

Digitalization and Industry 4.0: An Analysis of Professional Skills and Behaviours

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Abstract:

Purpose: Recent reports on Industry 4.0 reveal that a large part of Spanish companies have not yet made enough progress in the digitalization of processes and one of the most relevant challenges they face is training their employees to build a new culture that allows them to develop high-performance behaviors and take advantage of the potential of new technologies. This research seeks to identify the skills that could contribute to improving certain professional behaviors of employees who work mainly in the field of industrial engineering and that are considered necessary for the advancement of digitalization and Industry 4.0 processes.

Design/methodology/approach: For this purpose, a Delphi study was carried out, collecting the opinions of 38 teaching and professional experts, through face-to-face meetings or by videoconference, and analysing their opinions using descriptive statistics and structural equation models.

Findings: The results obtained show that the key skills for improving professional behaviours are teamwork, conduct, management, and problem-solving, which influence most of the behaviours analysed.

Originality/value: In practice, these results allow companies to be guided in terms of employee training in relation to digitalization skills and assist their selection processes. Additionally, educational institutions can review their study plans, increasing the relevance of the skills that companies value the most.

Keywords: skills, digitalization, industry 4.0, professional behaviours

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1. Introduction

Skills refer to the underlying characteristics in an individual that are causally related to a standard of effectiveness and/or superior performance in a job or situation (Spencer & Spencer, 2008). The concept of skill was developed from the analysis of human motivation (McClelland, 1987). In general, skills can consist of motives, character traits, attitudes, or values, cognitive or behavioural abilities that are causally related to professional performance (Fernández-Ríos, 1999). Based on the above concepts, numerous skills can be defined; for example, Alles (2005) indicates 160 skills for different levels of business management and for certain specific sectors.

In Spain, 50% of the population lacks basic digital skills (European Commission, 2020), although it has progressed in terms of digitalization— according to the Digital Economy and Society Index for Spain, on a scale from 0 to 100, it has risen from 40.0 in 2016 to 60.8 in 2022 (European Commission, 2022). Two thirds of Spanish companies are not advancing fast enough in their digitalization process (Jiménez, Campos-García & De-Pablos-Heredero, 2022), but significant investments are planned, within 2–3 years, in supply chain planning, equipment performance monitoring and establishing new product creation procedures (NTT DATA, 2022). In addition, more than 80% of the companies surveyed have a supply chain strategy in place (Fundación Telefónica, 2021).

However, Spanish companies need to improve the behaviours –what a person does or says (Alles, 2009)– of their employees in the face of the challenge of building a new digital culture and making the most of the potential of new technologies. In this way, it is possible to transform organizational or business models to create value for customers, employees, and shareholders (Ochoa, 2016).

In the context of digitalization and Industry 4.0 (hereafter I4.0), implemented since the second decade of the 21st century in all developed countries (Bartodziej, 2017; Molnar & Houtman, 2011; Zhong, Xu, Klotz & Newman, 2017), the application of different technologies – cloud computing, internet of things, robotics, intelligent systems, Big Data, software development, cybersecurity, artificial intelligence, distributed accounting technology, networking, and content for training and simulation – (Aranda-Jiménez, Campos-García, Cosculluela-Martínez, San-Martin & De-Pablos-Heredero, 2023) is indispensable and certain skills must be enhanced to influence the professional behaviours necessary for the business implementation of digitalization and I4.0. Training the skills of their employees is one of the main tools available to companies to build their digital culture and for their employees to develop the high-performance behaviours that guarantee success in the performance of their tasks (Boyatzis, 2008; Gumucio, 2010; Peiró & Martínez-Tur, 2022).

Identifying and relating the specific skills that employees need to acquire or improve to promote certain professional behaviours that are linked to the development and advancement of digitalization and Industry 4.0 is the objective of this research. The focus is on the area of industrial engineering, but it supports and complements previous work that revolves around digitalization, providing new evidence and greater understanding of the influence of eight types of skills on seven types of behaviours needed to meet the challenge of digitalization in companies.

To carry out this work, opinions were gathered through interviews with 38 Spanish experts, for which a questionnaire was previously designed containing a matrix with different skills and professional behaviours that previous literature indicates as relevant. Once the results of the interviews with the experts were known, a study of eight skills and seven professional behaviours was carried out by means of a descriptive statistical analysis and a structural equation analysis. The conclusions of the statistical analysis can help: (i) companies in the design of their training plans and employee selection processes, (ii) educational institutions to increase the effectiveness of their training programmes, (iii) consulting firms to complete their offerings in terms of I4.0 implementation plans, and (iv) employees concerned about developing their own professional careers.

This paper is structured as follows. The second section compiles previous literature on professional skills and behaviours for digitalization and I4.0 based on a systematic literature review. The third section describes the method and materials used in the research. Then, the fourth section shows the results obtained. The fifth section discusses the findings and, finally, the conclusions are presented.

2. The Professional Skills and Behaviours Required for Digitalization: A Review of the Literature

According to systematic literature review (Xiao & Watson, 2019), traditionally, research has focused on the hard skills required by the labor market -the technical requirements to a certain type of task or activity- but in recent years soft skills -personal attributes that complement hard skills and enhance an individual's interactions and job performance- have gained relevance. Previous works framed in the field of engineering have highlighted the importance of certain hard and soft skills that can be useful to improve some behaviours and achieve different results (Asefer & Abidin, 2021; Lyu & Liu, 2021; Munir, 2022; Saniuk, Caganova & Saniuk, 2023). In this area of knowledge, from a managerial perspective, a strong consensus can be found that skills such as communication, problem-solving, teamwork, self-management, cognitive skills, basic language, and conduct can contribute to a greater extent to developing professional behaviours such as individual performance, commitment to objectives, the work environment, integration into the culture, employee stability, acceptance of new challenges, and the implementation of an agile organization.

2.1. Skills

Table 1 below summarizes, according to previous systematic literature review (Aranda-Jimenez et al., 2023), the skills that have received the most attention in the literature of industrial engineering and management to develop a set of behaviours necessary for digitalization.

