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Continuous Vocational Training in Response to the Challenge of Industry 4.0: Required Skills and Business Results

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Abstract:

Purpose: To identify the technical skills which, linked to digitalization processes, are required to achieve different types of business results.

Design/methodology/approach: The Delphi method was applied, through the opinions of a group of Spanish experts, to identify the importance of certain skills for the advancement of digitalization and the implementation of Industry 4.0.

Findings: The results show that: 1) skills in Robotics, the Internet of Things, Networks and Artificial Intelligence are necessary to achieve results in the management of company technical areas; 2) commercial management needs skills in Intelligent Systems, Big Data, Cybersecurity, Distributed Technology and Contents; and 3) for the business challenges of sustainable development, the environment and energy efficiency, the most needed skills are in Big Data, Intelligent Systems and Artificial Intelligence.

Originality/value: The results are useful, firstly, in providing firms with a training and selection tool for the development of I4.0 and, secondly, in offering training centers criteria for drawing up their training programs.

Keywords: technical skills, continuous training, digitalization, industry 4.0, firm performance

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1. Introduction

The development of digitalization in enterprises, and more specifically the applications of Industry 4.0 (hereinafter I4.0), is the reference framework for increasing the competitiveness of industrial production and other economic sectors, using electronic and information technology. The I4.0 concept has been applied in the most technologically advanced countries in the second decade of the 21st century: in the USA with the *Advanced Manufacturing Partnership*, in the EU with the *Horizon 2020* program, in China with the *Made in China 2025* plan and in Japan with the *5th*

Science and Technology Basic Plan and *Industrial Value Chain Initiative* (Bartodziej, 2017; Molnar & Houtman, 2011; Zhong, Xu, Klotz & Newman, 2017).

Previous research has confirmed the positive influence of I4.0 on the competitiveness of companies, highlighting the improvement of the industrial environment through greater flexibility with customers (Bartodziej, 2017), the optimization of decision-making (World Economic Forum, 2018), efficiency and productivity of resources, and innovation (Rübmann, Lorenz, Gerbert, Waldner, Justus, Engel et al., 2015). The implementation of I4.0 in enterprises demands improvements in manufacturing, engineering, use of materials and life cycle management processes (Ávila-Bohórquez & Gil-Herrera, 2022). However, recently there has been a transition from a manufacturing-oriented definition to an industrial value chain-oriented meaning associated with the digitalization of value creation and delivery processes at diverse levels (Fogaça, Grijalvo & Neto, 2022).

European Commission publishes The Digital Economy and Society Index (DESI) −structured around the four cardinal points of the digital compass: human capital, connectivity, integration of digital technology and digital public services. With an average of 51.0 in 2021 for the 27 EU countries, the most advanced countries are Denmark, Finland, Sweden and Netherland −scores of 70.1, 67.1, 66.1 and 65.1, respectively. Spain, with a score of 57,4 ranks 9th among the 27 EU countries. However, enterprises are not yet taking sufficient advantage of new technologies such as Artificial Intelligence (AI), big data and cloud, which could help further develop productivity and e-commerce (European Commission, 2022). Two thirds of Spanish companies are not making swift enough progress in digitalization (Jiménez, Campos-García & Pablos-Heredero, 2022). However, the consultancy firm NTTDATA (2022) in the Smart Industry 4.0 report has emphasized that the COVID-19 pandemic has contributed to accelerating the digital transformation and significant investment is expected within 2 to 3 years in supply chain planning, monitoring of equipment performance and establishing new product creation procedures. Moreover, Fundación Telefónica (2021) also highlights that almost 70% of managers at Spanish companies claim to have undertaken some type of digital transformation in their business in response to COVID-19 and more than 80% of the companies consulted have a digital transformation strategy. Regardless of the level of I4.0 implementation in Spain, 50% of the population in Spain lacks basic digital skills (European Commission, 2020). The solution to the gap between I4.0 training needs and the current readiness of Spanish employees must be rooted in Continuing Vocational Training (CVT) as technical skills are needed for employees to contribute to the achievement of business results (DigitalES, 2019a). According to the European Union, CVT encompasses any activity undertaken by adults to improve their work-related knowledge, skills and abilities (Sancha-Gonzalo, 2020), and it includes formal activities, where participants receive recognized certification, non-formal activities, where participants can have explicit learning goals and informal activities, which are not organized in advance and do not have explicit learning goals (Lischewsk, Seeber, Wuttke & Rosemann, 2020).

The development and delivery of CVT fosters inclusive economic growth, social cohesion, competitiveness, and social capital because education is the basis, through increased productivity, for the creation of more permanent employment (González, 2021). Specifically, CVT would, firstly, update obsolete qualifications and alleviate problems related to at-risk groups in employment -persons with elementary education, veteran employees, and women. Secondly, it would provide more skills with labor market demand to promote personal development and improve professional opportunities (World Economic Forum, 2020). In connection with previous the statement, the European Centre for the Development of Vocational Training has recently proposed raising the participation of EU adults in CVT to 32% by 2025 (Jiménez et al., 2022), but it must be taken into account that for CVT to be effective it has to be based on appropriate teaching methods for adults in order to organize the learning of the knowledge, skills and competences required (Beer & Mulder, 2020).

In Spain, CVT is offered through four pathways: (1) Adult Vocational Training; (2) Postgraduate Continuing Education from universities or from other educational or business institutions; (3) on-the-job training provided by enterprises; and (4) specific programs for the unemployed. The lack of coordination between these four pathways results in a mismatch between the number and profile of people trained in certain fields and the demand for professional profiles which is not in line with the excess of people with higher education, or non-specialized or non-professional training (Jiménez et al., 2022).

In summary, the digitalization of companies and, in particular, the implementation of I4.0, is a global trend that Spanish companies must face through the development of investment projects and training plans for their employees because, by 2023, Spanish companies expect to find difficulties in hiring people with skills in Big Data, Digital Marketing, Artificial Intelligence and Blockchain, both at the university level and at the professional training level (Blázquez, Masclans & Canals, 2019). Every company needs to plan its I4.0 training in accordance with the results it aims to achieve in each specific plan. In addition, it is necessary to adapt the public management of CVT and the programs of training entities to business needs (Jiménez et al., 2022).

Considering the need to develop I4.0, the objective of this research is to identify and assess the technical skills needed in the development and implementation of I4.0 to achieve different types of business results. To this end, a study has been conducted based on the opinions of 38 experts gathered through interviews. The results of this research can facilitate and guide the design or redesign of training plans by companies, educational institutions, and public administrations in order to increase the effectiveness of such plans and digitalization processes.

