles can combine their capabilities in order to lift farmer revenue and reduce labour costs.
	The achievements from AFarCloud will be demonstrated in 3 holistic demonstrators (Finland, Spain and Italy), including cropping and livestock management scenarios and 8 local demonstrators (Latvia, Sweden, Spain and Czech Republic) in order to test specific functionalities and validate project results in relevant environments located in different European regions."[1]
	"[..] AFarCloud project assumes the urgent need of a holistic and systematic approach, through smart sustainable and digital automated production. According to this view precision farming needs to consider orchestration of different application capabilities like data collection and cloud computing, a sensing-on-the-move approach, cyber physical systems (CPS) management, IoT sensing and actuation, decision support systems, autonomous vehicles (UAVs/UGVs) for most aspects of agricultural processes."[2]
Main results in regard to Industry 4.0:	Planned impact of the project as reported in [2]: ● Enhance the applications of Cyber-Physical Systems in the farming domain ● Improve the autonomy and cooperation of farming CPS solutions ● Increase the interoperability, cooperation, and reuse of CPS and autonomous vehicles achieving a better level of reduction of human labor ● Enable reliable, high-performance, real-time and secure data exchange for CPS. Guaranteeing the exchange of data in real-time is a critical safety requirement for systems that operate with autonomous vehicles. In addition, obtaining measurements in real-time is essential both in the monitoring of crops, in order to detect as quickly as possible harmful conditions for crops, such as ice or frost, as well as in the monitoring of livestock, to react quickly to any change in the health of animals, such as diseases or a calving ● Generate a direct impact and innovation in the EU farming and mechatronics industry, by providing new standards in the UAV [Unmanned Aerial Vehicles] and UGV [Unmanned Ground Vehicles] industry, in order to demonstrate and apply a structured and cost-effective approach to the development of new farming solutions.
References:	1. https://cordis.europa.eu/project/id/783221 2. https://www.sciencedirect.com/science/article/pii/S0141933120303793

Co-funded by
the European Union

Title:	**Full title: Digital Technologies, Advanced Robotics and increased Cyber-security for Agile Production in Future European Manufacturing Ecosystems**
Acronym (if any):	**TRINITY**
Website:	https://cordis.europa.eu/project/id/825196
Period:	01.01.2019 – 30.06.2023
Source of funding:	Horizon2020 - EU.2.1.1.
Partners: (Latvian partners in bold)	• Tampereen Korkeakoulusaatio SR (Finland)- coordinator • Centria Ammattikorkeakoulu OY (Finland) • Universitetet I Tromsoe - Norges Arktiske Universitet (Norway) • Institut Jozef Stefan (Slovenia) • Panepistimio Patron (Greece) • Budapesti Muszaki Es Gazdasagtudomanyi Egyetem (Hungary) • Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany) • Flanders Make (Belgium) • **Elektronikas Un Datorzinatnu Instituts (Latvia)** • Leuven Security Excellence Consortium L-Sec Vzw (Belgium) • Fastems Oy Ab (Finland) • Lp-Montagetechnik Gmbh (Germany) • F6s Network Limited (United Kingdom) • Uab Civitta (Lithuania) • Comite Europeen De Cooperation Des Industries De La Machine-Outil Cecimo Aisbl (Belgium) • Toppindustrisenteret As (Norway)
Short overview:	"The main objective of TRINITY is to create a network of multidisciplinary and synergistic local digital innovation hubs (DIHs) composed of research centers, companies, and university groups that cover a wide range of topics that can contribute to agile production: advanced robotics as the driving force and digital tools, data privacy and cyber security technologies to support the introduction of advanced robotic systems in the production processes. The result will be a one-stop shop for methods and tools to achieve highly intelligent, agile and reconfigurable production, which will ensure Europe's welfare in the future. The network will start its operation by developing demonstrators in the areas of robotics we identified as the most promising to advance agile production, e.g. collaborative robotics including sensory systems to ensure safety, effective user interfaces based on augmented reality and speech, reconfigurable robot workcells and peripheral equipment (fixtures, jigs, grippers, …), programming by demonstration, IoT, secure wireless networks, etc. These demonstrators will serve as reference implementation for two rounds of open calls for application experiments,

