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Translating Industry 4.0 to improved SME policy instruments targeting innovation

Thematic report on the 3rd thematic issue

Innovation in software development

Region of Thessaly, Greece – Project Partner 4

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Introduction

The following report is a result of the transnational learning process that took part during the Phase 1 of the INNO PROVEMENT project for the 3rd thematic issue "Innovation in software development". More particularly the Region of Thessaly hosted on Semester 6 the 6th Transnational Thematic Meeting in which the partnership presented the framework and the initiatives that have been implemented in the participating countries and regions for the support of SMEs to introduce software innovation towards their digital transformation in order to adapt to the requirements set by the Industry 4.0.

The first section of the report provides an overview of the how the concept of innovation in software development affect business organizations in the era of Industry 4.0, while the second section presents national and regional policy initiatives focused on software innovation in enterprises mainly by calls for funding in the framework of European Structural and Investment Funds.

1. Theoretical Framework of Innovation and Software Development

1.1 The definition of Innovation and EU strategy

The term ''innovation'' can signify both an activity and the outcome of the activity. The general definition of an innovation is as follows: An innovation is a new or improved product or process that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process). This definition uses the generic term "unit" to describe the actor responsible for innovations. It refers to any institutional unit in any sector, including households and their individual members. This definition is further developed and operationalized to provides the basis for the practical guidelines in this manual for the business sector. Although the concept of innovation is inherently subjective, its application is rendered fairly objective and comparable by applying common reference

points for novelty and utility, requiring a significant difference to be appreciated. This facilitates the collection and reporting of comparable data on innovation and related activities for firms in different countries and industries and for firms of different sizes and structures, ranging from small single-product firms to large multinational firms that produce a wide range of goods or services. Innovation activities include all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm. A business innovation is a new or improved product or business process that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm.

As evidenced by the Europe 2020 Strategy (European Commission, 2010), until recently the EU has persevered on the central idea that innovation is to be achieved by fundamentally increasing investment in R&D to levels of 3% of GDP across the board (Rodríguez-Pose, 2020). This approach to innovation has been progressively complemented by more comprehensive efforts towards promoting innovation involving broader measures.

In fact, changes associated with the evolution of the Framework Programs (FPs) point towards a turning tide that goes beyond the conceptualization of innovation as an R&D-led activity. Initiatives such as the Smart Specialization platform are important steps in this direction, as has been the greater emphasis placed by the Horizon-2020 Framework on innovation and close-to-market activities, providing around 10% of the Horizon 2020 (H2020) budget to SMEs. But the reality has been that until the end of 2020 the 3% of GDP R&D objective remained the cornerstone of the EU innovation policy.

1.2 The Definition of Software Development

Software development refers to a set of computer science activities dedicated to the process of creating, designing, deploying and supporting software. Software itself is the set of instructions or programs that tell a computer what to do. It is independent of hardware and makes computers programmable. There are three basic types:

1. System software to provide core functions such as operating systems, disk management, utilities, hardware management and other operational necessities.
2. Programming software to give programmers tools such as text editors, compilers, linkers, debuggers and other tools to create code.
3. Application software (applications or apps) to help users perform tasks. Office productivity suites, data management software, media players and security programs are examples.

A possible fourth type is embedded software. Embedded systems software is used to control machines and devices not typically considered computers — telecommunications networks, cars, industrial robots and more. These devices, and their software, can be connected as part of the Internet of Things (IoT).

Software development is primarily conducted by programmers, software engineers and software developers. These roles interact and overlap, and the dynamics between them vary greatly across development departments and communities.

Software development can be also thought of as utilizing an "ever-expanding set of lego bricks" (Branstetter et al., 2019). It enables changes in the conceptual structure of products, services and business models across different industrial sectors and contexts (Porter and Heppelmann, 2015; Svahn et al., 2017). It also facilitates the development of new forms of emergent entrepreneurship and innovation. Since the applications of digital technologies developed in one sector can spread to other parts of the economy and be recombined with other applications of the same technology, digitalization holds considerable potential for new applications and innovation.

1.3 The link between Innovation and Software Development

There is a growing body of empirical evidence suggesting a "soft-ware-biased shift" in the nature and direction of innovation over recent decades (Branstetter et al., 2019), i.e., that new innovations are becoming increasingly software-centered or software-dependent. While this shift toward software-intensive innovation started in industries

such as electronics, semiconductors and IT hardware in the 1980s (Arora et al., 2013), it appears to have grown outside of the traditional ICT industry during the 2000s. Many firms in manufacturing and services develop software to differentiate their products and services, as well as to increase user value. Software development has thus become increasingly integrated into firms' innovation activities. While this shift toward software-intensive innovation may seem intuitive, there is still little empirical evidence as to its extent and variation across the economy. There are three main lines of research addressing the link between software development and innovation: (i) one studying the growth in software patents and its relationship to firm performance, (ii) one investigating software-intensity or software-dependence in innovation by looking at citations of software patents, and (iii) one focusing on the direct use of software in the innovation process.

1.4 The Oslo Manual

In 1991, the city of Oslo witnessed the first agreement within the global community of practitioners in the OECD Working Party of National Experts on Science and Technology Indicators on how to conceptualize and measure business innovation. These guidelines became known as the Oslo Manual, which was published and put to the test with the support of the European Union. The fast adoption and diffusion of the manual's proposals, both within and beyond the OECD and the EU, are a clear indication of the value of this initiative; in fact, innovation surveys covering more than 80 countries have been carried out thus far. Since 1992, the Oslo Manual has been the international standard of reference for conceptualizing and measuring innovation. It has since been revised on three occasions to account for growing levels of adoption and address evolving user needs.

The Oslo Manual provides guidelines for collecting and interpreting data on innovation. It seeks to facilitate international comparability, and provides a platform for research and experimentation on innovation measurement. Its guidelines are principally intended to support national statistical offices and other producers of innovation data in

designing, collecting, and publishing measures of innovation to meet a range of research and policy needs. In addition, the guidelines are also designed to be of direct value to users of information on innovation. These guidelines should be viewed as a combination of formal statistical standards, advice on best practices, as well as proposals for extending the measurement of innovation into new domains through the use of existing and new tools. At present, a large number of countries and international organizations recognize the importance of innovation measurement and have developed capabilities to collect such data. This manual supports this coordinated effort in pursuit of robust, internationally comparable data, indicators and analysis.

Innovation is central to improvements in living standards and can affect individuals, institutions, entire economic sectors, and countries in multiple ways. Policy can contribute directly and indirectly to setting the direction of innovation and shaping how its effects are distributed. Sound measurement of innovation and the use of innovation data in research can help policy makers better understand economic and social changes, assess the contribution (positive or negative) of innovation to social and economic goals, and monitor and evaluate the effectiveness and efficiency of their policies (OECD, 2010).