2. Theoretical Framework: Digitalization and Skill Requirements

2.1. Digitalization of Technical Skills

The development of digitalization in companies and I4.0 applications requires employees with digitalization technical skills in both types of technologies: interface -smart manufacturing, smart products, smart supply chain and smart work- and core technologies –the Internet of Things, Cloud Computing, Big Data and analytics (Fogaça et al., 2022). Previous studies have highlighted that skills in Cloud Computing, the Internet of Things, Robotics, Intelligent Systems, Big Data, Software Development, Cybersecurity, Artificial Intelligence, Distributed Technologies, Networks and Training Content are essential in achieving results in commercial management (AMETIC, 2021; Ávila-Bohórquez & Gil-Herrera, 2022; DigitalES, 2019a,b). These studies were found after an exhaustive bibliographic review from journals hosted in the WOS database in the Computer Science knowledge area throughout the year 2022. Table 1 below shows the main previous research on each type of skill.

Skills	Previous works
Cloud Computing	Zhong et al. (2017)
Internet of Things	Li, Xu & Zhao (2015); Zhong et al. (2017)
Robotics	Gharibi, Boutaba & Waslander (2016); Iost Filho, Heldens, Kong & de Lange (2020); Weiss, Wortmeier & Kubicek (2021)
Intelligent Systems	Bala & Verma (2018); Ngo, Kashani, Imbalzano, Nguyen & Hui (2018); Shin & Xu (2017)
Big Data	Anuradha (2015); Rübmann et al. (2015)
Software Development	Huang, Xu, Chen, Xia, Zhang & Yi (2020); Magdin & Prikler (2018); Niederauer (2017)
Cybersecurity	Rübmann et al. (2015); Stevens (2018)
Artificial Intelligence	Floridi & Chiriatti (2020); Madakam, Holmukhe & Jaiswal (2019); Smutny & Schreiberova (2020)
Distributed Technologies	Collomb & Sok (2016); Deloitte (2022); Hunhevicz & Hall (2020)
Networks	Kong, Shi, Yu, Liu & Xia (2019); Mishra (2017); Pham, Fang, Ha, Piran, Le, Le et al. (2020)
Contents for training, simulation	Marcotte (2017); Ruano, Cano, Gámez & Gómez (2016)

Table 1. Previous work on the necessary skills for digitalization

Cloud Computing expertise includes the provision of Cloud Computing services, through scalable and visualized resources, which enable companies to rationalize their investments in computing, storage devices, and also the expertise to manage virtual data centers. The ideal cloud should have five key features: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service (Zhong et al., 2017). It should solve the critical challenges that affect the reliability of Cloud Computing: privacy and security issues, data management and resource allocation, scalability and availability, migration, interoperability, and inter-cloud communications (Zhong et al., 2017). For instance, cloud manufacturing refers to an advanced manufacturing model supported by Cloud Computing that transforms manufacturing resources into services that can be shared and distributed end-to-end, covering the entire extended life cycle of a product. Therefore, it is generally considered a networked, distributed, parallel, intelligent manufacturing system, where production resources and capacities can be intelligently managed. In addition to the application of Cloud Computing for product manufacturing, there are many other applications such as achieving multilayer information fusion and identifying global sensitivities of input factors under uncertainty (Zhong et al, 2017).

A second type of skill relates to the *Internet of Things (IoT)*. This includes different resources - for example, 3D printers, home automation and CPS – that improve the management of product manufacturing in terms of visibility and traceability. In the IoT, typical production resources become smart manufacturing objects that are capable of perceiving, interconnecting, and interacting together to carry out manufacturing logics automatically and adaptively. Generally, the IoT empowers "things" with new capabilities (Li et al., 2015). In addition, IoT-enabled manufacturing facilitates real-time data collection and sharing between various manufacturing resources – machines, workers, materials, and jobs – using key technologies such as radio frequency identification (RFID) and wireless technology. In turn, CPS are mechanisms that link physical objects and software, allowing different components to interact fully to exchange information. Cybernetics theory, mechanical engineering, design and process science, and computer science are all involved. Furthermore, the IoT is used in other management areas such as energy, where it provides a framework to support the integration of energy data and improve energy efficiency (Zhong et al., 2017).

Skills in *Robotics*, robots and cobots, and the internet of drones are also relevant (Weiss et al., 2021). Robots are machines that can behave like humans, solving simple tasks using AI. Generally, a robotic mechanism is built by connecting rigid elements (called links) to each other by means of joints, so that relative movement between adjacent links is possible. These types of joints determine the degrees of freedom in the system. The links are moved by actuators, which are normally driven electrically or by pneumatic or hydraulic cylinders that make the robot move and exert forces in the desired manners. These movements are controlled by sensors that measure the movement of the joints (Lynch & Park, 2017). Cobots are systems and methods for direct physical interaction between a person and a general-purpose manipulator controlled by a computer. In I4.0, cobots and other networked technologies are more interesting than simple human labor because cobots enable safe, intuitive, and flexible interactions as well as acceptable and reliable high-level collaboration without the need for highly trained staff. These features are especially relevant where employee turnover and production fluctuations are difficult to tolerate (Weiss et al., 2021). The internet of drones is an architecture designed to provide coordinated access to controlled airspace for unmanned aerial vehicles (UAV), commonly known as drones, which has many applications in the global logistics network (Gharibi et al., 2016) or, for example, in the agricultural sector, in the early detection of outbreaks and application of treatments for effective pest management (Iost-Filho et al., 2020).

Intelligent Systems skills include Software Development for various business activities: digital marketing, enterprise resource planning ERP, additive manufacturing, modelling, optimization and control, neural networks, fuzzy logic, autonomous transportation, and Digital Twins (Shin & Xu, 2017). In particular, the role of marketing has changed drastically due to several crises and now the internet compels executives in this area to acquire accurate and timely information on customers, products, the market, and the general landscape. In addition, electronic commerce handles both the online sale and purchase of products (Bala & Verma, 2018). Additive manufacturing, on the other hand, facilitates design freedom, mass customization, waste minimization, and the ability to fabricate complex structures, as well as rapid prototyping in different areas (Ngo et al., 2018). Another area included in this type of systems is the cooperative manipulation of equipment in uncertain and unstructured environments that are inaccessible or dangerous. In these situations, transport teams do not follow predefined routes, do not use explicit communication, and do not have prior information about the payload, the number and distribution of teammates and the location of obstacles in the environment. (Farivarnejad, Wilson & Berman, 2016). Digital Twins are autonomous assistance systems that continuously interact with their physical and digital environment through simulations (Hartmann, Herz & Wever, 2018).

Big Data skills includes data science, data visualization and suitable software and process mining. Big Data has gradually shaped an environment in the industrial sector in which high quantities of data come from various channels: sensors, devices, video/audio, Networks, and log files (Zhong et al., 2017). The analysis of this data optimizes production quality, reduces energy consumption, and improves equipment service. More specifically, in the context of I4.0, the comprehensive collection and evaluation of data from many diverse sources becomes standard to support real-time decision making (Rübmann et al., 2015). The challenges of using Big Data include capturing, analyzing, storing, searching, sharing, displaying, and transferring. To solve these challenges, there are a wide variety of scalable database tools and techniques such as *Hadoop* (Anuradha, 2015). Furthermore, to make efficient use of the collected data, software – data mining methods and complex machine learning programs – is required to make experience-based decisions (Bartodziej, 2017).