Co-funded by the European Union

	where companies with agile production needs and sound business plans will be supported by TRINITY DIHs to advance their manufacturing processes. Besides technology-centered services, primarily laboratories with advanced robot technologies and know-how to develop innovative application experiments, TRINITY network of DIHS will also offer training and consulting services, including support for business planning and access to financing."[1]
Main results in regard to Industry 4.0:	This is an ongoing project, planned results are stated in the description given above. The role of EDI is described in [2]: "The main role of the EDI(Latvia) is to carry out experiments in co-operation with companies and collaborate to build on new calls as well as to strongly support dissemination and communication/networking activities. Also, EDI will take part in Business planning and TRINITY education & training knowledge transfer. Besides that, EDI will provide access to EDI IoT/WSN 100 node heterogeneous sensor network and wireless sensor network testbed (distributed around 7 floor building (inside & outside)) for validation and research in sensor network & wireless network protocols (additionally, 50 mobile nodes are available on site and can be moved to actual factory, to perform the tests in real production/manufacturing environment). EDI will provide best practices for rapid development of WSN/IoT systems. Created Impact: Decreased development and testing time/costs of WSN/IoT systems; Decreased time to market for large scale WSN/IoT networks in production environment; Smarter and more efficient production and manufacturing in factories. Also, EDI will provide access to ANN [Artificial Neural Network] algorithms and methods for object detection, recognition, classification, control, etc., which can be used for thousands of vision-based systems applications to automate/optimize different industrial processes. EDI will provide best practices for custom ANN development and use. Created Impact: Lower development costs; Rapid development; Smarter, optimized and more efficient production and manufacturing in factories."
References:	1. https://cordis.europa.eu/project/id/825196 2. https://www.edi.lv/en/projects/digital-technologies-advanced-robotics-and-increased-cyber-security-for-agile-production-in-future-european-manufacturing-ecosystems-trinity-2/

DigiWork

Digital Transformation, Industry 4.0 and Human Resources Management: Innovative skills to enhance HE students' employability, flexibility and transversal capabilities

Title:	**Framework of key enabling technologies for safe and autonomous drones' applications**
Acronym (if any):	**COMP4DRONES**
Website:	https://www.comp4drones.eu/
Period:	01.10.2019 – 30.09.2022
Source of funding:	ECSEL JU
Partners: (Latvian partners in bold)	• Indra Sistemas Sa (Spain)- Coordinator • **Elektronikas Un Datorzinatnu Instituts (Latvia)** • **Latvijas Universitates Matematikas Un Informatikas Instituts (Latvia)** • **Latvijas Mobilais Telefons SIA (Latvia)** • and 57 more partners from Spain, Austria, Belgium, Czechia, France, Italy, Netherlands and Belgium
Short overview:	"The COMP4DRONES project complements SESAR JU efforts with a particular focus on safe software and hardware drone architectures. COMP4DRONES will bear a holistically designed ecosystem ranging from application to electronic components, realized as a tightly integrated multi-vendor and compositional drone embedded architecture solution and a tool chain complementing the compositional architecture principles. The ecosystem aims at supporting efficient customization and incremental assurance of drone embedded platforms, safe autonomous decision making concerning individual or cooperative missions, trustworthy drone-to-drone and drone-to-ground communications even in presence of malicious attackers and under the intrinsic platform constraints, and agile and cost-effective compositional design and assurance of drone modules and systems. COMP4DRONES will also build an open sustainable ecosystem around public, royalty-free and goal-driven software platform standards that will ease the development of new drone functionalities for multiple application domains. Lead applications driving ecosystem development and benchmarking on the fields of transport, infrastructure inspection, urban logistic, precision agriculture, parcel delivery, among others, will be produced."[1] "The project will mainly focus on the following objectives: – Ease the integration and customization of embedded drone systems. – Enable drones to take safe autonomous decisions. – Ensure the deployment of trusted communications. – Minimize the design and verification effort for complex drone applications."[2]