Measurement requires an understanding of what needs to be measured and awareness of what can be reliably measured. In response to strong policy demand for empirical evidence on innovation, the Oslo Manual addresses both requirements, and supports further experimentation to improve and extend innovation data. The manual identifies best practices for data collection on innovation, facilitates international comparability, and provides a platform for research on innovation measurement. The manual plays a key role in communicating that innovation often does not require research and experimental development (R&D) and that innovation also involves the diffusion of existing technologies and practices across an economy.

The first edition of the Oslo Manual was issued in 1992 (OECD, 1992) and covered innovation in manufacturing industries. “Oslo” in the title of the manual is a reference to the city where the guidelines were first approved by the OECD Working Party of National Experts on Science and Technology Indicators (NESTI). Innovation surveys based

on the 1992 edition included the European Community Innovation Survey (CIS) and comparable surveys in Australia and Canada. These surveys showed that it was possible to develop and collect data on complex and differentiated innovation phenomena.

The second edition (OECD/Eurostat/EU, 1997) updated the concepts, definitions and methodology to incorporate accumulated survey experience as well as greater understanding of the innovation process. This edition included guidelines for measuring innovation in several service industries in addition to manufacturing. It expanded the guidance for developing internationally comparable innovation indicators for OECD countries and discussed analytical and policy problems that could be addressed using innovation data and indicators.

Both the first and second editions limited innovation to new or significantly improved "technological" products and processes. This reflected a focus on the technical development of new products and new production techniques and their diffusion to other firms. The measurement of "non-technological" innovation, however, was discussed in an annex to the second edition.

The third edition (OECD/Eurostat, 2005) built on a large amount of data and experience gained from the rapid adoption of innovation surveys worldwide, including in economies at very different levels of economic development. The third edition expanded the innovation measurement framework: it gave greater emphasis to the role of linkages with other firms and institutions in the innovation process, recognized the major importance of innovation in traditionally less R&D-intensive industries, and modified the definitions of innovation and innovation activities to accommodate innovation in market-based service industries. The identification of product and process innovation with technological change was abandoned in order to include service innovations that significantly improved user experiences without necessarily having a technological component. The definition of innovation was extended to include two additional and complementary types: organizational and marketing innovation. The third edition also included an annex on measuring innovation in developing countries, reflecting widespread interest in this topic.

The revisions to the Oslo Manual over time reflect continual evolution in expert consensus on what can and should be measured. This evolution is due to ongoing changes in economic and social factors, such as the nature of innovation and how it occurs, as well as the accumulation of measurement experiments and the sharing of experiences among experts interested in measuring innovation. Increasing societal awareness of innovation related phenomena has also expanded interest in new targets for measurement. Yet despite these advances, there are still major gaps in evidence and questions about the role of innovation and what policies can do to influence it. One of the main objectives of this fourth edition of the Oslo Manual is to address some of these gaps and outstanding questions.

Published 13 years after the release of the manual's third edition, this fourth edition seeks to strengthen its relevance as a source of conceptual and practical guidance for the provision of data, indicators and quantitative analyses on innovation. The role of the Oslo Manual as a key guideline for policy analysis and discussion was highlighted in the Group of Twenty (G20) Innovation Action Plan (G20, 2016) endorsed by G20 Leaders in Hangzhou, the People's Republic of China, in September 2016. The summit demonstrated high-level interest by the governments of the world's largest economies in good innovation measurement to assist policy, as well as reaffirming the OECD's role in supporting this objective.

The 2016 OECD Blue Sky III Forum (http://oe.cd/blue-sky) stressed the need to extend the measurement of innovation to the broader economy and society. With this in mind, NESTI proposed that this fourth edition also become a platform for future experimentation and guidance by discussing key innovation concepts in a broader sense and by providing a general definition of innovation, as requested by many stakeholders. Consequently, despite the Oslo Manual's focus on measuring innovation in the Business sector, the fourth edition includes a framework for measuring innovation in all sectors using a common definition. This explains why the title of the fourth edition does not refer explicitly to business innovation.

At the outset of the revision process, participants agreed that the fourth edition of the Oslo Manual should incorporate the following substantial extensions and improvements:

- Include general definitions and concepts of innovation applicable to all four economic sectors (Business, Government, Non-profits serving households, and Households). These are necessary for developing future guidelines for measuring innovation in sectors other than the Business sector.
- Ensure that the recommendations are relevant to both developed and developing countries so that the manual provides effective global guidance.
- Ensure consistency with the 2015 edition of the Frascati Manual for measuring R&D (OECD, 2015) and major statistical frameworks and guidelines, including the System of National Accounts (SNA).
- Address the ongoing digitalization of the economy and society, as identified in the OECD project "Going Digital" (www.oecd.org/sti/goingdigital.htm). The manual covers digital perspectives in several chapters and provides guidance on measuring innovation in digital products, platforms, and data capabilities.
- Fully reflect changing models of innovation, including those relating to open innovation, global value chains and global innovation networks.
- Apply the evidence and experience accumulated over the past decade to address long-standing challenges (subjectivity and international comparability, interpretation of the novelty and improvement requirements for innovation, quantitative measurement of innovation inputs and outputs, coverage of non-R&D-based innovation, etc.).
- Promote the collection of a broader set of data of relevance to both non-innovative and innovation-active firms, for instance on investments in knowledge-based capital (KBC) and on the internal and external conditions in which firms operate and decide to undertake innovation-relevant practices. This is required for analyses of the drivers and enablers of innovation.

- Provide in-depth discussion of survey methodology, plus the implications of data collection methodologies on data quality, timeliness, and international comparability.
- Discuss how statistical data on innovation can be used to support research, management, and policy, including indicator development and how to assess the effectiveness of policies to support innovation.

The fourth edition of the Oslo Manual focuses on innovation in the Business enterprise sector, including, in many cases, government-owned enterprises. The approach of the fourth edition is as follows:

- Collect innovation data using statistically representative samples of firms in the Business sector. Although new data sources are available, such as from the Internet, many of them do not share the desirable features of representative samples from the population of interest. Consequently, the manual recommends the use of representative surveys as the preferred method for data collection. Where feasible, these can be complemented with additional representative surveys or by linking surveys to administrative data.
- Highlight how responses to survey questions are influenced by survey methods and questionnaire design. In particular, it is advised not to combine an innovation survey with an R&D survey.
- Primarily collect data using a subject-based approach that captures all of a firm's innovation activities. This can be complemented with additional information on the firm's most important innovation (or the most important innovation activity, or change for non-innovative firms), also known as an object-based approach.

1.5 The Frascati Manual

The Frascati Manual has been an international standard for more than fifty years and it is now a world standard. The use of research and experimental development (R&D) statistics, based on the guidance in the manual, has gained influence and the statistics are being used in a wide range of policy areas, and in many countries outside of the

OECD. The manual provides the basis for a common language for talking about R&D and its outcomes. In keeping with the extensive use of the manual, and the presence of its definitions in other international manuals and in country regulations, the definition of R&D and its components have been kept close to those in previous editions. More attention has been spent on identifying boundaries between what is and what is not R&D and on meeting new demands on R&D statistics.