Skills in *Software Development* are also useful. These cover software tools, general or object-oriented programming, such as Python, Java, Objective-C, C++, C#, and PHP (Montero, Cevallos & Cuesta, 2018). The Objective-C programming language adds object-oriented programming concepts, including extensions to the language's functionality. PHP is a general-purpose scripting language oriented to web development, which is usually processed on a web server by a PHP interpreter. Its output can be any type of data, including binary image data. Additionally, PHP can be used for many programming tasks outside the web context, such as stand-alone graphical applications and robotic drone control (Niederauer, 2017). A Software Development Kit (SDK) is a collection of Software Development tools that can be installed in applications to provide analytics, application activity data and monetization options (Magdin & Prikler, 2018). C++ is a general-purpose programming language that has generic object-oriented functional characteristics, as well as facilities for low-level memory management. Its key applications are either resource-constrained or highly efficient applications - desktop applications, video games, e-commerce, web search or databases, telephone switchboards, or space probes - where maximum software execution efficiency is key (Huang et al., 2020).

Another highly valued type of skill relates to *Cybersecurity*, which includes areas such as network security, encryption, attacks and countermeasures, Cybersecurity risk analysis, and hacking (Stevens, 2018). Cybersecurity emerged as a major policy consideration for states, businesses, and civil society in the early 21st century. This problem is exacerbated by greater dependence on and interweaving with transnational information technology assemblies. Many companies, with the increased connectivity and use of standard communication protocols that I4.0 involves, have a need to protect their critical industrial systems. Their Cybersecurity needs rise dramatically as they need to ensure secure and reliable communications as well as sophisticated machine and user identity and access management (Rübmann et al., 2015). Specifically, Cybersecurity is a critical challenge affecting the reliability of Cloud Computing (Zhong et al., 2017).

Artificial Intelligence (AI) skills are increasingly required. They include issues related to RPA, Chatbots and VAs, computer vision, transfer of learning, GPT-3 and Gopher (Murphy, 2019). The general aim of AI is the intelligent performance of machines. Specifically, AI in Robotics is used for learning, planning, reasoning, problem solving, knowledge representation and computer vision. Robotic Process Automation (RPA) is the name given to a combination of hardware and software, networking, and automation for doing things very simply, which can add value to core business processes, including inventory management and reporting (Madakam et al., 2019). GPT-3 is a computer system designed to generate sequences of words, code, or other data: using a source input, called a prompt, it automatically and autonomously writes texts. For example, The Guardian newspaper recently published an article written by GPT-3 which drew much attention (Floridi & Chiriatti, 2020). Chatbots are mobile devices that are changing the way we communicate. They are used to provide information, answer questions or discuss a specific topic in different domains, such as marketing, customer service, technical support, education or training (Smutny & Schreiberova, 2020).

Distributed Ledger Technology or DLT is a consensus of replicated, shared, and synchronized digital data, geographically distributed across multiple sites, countries or institutions, which provide the opportunity to integrate digital information, management and contracts to increase trust and collaboration within industry (Collomb & Sok, 2016).

Specifically, DLT enables direct peer-to-peer transactions of value over a distributed network by providing an immutable and transparent record of these transactions. One form of DLT is the Blockchain system, which may be public or private, which consists of a growing list of records that are linked together using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. The timestamp proves that the transaction data existed when the block was posted. Since the blocks contain information about the previous block, they form a chain, with each additional block reinforcing the previous ones. Therefore, Blockchains are resistant to modification of their data because, once recorded, the data in any given block cannot be retroactively altered without altering all subsequent blocks (Hunhevicz & Hall, 2020). Blockchain Networks can be used for specific applications in different areas of company management, they even allow for digital business process to be created and shared among participants with the necessary identity and digital trust measures (Deloitte, 2022).

Network technologies have recently attracted wide attention in academia and industry (Kong et al., 2019). There are numerous technologies for network development, among which the OSI, 5G and MQTT Models stand out. The aim of open systems interconnection models (OSI models) is the interoperability of various communication systems with standard communication protocols, through the characterization and standardization of the internal communication functions of a computer or telecommunications system, regardless of its structure and internal technology. OSI Models describe only what the various layers must do; each intermediate layer offers a class of functionality to the layer above and is served by the layer below. These models are the reference used for communications between two end users through the network (Mishra, 2017). In telecommunications, 5G is the fifth-generation technology standard for cellular broadband networks. In 5G Networks, cellular Networks are divided into small geographical areas where all 5G wireless devices are connected to the Internet and the telephone network by radio waves through a local antenna. The 5G network is expected to meet an unprecedented increase in traffic volume and computing demands (for example, driverless vehicles, augmented reality, and Robotics). To solve the problem of end users' limited storage capabilities, as well as their limited processing capacity, Mobile Edge Computing (MEC) technology and RAN radio access is used (Pham et al., 2020). Finally, MQTT is an insertion protocol for device-to-device communications in IoT, where the transmission of messages between different devices is important (Soni & Makwana, 2017). In addition to the above models, antenna systems, fiber optics, routing and switching, submarine cables, Lora WAN, Sigfox and Narrowband IoT are important for the development of networks.

Lastly, remote *Learning Management Systems (LMS)* are ubiquitous in education institutions around the world. Content creation is also a complex activity for creators of teaching materials and in other activities such as design and video game development, as well as simulation for training purposes, which can include, for example, training systems based on virtual and augmented reality and social networks (Ruano et al., 2016). The Shareable Content Object Reference Model (SCORM) is a set of standards and specifications for the creation of e-learning Content compatible with most existing LMS. This model is based on a complex idea called sequencing, which is a set of rules that specifies the order in which a learner can experience content objects. In simple terms, the learner: (i) must follow a fixed set of paths through the training material, (ii) can mark her progress and (iii) assures her of the acceptability of her test scores. Additionally, laboratory software developed in Java can be integrated into the SCORM package for electronic educational technology (Ruano et al., 2016). Responsive Web Design (RWD) is an approach to Web design that aims to make Web pages display properly on a variety of devices and screen or window sizes, from minimum to maximum display size, to ensure ease of use and customer satisfaction. To do this, RWD uses three technical ingredients: fluid grids, flexible images, and media queries (Marcotte, 2017).