Co-funded by
the European Union

Main results in regard to Industry 4.0:	Results mentioned in [5] that have been created with this project include (some of them not yet finished as the project hasn't concluded yet): ● Drones regulations compliance handbook [3]; ● Specification of Integrated and Modular Architecture for Drones[4]; ● Safe and reconfigurable UAV [Unmanned Aerial Vehicle] software components that support autonomous decision making; ● Robust and efficient UAV communication infrastructure that ensures trustworthy drone-to-drone and drone-to-ground communications. As stated in [2]: EDI will develop a modular, highly adaptable and power efficient embedded platform for sensor data acquisition, fusion and processing in drones.
References:	1. https://www.comp4drones.eu/project-info/overview/ 2. https://www.edi.lv/en/projects/framework-of-key-enabling-technologies-for-safe-and-autonomous-drones-applications-comp4drones-2/ 3. https://www.comp4drones.eu/wp-content/uploads/2022/03/C4D_D2.5_D2.5-%E2%80%93-Drones-regulations-compliance-handbook_v3.1.pdf 4. https://www.comp4drones.eu/wp-content/uploads/2021/02/C4D_D3.1_Specification-of-Integrated-and-Modular-Architecture-for-Drones_v1.5.pdf 5. https://aeneas-office.org/funding/ecsel-ju/ecsel-projects-overview/comp4drones-3/

Title:	**Strategic programs for advanced research and technology in Europe**
Acronym (if any):	**SPARTA**
Website:	https://www.sparta.eu/
Period:	01.02.2019 – 31.01.2022
Source of funding:	H2020-EU.2.1.1.
Partners: (Latvian partners in bold)	• Commissariat A L Energie Atomique Et Aux Energies Alternatives (France)- coordinator • **Latvijas Mobilais Telefons SIA (Latvia)** • And 45 others from Austria, Belgium, Czechia, Germany, Estonia, Greece, Spain, France, Italy, Lithuania, Luxembourgh, Poland and Portugal
Short overview:	"The digital era has brought with it many advantages for mankind, but the issue of secure data exchange remains among the most significant concerns. The EU-funded SPARTA project is bringing together a unique set of actors at the crossroads of scientific excellence, technological innovation and social sciences to address the issue of cybersecurity. The project aims to set up unique collaborations, build transformative

	capabilities and form world-leading expertise centres. Through innovative governance, ambitious demonstration cases and active community engagement, SPARTA intends to re-think the way cybersecurity research is performed in Europe across various domains and fields of expertise."[1] SPARTA will create a long-lasting community capable of collaboration to define, develop, share, and evolve solutions that will help practitioners prevent cybercrime and enhance cybersecurity [3].
Main results in regard to Industry 4.0:	In [2] these results are listed among others: ● International and national cybersecurity certification initiatives ● Cybersecurity skills framework ● AI systems threat analysis mechanisms and tools ● Security-by-design framework for the intelligent infrastructure
References:	1. https://cordis.europa.eu/project/id/830892 2. https://cordis.europa.eu/project/id/830892/results 3. https://www.sparta.eu/#Structure

Title:	**Development of a robotic weed management equipment**
Acronym (if any):	**RONIN**
Website:	https://www.zm.gov.lv/lauku-attistiba/statiskas-lapas/projekts-robotizetas-nezalu-ierobezosanas-iekartas-izveide-?id=19468#jump
Period:	01.01.2019 - 31.12.2020
Source of funding:	European Agricultural Fund for Rural Development, Rural development 2014-2020 for Operational Groups
Partners: (Latvian partners in bold)	• **Latvia University of Life Sciences and Technologies (Latvia)- coordinator** • **Institute of Electronics and Computer Science (EDI) (Latvia)** • **Lejasvagaļu dārzs SIA (Latvia)** • **J. Lipska saimniecība "Absolūts Ēd" (Latvia)** • **Atvases ZS (Latvia)**
Short overview:	Source [1] sumarizes the goal of the project: "Within the project it is planned to develop a weed management equipment that would be able to autonomously move on a field and identify weeds and crops, as well as a high-power laser or precisely positioned mechanical tool is going to be used, to destroy the weed or considerably hinder its further growth."
Main results in regard to Industry 4.0:	Outcomes of this project as reported in [2] are: ● A functioning prototype of a weed management robot that can autonomously move to the field, move along the row of crops, detect and destroy weeds using laser or a mechanical tool. ● An algorithm for detecting weeds (based on deep learning with convolutional neural networks). ● An algorithm for detecting a row of crops.