For more than 50 years, the OECD Frascati Manual has been the acknowledged worldwide standard for collecting and reporting internationally comparable statistics on the financial and human resources devoted to research and experimental development. The coordinated efforts among and beyond OECD countries to define and implement the recommendations in this manual have resulted in a valuable source of evidence for science, research and economic policy makers. The definitions provided herein have been adopted and adapted by many governments and serve as a common language for discussions across multiple domains, including those related to science and technology policy, economic development policy, and fiscal, tax and regulatory policy, as well as for the development of guidance on financial accounting, investment and trade statistics, among others.

Interest in measuring research and experimental development (which in this manual is used interchangeably, but precisely, with the term “R&D”) stems from its potential to make a significant contribution to economic growth and prosperity. The new knowledge resulting from R&D can be used to meet national needs and global challenges and to improve overall societal well-being. Individuals, institutions, economic sectors and countries, both developed and developing, are affected in multiple ways by the outcomes of R&D. Hence, the indicators collected in the framework of the Frascati Manual influence and inform discussions on such important debates.

From its initial origins, the Frascati Manual has been written by and for national experts who collect and issue national R&D statistics and submit responses to R&D surveys by the OECD, the EU, UNESCO and other international organizations. Although many examples are given, this manual remains a technical document that is intended as a

reference work. In the same vein, the Frascati Manual has never been a binding document but instead a set of proposed guidelines discussed at length and agreed upon by consensus. Since the first guidelines were adopted in 1963 by the conference of national experts from OECD member countries in the Italian town of Frascati, this manual had been revised on five previous occasions, to reflect and address known measurement challenges, new user needs and best practices developed worldwide. The process of revision and dialogue with users reflects the capacity for the community of experts that produce this manual to engage in on-going learning.

Throughout its history, the Frascati Manual has provided the definition of R&D used in other manuals, and it has been complementary to other manuals that have appeared and now form part of a framework for science, technology and innovation statistics, known as the Frascati "family" of manuals, a body of guidelines in a state of constant and overlapping evolution.

The sixth revision of the Frascati Manual incorporates major changes in terms of presentation, coverage and collection detail. Major changes, revisions and improvements are highlighted. However, it is important to emphasize that the definition of R&D presented in this manual is still consistent with the definition of R&D used in the previous edition of the Frascati Manual (OECD, 2002) and is intended to cover the same range of activities. Indeed, every effort was made to minimize the potential need for revisions in major statistical R&D indicator time series. Nonetheless, revisions may be the necessary outcome in the practice of some individual countries, as the steps for convergence with established international guidance become clearer with the revised manual. It is also intended and expected that the clarifications contained in this manual will facilitate the assessment and interpretation by policy makers of official R&D statistics and of R&D figures obtained from complementary accounting, tax, trade and other sources. Unlike the more recent revisions to this manual, the changes introduced in this edition appear, and to some degree are extensive. A number of factors weighed on the decision to expand coverage and increase guidance on the "hows", "whats" and "whys" of collecting R&D statistics. Several of the more influential factors included the following:

- From its very beginning, this manual has been closely linked to the System of National Accounts (SNA). One major change in the 2008 revision of the SNA was the explicit adoption of Frascati R&D definitions and data as the basis for recommending the treatment of R&D expenditures as capital formation, that is, as investment. This development placed the Frascati Manual firmly within the framework of national statistical accounting standards, but also called for a number of adaptations to facilitate the use of Frascati R&D data by national statisticians. This revision thus considered the feasibility of implementing a number of recommendations laid out in the OECD Handbook on Deriving Capital Measures of Intellectual Property Products (OECD, 2009a). Classification relationships with and data needs for the SNA are introduced in detail in Chapter 3 and then highlighted and clarified throughout this manual.
- The widespread use of this manual for both statistical and policy-related purposes has resulted in repeated calls to clarify concepts, definitions and measurement practices. Quite often these requests reflect conflicting agendas and vested interests. This manual does not presume to take sides on such matters, but rather offers clear guidance on the preferred and recommended definitions and collection methods that should—or can be—universally applied. To that end, it has been necessary on the one hand to expand the manual's coverage to make R&D statistics relevant for a wider range of policy decisions but on the other hand to provide for as few changes as possible so that there remains stability in the core historical series.
- The Frascati Manual is the de facto R&D reference document across countries at different stages of economic development, with varying forms of economic structures and national research systems and with a wide spectrum of statistical infrastructures. In line with the expanding membership of the OECD itself and a major shift towards greater engagement with non-member countries, this manual attempts to provide guidance for identifying and collecting R&D data that is relevant for countries with very diverse economic and research characteristics. A conscious effort has been made to understand the idiosyncratic approaches

used by some countries in apparent contradiction with Frascati guidance and to find a more appropriate formulation of the intentions behind the existing guidelines.

- There is mounting recognition of the importance of a variety of ongoing changes in the organization of R&D activities and the challenges these pose. These changes include R&D's role in the globalization of value chains; the adoption of new organizational arrangements that extend beyond the traditional boundaries of individual organizations, sectors or countries; and new approaches to providing financial support for R&D, all of which are giving rise to new user needs as well as calls for data collection practices to be revised and extended. This manual recognizes the importance of such developments and to the extent possible offers guidance on how to address these new statistical challenges.
- The need to address emerging methodological challenges and opportunities is paramount. On the one hand, general guidance on such matters is of relevance to the collection of all types of economic statistics. On the other hand, the atypical characteristics of R&D both from an activity perspective (a difficult-to-define, often nonexclusive, intangible service) and from a statistical perspective (a rare, highly skewed often non-continuous event) warrant special methodological guidance. There is furthermore the need to take into account new types of uses of R&D data, including causal analysis of the relationship between inputs and outputs, using micro-data, subject to confidentiality constraints, matched with supplementary sources. An expanded Chapter 6 on statistical methodology as well as sector-specific guidance in the individual sector chapters addresses key issues, including difficulties experienced in maintaining response rates and reducing the burden on respondents; the use of administrative data sources; and demands for ensuring the international comparability and consistency over time of national R&D indicators. Adherence to such guidance will enable countries to demonstrate compliance with best statistical practices and exploit the full potential of the resulting microdata.

- Finally, and of practical importance, there is the need to reflect changes in statistical classification systems and practices, such as the UN classifications of industry (ISIC), education (ISCED) and the 2008 SNA. Most statistical manuals have been revised since the 2002 edition of the Frascati Manual, which until this revision continued to refer to some outdated statistical practices and concepts.

2. National/ Regional Framework and Initiatives in Innovation in Software Development

In this chapter is presented the national and regional framework and the initiatives in innovation in software development, as a result of the interregional learning process of the INNOPROVEMENT partnership and the 6th Transnational Thematic Meeting which was organized by the Region of Thessaly on 11-12 of May 2021.

2.1 Hungary - Ministry of Finance

Theoretical Framework of Innovation in Software Development

Software development is the description of a unique relationship ('algorithmisation') and its application by the creation (implementation) of an appropriate software environment. The big question for software development is when is it development, when is it innovation and when is it research and development.