2.2. Business Performance

Having described the skills that previous literature has associated with the progress of digitalization and the implementation of I4.0, the different types of results where such skills could have an impact on more effective business management are set out below. These are manufacturing and logistics, commercial management, productivity, innovation, employment, and other results that are currently expected of business such as contribution to sustainable development, environmental protection, and energy efficiency. Table 2 shows relevant previous studies in relation to the different types of business results. These studies were found after an exhaustive bibliographic review from journals hosted in the WOS database in the Business Administration knowledge area throughout the year 2022.

Business performance	Previous research
Manufacturing and logistics	Ivanov, Tang, Dolgui, Battini & Das (2021); Thomé, Scavarda & Scavarda (2016)
Sales management	Dalcher (2017); Morgan, Whitler Feng & Chari (2019); Palmatier & Crecelius (2019)
Productivity	Fernández-Cabrera & Ramírez-Olascoaga (2017); Jensen & van der Voordt (2020)
Innovation	Afuah (2003); Bogers, Chesbrough & Moedas (2018); Chesbrough, Lettl & Ritter (2018); Nambisan, Lyytinen, Majchrzak & Song (2017)
Employment	Illanes, Lund, Mourshed, Rutherford & Tyreman (2018); Jiménez et al. (2022)
Sustainable development	Bernal-Torres, Paipa Galeano, Jarrah-Nezhad, Agudelo-Otálora & Millán (2021); Galindo, 2019; Silvestre & Ţîrcă (2019)
Environmental responsibility	Salas-Canales (2018)
Efficient use of energy	Kerr, Gouldson & Barrett (2017); Trianni, Cagno & Farné (2016)

Table 2. Previous work on the results to be achieved with skills in digitalization

Results in *manufacturing and logistics* encompass the areas of supply chain management, planning, programming and control of operations, operations between companies, inventory management, information systems in operations, operations strategy, agile operations, total quality management, *kaizen, six-sigma*, performance measurement and management and operations sustainability (Thomé et al., 2016). For all of them, I4.0 offers a set of data-driven technologies, organizational concepts and management principles and a dynamic network adaptable to changes in supply and demand through the rapid reorganization and relocation of its components and capabilities (Ivanov et al., 2021).

Commercial management refers to the identification and development of business opportunities and effective management through a variety of roles - sales, marketing, contracting and negotiation roles (Dalcher, 2017). On the one hand, reports on the main challenges facing markets (Morgan et al., 2019; Whitler, Boyd & Morgan, 2017) reveal numerous questions within the marketing domain such as: i) how to create organizational structures that allow better development of marketing strategies and help navigate and adapt to the changing needs of customers and businesses, (ii) how to choose the optimal set of marketing strategies to drive results given competing priorities and a myriad of internal and external stakeholders and (iii) how to lead executives across the enterprise in developing and implementing strategies that generate greater customer concentration and engagement (Morgan et al., 2019). On the other hand, the marketing domain has become increasingly rich in data, frameworks and analytics that allow marketers to design and execute effective strategies, but at the same time they represent a potential barrier to strategy formation due to their diversity and complexity. In addition, a possible framework for marketing strategy decisions has four principles that guide the effectiveness of any strategy: (1) all customers differ, (2) all customers change, (3) all competitors react and (4) all resources are limited (Palmatier & Crecelius, 2019).

Productivity is about maximizing production with minimal effort or expense whilst achieving the desired results. Input or expenditure are necessary production factors such as labor, capital, information, technology, enterprise infrastructure buildings, facilities, services, and natural resources such as energy and raw materials (Jensen & van der Voordt, 2020). Productivity is improved by process management that seeks to benefit all the activities of the company from resource planning to the distribution of the product to the final customer and develops mechanisms to improve the performance of all processes (Fernández-Cabrera & Ramírez-Olascoaga, 2017).

Innovation is defined as incorporating ideas that are new to the organization that adopts them, using new skills to offer a new product or service that customers want. This, in other words, means a new way of making the products and services that are marketed. However, rapid, and widespread process digitalization has changed existing theories on innovation management (Nambisan et al., 2017). Technological innovation refers to skills in components, the links between components, methods, processes, and techniques involved in a product or service. The result of innovation is a new product or service, in the sense that it has a lower cost, improved attributes or new attributes that it has previously never had (Afuah, 2003). Open innovation means that companies can and should use external ideas, as well as ideas and paths internal and external to the market. This type of innovation requires collaboration between distributed but interdependent actors who rely on each other's capabilities for value creation and capture (Chesbrough et al., 2018). Open innovation practices combine internal and external ideas into platforms, architectures and systems and therefore effective policymaking based on open innovation should take advantage of the added value of scientific progress and, at the same time, promote the investment needed to transform open initiatives into new technologies and business models (Bogers et al., 2018).

From the quantitative perspective of *employment*, there is a disparity of opinions on the number of jobs that the application of I4.0 will create or destroy (Eberhard, Podio, Alonso, Radovica, Avotina, Peiseniece et al., 2017; Evans, 2015; World Economic Forum, 2018). While some authors argue that the number of jobs will increase, mainly the ones with low qualifications and with high qualifications, for example, those of specialists in data analysis, Artificial Intelligence, digital transformation, marketing and sales and organizational development, other authors point to a negative balance because simple activities will be less necessary as a result of the application of I4.0. For example, 47% of jobs in the United States are at risk of partial or total automation (Hirschi 2018). Investing in training and improving the skills of their workers is increasingly an urgent priority for company management. By 2030, according to a report by the Lund, Madgavkar, Manyika, Smit, Ellingrud and Robinson (2020), up to 375 million workers, or approximately 14% of the global workforce, may need to change occupational categories because digitalization, automation and advances in Artificial Intelligence disrupt the world of work (Smit, Tacke, Lund, Manyika, Thiel, 2020). The type of skills companies require will change and will have profound implications for the careers people will have to follow. Many companies are trying to figure out how their job roles will change and what kind of talent they will require in the next five to ten years (Illanes et al., 2018).

Sustainable business development, defined as the ability to generate added value in the short, medium, and long term for firm's stakeholders, whilst minimizing the negative impact on society, has four dimensions: social, environmental, operational and financial (Bernal-Torres et al., 2021). This sustainable development goal has been the subject of increasing attention from academics, industry representatives and policy makers. As innovations constantly change the external environment and our way of life, they are key elements through which organizations, supply chains, institutions, communities, regions and countries can implement sustainability (Silvestre & Ţîrcă, 2019). However, for companies to contribute to sustainable development they need to incorporate new methodologies that allow them to respond more swiftly to customer needs by acting and evolving through trial and error. In fact, there is discussion of the digital transformation in the business world and part of this transformation necessitates internal changes that include the incorporation of new methodologies (Galindo, 2019).

In line with the preceding idea, companies have begun to formulate and implement environmental responsibility policies that can be summarized into three strategies: eco-efficiency, improving internal processes to reduce costs, cutting the use of energy sources, and reducing waste and polluting gases; reputation, implementing ISO 14001; and ecobranding, redesigning existing brands by turning them into green products. The aim of a company in implementing environmental measures is reducing the effects of its products or services and improving and publicizing its business image. In this task, the commitment of the organization and its customers is key (Salas-Canales, 2018).