References:	1. https://www.edi.lv/en/projects/development-of-a-robotic-weed-management-equipment-ronin/ 2. https://www.zm.gov.lv/public/ck/files/Nosleguma_parskats_RONIN_V2.pdf

Title:	**Automotive Intelligence for/at Connected Shared Mobility**
Acronym (if any):	**AI4CSM**
Website:	https://ai4csm.automotive.oth-aw.de/
Period:	01.05.2021. - 30.04.2024.
Source of funding:	Horizon 2020 ECSEL Joint Undertaking
Partners: (Latvian partners in bold)	• Infineon Technologies AG- coordinator • **Institute of Electronics and Computer Science (EDI) (Latvia)** • **Smartsol SIA (Latvia)** • And 38 others from Germany, Austria, Norway, Belgium, Czech Republic , Italy, Netherlands , Lithuania, India.
Short overview:	"Digital technologies are a significant enabler for attaining sustainability goals in mobility and transportation. The EC is taking initiatives to ensure that digital technologies such as AI, 5G, IoT, and cloud/edge computing can accelerate the transition of the automotive industry to electrical, autonomous, connected, and shared vehicles. [..] The AI4CSM project will develop advanced electronic components and systems (ECS) and architectures for future mass-market ECAS vehicles. [..] AI4CSM will deliver key innovations in technical areas including sensor fusion and perception platforms; efficient propulsion and energy modules; advanced connectivity for cooperative mobility applications; vehicle/edge/cloud computing integration concepts; new digital platforms for efficient and federated computing; and intelligent components based on trustworthy AI techniques and methods. ECAS vehicles enabled by embedded intelligence and functional integration for future mobility become the pivotal factor for the automotive sector to address the Green Deal principles. "[1]
Main results in regard to Industry 4.0:	Planned results described in overview section. According to [1], EDI will develop hardware for AI-based near field, high resolution 360- degree perception system, AI algorithms for the detection and classification of different surrounding objects with high accuracy, and implementation of developed algorithms in Infineon Aurix PPU.
References:	1. https://www.edi.lv/en/projects/10788/

Title:	**Trustworthy and Smart Actuation in IoT systems**
Acronym (if any):	**ENACT**
Website:	https://www.enact-project.eu/
Period:	01.01.2018 – 31.12.2020
Source of funding:	H2020
Partners: (Latvian partners in bold)	• Sintef As (Norway)- Coordinator • Ca Technologies Development (Spain) • Ca Spolka Z Ograniczona Odpowiedzialnoscia (Poland) • Ca Technology R&D Limited (United Kingdom) • Evidian Sa (France) • Indra Sistemas Sa (Spain) • Fundacion Tecnalia Research & Innovation (Spain) • Tellu As (Norway) • Centre National De La Recherche Scientifique Cnrs (France) • Universite Cote D'azur (France) • Universitaet Duisburg-Essen (Germany) • Istituto Per Servizi Di Ricovero E Assistenza Agli Anziani (Italy) • **Baltic Open Solutions Center (Latvia)** • **Institute Of Electronics And Computer Science (EDI) (Latvia)** • Stiftelsen Sintef (Norway) • Tellu Iot As (Norway) • Montimage Eurl (France) • Beawre Digital Sl (Spain)
Short overview:	"To unleash the full potential of IoT, realizing the digital society and flourishing innovations in application domains such as eHealth, smart city, intelligent transport systems, and smart manufacturing, it is critical to facilitate the creation and operation of trustworthy Smart IoT Systems. Since smart IoT systems typically operate in a changing and often unpredictable environment, the ability of these systems to continuously evolve and adapt to their new environment is decisive to ensure and increase their trustworthiness, quality and user experience. The DevOps movement advocates a set of software engineering best practices and tools, to ensure Quality of Service whilst continuously evolving complex systems and foster agility, rapid innovation cycles, and ease of use. Therefore, DevOps has been widely adopted in the software industry. However, there is no complete DevOps support for trustworthy smart IoT systems today. The main technical goal of ENACT is to develop novel IoT platform enablers to: Enable DevOps in the realm of trustworthy smart IoT systems, and enrich it with novel concepts for end-to-end security and privacy, resilience and