Skill	Authors
Communication	Eberhard, Podio, Alonso, Radovica, Avotina, Peiseniece et al. (2017); Hargie, Dickson & Tourish (2017)
Problem-solving	Cottrell (2017); Bogoviz, Osipov, Chistyakova & Borisov (2019); Hecklau, Galeitzke, Flachs & Kohl (2016)
Teamwork	Britton, Simper, Leger & Stephenson (2017); Hecklau et al. (2016)
Self-management	Thompson (2021); Claro, Paunesku & Dweck (2016)
Cognitive skills	Wall (2015); Mumford, Todd, Higgs & McIntosh (2017)
Management	Goran, LaBerge & Srinivasan (2017); Srivastava, Bhardwaj & Saraswat (2017); Castellano-Lendínez (2019)
Basic language	Grossman & Frieder (2004); Abualigah, Diabat, Mirjalili, Abd-Elaziz & Gandomi (2021); Jones, Bodie & Hughes (2019)
Conduct	Organ (2018); Ferrell, Harrison, Ferrell & Hair (2019)

Table 1. Previous works on skills

Communication skills include individual techniques for communicating, such as pitch creation and storytelling, as well as the principles of the necessary internal communication within each company and communication oriented to external organizations such as public regulators and social institutions. Communication is one of the most important social skills that involves the knowledge and skills of all employees to realize goals and plans in social interactions (Eberhard et al., 2017). In addition, managers need communication to maintain an effective flow of information and promote harmonious relationships within the workplace. At any level of decision-making, communication is necessary within its four main types of activity: planning, organizing, leading, and evaluating. On the part of employees, access to company information, upward communication, regular personal relationships with other colleagues and with their superiors, as well as communication training, are expected (Hargie et al., 2017).

A second type of skill is related to **problem-solving**, which includes analytical and critical thinking to analyse information, complex problem-solving, and the drive for transformation to apply innovations and creativity. Critical thinking provides the tools to use scepticism and doubt constructively, so that individuals can analyse what is in front of them. It also helps people make better, more informed decisions about whether something is likely to be true, effective, or productive. As a complex deliberative process, critical thinking involves a wide range of skills and attitudes: identifying other people's positions and arguments, evaluating evidence for

alternative points of view, weighing opposing arguments, recognizing techniques used to make certain positions more appealing than others, drawing conclusions about whether arguments are valid and justifiable, and presenting a point of view in a structured, clear, and well-reasoned way that convinces others (Cottrell, 2017). In addition, within problem-solving, transformational drive can be considered a necessary ability to create new knowledge, modernize, and develop existing technologies, and generate innovations (Bogoviz et al., 2019). Finally, creativity techniques needed to create more innovative products and internally improve business processes can be included within this skill (Hecklau et al., 2016).

Similarly, **teamwork** encompasses different skills – persuasion and conflict resolution, emotional intelligence, leadership, and social influence, mentoring and teaching strategies, empathy, trust building, and developing collaborative environments-to achieve results by working with other employees with different professional experiences (Hecklau et al., 2016). Teamwork skills are essential for professional success in an increasingly team-based organization, although collaboration has always been an important aspect of professional work. In addition, rapid technological advances lead teamwork to become an increasingly necessary and critical ability, constantly identified as a crucial skill for professional success. The most important dimensions of teamwork appear to be shared decision-making, use of the expertise of all members, learning orientation, and social support (Britton et al., 2017). In addition, the theory of relational coordination – a mutually reinforcing process of interaction between communication and relationships, which is carried out for the purpose of integrating tasks – indicates that participants must be connected by relationships involving shared goals and mutual respect (Gittel, 2011).

Self-management skills include different techniques – initiative, agile, and active learning, self-awareness, growth mindset, adapting to volatility and ambiguity, emotional control and intelligence, assertiveness, and managing one's time – to build on positive qualities and be wary of the negative ones that can get in the way of effective practice. In short, self-management has an important role to play in the development of people skills (Thompson, 2021). For its part, a growth mindset helps people feel good in the short and long term, helping to overcome challenges and setbacks on the path to learning. People who believe that their talents can be developed through hard work, good strategies and input from others have a growth mindset, achieving more than those with a more fixed mindset – those who believe their talents are innate gifts. This result is because people with a growth mindset worry less about looking smart and devote more energy to learning. Extrapolating the growth mindset to companies, in those with a growth culture their employees report feeling much more engaged, and also that they receive much greater organizational support for collaboration and innovation (Claro et al., 2016).

Cognitive skills that are important to employees encompass: (i) inference, which seeks to identify and secure the elements necessary to draw reasonable conclusions; (ii) explanation, which involves coherently presenting the results of one's reasoning; (iii) evaluation, which aims to analyse the credibility of statements or other representations that are accounts or descriptions of perceptions, experiences, or opinions; (iv) self-regulation, which consists of being conscious to monitor one's own cognitive activities and the elements used in those activities; (v) interpretation, which includes understanding and expressing the meaning of a wide variety of experiences; and (vi) analysis, in order to identify intended and actual inferential relationships between statements, questions, and concepts or descriptions. All of these are demanded of employees in companies where advances in technology create rapid changes in the workplace (Wall, 2015). In addition, over the years, a growing body of work has indicated that certain cognitive skills are a critical determinant of leader performance; furthermore, nine key skills necessary for positions with significant leadership responsibilities can be distinguished: problem definition, cause/goal analysis, constraint analysis, planning, foresight, creative thinking, idea evaluation, wisdom, and sense-making/vision (Mumford et al., 2017).

Other types of highly valued skills relate to **management** because, irrespective of specific techniques, experience indicates that companies with significant digital investments need employees who are more responsive to customers and more willing to take risks (Goran et al., 2017). Different techniques –a digital-first strategy and culture, multilevel change management, design thinking, lean startup, scrum, Kanban, project management, management by objectives and risk management– can be encompassed in the

management skill. For example, scrum is a method for facilitating agile development, and is currently the most widely used technique in development not only for software, but even in the fields of finance and research (Srivastava et al., 2017). On the other hand, the development of Kanban, which was created by Toyota to monitor the progress of work performed along a supply chain, has the main objective of ensuring sustainable production to avoid excesses of final products, bottlenecks and delivery delays. According to Kanban, work in progress must be organized according to the skill of work centres and teams, requiring real-time communication (Castellano-Lendínez, 2019).

Basic language skills encompass algorithms, design tools and active listening. An algorithm, in mathematics and computer science, is a finite sequence of well-defined instructions, typically used to solve a specific class of problems, perform computations, process data, automate reasoning, or make decisions in an automated fashion. Algorithms can be expressed within a finite amount of space and time or in a well-defined formal language to compute a function (Grossman & Frieder, 2004). For example, the arithmetic optimization algorithm, which uses the distribution behaviour of the main arithmetic operators in mathematics, is modelled and implemented mathematically to perform optimization processes in a wide range of search spaces (Abualigah et al., 2021). In turn, empathy and active listening influence the relationship between two facets of mindfulness – describing and observing – and the two perceptual outcomes, the discrimination of messages and facilitation of re-evaluations. Consequently, the results point to mindfulness as an important factor influencing cognitive-affective processes and supportive communication (Jones et al., 2019).