Finally, the efficient use of energy is a concern for a variety of reasons. In recent years, the International Energy Agency (IEA) has sought to highlight the importance of energy efficiency. This approach is partly due to the perception that demand-side energy policy options have been overlooked in favor of supply-side options with a resulting bias towards investment in power generation over reduced energy demand (Kerr et al., 2017). However, companies must make progress in their energy efficiency, in which they must face and overcome different barriers: (i) economic; (ii) information-related; (iii) organizational; (iv) behavioral; (v) competition-related; (vi) technology-related; and (vii) awareness-raising (Trianni et al., 2016).

3. Research Design

3.1. Sample and Data Collection

To analyze the degree to which certain technical skills can contribute to the achievement of different types of business results and consequently identify employee training needs in a 5-year time horizon, we first selected the Delphi method to conduct the research. The Delphi method is a forecasting technique that aims to collect information and discuss a defined problem through the participation of a group of experts (Gordon, 1994; Grime & Wright, 2016; Landeta-Rodríguez, 2002; Lian, 2020).

Next, the questionnaire was designed with the help of 6 professional experts (university professors of engineering, training managers of the I4.0 Observatory and HR managers) and, prior to its launch, it was tested by themselves in order to improve clarity and readability and ensure ease of use (see Annex I). The questionnaire included Likert-type scale questions, in the form of a matrix, to assess the relevance of each technical skill in contributing to each type of business result. Finally, it was distributed among the experts and was conducted in face-to-face meetings or by videoconference between February and March 2022.

Second, the final panel of experts was selected by contacting professionals who, due to their knowledge and experience, were closely linked to the subject under study. Finally, 38 experts participated in the research: 21 professionals - employees in technology or consulting companies and/or entrepreneurs - and 17 teachers - professors in Vocational Training centers and universities (for more details see Annex II).

3.2. Variables

Based on previous literature and the opinion of the experts consulted, this study has examined 11 types of technical skills that may be required in digitalization and I4.0 applications in companies. These are:

1. Cloud Computing (clou-comp)
2. Internet of Things (inter-thing)
3. Robotics (robotics)
4. Intelligent Systems (intell-syst)
5. Big Data (big-data)
6. Software Development (soft-develo)
7. Cybersecurity (cybersecur)
8. Artificial Intelligence (artif-intelli)
9. Distributed Ledger Technology (distrib-tech)
10. Networks (networks)
11. Contents for training and simulation (conte-simul).

The following 8 types of business results have been examined:

1. Manufacturing and logistics (manu-logis)
2. Commercial management (comm-man)
3. Productivity (productiv)
4. Innovation (innovation)
5. Employment (employm)
6. Sustainable development (sustai-dev)
7. Environmental responsibility (envir-resp)
8. Energy efficiency (energ-effic)

3.3. Statistical Analysis

Two-stage statistical analysis was conducted. Firstly, a descriptive analysis was performed by calculating the statistics for the 88 pairs of skills-results variables using the SPSS program. Secondly, using R, Confirmatory Factor Analysis (hereinafter, CFA) was performed to assess the structure of the interrelationships of the data set. The descriptive analysis considered the mean and standard deviation of the variables of the dataset. In the CFA, a prior assumption is made to establish the latent variables, although in this analysis, to not interfere with the result, the 8 target variables were all taken as latent variables.

4. Results

Table 3 shows the mean and standard deviation of each pair of variables.

clou-comp manu-logis	clou-comp comm-man	clou-comp productiv	clou-comp innovation	clou-comp employm	clou-comp sustai-dev	clou-comp envir-resp	clou-comp energ-effic
3.14 (0.974)	3.51 (1.095)	3.51 (1.040)	3.91 (1.095)	3.15 (1.282)	3.79 (1.008)	3.03 (1.193)	3.24 (1.103)
inter-thing manu-logis	inter-thing comm-man	inter-thing productiv	inter-thing innovation	inter-thing employm	inter-thing sustai-dev	inter-thing envir-resp	inter-thing energ-effic
3.89 (0.932)	2.77 (1.190)	3.71 (0.893)	4.11 (0.900)	3.26 (0.994)	3.68 (1.224)	3.44 (1.078)	3.59 (1.062)
robotics manu-logis	robotics comm-man	robotics productiv	robotics innovation	robotics employm	robotics sustai-dev	robotics envir-resp	robotics energ-effic
4.60 (0.651)	2.66 (0.968)	4.26 (0.852)	4.14 (0.944)	3.68 (0.768)	3.71 (1.142)	3.32 (1.147)	3.56 (1.106)
intell-syst manu-logis	intell-syst comm-man	intell-syst productiv	intell-syst innovation	intell-syst employm	intell-syst sustai-dev	intell-syst envir-resp	intell-syst energ-effic
3.94 (0.988)	3.97 (1.043)	4.03 (0.985)	4.34 (0.684)	3.59 (0.821)	4.03 (1.029)	3.49 (1.222)	3.46 (1.120)
big-data manu-logis	big-data comm-man	big-data productiv	big-data innovation	big-data employm	big-data sustai-dev	big-data envir-resp	big-data energ-effic
3.71 (0.860)	4.37 (0.843)	4.14 (0.912)	4.23 (0.843)	3.59 (1.048)	4.09 (0.933)	3.66 (1.162)	3.86 (0.974)
soft-develo manu-logis	soft-develo comm-man	soft-develo productiv	soft-develo innovation	soft-develo employm	soft-develo sustai-dev	soft-develo envir-resp	soft-develo energ-effic
3.34 (1.162)	3.11 (1.157)	3.49 (1.245)	3.94 (0.968)	3.85 (0.972)	3.91 (1.164)	3.15 (1.209)	3.20 (1.183)
cybersecur manu-logis	cybersecur comm-man	cybersecur productiv	cybersecur innovation	cybersecur employm	cybersecur sustai-dev	cybersecur envir-resp	cybersecur energ-effic
3.69 (1.183)	3.66 (1.136)	3.49 (1.245)	3.89 (1.183)	3.59 (0.957)	3.85 (1.077)	2.82 (1.336)	2.94 (1.391)
artif-intelli manu-logis	artif-intelli comm-man	artif-intelli productiv	artif-intelli innovation	artif-intelli employm	artif-intelli sustai-dev	artif-intelli envir-resp	artif-intelli energ-effic
3.89 (0.932)	3.63 (1.140)	4.23 (0.808)	4.43 (0.655)	3.53 (0.961)	4.18 (0.834)	3.51 (1.121)	3.60 (1.218)
distrib-tech manu-logis	distrib-tech comm-man	distrib-tech productiv	distrib-tech innovation	distrib-tech employm	distrib-tech sustai-dev	distrib-tech envir-resp	distrib-tech energ-effic
2.47 (1.187)	2.85 (1.282)	2.67 (1.109)	3.21 (1.139)	2.78 (1.039)	3.19 (1.148)	2.63 (1.212)	2.58 (1.146)
networks manu-logis	networks comm-man	networks productiv	networks innovation	networks employm	networks sustai-dev	networks envir-resp	networks energ-effic
3.71 (1.100)	3.03 (1.272)	3.51 (1.245)	3.91 (1.011)	3.35 (1.178)	3.79 (1.149)	2.88 (1.297)	3.15 (1.209)
conte-simul manu-logis	conte-simul comm-man	conte-simul productiv	conte-simul innovation	conte-simul employm	conte-simul sustai-dev	conte-simul envir-resp	conte-simul energ-effic
2.69 (1.148)	3.63 (1.338)	3.06 (1.162)	3.81 (1.030)	3.72 (0.924)	3.71 (1.039)	2.78 (1.211)	2.90 (1.274)