	robustness strengthening trustworthiness, taking into account the challenges related to "collaborative" actuation and actuation conflicts. Facilitate the smooth integration of these to leverage DevOps for existing and new IoT platforms and approaches (e.g., FIWARE, SOFIA, and TelluCloud)."[1]
Main results in regard to Industry 4.0:	"ENACT supports DevOps practices during the development and operation of trustworthy smart IoT systems by offering software tools, called "enablers", for each of the seven stages of the DevOps life-cycle model [3]." Book "DevOps for Trustworthy Smart IoT Systems" documents the results of the project (available here: https://nowpublishers.com/Article/BookDetails/9781680838244) EDI will define the requirements for future IoT systems in intelligent transport usecase, testing of developed solutions and will provide the infrastructure and platform for the showcase and validation of ENACT results with train transport [2].
References:	1. https://cordis.europa.eu/project/id/780351 2. https://www.edi.lv/en/projects/trustworthy-and-smart-actuation-in-iot-systems-enact-2/ 3. https://nowpublishers.com/article/Chapter/9781680838244?cId=978-1-68083-825-1.ch1

Title:	**Artificial Intelligence for Digitizing Industry**
Acronym (if any):	**AI4DI**
Website:	https://ai4di.eu/
Period:	01.05.2019 – 30.11.2022
Source of funding:	H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP
Partners: (Latvian partners in bold)	• Infineon Technologies AG (Germany)- coordinator • **Institute Of Electronics And Computer Science (EDI) (Latvia)** • And 46 other partners from Germany, Austria, Czech Republic, Italy, Norway, Latvia, Taiwan, Belgium, Lithuania, France, Greece, Finland
Short overview:	"AI4DI aims to strengthen and expand AI usage in European industry digitization process. Enabling of performance, industry and humanity by AI for digitising industry is the key to push the AI revolution in Europe and step into the digital age. Potential users of AI are not sufficiently supported to facilitate the integration of AI into their applications. Existing services providing state of the art machine learning (ML) and artificial intelligence solutions are currently available in the cloud. AI4DI project aim is to transfer machine learning and AI from the cloud to the edge in

	manufacturing, mobility and robotics. To achieve these targets AI4DI will connect factories, processes, and devices within digitised industry by utilizing ML and AI for human machine collaboration, change detection, and detection of abnormalities."[1]
Main results in regard to Industry 4.0:	According to [3], project works with AI technologies in such industrial applications as: Food and Beverage, Industrial Machinery, Automotive, Semiconductor and Transportation and plans to provide a deployment plan showing how to develop and valorise AI technology in each of those industrial sectors. "The project will deliver several solutions including different AI-based functions and will be validated in 15 industrial demonstrators such as: ● An application for analysis, planning and decision-making powered by AI-based methods for the complex logistics control processes, such as supply chain control strategy and distributed and secure computing with data anomaly checks. ● An innovative edge-based system with integrated Machine Learning (ML) algorithms for 3D image analysis, trends recognition and full supervision availability for improved product quality. ● An automated wood machinery with Augmented reality (AR), Voice recognition and direct operator interaction to enhance safety and productivity on autonomous and collaborative robots and machine tools in their interaction with human operators."[4] Contribution of EDI [1]: ● develops cognitive sensing to perceive and understand dynamically changing environment for randomly dropped object detection, pose estimation and pick-up by an industrial robot – AI is used to analyze the data of a stereo vision system, which incorporates processing on the edge (FPGA based SoC) [1]. ● together with partners enables robots of any size to "feel" – a reflectometric sensor is proposed featuring miniaturized electronics and single-channel measurement also for large scale areas. Neural networks are used to map the sensor signal to the apparent deformation which is related to the touch input or collision event. ● together with partners develops technologies to detect the position between the robot and surrounding objects, and to allow unobtrusive/contactless interaction between the operator and the robot.
References:	1. https://www.edi.lv/en/projects/artificial-intelligence-for-digitizing-industry-ai4di/ 2. https://ai4di.eu/ 3. https://ai4di.automotive.oth-aw.de/library/brochures 4. https://www.tttech.com/innovation/research-projects/ecsel-artemis/ai4di/