The skill referred to as **conduct** includes business ethics, prosocial behaviour –*citizenship behaviour* – integrity and legal provisions that bind employee behaviour. In recent years, there has been growing evidence that satisfaction, although not strongly related to employee task productivity, is linked to a different type of contribution, which is known as prosocial behaviour and is related to culture, attitudes, personality, mood, stress, and organizational performance (Organ, 2018). In addition, it is important to understand the importance of business ethics and social responsibility in determining brand attitudes. For their part, customers value business ethics as a critical behaviour in their perceptions of brand attitudes (Ferrell et al., 2019).

2.2. Professional Behaviours

The above skills may have different applications in professional behaviours of industrial engineering and management fields. Previous literature has focused on the types of behaviours that are most demanded by digitalization in companies. These are listed below in Table 2.

Behaviour	Authors
Individual performance	Abdi-Mohamud, Ibrahim & Hussein (2017); Charbonnier-Voirin & Roussel (2012).
Commitment to objectives	Agada and Zeb-Obipi (2018); Islami, Mulolli and Mustafa (2018)
Work Environment	Berberoglu (2018); Hafeez, Yingjun, Hafeez, Mansoor and Rehman (2019); Putri, Ekowati, Supriyanto and Mukaffi (2019); Shanker, Bhanugopan, Van der Heijden and Farrell (2017)
Integration into the culture	Ferrell et al. (2019); Groyberg, Lee, Price & Cheng (2018); Guiso, Sapienza and Zingales (2015); Malik (2015)
Employee Stability	Al-Mamun and Hasan (2017); Cloutier, Felusiak, Hill and Pemberton-Jones (2015)
Acceptance of new challenges	Quintana (2020); Scherer, Rasche, Palazzo and Spicer (2016); Vidgen, Shaw and Grant (2017)
Agile organization	Brosseau, Ebrahim, Handscomb and Thaker (2019); Hadida and Troilo (2020); Valderrama (2019)

Table 2. Previous work on the behaviours required for digitalization

Regarding **individual performance** behaviour, it should be noted that the management of employees' performance at work is a very important management tool for companies, although it has traditionally been considered that salary policy and job function design are the most important employee management tools for improving employee performance (Abdi-Mohamud et al., 2017; Lado, Alonso, Cuadrado & Otero, 2023). But today's digitalization means that companies are facing particularly complex and volatile conditions, so employees must change their professional behaviour to meet the demands of a new environment, adapt to dynamic work situations, and adjust their behaviour to the requirements of work situations and new events. Consequently, for many companies, employee adaptability has become increasingly important as the nature of work has changed, requiring employees to have a wide range of interpersonal skills, the ability to cope with unstable competitive environments, and adapt to the continuous evolution of technology (Charbonnier-Voirin & Roussel, 2012).

Commitment to objectives – the mentality to remain in a company showing loyalty, participation, dedication, and unwavering affiliation to its objectives – is one of the most determining factors of job performance (Prieto-Díez, Postigo, Cuesta & Muñoz, 2022). This commitment implies duty towards the company as reciprocity for: (i) the benefits enjoyed in it, or normative commitment, (ii) practical conformity for the growth and ethics of the company, or affective commitment, and (iii) the will to continue with the same company to avoid losing cumulative benefits when leaving it, or continuity commitment (Agada & Zeb-Obipi, 2018). In addition, on the part of the company, management by objectives implies the creation of aims, their communication, and planning, the establishment of control points, the commitment of employees to such goals, freedom and independence in the fulfilment of the aims, functions, and continuous communication on the degree of achievement (Islami et al., 2018).

The behaviour of the **work environment** includes the physical work environment and the organizational climate. On the one hand, the physical work environment –a comfortable environment and adequate facilities– causes employees to improve their performance (Putri et al., 2019). Specifically, employees working in software companies need an attractive and peaceful work environment –adequate lighting, a clean and noise-free office, comfortable seating, etc.– to achieve a higher level of performance, since the office environment affects positively the individual behaviour of employees (Hafeez et al., 2019). On the other hand, the organizational climate, through informal relationships between employees and their supervisors, enhances work performance. There is also evidence that there are important relationships between individual innovation and dimensions of the organizational climate related to autonomy, freedom, feedback, and work challenges (Shanker et al., 2017). Employees should communicate openly with their supervisors and receive feedback and support, when necessary, to create an environment of trust that involves good relationships with supervisors and contributes to employees' organizational commitment. In addition, managers must offer rewards to their employees and, at the same time, monitor the distribution of these to create a positive climate because a perception of unfairness can cause a reverse impact. Finally, the organizational structure –regulations, standards, and work organization– is another component of the organizational climate that has an impact on the perception of organizational commitment and performance (Berberoglu, 2018).

Integration into the business culture, by employees, adds value to the company (Guiso et al., 2015). It must be taken into account that four attributes can be identified in a business culture: that it is (i) shared – culture is a group phenomenon that resides in shared behaviours, values and assumptions and is most commonly experienced through unwritten rules; (ii) pervasive – culture permeates multiple levels and is applied very widely in an organization, manifesting itself in collective behaviours, physical environments, group rituals, visible symbols, stories, and legends; (iii) durable – culture can direct the thoughts and actions of group members in the long term, becoming a social pattern that reinforces itself and becomes increasingly resistant to change and external influences; (iv) implicit – despite its subliminal nature, employees recognize it and respond to it instinctively (Groysberg et al., 2018). It should also be considered that a company's culture can be expressed in its business ethics and corporate social responsibility. The latter plays an important role in enhancing the value of the company by promoting employee productivity, ensuring better operational performance, expanding the product market, improving capital market profits, building a corporate reputation, and strengthening the company's relationship

with society (Malik, 2015). Finally, customers value business ethics as a critical behaviour in their perceptions of business brand attitudes. For this reason, corporate social responsibility can influence hiring opportunities, employee loyalty, and relationships with regulatory groups (Ferrell et al., 2019).

Employee **stability** is important to improve the business development of enterprises. In particular, it increases organizational effectiveness and productivity, and therefore possible causes of employee turnover (e.g., managerial factors, the work environment, salary, fringe benefits, career advancement, job fit, clear job expectations, or alternative employment opportunity) should be analysed (Al-Mamun & Hasan, 2017). Specifically, the offer of internal employee development and training programmes is necessary for the objective of employee retention, and programmes can be offered to: (i) give more authority to employees so that they can self-manage and decide on their professional career within the company, (ii) assign employees to lead projects or teams, (iii) provide the opportunity for employees to train for other positions and responsibilities, and/or (iv) encourage employees to obtain additional training by attending external seminars and courses (Cloutier et al., 2015).