Table 3. Mean and standard deviation of the variables examined

From the above table it can be concluded that: 1) Cloud Computing skills contribute mainly to the innovation, productivity and commercial management results with means of 3.91, 3.51 and 3.51, respectively; 2) skills in the Internet of Things contribute to a greater degree to the manufacturing and logistics, productivity and innovation results with means of 3.89, 3.71 and 4.11, respectively; 3) Robotics skills are more important in achieving manufacturing and logistics results, as well as in productivity with means of 4.60 and 4.26, respectively; 4) Intelligent Systems skills facilitate innovation, productivity and sustainable development results with means of 4.34, 4.03 and 4.03, respectively; 5) Big Data skills contribute mainly to the commercial management and innovation results with means of 4.37 and 4.23, respectively; 6) skills in Software Development help to deliver results in innovation and sustainable development with means of 3.94 and 3.91, respectively; 7) Cybersecurity skills foster innovation and sustainable development results with means of 3.89 and 3.85, respectively; 8) Artificial Intelligence skills drive innovation and productivity results with means of 4.43 and 4.23, respectively; 9) skills in Distributed Technologies contribute above all to innovation and sustainable development results with means of 3.21 and 3.19, respectively; 10) skills in Networks are mainly useful in achieving innovation and sustainable development results with means of 3.91 and 3.79, respectively; and 11) skills in Contents and simulation mainly facilitate innovation and employment results with means of 3.81 and 3.72, respectively.

Table 4 shows the non-standardized weights obtained by CFA. Due to the statistical characteristics of the database, skills in Software Development, Networks, and Content for training and simulation were disregarded. In addition, skills in the Internet of Things and Robotics was summarized in a single variable. The pre-established latent variables are reflected in the first row of the table.

	Manu-logistic	Comm-manag	Productivity	Innovation	Employment	Sustain develop	Environ respons	Energy efficiency
Cloud Computing	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Internet things & Robotics	2.03	0.87	0.63	0.80	1.29	1.01	1.06	1.40
Intelligent Systems	3.21	0.80	1.08	1.18	1.44	0.66	1.30	2.08
Big Data	2.95	0.31	0.96	1.06	0.89	0.23	1.12	1.49
Cybersecurity	3.14	0.96	1.25	1.20	1.62	0.83	0.67	1.40
Artificial Intelligence	2.74	1.06	1.40	1.14	1.75	0.65	1.46	2.33
Distributed Technology	1.85	1.31	1.21	0.66	1.38	0.53	0.88	1.11

Table 4. Non-standardized weights of the CFA

The results of the CFA show that the set of digitalization skills has an important influence on manufacturing and logistics results. Furthermore, the highest weights in the CFA correspond to high mean values: Internet of Things and Robotics with manufacturing and logistics (CFA weight: 2.03; mean: 4.25); Intelligent Systems with manufacturing and logistics (CFA weight: 3.21; mean: 3.94); Big Data with manufacturing and logistics (CFA weight: 2.95; mean: 3.71); Cybersecurity with manufacturing and logistics (CFA weight: 3.14; mean: 3.69); Artificial Intelligence with manufacturing and logistics (CFA weight: 2.74; mean: 3.89); and Distributed Technologies with manufacturing and logistics (CFA weight: 1.85; mean: 2.47).

The findings reveal the main relationships between the different types of skills and the different business results, as shown in Table 5.

From the preceding results, the following can be noted: (i) the similarity of results that can be achieved by the Internet of Things and Robotics; that is, both skills form part of an area of skills required to achieve the same results - manufacturing and logistics, productivity and energy efficiency; (ii) the scant relevance of Content skills to business results, except in employee training; and (iii) the lesser relevance of Networks skills in business results, except in innovation and sustainable development.

Table 6 classifies the skills required for the development and application of I4.0 as key skills - absolutely necessary - and other relevant skills - useful to the job.

Technical skills	Business results
Cloud Computing	Commercial management Productivity Innovation Sustainable development
Internet of Things	Manufacturing and logistics Productivity Innovation Energy efficiency
Robotics	Manufacturing and logistics Productivity Innovation Energy efficiency
Intelligent Systems	Commercial management Productivity Innovation Sustainable development
Big Data	Commercial management Productivity Innovation Sustainable development
Software Development	Innovation Employment Sustainable development
Cybersecurity	Manufacturing and logistics Commercial management Innovation Sustainable development
Artificial Intelligence	Manufacturing and logistics Productivity Innovation Sustainable development
Distributed Ledger Technology	Commercial management Innovation Sustainable development
Networks	Manufacturing and logistics Innovation Sustainable development
Content for training and simulation	Commercial management Innovation Employment Sustainable development

Table 5. Contribution of the different types of skills to the main business results

Business results	Key skills	Relevant skills
Manufacturing and logistics	Robotics Internet of Things	Intelligent Systems, Big Data, Cybersecurity, Artificial Intelligence, Networks, Contents and Simulation
Commercial management	Intelligent Systems Big Data	Cloud Computing, Cybersecurity, Artificial Intelligence, Distributed Technology, Contents and Simulation
Productivity	Robotics Internet of Things Artificial Intelligence	Cloud Computing, Intelligent Systems, Big Data, Cybersecurity, Distributed Technology
Innovation	Internet of Things Robotics Intelligent Systems Big Data Artificial Intelligence	Cloud Computing, Software Development, Cybersecurity, Distributed Technology, Networks, Contents and Simulation
Employment	Software Development	Robotics, Intelligent Systems, Cybersecurity, Artificial Intelligence, Contents and Simulation
Sustainable development	Artificial Intelligence Big Data Intelligent Systems	Cloud Computing, Internet of Things, Robotics, Software Development, Cybersecurity, Distributed Technology, Networks, Contents and Simulation
Environmental responsibility	Big Data	Intelligent Systems, Artificial Intelligence
Energy efficiency	Internet of Things Robotics Big Data	Intelligent Systems, Artificial Intelligence

Table 6. Key skills and relevant skills per results area

5. Discussion

This research supports and complements previous studies on digitalization. However, it also challenges previous findings and provides new evidence and greater understanding on the impact of eleven types of skills on eight types of business results, underlining the importance of continuous training in facing the challenge of I4.0.