Co-funded by
the European Union

Title:	**Development of microrobot based on visual recognition and machine learning for manipulation of individual living cells**
Acronym (if any):	**RoVam**
Website:	https://www.edi.lv/en/projects/development-of-microrobot-based-on-visual-recognition-and-machine-learning-for-manipulation-of-individual-living-cells-rovam/
Period:	01.01.2021. – 31.12.2023.
Source of funding:	Unknown
Partners: (Latvian partners in bold)	• **Institute Of Electronics And Computer Science (EDI) (Latvia)** • Lithuania • Taiwan
Short overview:	"We are aiming to create new type autonomous flexible microrobot for the manipulation of individual living cells. The problems in micromanipulation systems are: they are usually not autonomous, and do not recognize the objects, therefore only highly skilled person can work with the system. Our system will solve these problems: it will be smart, autonomous, and will automatically process data obtained from measurements."[1]
Main results in regard to Industry 4.0:	Planned results according to [1] are: 1) micro-positioning system, which allows to displace the manipulating tool in 3D space; 2) video recognition system for the micro-objects recognition; 3) machine learning system for the control. Tasks to be performed by EDI [1]: 1) Development and implementation of the recognition system, which will be able to: detect biological object contained in the small amount of the solution, determine object center co-ordinates and pick-up point by defining object boundaries and shape; 2) Implementation of a calibration technique for coordinate system alignment for imaging and mechanical manipulator systems.
References:	1. https://www.edi.lv/en/projects/development-of-microrobot-based-on-visual-recognition-and-machine-learning-for-manipulation-of-individual-living-cells-rovam/

Title:	**Intelligent Motion Control under Industry 4.E**
Acronym (if any):	**IMOCO4.E**
Website:	https://cordis.europa.eu/project/id/101007311
Period:	09.2021.-08.2024.
Source of funding:	H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP
Partners: (Latvian partners in bold)	• SIOUX CCM (Netherlands) - coordinator • **AS Madara Cosmetics (Latvia)** • **Institute Of Electronics And Computer Science (EDI) (Latvia)** • Netherlands, Czech Republic, Spain, Greece, Ireland, Italy, Belgium, Latvia, Poland, Denmark, Romania, Finland, Switzerland
Short overview:	"The broad IMOCO4.E challenge is to bridge the gap between the latest research results and best industrial practice in digital twins, AI and advanced mechatronic motion control systems. IMOCO4.E strive to create solid and unimpeachable knowledge for optimizing machines and production lines over their whole lifecycle."[1] "IMOCO4.E project aims to push mechatronic systems to the limits, make them smarter and more configurable. This will be achieved by combining and exploiting novel sensory information, model-based approaches, AI, machine learning and industrial IoT philosophies. IMOCO4.E will provide edge-to-cloud intelligence for machines, robots and other human in the-loop automation systems. [..] the project will help shape the future of Industry 4.0 manufacturing in Europe. It will both perceive and control complex machines and robots. Specifically, it will deliver a reference architecture that will be verified in applications for semiconductors, packaging, industrial robotics and healthcare."[2]
Main results in regard to Industry 4.0:	Planned results according to [1] are: Software and Hardware building blocks (BBs), edge-to-cloud distributed and featuring standardized interfaces, will be developed to deliver a complete IMOCO4.E reference framework. These building blocks will embed the latest thinking from the academic community and, moreover, can be enhanced in future with new research results. The project will deliver a flexible, scalable, future-proofed and fully functional product architecture to be exploited in industry in high-performance motion control applications with several overlaps to health, mobility and supply chain management domains. Planned contribution from EDI [1]: "EDI continues to research and develop intelligent industrial robots. Our first challenge is to demonstrate the ability of an adaptable robot to work on real production lines, where the robot must be able to take objects of different types and sizes from a random pile and place them in the