- Development: If the existing supply (product or service portfolio) is not expanded with a new product or service, and the software development is aimed at solving existing problems, then in this case, no R & D & I activity takes place.
- Innovation: If the development is not aimed at merely increasing the capacity, but at creating the conditions necessary to expand the existing supply, it is considered business innovation.
- Research and Development: If a new creative activity takes place, then in this case, an R&D activity can be identified.

Under Hungarian legislation, research-development activities include those that have the following general characteristics at the same time:

- Novelty: Its result being new, not known in this form and/or with these characteristics (not part of technology as exist at the time).
- It is based on a unique idea: It is created based on a unique, non-apparent idea and concept.
- Technical and technological uncertainty: The result is not obvious, an expert cannot simply arrive to the particular conclusion, due to the uncertainties around implementation.

  Experimenting: In each case, creation of the result requires systematic and documented experimenting.

Software development can become R&D activity with the following steps:

1. By performing predictions with the help of an algorithm representing our theoretical model.
2. By comparing the obtained data with the data experienced.
3. Then, the handling of a given problem and the applicability of an algorithm implemented as a prototype can be determined by these comparative analyses.
4. In many cases, this can even result in a review and rewording of the algorithm, which can lead to a circular algorithmisation and testing process.

The difficulty with the software development is the uncertainty and the state of the art of the technology. The state of the art is difficult to identify due to the lack of publication and the lack of copyright applicants.

R&D certification of software developments is a potential solution. In Hungarian legal practice, it is possible to classify, and establish that, according to the legislation:

- The given project can be considered as a research and development activity.
- What is the proportion of the types of research and development activities within the given project (basic research, applied research, experimental development).

- The given project will be carried out within the scope of the applicant's own activities.

Hungary has detailed legal regulations in line with international practice for research and development and innovation, intellectual property and their utilization. Also, Hungary is a member of all international and regional conventions that play a key role in research and development, innovation and intellectual property.

The important elements of the Hungarian legal regulation are the following:

- Separate law on research and development and innovation: LXXVI of 2014 Act on Research and Development and Innovation (Innovation Act)
- Legislation on Intellectual Property Act LXXVI of 1999 on Copyright, XXXIII Act of 1995 on the Patent Protection of Inventions, Act XI on the Protection of Trademarks, Act XLVIII of 2001 Act on the Protection of Designs, Other Legislation by Type of Intellectual Property (Intellectual Property: Copyright, Industrial Property Protection)
- Know-how law: LIV Act of 2018 on the Protection of Business Secrets
- Rules related to the accounting of R&D and innovation activities: Act C of 2003 on Accounting (Accounting Act) Legislation related to the taxation of research and development and innovation activities: LXXXI Act of 1996 - Corporate tax law (Act on corporate income taxes), ancillary legal regulations on local business tax, innovative contributions (Tax Laws)
- Legislation supporting the use of tax benefits: 9/2012. (11.1) Government Decree on Research and Development Certification (R&D Qualification for Tax Benefits)

In addition, according to the Hungarian Innovation Act, R&D activities include basic research, applied research and experimental development. The Innovation Act provides exact definitions for each type of R&D based on the Frascati Manual. In order to have a project qualified as R&D, it should meet the requirements of one of the three types of activities.

Hungarian Intellectual Property Office (HIPO) is the central government office responsible for the protection of intellectual property, supervised by the Minister for

Innovation and Technology, and provides regulatory and technical support to the companies and the government in the context of qualification for R&D activities.

According HIPO, basic research is the experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts without any particular application or use in view. Also, applied research is the planned investigation or critical analysis undertaken in order to acquire new knowledge and expertise for the development of new products, processes or services, or for the considerable development of existing products, processes or services. Experimental development is the acquisition, summarization, formation and use of existing scientific, technological, commercial and other relevant knowledge and expertise to elaborate new products, processes or services, or to improve existing products, processes or services

Hungary provides several types of subsidies and tax incentives to facilitate R&D activities. To ensure the unified interpretation of R&D and the proper allocation of R&D funding, the Hungarian Government established a transparent institutional system for R&D qualification. Since 2012, HIPO has been fulfilling the role (in addition to its Intellectual Property and copyright-related tasks) of qualifying R&D activities as an independent government agency. The purpose of the qualification system is to strengthen legal certainty through the use of R&D subsidies and tax benefits.

The result of an R&D qualification can be used for verifying the R&D content of projects when using state aid and utilizing R&D tax incentives. The resolution or expert opinion issued by HIPO serves as a guarantee both to the companies and the government in relation to:

- Allocating subsidies either from the state budget or from EU sources
- Monitoring whether state aid was actually spent on R&D purposes
- Revising whether the utilization of R&D tax incentives is justifiable
- Determining whether the support of R&D investments in Hungary by foreign companies is well-founded

The Hungarian Innovation Act of 2014 provides a uniform definition of R&D, and guarantees that qualifications from HIPO are based on a standard and transparent procedure. According to the Innovation Act, R&D includes:

- basic research
- applied research
- experimental development

HIPO may evaluate the R&D content of a project in three types of qualification procedures:

- project qualification
- expert opinion
- project group qualification

In order to increase transparency and provide a reliable source of information about the qualification procedure, HIPO has published a Methodology Guide. The Guide is based on national and international standards and practices, such as the Frascati Manual by OECD.

The Methodology Guide elaborates on the definition of the R&D activity. It also marks off related activities not belonging to research and development, and gives examples to help define the types of R&D. The document also gives a detailed overview of the different procedures, and lists all the important criteria of the qualification procedure.

R&D comprises creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society, and to devise new applications of available knowledge in order to resolve some scientific or technical uncertainty. Scientific or technical uncertainty means the desired knowledge or a solution to a problem is not obvious to a person who has the basic scientific knowledge and technical skills in the relevant field.

HIPO examines whether the following criteria can be found in the project.

Novelty

The intention to create new knowledge is an integral conceptual element of research and development. However, when assessing novelty, HIPO does not perform a novelty search as defined by the Patent Act. The assessment of novelty in the R&D qualification process is categorically separated from the novelty search of the patent process.

When determining novelty, global state of the art should be the starting point. Examining the state of the art is the examination of freely accessible information, which has to be performed in detail, as this is the reference point for the desired activity. It is essential to demonstrate how the desired acquisition of novel knowledge means advancement.

Results of the project have to be novel not only for the given company, but it has to be proven that similar solutions haven't been used before in the given industry. At the same time, if there is a need for new solutions and new knowledge in order to adapt an already known and accessible system from another source, then the activity of elaborating and acquiring such solutions and knowledge should be regarded as research and development.

The applicant as a person conducting the R&D activity has to describe the accessible knowledge and the state-of-the-art technology with due diligence.

The requirement of novelty is to be interpreted differently in each type of R&D. From basic or applied research to experimental development, the novelty requirement rests on gradually different meanings. In the case of basic and applied research, the focus is on obtaining novel knowledge. In the case of experimental development, the qualification rather focuses on assessing whether a solution to a problem is obvious to a person who has the basic scientific knowledge and technical skills in the related field.