With regard to *Cloud Computing* skills, this paper underlines their importance and contribution to aspects related to manufacturing, logistics, productivity and innovation, which is in line with Stark, Wan and Chin (2022), who state that this skill has a positive impact on cost efficiency, rapid adaptation, reliability, supply management, design and prototypes. Other researchers also endorse the application of Cloud Computing skills in commercial management - for example, online banking, online advertising, online shopping, data analysis techniques to extract and visualize trends or patterns, collective computing, etc. or in sustainable development management (Ali, 2020; Wang, Chen & Wang, 2015).

The *Internet of Things* applications highlighted herein for manufacturing, logistics and productivity also coincide with the findings of Stark et al. (2022): interconnectivity, automation control, contribution to logistics, energy consumption, proactive maintenance, data collection and interoperability. In line with Bilgeri, Gebauer, Fleisch and Wortmann (2019), this study also shows the contribution it makes to innovation processes.

The usefulness of *Robotics* skills in manufacturing, logistics and productivity has also been highlighted by Stark et al. (2022), who note their positive impact on ergonomics, performance, costs and safety, among other areas. Our results reveal that such skills also boost innovation, as evidenced by other studies (for example, Gettman & Rivera, 2016).

In relation to *Intelligent Systems* skills, their application in delivering greater efficiency in manufacturing has also been highlighted by Stark et al. (2022), who reveal that they promote manufacturing flexibility, the use of materials, production costs, production time, production quality, product volume, energy efficiency and automation. According to other previous studies, these skills also contribute to commercial management because they help represent a wide range of advertising, objects and environments, facilitate analysis and modeling of complex behaviors, deliver information to potential consumers and provide efficient and optimal solutions for advertising decision-making and market design (Yang, Yang, Jansen & Lalmas, 2017).

This study also indicates that skills in *Big Data* mainly improve commercial management, productivity, innovation and sustainable development. In the case of application in commercial management, Saura (2020) also highlights the benefits in analyzing user-generated content, optimizing customer preferences, tracking customer behavior online, and optimizing stock levels on e-commerce website. Likewise, Barbeito‑Caamaño and Chalmeta (2020) stress the benefits of this type of skill in improving performance in sustainable development management.

This study also highlights that *Software Development* skills favor innovation, employment and sustainable development. Previous studies have addressed the relationship between digitalization skills and employment conditions and work organization for different business sectors or regions (e.g., Barrett, 2001; Flecker & Meil, 2010). In this regard, works such as the study by Iatsyshyn, Iatsyshyn, Artemchuk, Kameneva, Kovach and Popov (2020) reveal the relationship between this type of skill and sustainable development-linked results, in a proposal to improve specialist and manager qualifications and provide scientific and methodological support and guidance in the software implementation process.

Cybersecurity skills contribute mainly to manufacturing and logistics processes, commercial management, innovation and sustainable development, which is in line with previous research. According to previous studies, information security plays a key role in company management, since it deals with the confidentiality, privacy, integrity and availability of one of its most valuable resources: data and information. The results of Cybersecurity improvement projects show a clear benefit for companies, mainly attested by their increased robustness in information security management and the cyber-awareness of their collaborators (Antunes, Maximiano, Gomes & Pinto, 2021; Lee, 2020).

Manufacturing and logistics, productivity, innovation and sustainable development can all benefit from *Artificial Intelligence* skills. Recent research has underlined, above all, its potential to improve innovation processes and facilitate the achievement of the Sustainable Development Goals (Cockburn, Henderson & Stern, 2018; Vinuesa, Azizpour, Leite, Balaam, Dignum, Domisch et al., 2020).

On *Distributed Ledger Technology* skills, this study notes that they mainly contribute to innovation processes, by changing the way companies interact with stakeholders. For Baudier, Chang and Arami (2022), this technology can record the origin of a document and is not limited to finance or services as it is also having an impact in other industries. Thus, its implementation within companies could influence their process management and strategy and be an active driver of value and provide access to large volumes of data inside and outside an organization. Distributed Ledger Technology can also be paired with AI to provide more insights, manage model and data sharing and create a data economy. Currently, this new technology is expected to bring enormous benefits to consumers, the current banking system and society in general, as well as in the sustainable development of the global economy, as Nguyen (2016) also states.

Network skills can greatly benefit manufacturing and logistics processes because, according to Funke & Becker (2020), material flow management becomes much easier due to the ubiquitous availability of transportation and production plant data. They also facilitate innovation processes, especially when these are open processes in which other companies participate (Biemans, 2018).

In line with this research, previous studies have also highlighted that manufacturing system *simulation* skills have proven to be a powerful tool for designing and evaluating a manufacturing system due to their low cost, rapid analysis, low risk, and significant insights (Mourtzis, 2020). Marketing simulations are also useful for improving customer relationship management and sales force automation, as they provide new ways to compete (Bolton, Chapman & Mills, 2019).

In short, most of the results reported herein complement the previous literature with regard, above all, to manufacturing and logistics, commercial management, productivity, innovation and employment. However, new ideas on sustainable development, environmental management and energy efficiency are also added.

6. Conclusions

This research has attempted to establish a relationship between the digitalization skills needed to drive forward I4.0 and different types of business outcomes based on the views of a panel of 38 experts from the fields of education and training, commercial management and I4.0 consulting. The most important contribution of the study is, according to the opinions of the experts, the construction of a reference framework of key and relevant skills for digitalization.

The commercial management applications of digitalization skills can be summarized as: (i) skills in Robotics, the Internet of Things, Networks and Artificial Intelligence are necessary in achieving results in business technical management, whether in manufacturing, logistics, productivity or innovation; (ii) commercial management needs skills in Intelligent Systems, Big Data, Cybersecurity, Distributed Technology and Content; (iii) for the business challenges of sustainable development, the environment and energy efficiency, the most necessary skills are Big Data, Intelligent Systems and Artificial Intelligence; and (iv) Cloud Computing skills are essential in all of the business results considered in this study.

These results allow companies to be guided in terms of employee training for I4.0 skills and competences. In accordance with the findings presented herein and depending on the area where they seek to achieve results (for example, manufacturing, logistics, commercial, etc.), companies could more precisely define training needs and the design or redesign of training plans. It is incumbent on each company to identify deficiencies, the target audience, the type of training, the places, methods and means of training, the trainers and the degree of learning desired for the purpose of starting, per the available budget, programs of recycling and continuous training in digital matters and, ultimately, to analyze the usefulness and efficiency of these programs based on the future behavior of employees and the results they achieve. Companies may also benefit from and use these findings to guide their hiring processes. New certifications and postgraduate courses can, to a certain extent, ensure that candidates have skills suited to the position and specific needs of each company. On the other hand, universities, CVT centers and other educational institutions can leverage the conclusions to offer training programs in digitalization and I4.0.