Each company must also face **new challenges** arising from the evolution of its products, the transformation of its markets, and the evolution of its competitors. In addition, there are now new challenges that affect all companies, such as digitalization and corporate social responsibility. The latter is interpreted as a corporate attempt to close governance gaps at the local, regional, and global levels (Quintana, 2020; Scherer et al., 2016). Moreover, to meet new challenges, companies need the right people to effect cultural change driven by the necessary new business models (Vidgen et al., 2017).

The cultural transformation of the company, which facilitates its evolution towards an **agile organization**, is key to achieving the digital transformation in the company that allows for a focus on the customer, obtaining the collaboration of empowered people in networks of teams, making decisions agilely, and achieving leaders who promote commitment and innovation (Valderrama, 2019). Agile organizations are different from traditional organizations that are built around a static, siloed structural hierarchy. These agile organizations are characterized by a network of teams that operate in rapid cycles of learning and decision-making. In contrast to traditional organizations where governing bodies are at the top and decision rights flow down the hierarchy, agile organizations instil a common purpose and use new data to grant decision rights to the teams closest to information. An agile organization should ideally combine speed and adaptability with stability and efficiency, through six necessary characteristics: (i) strong and aligned leadership from the top, (ii) an agile operating model to provide a clear vision, (iii) indicators that demonstrate its value through tangible business results, (iv) agile operating units, (v) a governance and decision-making framework, and (vi) new skills, behaviours, and mindsets across the organization (Brosseau et al., 2019). From the point of view of their employees, agile organizations need them to think differently – conceptualize possibilities in a virtual world, manage increasing cognitive complexity, and envisage new ways of doing things, act differently – collaborate easily on different teams and value the contributions of new partners and various stakeholders, and react differently – tolerate an environment of risk and ambiguity and show resilience in the face of constant change (Hadida & Troilo, 2020).

3. Materials and Method

3.1. Sample and Data Collection

To analyse the degree to which certain skills can contribute to the achievement of certain behaviours at work and identify the training needs of employees, the Delphi method was first one chosen for conducting the research. The Delphi method is a prospective procedure that aims to gather information and discuss a defined problem through the participation of a group of experts (Gordon, 1994; Grime & Wright, 2016; Landeta, Matey de Antonio, Ruiz Herrán & Villarreal Larrinaga, 2002; Lian, Liu & Chen, 2020).

First, a questionnaire was designed and tested in February 2022 with six professionals to improve its understanding and interpretation, facilitate its implementation, and prepare its presentation to the group of experts. The final questionnaire (see Appendix I) included Likert scale questions – scored from 1 to 5 depending on the need for each skill in achieving the professional behaviours – to assess, in the form of a matrix, the relevance of each skill in contributing to each type of employee behaviour. Second, the selection of the panel of experts was carried out by contacting professionals who, due to their knowledge and experience, were closely related to the subject of this

study. Finally, 38 Spanish experts participated in the research (21 professionals – employed in technology companies or consulting firms and/or entrepreneurs – and 17 teachers – professors in vocational training centres and universities; for more details, see Appendix II). The questionnaire was completed in face-to-face meetings or by videoconference between March and April 2022.

3.2. Variables

Based on previous work, this research has considered eight types of skills that might be required for digitalization and I4.0 applications in companies:

1. Communication (communicat)
2. Problem-solving (proble-solv)
3. Teamwork (teamwork)
4. Self-management (self-manage)
5. Cognitive skills (cogni-skills)
6. Management (management)
7. Basic language (basic-languag)
8. Conduct (conduct)

On the other hand, the following seven types of professional behaviours of employees necessary for digitalization and I4.0 applications in companies have been considered:

1. Individual performance (indiv-perform)
2. Commitment to objectives (commit-obje)
3. Work environment (work-environ)
4. Integration into the culture (integra-cultu)
5. Employee stability (employ-stabil)
6. Acceptance of new challenges (new-challeng)
7. Agile organization (agile-organiz)

3.3. Statistical Analysis

First, a descriptive statistical analysis was carried out with SPSS, calculating the statistics of the 56 pairs of professional skills-behaviour variables. Second, a dimensionality reduction was carried out by means of an exploratory factor analysis (EFA) of the observed variables to determine, using the usual criteria, the optimum number of latent variables sufficient to explain the greatest possible variability. Subsequently, a structural equation model (SEM) was estimated where only the skills are the constructs (unobserved variables) explaining all the structural relationships between the observed variables (professional behaviours). Through the observed values, the skills indicated above are explained as follows:

$$\eta_i = \alpha_i + (\gamma_{i1} \quad \dots \quad \gamma_{in})(I) + \zeta_i I = 1, I: \forall n = 1 \dots 7$$

η_i : representing the skills.

γ_{i1} : the regression path of the skill η_i of the first observed variable ξ_{i1}

γ_{in} : the regression path of the skill η_i of the seventh observed variable ξ_{in} .

In compact notation $\eta = \alpha + \Gamma\xi + \zeta$, where: Γ is the relationship between exogenous and endogenous variables, with $\Sigma \approx S \approx \hat{\Sigma}$ of a sample size of 38.

The methodology applied a latent variable for each occupational skill (1-8) and an observed variable for each behaviour (1-7).

The descriptive statistics and SEM were repeated separately for the teaching experts (17) and business professionals (21).

4. Results

4.1. Descriptive Analysis

Table 3 shows the descriptive statistics of each pair of variables: mean and standard deviation in parentheses. Skills appear in the first column and professional behaviours in the first row. As can be seen, all the average values obtained are above 3 (on a scale of 1 to 5), with 'basic language' being the one that presents the lowest values in relation to the majority of professional behaviours analysed (especially, 'commitment to objectives', 'work environment', 'integration into the culture' and 'employee stability'). On the contrary, the average values indicate a strong dependence and relevance of the 'problem-solving' and 'self-management' skills to achieve 'individual performance' and of 'teamwork' for a good 'work environment', being found in these pairs of variables the highest figures.