Based on creative activity

An R&D project has to realize new creative concepts and ideas, which result in the acquisition of new knowledge. For instance, data processing is a routine activity, therefore, it cannot be considered R&D. However, if this activity is part of a project

aimed at developing new methods in data processing, and the activity is necessary to dispel some scientific/ /technological uncertainties, then the activity could fall within the scope of R&D.

Based on scientific or technical uncertainty

There is no scientific or technological uncertainty if the new knowledge to be acquired or the solution to a problem is obvious to a person familiar with the basic scientific knowledge and techniques of the relevant field. This person is someone who has the required expertise (qualifications) and experience in the given field. Often scientific/technological uncertainty arises if a scientifically/technologically feasible solution has to be adapted into a cost-effective, reliable and reproducible process, material, product or service. In general, uncertainty in an R&D project may arise with regard to its budget, time frame or feasibility. Furthermore, there might be inherent systemic uncertainty in the scientific and technological uncertainties as well, which stems from the complexity of a system rather than how the individual components behave separately.

Systematic activity

A basic feature of R&D is that the exploration of new knowledge and coherent relationships needs a systematic approach. R&D work is carried out systematically if a scientifically and/or technologically interpretable hypothesis is set up that is supported by literature, which has to be realized by planned and documented collection of information or scheduled experiments and if planned and documented experiments and/or modelling are realized in order to dispel a scientific and technological uncertainty and risk.

Transferable and/or reproducible by others

The description of the R&D process has to be concrete enough, so that other competent experts could potentially realize the same research. The research steps have to be reproducible and transferable based on the research plan and other documentation. The purpose of R&D is to increase the existing stock of knowledge. In a business

environment, however, the results will be protected by secrecy or other means of intellectual property protection. While at universities and research institutes, the codification of knowledge and its dissemination is the main purpose of R&D.

During the qualification, HIPO examines the activities based on the description provided in the application. The applicant shall provide a technical and technological description of the project, and shall focus on the special features of the given field by considering the following topics:

- the scientific knowledge necessary for implementing the project, the state-of-the-art technology at the time of the submission of the application
- the assessment of the scientific uncertainty at the start of the project, which hinders the achievement of the targets
- the definition of the new concept, which dispels the scientific uncertainties
- the novelty of the project and the scientific uncertainty to be dispelled the desired new scientific outcomes of the project content of the qualification
- the desired new scientific outcomes of the project
- the progress brought about by the new method, compared to existing technologies
- the methodology applied during the project

Project Presentation

According HIPO a project presentation has to follow the next 5 steps:

- Target
- State of the art
- Novelty
- Steps of implementation
- Uncertainty

R&D qualification procedures

The result of the R&D qualification procedures may be used for taking advantage of state subsidies and/or tax and contribution rebates. Applicants may choose from three

different types of procedures depending on the criteria and the applicants' needs and purposes.

- Project Qualification: Anyone who intends to realize an R&D project can initiate a preliminary project qualification at HIPO. In this case, HIPO in its official capacity issues a binding resolution. The subject of the qualification procedure can only be a fixed term project or part of a project to be started after the submission of the application.
- Expert Opinion: HIPO may provide expert opinions on issues such as the qualification of certain research and development activities and whether the costs incurred can fall under the scope of R&D activities. An expert opinion is typically requested after a project is realized, but sometimes it happens that applicants ask for the evaluation of ongoing projects, or in some exceptional cases, for the preliminary evaluation of future projects as well. Expert opinions are legally non-binding.
- Project group qualification: A project group qualification is a special alternative qualification procedure for large companies, which perform a multitude of R&D projects within a tax year, and would like to utilize the R&D activity-related corporate income tax allowances. HIPO issues a binding resolution stating that project groups – which contain certain projects realized within a tax year, which are put in the group according to the same criteria – can be regarded as R&D. This means that HIPO's decision will cover not only one project's qualification, but the legal presumption will be extended to all projects realized within a tax year. The project group qualification assesses finished or ongoing projects realized in the given tax year. HIPO's resolution can be primarily used for verifying the utilization of tax incentives, but in certain cases, for receiving cash grants as well.

National Initiatives on Innovation in Software Development

The Ministry of Finance in Hungary has the experience from two large horizontal R&D&I open calls from 2015-2017 in the framework of Economic Development and Innovation Operational Programme (EDIOP).

EDIOP-2.1.7 Prototype, product, technology and service development

The aim of the call was to support the prototype development and the market entry of innovative products and services. Eligible applicants were micro, small and medium enterprises and no track record needed, so newly established companies were eligible too. Six out seven regions from Hungary were eligible (Central-Hungary supported from a territorial operational programme call). There were no sectorial constraints, as it was a horizontal call for all major economic sectors, but only for single SME projects. The total budget of the call was 156 m €. The grant volume per project was 32.000€ – 160.000€ for applicants without a full closed business year and 32.000€ – 417.000€ for applicants with at least 1 full closed business year. The intensity rate was 25-70% depending on company size and on aid categories. Typical average intensity rates were between 50-60%.

Main activities supported in this call were:

- Experimental development (wage cost, subcontracting, material costs, depreciation of purchased tangible and intangible assets).
- Project preparation, project management, intellectual property rights, market entry and related activities (under de minimis aid).
- Purchase of tangible and intangible assets (Regional investment aid).
- Consultancy services under (Aid to SMEs for consultancy services).

The project duration was 24 months, while from the 2.688 applicants, 747 projects approved.

EDIOP-2.1.1 Support to R&D&I activities of enterprises

The aim of the call was to support research and development and innovation activities of companies so that new, marketable products, services, technologies are reached.

Eligible applicants were micro, small and medium enterprises and large companies with tracking record at least 1 full closed business year. Six out seven regions from Hungary were eligible (Central-Hungary supported from a territorial operational programme call). There were no sectorial constraints, as it was a horizontal call for all major economic sectors. Single SME projects and consortia were both allowed to submit.

The total budget of the call was 240 m €. The grant volume per project was 160.000€ – 3.200.000€ The intensity rate was 25-80% depending on company size and on aid categories. Typical average intensity rates were between 55% - 65%.

The main activities supported in this call were:

- Applied research (wage cost, subcontracting, material costs, depreciation of purchased tangible and intangible assets)
- Experimental development (wage cost, subcontracting, material costs, depreciation of purchased tangible and intangible assets)
- Project preparation, project management, intellectual property rights, market entry and related activities
- Purchase of tangible and intangible assets, infrastructure development
- Consultancy services under (Aid to SMEs for consultancy services)

The project duration was 24 months, while from the 1.103 applicants, 218 projects approved.

Software development had a substantial share in both calls. In EDIOP 2.1.7 call, 195 projects had been submitted with substantial software development project part or focus on software development. 38 projects had been submitted asking for the prior R&D content qualification issued by the Hungarian Intellectual Property Office (HIPO). In EDIOP 2.1.1 call, 41 projects had been submitted with substantial software development project part or focus on software development. 2 projects had been submitted asking

for the prior R&D content qualification issued by the Hungarian Intellectual Property Office (HIPO).