However, the rapid evolution of digitalization and the skills linked to this process may limit, in the medium term, the contributions of this study. For this reason, future research could consider updating the conclusions drawn herein and the practical recommendations in line with the evolution of the future range of digital technologies. A similar analysis applied to the soft skills needed to work in digitized business areas could also be considered.

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Annex I

1. Questionnaire on Training for I4.0 and Digitalization

The purpose of this questionnaire is to identify the training needs on a 5-year scale for the implementation of I4.0 in Spanish industrial companies; specifically, the necessary training for technical personnel and department managers, excluding the general managers of large management areas. The questionnaire seeks to conduct analysis, through the opinions of experts, so as to offer a set of recommendations that can help tailor the training of current professionals to the needs of companies in Industry 4.0.

The questionnaire covers digitalization technical skills. In the questionnaire we name them **S** variables. The questions on skills (S) address their relevance and importance in achieving results in set management areas of the company (**R** variables).

The answer to each of the questions is a number from 1 to 5 based on the relevance of the S to achieving the R.

1 implies that skill is not necessary to achieve the results
2 implies that skill is slightly necessary to achieve the results
3 implies that skill may be necessary to achieve the results
4 implies that skill is necessary to achieve results
5 implies that skill is essential to achieve results

The matrix of questions on the relevance of skills (**S**) to achieve business results (**R**) is on page 2 of this document.

2. Matrix of Answers on the Relevance of C (technical skill) to Achieving R (business results)

State (1 being the lowest and 5 being the highest) the degree to which the skills (C) are relevant to achieving the optimal results (R) results in the stated areas. To answer this matrix, you are not required to work in a specific area or department.

	R1 Manufacturing	R2 Commercial Management	R3 Productivity	R4 Innovation	R5 Employment	R6 Sustainable development	R7 Environment	R8 Energy
S1 Cloud Computing								
S2 Internet of Things								
S3 Robotics								
S4 Intelligent Systems								
S5 Big Data								
S6 Software Development								
S7 Cybersecurity								
S8 AI								
S9 DLT – Blockchain								
S10 Networks								
S11 Content simulation								

3. Skill Definitions (The Main Topics they Include are Indicated)

S1 Cloud Computing: cloud computing; virtual data center.

S2 IoT: 3D printers, home automation, consumer products, CPS.

S3 Robotics: automation, industrial machinery, drones, mobile robotics.

S4 Intelligent systems: e-commerce, digital marketing, customer centricity, advertising and media, ERP, additive manufacturing, autonomous transport, AR, VR, Digital Twins, simulation, computer vision.

S5 Big Data: data science, data engineering, data visualization, Hadoop, data-driven, process mining.

S6 Software Development: html web design, Javascript, CSS3, Objective-C, Python, PHP programming, Ruby programming, SDK environment, Devops, Xcode. Angular, Typescript and Javascript, C++, Qt and QML, Android programming, Linux, Coding Programming, Codeless.

C7 Cybersecurity: network security, encryption, attacks and countermeasures, ethical hacking, cybersecurity risk analysis.

C8 Artificial Intelligence: machine learning, RPAs, Chatbots and VAs, knowledge representation, computer vision, transfer of learning, GPT3 and Gopher.

C9 Distributed Technology - Blockchain: contracts and titles, Blockchain networks, Bitcoin and cryptocurrencies.

C10 Networks: 5G, antennas, fiber optics, routing and switching, submarine cables, OSI stack, IoT protocols, MQTT, Lora WAN, Sigfox, Narrowband IoT.

C11 Content and simulation: responsive design, SCORM content, signal and video editing, video games, social networks

4. Definitions of Results (The Objectives to Be Achieved Are Indicated)

R1 Manufacturing and logistics: optimize both processes, make production more flexible and customized.

R2 Commercial management: increase turnover and commercial margins.

R3 Productivity: reduce the amount of resources used to make our products.

R4 Innovation: innovate the product portfolio and/or process management, delivering more than simple improvements.

R5 Generate employment: reskill employees with unnecessary or obsolete skills, and/or increase the number of people in employment.

R6 Sustainable development: sell new products or services that increase economic and/or social well-being.

R7 Environment: reduce CO2 emissions and other polluting materials.

R8 Energy efficiency: reduce the need for total energy consumption to produce our current products.

Annex II

Information on the Experts

Expert	Classification	Company or institution	Position
1	Professional	Big Data Analytics	I4.0 Innovation Team Leader
2	Professional	BBVA	IT Department
3	Professional	IIE	Training Department
4	Professor	IESE	Training Coordination
5	Professional	Asociación ICAI	President
6	Professor	Tomillo Foundation	Director of CVT
7	Professor	Virgen de la Paloma CVT	Director
8	Professor	IESE	Energy Management Training
9	Professional	SECOT	HR Manager
10	Professional	IIE	Training Director
11	Professor	Domingo Savio CVT Center	Training Consultant
12	Professor	Rey Juan Carlos U	Computing teacher

Expert	Classification	Company or institution	Position
13	Professional	German Chamber of Commerce	Training Director
14	Professional	I4.0 Observatory	Training Director
15	Professional	Company of the I4.0 Observatory	Production Department
16	Professional	Company of the I4.0 Observatory	Organization Department
17	Professional	Company of the I4.0 Observatory	Engineering Department
18	Professional	Company of the I4.0 Observatory	Production Department
19	Professor	ICAI	Professor Dept. Machines
20	Professional	High Tech Institute	Professor Software Development
21	Professor	ICAI	Professor Electrical engineering
22	Professor	ICAI	Design and Manufacturing Manager
23	Professor	Mondragón U	General Coordinator
24	Professional	Independent	Business Strategy and Management
25	Professor	Industrial Engineering ETS	Organization Engineering Department
26	Professional	IIE	Training Department
27	Professor	IESE	Information Technology Professor
28	Professional	Técnicas Reunidas	Project Management
29	Professor	Rey Juan Carlos University	Computing teacher
30	Professor	Rey Juan Carlos University	Professor of industrial engineering
31	Professional	Repsol	IT Department
32	Professor	Rey Juan Carlos University	Computing teacher
33	Professor	Agricultural Engineering ETS	Professor dept. Edaphology
34	Professor	Madrid Polytechnic U	Professor of Mines
35	Professional	Pernod Ricard	Programming
36	Professional	IIE	Former President
37	Professional	Company of the I4.0 Observatory	Department of Engineering
38	Professional	ICAI Association	Manager