	Indiv- perform	Commit- obje	Work- environ	Integra- cultu	Employ- stabil	New- challeng	Agile- organiz
Communicat	3.76 (1.342)	4.11 (0.875)	4.43 (0.689)	4.30 (0.878)	3.70 (1.127)	3.81 (1.101)	3.95 (1.177)
Proble-solve	4.58 (0.649)	3.86 (0.931)	3.86 (1.018)	3.42 (1.251)	3.67 (1.069)	4.11 (0.887)	4.11 (0.854)
Teamwork	3.94 (1.194)	4.61 (0.803)	4.78 (0.485)	4.25 (0.967)	4.14 (0.931)	4.42 (0.649)	4.42 (0.874)
Self-manage	4.58 (0.604)	3.97 (0.971)	3.63 (1.031)	3.56 (1.054)	3.72 (1.059)	4.17 (0.941)	4.14 (0.798)
Cogni-skills	4.53 (0.774)	3.64 (1.150)	3.47 (1.082)	3.08 (0.967)	3.47 (1.134)	3.97 (1.000)	3.67 (1.242)
Management	4.08 (0.874)	3.78 (1.198)	3.60 (1.063)	3.56 (1.182)	3.69 (1.009)	4.00 (0.862)	4.31 (0.856)
Basic-leng	3.82 (0.968)	3.03 (1.193)	3.00 (1.128)	3.03 (1.141)	3.03 (1.243)	3.26 (1.238)	3.29 (1.219)
Conduct	4.00 (1.080)	4.24 (0.955)	4.41 (0.832)	4.49 (0.651)	4.27 (0.804)	3.92 (1.115)	3.62 (1.381)

Table 3. Means and standard deviations

Specifically, the results reveal that: (1) communication skills contribute mainly to the behaviours of the work environment, integration into the culture, and commitment to objectives; (2) problem-solving skills favour individual performance behaviours, the acceptance of new challenges, and the organization becoming an agile one; (3) teamwork skills influence more markedly work environment behaviours, commitment to objectives, and the acceptance of new challenges; (4) self-management skills mainly help the behaviours of individual performance, the acceptance of new challenges, and the evolution of an agile organization; (5) cognitive skills basically act on the behaviours of individual performance, the acceptance of new challenges, and the development of an agile organization; (6) management skills contribute to the advancement of an agile organization, individual performance, and the acceptance of new challenges; (7) basic language skills are more related to the behaviours of individual performance, the implementation of an agile organization, and the acceptance of new challenges; and (8) conduct skills positively affect integration into the culture, the work environment, and stability of employees.

4.2. Exploratory Factor Analysis

EFA reduces the dimensionality of the sample of professional behaviours for each skill into two unique latent (unobserved) variables, as indicated in Table 4. The variables (skills) that according to EFA explain the latent variables that could be considered as company commitment and personal development are placed in the first column. Thus, those skills explain the variance, hereinafter saturate the variance of the latent variables or factors (company commitment and personal development). The second column shows the percentage variance that each skill saturates. The rest of the columns explain the content of each skill.

Skill	Variance saturation	Latent variable 1 (company commitment)	Latent variable 2 (personal development)
Communication	56%	Identification with the company (commitment to objectives, the work environment, integration into the culture, and the stability of employees)	Performance in changes and new challenges (individual performance, acceptance of new challenges, and an agile organization)
Problem-solving	56%	Identification with the company (commitment to objectives, the work environment, integration into the culture, employee stability, and acceptance of new challenges)	Performance in changes and new challenges (individual performance and an agile organization)
Teamwork	52%	Performance in changes and new challenges (commitment to objectives, the work environment, acceptance of new challenges, and an agile organization)	Commitment to the company (individual performance, integration into the culture, and employee stability)
Self-management	49%	Identification with the company (work environment, integration into the culture, employee stability, and the acceptance of new challenges)	Performance to achieve goals (individual performance and commitment to objectives)
Cognitive skills	62%	Identification with the company (individual performance, commitment to objectives, the work environment, integration into the culture, and acceptance of new challenges)	Acceptance of changes (employee stability and an agile organization)
Management	66%	Permanence and adaptation in the company (integration into the culture, employee stability, and an agile organization)	Performance to achieve goals (individual performance, commitment to objectives, the work environment, and the acceptance of new challenges)
Basic language	75%	Permanence and adaptation in the company (work environment, integration into the culture, employee stability, and an agile organization)	Performance to achieve goals (individual performance, commitment to objectives, and acceptance of new challenges)
Conduct	73%	Performance in changes and new challenges (individual performance, acceptance of new challenges, and an agile organization)	Identification with the company (work environment, integration into the culture, and the stability of employees)

Table 4. Latent variables for each skill according to the exploratory factor analysis

These results of the EFA can be summarized in the definition of two groups of basic professional behaviours: (i) identification with the company – the synthesis of commitment to objectives, the work environment, integration into the culture, and stability of employees, and (ii) performances – the synthesis of individual performance, acceptance of new challenges, and existence of an agile organization.

Table 5 shows the diagnosis data for the estimated model, which indicate its validity and reliability based on the observed data.

Skill	Approached to collinearity	Kaiser-Meyer-Olkin factor	Bartlett test
Communication	0.03714 ***	0.600 +	2.62e-14 \$
Problem-solving	0.04670 ***	0.634 +	6.45e-13 \$
Teamwork	0.07363 **	0.632 +	3.22e-10 \$
Self-management	0.06966 **	0.692 +	1.53e-10 \$
Cognitive skill	0.01552 ***	0.758 +	9.19e-20 \$
Management	0.01552 ***	0.847 +	2.50e-21 \$
Basic language	0.00118	0.892 +	1.07e-36 \$
Conduct	0.00118	0.826 +	3.39e-30 \$

*** indication of rejection of presence of Ho above 99%

** indication of rejection of presence of Ho above 95%

* indication of rejection of presence of Ho above 90%

+ indicates sampling adequacy above 0.60

\$ indicates homoscedasticity.

Table 5. Diagnostic criteria

As can be seen, the diagnosis of the estimated models reflects the absence of perfect collinearity, the adequacy of the samples, and the absence of homogeneity of the sample variances.

Table 6 shows the results of the SEM analysis, where the degrees of influence of each skill on each professional behaviour are shown, with the variances of these relationships in parentheses (see Figures in Appendix III).