Co-funded by
the European Union

	appropriate size sockets. The second challenge is to make this robot to be quickly retrainable by anyone to work with previously unseen objects. "
References:	1. https://www.edi.lv/en/projects/intelligent-motion-control-under-industry-4-e-imoco4-e/ 2. https://cordis.europa.eu/project/id/101007311

Title:	**Industrial inertial wireless sensor** **Industrial inertial wireless sensor part 2**
Acronym (if any):	**IIWS**
Website:	https://www.edi.lv/en/projects/industrial-inertial-wireless-sensor/ https://www.edi.lv/en/projects/industrial-inertial-wireless-sensor-iiws-part-2/
Period:	01.05.2020. - 30.09.2020. 01.01.2021. – 30.06.2022. (part II)
Source of funding:	ERDF
Partners: (Latvian partners in bold)	• **Institute Of Electronics And Computer Science (EDI) (Latvia)**
Short overview:	"Industrial inertial wireless sensor (IIWS) performs measurements of movements of a mechatronic machine. [..] Movement measurements allow to register information about changes in the position of the machine, making it possible to assess the absolute position, vibration or other physical changes of the equipment after performing the data processing. The proposed technology, in the context of mechatronics and robotics, addresses a number of industrial production challenges. By evolution of Industry 4.0 concept, where various mechatronic and robotic hardware is supplemented with different sensors to enhance the efficiency of performance and production, industry starts to require industries need new and reliable sensors. Moreover, since many of these mechatronic and robotic systems have moving and rotating components, when installing sensors on these, there is no option to install wiring harnesses, to ensure power supplying and communication capabilities, therefore industry starts to see demand rising for sensors, which have power supply and radio communication module installed in themselves."[1] Overview of the part II [2]: "Various analogue solutions for monitoring concrete structures have been available for many years, but those are not easy to use. Also traditionally this is a time-consuming process and

Co-funded by the European Union

	construction company employees usually have to come to the construction site in order to carry out specific measurements or to read measurements generated by various sensors. [..] The EDI solution to monitor concrete behavior and shrinkage fits perfectly into the general process of construction digitization[..]"
Main results in regard to Industry 4.0:	The main aim is to advance this technology [Industrial inertial wireless sensor] to TRL7 level [1]. "The main target [of part II] is to develop modern IoT solution – to secure wireless communications between sensors that can monitor concrete structures, concrete hardening , shrinkage process and hand held end-user equipment. This includes the creation of a convenient graphical interface design and the ability to use the solution remotely via a cloud server when responsible persons are located in company office." [2]
References:	1. https://www.edi.lv/en/projects/industrial-inertial-wireless-sensor/ 2. https://www.edi.lv/en/projects/industrial-inertial-wireless-sensor-iiws-part-2/

Appendix 5: Companies

Title:	Autentica
Website:	https://www.autentica.lv/lv/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	SIA Autentica is an IT company engaged in digitisation, automation and robotisation of business processes. Their clients are public authorities as well as medium and large companies in the Baltics and Scandinavia [1]
Reference:	1. https://www.autentica.lv/lv/par-mums/

Title:	Squalio
Website:	https://squalio.com/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company offers data and AI services like data analytics, data visualisation, automation and AI for industries (finance, transport and logistics, retail, healthcare, education, human resources) [1]
Reference:	1. https://squalio.com/services/data-ai-services/

Title:	Emergn Latvia
Website:	https://www.emergn.com/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company, among other services, offers data analytics and intelligent automation [1, 2]
Reference:	1. https://www.emergn.com/data-and-analytics/ 2. https://www.emergn.com/intelligent-automation/