Software development is present in a high share of projects. Prior HIPO confirmation on R&D content was voluntary in both calls. Some software development projects did use this opportunity to get confirmation on their R&D content.

In EDIOP-217 most of the projects was implemented by micro-companies whereas in EDIOP-2.1.1 by middle companies.

Software development is present in all main economic sectors, but service sector is clearly dominant in both calls.

Company size breakdown of winning projects with substantial software development project part or focus on software development:

- EDIOP-2.1.7 Prototype, product, technology and service development: 195 contracted projects of which 113 were micro companies, 70 small companies and 12 were middle companies
- EDIOP-2.1.1 Support to R&D&I activities of enterprises: 41 contracted projects of which 12 were micro companies, 4 were small companies and 24 were middle companies

Examples of submitted projects in the two calls with software development project part related to Industry 4.0:

EDIOP-2.1.7 Prototype, product, technology and service development:

- ‘’Self-learning intelligent home control”
- ‘’Top quality food production using a smart monitoring system”
- ‘’Development of an integrated information system supporting and controlling furniture industry manufacturing”
- ‘’Development of an industrial laser device that can be integrated into an Industry 4.0 system”
- ‘’Development of a cloud-based software service that secures complete ISO support for micro- small and medium enterprises”

EDIOP-2.1.1 Support to R&D&I activities of enterprises:

- ''Development of Intelligent Storage and Dispensing System for small-sized products"
- ''Automated package size detection system of complex shapes in motion by optical and laser scanning"
- ''Prototype development of an electric forklift docking system"
- ''Development of a cloud-based wood-mass estimation and forestry registration system based on remote sensoring"
- ''Unique device and technology development based on modern video technology in explosive and flammable hydrocarbon and chemical systems"

2.2 Czech Republic - Ministry of Industry and Trade

The Ministry of Trade and Innovation of Czech Republic launched the Support Programme call under the Operational program of Entrepreneurship and Innovation, Priority Axis 1: Promotion of research and development for innovation, Specific Objective 1.1 Increasing innovation performance of enterprises financed from the ERDF. During this call 971 projects have been approved until April 2021, while a new call was launched in May 2021. A call for the projects focused on the software development is planned to be open in the next programming period.

The aim of the Support Programme was for businesses to gain new knowledge needed for the development of new products, materials, technologies and services through the implementation of industrial research and experimental development projects.

Eligible applicants were small, medium and large enterprises from all regions outside NUTS 2 Prague. As for sectorial constraints, beneficiaries could be business entities (legal persons). Partners with a financial contribution (together with the beneficiary) could be business entities (legal persons) and research organizations. Grant applications could be submitted by individual entities and consortia.

The budget of the last call was 97,3 m € with grant volume per project from 78.000€ - 2.000.000€ for projects implemented without the so-called effective cooperation, and 78.000€ – 3.900.000€ for projects implemented as part of effective cooperation, CZ-NACE 30.3 (Manufacture of other transport equipment) or under intervention codes 063 (Information service activities) or 065 (low carbon and climate resilient economy). The intensity rate was 25-70% depending on company size and on aid categories.

The main activities supported by the call were:

- Industrial Research/Experimental development.
- Precise idea of the final product/service/process to the new innovation.
- Personnel costs; costs of tools, instruments and equipment acquired from third parties in the form of depreciation of tangible fixed assets contract research costs; costs of R&D consulting services; additional overhead and other operating costs, including material and delivery costs.

The average project duration was 36-48 months, and the outputs were prototypes, software, utility models, certified methodology or proven technologies.

The submitted projects focused on software development/information services were 484 and 180 of them have been approved. The amount of the grants provided to the approved projects was 93.388.947,01 €.

2.3 Greece - Region of Thessaly

In the framework of Industry 4.0, Greece is considered to lag behind in software innovation compared to other European countries. Greece's suboptimal position with regards to its digital infrastructure and the provision of digital public services, prevent the Greek enterprises from rapidly adopting new Industry 4.0 technologies and supporting their technology needs. Exception to Greece's overall low digital maturity is the strength that the country demonstrates on the use of big data analytics. In fact, Greek companies have understood that data is the new digital capital and increasingly exploit the potential of Big Data Analytics.

With regards to human capital, Greece's limited digital skills across its society is also considered a structural inhibitor of the country's rotation towards Industry 4.0. Nevertheless, if we focus on our country's tertiary education, we observe that Greece demonstrates a technically adept human capital, with an overall high number of tertiary graduates and an adequate number of ICT and STEM graduates. What is more, in the context of R&D and innovation area, our country is home to a burgeoning start-up & Digital Innovation Hubs scene.

In addition, currently the General Secretariat of Industry of the Ministry of Development and Investment with the support of the DG REFORM is formulating the National Strategy of Industry 4.0 to be applied through specific actions within the next programming period 2021-2027 with a special focus on the 3 priority cases: Smart Manufacturing Technologies, Structural Materials Value Chain and Circular Economy. The suggested Operational plan includes initiatives that aim to drastically upgrade the Greek industrial ecosystem and assist enterprises and the human workforce within it with the right tools and training in order to make the leap to the Digital Age as swiftly and efficiently as possible. The proposed execution pillars are the following:

- Digital skills & human capital qualifications
- Innovation & start-up supporting mechanisms in the Digital Age
- Collaboration & synergies
- Standardization & Norms
- Regulatory Environment
- Acceleration of investment in digital technologies

Operational Program "Competitiveness, Entrepreneurship & Innovation" (EPAnEK)

During the 2014-2020 programming period, the Operational Program "Competitiveness, Entrepreneurship & Innovation" (EPAnEK) aims to enhance the competitiveness and extroversion of enterprises, to facilitate transition to quality entrepreneurship with innovation and the growth of domestic added value as the cutting edge. EPAnEK funds the State Aid Action "Research – Create – Innovate" managed by the General Secretariat for Research and Technology (GRST) and aimed to support:

- research and innovation
- technological development and demonstration at operating enterprises for the development of new or improved products
- the development of synergies among enterprises
- research and development centers and higher education sector
- the patentability of research results and industrial property

The total budget of the program was 542,5 m €

Beneficiaries were enterprises of any legal form registered in Greece or in any other Member State (undertakings in difficulty are excluded) and Research Organizations (Universities, Research Institutes, Public Bodies). The evaluation criteria (Excellence, Implementation and Impact) were aligned with the criteria used for H2020 projects.

The great interest expressed through the number of applications (2.426 proposals submitted at the 1st call of 2017 requesting 1,395 m € and 2,912 at the 2nd call of 2019 requesting 1,736.7 m € public funding) led to the allocation of additional funding (initial public budget 280 m € – current budget 542,5 m €).

The objective to mobilize the enterprises to participate in RTDI activities has been fulfilled and the highest participation came from small and very small enterprises (68%).