	Indiv- perform	Commit- obje	Work- environ	Integra- cultu	Employ- stabil	New- challeng	Agile- organiz
Communicat	(1.39) 0.83	(0.57) 0.58	(0.13) 0.84	(0.27) 1.00	(0.68) 1.07	(0.87) 0.78	(1.15) 0.60
Proble-solve	(-) -	(0.30) 0.72	(0.51) 0.68	(0.49) 1.00	(0.20) 0.95	(0.65) 0.29	(-) -
Teamwork	(-) -	(0.48) 0.57	(0.14) 0.46	(0.64) 0.78	(0.66) 0.62	(0.03) 1.0	(0.41) 0.91
Self-manage	(-) -	(0.57) 0.69	(0.31) 1.00	(0.17) 1.16	(0.60) 0.82	(0.50) 0.71	(-) -
Cogni-skills	(0.45) 0.37	(0.46) 1.02	(0.35) 1.00	(0.24) 0.92	(0.45) 1.00	(0.67) 0.58	(0.91) 0.84
Management	(0.38) 0.59	(0.16) 1.13	(0.40) 0.82	(0.38) 1.00	(0.42) 0.75	(0.43) 0.53	(0.48) 0.46
Basic-leng	(0.57) 0.51	(0.34) 0.99	(0.12) 1.04	(0.21) 1.00	(0.21) 1.11	(0.30) 1.06	(0.69) 0.81
Conduct	(0.18) 1.00	(0.35) 0.75	(0.33) 0.59	(0.35) 0.23	(0.38) 0.50	(0.24) 1.01	(0.38) 1.24

Table 6. Degrees of influence of each skill on each professional behaviour

Based on this table, it can be noted that: (i) communication skills contribute to further improving employee stability, the work environment, and individual performance; (ii) problem-solving skills have a greater influence on employee stability, commitment to objectives, and the work environment; (iii) teamwork skills mainly contribute to the organization becoming an agile one, integration into the culture, and the stability of employees; (iv) self-management skills above all favour integration into the culture, employee stability, and the acceptance of new challenges; (v) cognitive skills help more with the commitment, employee stability, and culture integration; (vi) management skills most affect commitment to objectives, the work environment, and employee stability; (vii) basic language skills act more on employee stability, the acceptance of new challenges and the work environment; and (viii) conduct fundamentally contributes to the development of an agile organization, the acceptance of new challenges, and commitment to objectives.

In confirmatory factor analysis, several statistical tests are used to determine how well the model fits the data. Kline & Rosenberg (2010) recommends reporting the comparative fit index (CFI) test, which analyses model fit by

examining the discrepancy between the data and the hypothesized model. The CFI values range from 0 to 1, with larger values indicating a better fit. Therefore, a CFI value of 0.90 or higher is currently accepted as an indicator of a good fit. In addition, the non-normed fit index known as the Tucker-Lewis index (TLI), built on an index formed by Tucker and Lewis in 1973, solves some of the problems of negative bias. Values for the TLI should range between 0 and 1, with a cutoff of 0.95 or greater indicating a good model fit.

Skill	CFI	TLI
Communication	0.568	0.352
Problem-solving	0.941	0.882
Teamwork	0.762	0.604
Self-management	0.941	0.881
Cognitive skill	0.782	0.673
Management	0.926	0.889
Basic language	0.977	0.965
Conduct	0.790	0.685

Table 7. CFI and TLI values

As can be seen in Table 7, the fit of the model is good, as there are four skills with a CFI value greater than 0.90. As far as negative biases are concerned, TLI values are high in the four aforementioned skills. Communication is the one skill that has a poor fit to the model.

Based on all previous results, Table 8 shows a classification of the skills required to improve the necessary behaviours. Specifically, a distinction is made between key skills for digitalization, because they are absolutely necessary to achieve each type of behaviour, and other relevant skills, because they are useful in improving behaviours. The first column corresponds to the behaviours while columns 2 and 3 refer to the skills that according to the analysis are required to achieve them.

Behaviours	Key skills	Relevant skills
Individual performance	Self-management Problem-solving Basic language	Management Communication
Commitment to objectives	Cognitive skill Management	Conduct Problem-solving Teamwork
Work environment	Communication Teamwork	Problem-solving Basic language Conduct Management
Integration into the culture	Problem-solving Self-management Conduct	Communication Cognitive skills Teamwork
Employee stability	Communication	Teamwork Self-management Cognitive skills Management
Acceptance of new challenges	Self-management Teamwork Basic language	Conduct Problem-solving
Agile organization	Management Teamwork Conduct	Cognitive skills Basic language

Table 8. Key and relevant skills according to behaviours

4.3. Analysis of the Differences Between Teaching Experts and Professional Experts

Table 9 shows, based on the averages obtained, the behaviours most influenced by each skill according to the differentiated opinions of the groups of teachers and professionals. The two groups correspond in terms of behaviours influenced by problem-solving skills, teamwork, self-management, cognitive skills and basic language skills (e.g., communication skills are linked to the agility of the organization, the individual performance and the working environment according to teachers while according to professionals' communication skills are linked mostly to the employee stability).

In the communication, management, and conduct skills, the differences between the two groups are shown: (1) in communication, they only coincide in the behaviour of the work environment, (2) in terms of management, the coincidence is in the commitment to objectives, and (3) in relation to conduct, the coincidence is only in regard to the development of an agile organization.

Skill	TEACHERS' opinions	PROFESSIONALS' opinions
Communication	Agile organization, individual performance, the work environment.	Employee stability, the work environment.
Problem-solving	Employee stability, acceptance of new challenges, individual performance.	Employee stability, the work environment, individual performance
Teamwork	Employee stability, the development of an agile organization, the work environment.	Agile organization, integration into the culture, the work environment.
Self-management	Individual performance, integration into the culture, employee stability.	Individual performance, integration into the culture, commitment to objectives.
Cognitive skill	Individual performance, acceptance of new challenges, employee stability.	Individual performance, employee stability, the development of an agile organization.
Management	Commitment to objectives, the work environment, the development of an agile organization.	Employee stability, commitment to objectives, individual performance.
Basic language	Acceptance of new challenges, employee stability, individual performance.	Individual performance, the work environment, employee stability.
Conduct	Agile organization, acceptance of new challenges, the work environment.	Integration into the culture, the development of an agile organization, commitment to objectives.

Table 9. Differences between teachers' and professionals' opinions

5. Discussion

This study supports and complements previous research that revolves around digitalization and the need to adapt skills and competencies to its progressive evolution in companies (Chaibatte & Bakkali, 2017; Soupez, 2023). It also discusses the previous findings and provides evidence and understanding about the influence of each of the eight types of skills studied on each of the seven types of behaviours necessary to face the challenge of digitalization in companies.

With regard to **communication**, leaders are required to develop a combination of digital and human skills, mainly related to the ability to communicate effectively in a digitalized context (Cortellazzo, Bruni & Zampieri, 2019), covering the four areas of communication: integration, interpretation, identity, and image (Crane & Glozer, 2016). According to these authors, this work indicates that communication mainly contributes to behaviours linked to commitment to objectives, the work environment, integration into the culture, employee stability, and the acceptance of new challenges. The progressive digitalization of firm's operational processes increases the need for increase the ability to communicate effectively in industrial engineering and management contexts (Tseng, Tran, Ha, Bui & Lim, 2021).