Title:	LVM GEO
Website:	https://www.lvmgeo.lv/en/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	LVM GEO offers a collection of geospatial information technology (GIT) products and services. LVM GEO services are [1]: ● Geographic information system development ● Spatial planning optimisation model development ● GIS consulting and project management ● GIS data management and analysis ● Remote sensing services
Reference:	1. https://www.lvmgeo.lv/en/about-lvm-geo

Title:	dots.
Website:	https://www.wearedots.com/en
Short overview of involvement in Industry 4.0 (activities/results/etc.):	One of the product types of this company is related to cybersecurity [1]
Reference:	1. https://www.wearedots.com/en/protect

Title:	Peruza
Website:	https://peruza.com/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company's core competence comes from processing small pelagic fish production from ship to shelf. PERUZA is researching new Artificial Intelligence-based vision systems that will allow ensuring processing and quality checks for more quality products. [1]
Reference:	1. https://peruza.com/contact-us/#aboutus

Title:	Systemview
Website:	https://systemview.lv/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The enterprise helps companies implement efficient Internet of Things (IoT) solutions. They offer services in [1]: 1. Remote reading of water meters 2. Waste monitoring 3. Asset protection 4. Smart street lighting 5. Building energy efficiency 6. Smart parking 7. Air quality monitoring 8. Water quality monitoring 9. Other solutions 10. Safety of seniors
Reference:	1. https://systemview.lv/

Title:	Digital Mind
Website:	https://en.digitalmind.lv/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company provides solutions in intelligent process automation and cloud business application [1]
Reference:	1. https://en.digitalmind.lv/

Title:	cognizant
Website:	https://www.cognizant.com/lv/en
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company offers services in the fields of artificial intelligence, cloud enablement, intelligent process automation, and security [1]
Reference:	1. https://www.cognizant.com/lv/en

Co-funded by the European Union

Title:	Geomatic
Website:	https://www.geomatic.lv
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company offers augmented reality services, among others. This service is intended both for builders and designers to show what the planned buildings and structures will look like in a real environment. [1]
Reference:	1. https://www.geomatic.lv/en/services/augmented-reality/

Title:	Baltic3D
Website:	Baltic3D.eu
Short overview of involvement in Industry 4.0 (activities/results/etc.):	Founded in 2013, Baltic3D.eu is the regional market leader in High Performance 3D Industrial Printing. As the official representative of Stratasys (one of the largest Industrial 3D Machine manufacturers in the World), Baltic3D is a one-stop shop for Industrial Customers in Europe: from in-house 3D modelling to series production with Quality Assurance and delivery to your Factory door-step within days. [1]
Reference:	1. https://www.baltic3d.eu/baltic3d-team

Title:	Cyber Circle
Website:	https://cybercircle.eu/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company is a professional cyber security expertise provider in active cyber defence and advanced cyber education [1].
Reference:	1. https://cybercircle.eu/

Title:	Lightspace
Website:	https://lightspace3d.com/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	Lightspace is a Deep-tech company with its R&D laboratories, industrialisation and fabrication facilities developing key technologies for the next generation of augmented reality. A global leader in volumetric, multi-focal and light field technologies.[1]
Reference:	1. https://lightspace3d.com/products/

Title:	SIA "Robologic"
Website:	https://robologic.group/about-us/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	ROBOLOGIC company specialises in any complexity process automation. Its main services include online and offline robot programming, electrical engineering and PLC programming Thanks to our qualified specialists, "Robologic Group" provides a service for full or partial automation of any process: from small business algorithms to high-powered line production [1]
Reference:	1. https://robologic.group/about-us/

Title:	Tilde
Website:	https://www.tilde.lv/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company is a leader in language processing technology, offering machine translation tools and solutions, virtual assistants, voice technologies [1]
Reference:	1. https://www.tilde.lv/

Title:	LMT
Website:	https://www.lmt.lv/lv/
Short overview of involvement in Industry 4.0 (activities/results/etc.):	The company introduces 5G technology and participates in many technologically advanced projects that include cloud computing, artificial intelligence and cybersecurity [1]
Reference:	1. https://www.lmt.lv/lv/

Co-funded by
the European Union