Digital Step – Digital Leap

‘‘The Digital Step’’ was an action co-financed by Greece and the European Union - European Regional Development Fund and refers to digitally immature businesses (low or middle digital rank), which could submit an investment budget plan of between 5.000 € and € 50.000 €. The total budget of the call was 84,4 m €. The project duration was 12 months.

The ‘‘Digital Leap’’ was the twin action of the ‘’Digital Step’’. This action referred to digitally mature businesses respectively (higher or highest digital rank), which would be able to submit an investment budget plan of between 55.000 € and 400.000 €. The total budget of the call was 51,6 m €. The project duration was 18 months.

Eligible expenditures were new ICT equipment, software, e-shop development, ordering and payment software, hosting, digital advertising (google ads, facebook ads), digital content creation, digital security, data transportation, wage cost, etc.

The period for submission of investment projects was from 11/06/2018 to 15/11/2018.

Regional Calls

During 2014-2020 period the Region of Thessaly launched two calls addressed to new and existing companies for the utilization of patents and/or innovations, as well as support services for the improvement of their activities or for the development of new products and services. In the framework of Regional Operational Programme (ROP) 2014-2020, the Calls "Invest in Thessaly" and "Re-invest in Thessaly" have been launched under Investment Priority 3a "Promoting entrepreneurship, by facilitating the economic exploitation of new ideas and supporting the creation of new businesses, including through incubators" and Specific Objective 1.4.1 **"**Business exploitation of R&D&I products from existing and newly established SMEs to increase their productivity". In total, 664 SMEs applied in both calls, while 583 were awarded.

Invest in Thessaly

This call supported new, newly established and start-up companies for the utilization of patents and/or innovations, as well as supported services for the improvement of their activities or for the development of new products and services. The budget per project was 50.000€ - 400.000€ (60% public fund). The total budget of the call was 53 m € and the project duration was 24 months. The submission period for this call was from 17/09/2019 to 29/11/2019.

The evaluation criteria related to innovation were the following:

- Utilization of patent
- Exploitation of Research results
- Use of product or service awarded on innovation/ entrepreneurship competition
- Use of product or service participated on innovation/ entrepreneurship competition

In overall from the 278 RIS related approved projects, 40 of them were awarded with innovation criteria (14%).

Re-invest in Thessaly

This call supported existing companies for the utilization of patents and/or innovations, as well as supported services for the improvement of their activities or for the development of new products and services. The budget per project was 80.000€ - 400.000€ (50% public fund). The total budget of the call was 23,5 m € and the project duration was 24 months. The submission period for this call was from 16/05/2019 to 31/10/2019.

The eligible expenditures of these calls were tangible & intangible assets (construction, equipment, certifications, ICT equipment and solutions, consulting services, participation in trade fairs, innovation aid (acquisition, transfer and use of know-how, intellectual property rights), new staff cost, operating costs.

The evaluation criteria related to innovation referred to the Utilization of patent or innovation. In total of 137 RIS related approved projects, 14 of 10% were awarded for innovation.

2.4 Italy - Marche Region

According to Marche Region INNO PROVEMENT stakeholders, a software can be defined "innovative" when it brings innovation on the production process of a company, following the criteria of Industry 4.0 national Plan (the so called Piano Calenda from the name of the Minister that launched it on 2017), and in accordance with the company's framework. In addition, in order to foster innovation software, it is important to create an ecosystem providing specific and professional actors such as advisors, facilitators and skilled employees, or key infrastructures such as DIHs that can collaborate with companies. This opinion was strongly supported by the companies and trade associations representatives of the stakeholder group.

At the moment, there is a lack in the incentive mechanisms for companies to involve these kinds of professional figures in their projects, but according to the stakeholder group, these figures are crucial to help the digital transformation in the companies.

Regional calls issued up to now on digital transformation seem to have stimulated some virtuous behaviors from the side of the beneficiaries. In fact, in regional calls issued in the 2014-2020 programming period on I4.0, beneficiaries were required to submit a technical report signed by a qualified professional certifying the compliance of the investment made with the I4.0 paradigm.

The beneficiary companies, have deemed it appropriate to request appraisals and consultancy not only in the ex post phase as requested by the calls, but also in the design phase, in order to avoid being denied the certification when the investment had already been made.

As Marche Region refunds up to 2.000€ for this kind of certificate this rule of the call made it possible to avoid or at least limit the presentation of fees much higher than the budget fixed by the call.

SMEs must be supported in the process of understanding what their needs are and consequently what can be the best solution to make their production process more efficient and sustainable or to digitize the Business to Consumer process.

The businesses want:

- limit restrictions and give more opportunities for digital transformation to micro and small businesses.
- investing in human resources through training or internships, in order to include in the companies, professional figures able to integrate machineries, software and processes
- adopt more flexible criteria, in accordance with the amount of the investment, in order to simplify procedures and avoid for micro and small companies useless administrative burdens.

Before the outbreak of the Covid-19 software was included among the intangible assets listed in the Italian National Plan for Industry 4.0 together with applications and platforms (Plan Industria 4.0, 2017 and Impresa 4.0, 2019). In the updated plan Transizione 4.0 revised after the outbreak of Covid-19, software was not only linked to Industry 4.0 tangible goods. Software is pictured as an organizational change.

The measures introduced by Italian regions for supporting the adoption of I4.0 technologies among firms were analysed: immediately after the outbreak (Phase 1 - March to May 2020) and after the end of the lockdown (Phase 2 - May till September 2020).

These measures were:

- Capital grants to firms with plans for re-opening that foresee the adoption of innovative models, to organize work based on new technologies (Marche).
- Training kit to facilitate the transition of the PA and firms to remote working (Friuli Venezia Giulia).
- Digital vouchers to purchase technological equipment or ask for consultancy for remote working (Lombardy, Lazio).
- Incentives material and immaterial goods for remote working in the firms development plans. (Basilicata).
- “Family-friendly” plans to approach remote working and facilitate the adoption of new organizational models. The expenses eligible relate to consultancy, equipment, software, and training (Puglia).
- Ensuring high speed connection (Emilia-Romagna)

The Marche Region intends to trace its path to Industry 4.0 in order to adapt its production system to the innovative approach represented by the "smart factory", taking into account local peculiarities and the need to combine the traditional skills and knowledge of the manufacturing and artisan world with new digital technologies.

Aware that - first of all - it is necessary to systematize the skills disseminated throughout the territory, the Marche Region in 2019 launched the regional call "Promoting the creation and development of Digital Innovation Hubs in the regional territory" aimed at

inducing the development of those territorial infrastructures fundamental for the success of the regional transformation process, that is the Digital Innovation Hubs (DIHs).

The DIHs constitute the real "gateway" for companies to access the world of Industry 4.0. In fact, they provide them with services to:

- introduce 4.0 technologies
- develop digital transformation projects,
- access the regional, national and European innovation ecosystems

The regional call was also intended to be part of the European Commission's strategy which provides for the establishment of a European inventory where no more than one DIH will be recognized for each region. To this end, the notice provided for a system of rewarding for those DIHs that were promoted by at least two different trade associations, with a view to rationalizing these subjects.