With digitalization processes underway, companies must **solve problems** relating to the reduced time to market and shorter product life cycles, as well as need to reduce costs to remain competitive (Hecklau et al., 2016). In addition, the employees of a company must apply the ability to solve problems to the relationships between themselves and with other employees of companies that supply or compete with their own (Hecklau et al., 2016). The analysis reveals that the influences for the ability to solve problems that arise which are: individual performance, the acceptance of new challenges, the development of an agile organization, the work environment, employee stability, and their commitment to objectives. In deep, each one of those behaviours is enhanced by different skills that could be classified in two different groups: towards others (e.g. communication) or to self (e.g.

self-management). Thus, the personal ability to quickly and efficiently solve complex and relational problems is directly linked to esteem and self-actualization, boosting company competitiveness.

According to Hecklau et al. (2016), the ability **to work as a team** is one of the eight social skills necessary for the development of I4.0. Britton et al. (2017) defines different dimensions of teamwork: communication, shared decision-making, use of the experience of all members, full participation, collaboration, learning orientation, coordination and effort, social support, respect for members, psychological security, active conflict management, shared objectives, and group cohesion. Communication also must be frequent, timely, and precise to solve problems and to improve the quality of working relationships between people and the coordination of their work with each other more effectively (Gittell, 2011). This study reaffirms the work of previous authors, who indicate that the skill for teamwork contributes mainly to six behaviours: work environment, commitment to objectives, acceptance of new challenges, the development of an agile organization, integration into the culture, and employee stability.

Self-management includes planning, action, feedback and control at the individual level. According to Jain and Sinha (2006), self-managed employees develop good behaviours in their work and, in addition, go beyond working in the interests of their organization. In addition, a self-managed employee develops knowledge, cognitive skills, and other characteristics by setting appropriate goals, putting in consistent effort, and providing self-feedback. In line with this author, this work indicates that self-management mainly contributes to the behaviours of individual performance, integration into the culture, the acceptance of new challenges, the development of an agile organization, and employee stability. Millikin, Hom and Manz (2010) evidence how in industrial engineering contexts self-management competencies have a positive impact in final productivity of self-managing teams.

This work also highlights that **cognitive skills** are important for different professional behaviours: commitment to objectives, integration into the culture, the development of an agile organization, the work environment, and employee stability. Similarly, other authors have indicated, first of all, that the concept of organizational learning behaviour is based on four perspectives: autonomy – how an individual can achieve a level of autonomy that makes them feel good, mastery – how it can be improved so that the work is pleasantly challenging, purpose – how to feel good in line with the company's mission – and hygiene – how to minimize dissatisfaction at work (Thomson, 1998). Second, it is highlighted that skills such as problem definition, cause/objective analysis, and creative thinking are necessary for employees' commitment to objectives (Mumford et al., 2017). This is especially key in industrial engineering and managerial contexts such as Kumbure, Tarkiainen, Luukka, Stoklasa and Jantunen (2020) argue in a comparative analysis in business student's and managers making decisions in real life problems.

The McKinsey report "Culture for a digital age" (Goran et al., 2017) highlights the importance of professional skills so that the **management** of cultural problems – risk aversion, weak customer focus and isolated mentalities – is less slow and complex. In addition, specifically, the main objective of the kanban methodology is to ensure a sustainable production rate to avoid excess finished product, bottlenecks, and delays in the delivery of orders (Castellano-Lendínez, 2019). Expanding on the above, this work generalizes that management skills contribute mainly to behaviours including employees' commitment to objectives, the work environment, employee stability, the development of an agile organization, individual performance, and the acceptance of new challenges.

According to our findings, **basic language** skills – algorithms, design tools and active listening – mainly contribute to individual performance, the work environment, employee stability, the development of an agile organization, and the acceptance of new challenges. These results reaffirm what was indicated by other authors. First, algorithms – a finite sequence of well-defined instructions – are used to solve a class of specific problems, perform calculations, process data, automate reasoning, and make automated decisions (Grossman & Frieder, 2004). Second, algorithms are also used in the area of human behaviour; for example, they can be used proactively for incident prevention or reactively for after-the-fact investigation (Candamo, Shreve, Goldgof, Sapper & Kasturi, 2009). Third, the facets of mindfulness – describing, observing, non-judging, consciously acting and non-reacting – positively influence cognitive abilities such as empathy and active listening. Mediation analyses showed that empathy and active listening are important for discriminating person-centred messages and facilitating reappraisals. Consequently, the results point to mindfulness as an important factor that influences cognitive-affective processes and the communication of emotional support (Jones et al., 2019).

Currently, within the skill referred to as **conduct**, it is estimated that prosocial behaviour is related to culture, attitudes, personality, mood, stress, and organizational performance (Organ, 2018). In addition, customers value business ethics and corporate social responsibility as critical behaviour in their perceptions of brand attitudes (Ferrell et al., 2019). On the other hand, an agile organization is achieved with: (i) agile work teams capable of collectively responding to crises and shocks, (ii) a culture of growth where failure is considered part of learning to get ahead, and (iii) resource fluidity (Elali, 2021). According to the previous authors, the results of this work indicate that conduct contributes to commitment to objectives, integration into the culture, the work environment, employee stability, the development of an agile organization, and the acceptance of new challenges.

Finally, the results obtained based on the two groups of experts are discussed. On the one hand, teachers and professionals agree in the importance of problem-solving, teamwork, self-management, cognitive skills, and basic language skills. On the contrary, the greatest disparities in pointing the weight are found in communication, management, and conduct. Regarding the latter, a possible justification is linked to the intensity with which the problems related to these three skills are experienced in companies more than in educational institutions.

6. Conclusions

6.1. Contributions to Theory and Practice

Digitalization and its application in the management of companies require a different profile of workers and employees different from those of previous industrial revolutions (the ‘Steam Age’ (I1.0) promoted manufacturing equipment, the ‘Electric Age’ (I2.0) promoted electricity and the division of labor and favored mass production, the ‘Automation Age’ (I3.0) encouraged the massive use of information technology, and the ‘Intelligent Age’ (I4.0) has merged IT and Operational Technology (OT) in a cyber-physical system manner for mass customization/personalization with intelligence (Leng, Sha, Wang, Zheng, Zhuang, Liu et al., 2022)). Currently, Industry 4.0 represents the challenge of readapting professionals with weaker training in new technologies, to an environment where new technologies represent a transversal skill. The use of a certain programming language or basic knowledge of cybersecurity is no longer restricted only to the technological sector, but its scope of application is found throughout the industrial sector, regarding the use of modern equipment, management and digitization of information, communication with sensors, programming of actuators, etc. This is why professionals who, either through their basic training or through complementary learning after their basic training, can equip themselves with these technological skills, will have better inclusion in Industry 4.0.