For the implementation of the regional call the Marche Region has made available a total amount of 800,000 euros from regional resources allocated according to the regional Law n. 25/2018 on "Enterprise 4.0: Innovation, research and training".

At the end of the procedure:

- 5 applications were received by almost all the most representative Trade Associations
- 3 out of 5 have been presented by aggregate promoters
- for a total amount of contributions requested of 997.715,11€ and total costs of investment for 1.374.275,18€.

All the applications received were admitted for funding and all the projects were launched in 2020. The 5 DIHs created thanks to this call, along with the technological universities of the Marche, 2 regional Competence Centres and the Marche Region Chamber of Commerce have connected together to form the eDIH4Marche Hub created to participate to the European call within the "Digital Europe Programme".

The eDIH4Marche Innovation Hub was set up with the aspiration to:

- promote the acceleration of the digital transformation of the Marche production system, through the provision of innovative specialized services,
- become the main point of reference for the Marche economic territory on the theme of Digital Transformation,
- strengthen the collaborations and synergies between regional and European and/or international level.

On 24th September 2020 the eDIH4Marche Innovation Hub submitted the application form to participate to the call "Digital Europe Programme"

The path towards I4.0 offered to SMEs is strongly linked to the characteristics of the DIHs and the relationships that these hold in the territory. The process is bi-directional since the partners and the SMEs can impact and enrich the key knowledge of the DIHs, redefining its fundamentals. After the outbreak of the pandemic, a Framework Agreement between regional DIHs and Competence Centres was signed in April 2020. The agreement recognizes the role of these actors in supporting the recovery phase through joint networking activities. Also, Webinars were organized by regional DIHs to create awareness of software opportunities for data analysis and remote working. The DIH Ancona, Pesaro, and Urbino launched online training in collaboration with the Polytechnical University of Marche, focusing on digital transformation to face the Covid-19 crisis.

2.5 Portugal – MA Compete 2020

The Managing Authority of Compete 2020 (Operational Programme for Competitiveness and internationalization) has the goal of improving the competitiveness of enterprises and their internationalization (in global competitive contexts), creating jobs and generating growth and added value, launching calls using public support incentives and grants to improve the Portuguese economy and our global situation.

The Compete 2020 and Internationalization supports R&D&I and Software Innovation by launching calls in the following fields:

- Research & Development: beneficiaries all companies, R&D entities, Experts and Intermediate Bodies.
- Innovation: addressed to SME, Business Associations Intermediate Bodies.
- Financial Instruments: for Startups with less than 3 years activity, Venture Capital Funds and Business Angels.

In the field of Research & Development, 1.200 projects have been approved with total grant 870 m €. 10% of them were ICT projects with total grant 106 m €. The eligible costs of the projects include Wage Costs, Subcontracting, Material Costs, Tangible and Intangible Assets.

In terms of Innovation, 850 projects have been awarded with total grant of 2,37 m €. 4% of them were ICT projects with total grant 17 m €, while the eligible costs refer to Wage Costs or Tangible and Intangible Assets, Consultancy.

Finally, 257 Financial Instrument projects have been funded with total grant of 48 m €, 69% of which were ICT projects with total grant of 24 m €.

2.6 Poland – Lodzkie Region

Poland is pursuing a responsible development strategy, which is based on reindustrialization, development of innovative companies, creation of development capital, digitization, support for SMEs and cultivation of foreign markets as well as social and regional development.

During 2014-2020 programming period funded projects under the Regional Operational Programme of the Łódzkie Region, Priority Axis II "Innovative and competitive economy", measure II.3 "Improving the competitiveness of SMEs", sub-measure II.3.1 "Innovations in SMEs", through which companies implemented the following investments or designed new products related to Industry 4.0:

- Sales Force Automation (SFA) systems integrated with Enterprise Resource Planning systems (ERP)
- Robotization of production lines

- Implementation of MES (Manufacturing Execution System) systems
- Automation of production in the medical sector
- Analytical engine for advanced data processing
- IT system for hotel facility management in an interactive model

2.7 Finland - Regional Council of Kainuu

The aim of the Regional Council of Kainuu is to promote the vitality and sustainable development of Kainuu region and the well-being of its inhabitants. The Regional Council is responsible for the general development of the region and the regional land use planning. That organization promotes the livelihoods of Kainuu region through its role as the funding authority for EU programmes.

In Finland the focus has been for several years on AI (artificial intelligence). Local projects have produced a number of inventions and innovations on AI, including robotics and automation solutions. That has been mostly at software level. Uptake of innovation, including Industry 4.0 and the solutions that have been produced in the regions of Finland, has not been on the same level (policy instrument report).

The rise of Industry 4.0 and of smart factories along with all enabling technologies such as cloud computing, Internet of Things, multi agent systems, cyber physical systems, artificial intelligence, etc. will transform current factory workers to knowledge workers. Hard work and routine tasks will be executed by machines or robots, while tasks requiring experience, intuition, creativity or decisions making based on uncertainty will still reside to humans. This constitutes a huge shift on the required competences. Further, this change is transforming manufacturing to a software intense business, where software development and operation is a core part of the manufacturing process, but as well as of the products being manufactured either as a standalone component or as a part of a larger product or service. With the advent of Industry 4.0, the companies will not only face challenges in finding the skilled employees but also a few other challenges related to their exiting workforce and skill development programs as mentioned below:

- Up-skilling: Companies will have to up-skill their workforce via in-house or external training centers. For example, an assembly line worker involved in manually fitting a part will be required to operate a robot or other tools to do so. He / she should develop the skills to be able to operate the new tools efficiently.
- Re-skilling: Industry 4.0 is expected to result in job displacement to a certain extent. A number of jobs will cease to exist. And a number of new jobs will be created. Companies will have to make the investment in re-skilling of the labor force to prepare for this expected shift.
- Continuous Learning: Technologies will become obsolete at a faster rate. Continuous professional development strategies will be required to easily adapt to the changes that technological advancement brings.
- Mindset change: Given that the labor force will have to adapt to a number of changes, they will resist and oppose implementation of newer technologies. This will require companies to plan for mindset change of its employees to facilitate smooth transition to advanced manufacturing processes.

The target profile for Engineers for Industry 4.0 has five components:

1. Basic specialist knowledge in an engineering discipline
2. Methodological skills, process-related and systems thinking
3. Cross-discipline knowledge such as mechanical, electrical and electronic engineering in computer sciences and data science, and respectively, basic knowledge of mechanical, electrical, and electronic engineering and data science for computer sciences
4. Contextual knowledge, i.e. knowledge of conditions, requirements, and perspectives in other divisions and disciplines
5. Interdisciplinary skills, especially the ability to work in a team, self-sufficiency, motivation, problem-solving skills, the ability to learn and adapt, openness, and communication skills.

The purpose of the Regional Council of Kainuu is to generalize Industry 4.0 uptake by non-high tech businesses.

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