The need to improve professional behaviours of employees working in the field of engineering has previously been recognised (Chaibate & Bakkali, 2017; Soupeze, 2023) and this study has analysed the skills that could improve the professional behaviours of employees who work in this field. Based on the opinions of a panel of 38 experts from the fields of education and training, business management, and digitalization consulting, a reference framework has been developed that relates eight key and relevant skills for digitalization, specifying the influence of each one on the seven professional behaviours analysed. The findings demonstrate that the eight skills considered clearly influence individual performance, commitment to objectives, integration into the culture, employee stability, the acceptance of new challenges, and the development of an agile organization. But it is worth highlighting that among the set of eight skills analysed, four of them stand out: (i) the ability **to work as a team** is the one that most influences the behaviours necessary for digitalization linked to the work environment, commitment to objectives, the acceptance of new challenges, the agile organization, integration into the culture, and the stability of employees; (ii) **conduct** is relevant to behaviours regarding integration into the culture, the work environment, employee stability, the acceptance of new challenges, commitment to objectives and the evolution of an agile organization; (iii) the ability linked to **problem-solving** is important for behaviours related to individual performance, commitment to objectives, employee stability, acceptance of new challenges, the implementation of an agile organization, and the work environment; (iv) and **management** skills improve individual performance behaviours, commitment to objectives, the work environment, employee stability, and the organization becoming an agile.

The findings noted here allow companies to be guided in terms of employee training in regard to digitalization skills. In accordance with what is reported here and depending on the behaviours that companies need, they could more precisely define their training needs and the design or redesign of training plans. In addition, companies can

benefit from and use these findings to guide their selection processes, studying to what degree different candidates possess the eight skills studied that are important to them. On the other hand, universities, VET centres and other educational institutions can take advantage of this knowledge to review their study plans, increasing the relevance of the skills that professionals currently value more than teachers: problem-solving and cognitive skills. Finally, professionals, at an individual level, can guide their careers, taking into account the gap between their own skills and those currently most valued in companies.

In addition to the theoretical-practical contribution around I4.0, this work can also lay the foundations for research framed in the context of the 'Human-centricity Age' or Industry 5.0 (it combines human intelligence with artificial intelligence emphasizing the value of humanistic care and evolving toward the symbiotic ecosystem), which is still in its infancy and has few results and diverse concepts (Leng et al., 2022), and its implementation. Industry 5.0 aims and challenges to place human well-being at the center of manufacturing systems to achieve social objectives beyond employment and business growth. (Akundi, Euresti, Luna, Ankobiah, Lopes & Edinbarough, 2022; Huang, Wang, Li, Zheng, Mourtzis & Wang, 2022; Leng et al., 2022; Xu, Lu, Vogel-Heuser & Wang, 2021). Compared to past industrial revolutions that emphasized more the economic aspect of sustainability, the vision of Industry 5.0 leans towards human centrality and social needs (Leng et al., 2022). Although this work does not go in that direction (I4.0 focuses more on digitalization and technologies to increase productive efficiency while I5.0 focuses on the principles of social justice, sustainability and resilience (Akundi et al., 2022; Xu et al., 2021)), the findings presented here can be useful to promote the training and development of employees' professional careers, something that contributes to their quality of life and personal and professional well-being and also acts as a facilitator and contributes significantly to business results.

6.2. Limitations of the Research and Avenues for Future Research

This study is not without limitations. The number of experts that make up the panel and the subjective nature of the information collected are the main ones. Another of them has to do with the fact that the study is limited to the field of industrial engineering and only in the Spanish context, which has certain particularities or differences with respect to countries that show greater or lesser progress in the implementation of I4.0. Given such limitations, future research could try to expand the sample of experts or conduct questionnaires to employees in this area could enrich the findings reported here. It would also be very relevant to carry out this study taking into account the different professional levels within the industry, since according to the roles played by the different professionals in the production chain, they may have a different perception of the relevance of the skills that have been analyzed. Exploring coincidences or disparities in terms of the skills required in other sectors or fields of activity, as well as in other national contexts, in the face of the advance of digitalization and I4.0, would also be interesting. The results derived from this research could be useful, for example, for those workers who want to change sectors or pursue professional careers that contemplate mobility to other destination countries. Future research could also focus on the need to develop other types of desirable skills or behaviours within the framework of Industry 5.0 that can promote the sustainability of human capital. Accordingly, Campos-García, Alonso-Muñoz, González-Sánchez and Medina-Salgado (2023) recognize the relevance of paying greater attention to the contribution of human resources to organizations and vice versa, focusing especially on aspects related to Sustainable Development Goals 3 (Health and well-being) and 8 (Growth and decent work).

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Appendix I: Questionnaire

The answer to each of the questions is a number from 1 to 5:

- 1 implies that skill is not necessary to achieve professional behaviors.
- 2 implies that skill is little necessary to achieve professional behaviors.
- 3 implies that skill may be necessary to achieve professional behaviors.
- 4 implies that skill is necessary to achieve professional behaviors.
- 5 implies that skill is essential to achieve professional behaviors.

Response Matrix on the Relevance of Digitalization Skills to Improve Professional Behaviours

	Indiv-perform	Commit-obje	Work-environ	Integra-cultu	Employ-stabil	New-challeng	Agile-organiz
Communic							
Proble-solv							
Teamwork							
Self-manage							
Cogni-skills							
Management							
Basic- languag							
Conduct							

Definitions of Digitalization Skills

Communication: expression skills, Pitch creation, Storytelling, communication for reputational management, communication with regulators and institutions.

Problem solving: analytical thinking to analyze information, resolution of complex problems or in complex environments, critical thinking, creativity, capacity for abstraction, drive for transformation to apply innovations.

Teamwork: people management, persuasion and conflict resolution, service orientation, emotional intelligence, leadership and social influence, mentoring and teaching strategies, empathy, building trust, development of collaborative environments, collective intelligence, diversity management.

Self-management: initiative, agile and active learning, resilience and flexibility, Self-awareness, Growth-mindset, adaptation to volatility and ambiguity, personal productivity, emotional control, assertiveness, time management, emotional intelligence.

Cognitive skills: precision and endurance, memory, visual and auditory dexterity, cognitive skills.

Management: strategy, “Digital first” culture, material and financial resources, marketing and sales of digital products and services, multilevel change management, Design thinking, Lean startup, Scrum, Kanban, project management, management by objectives and purposes, Risk management.

Basic language: design and algorithm tools, active listening, mathematics.

Conduct: business ethics, Citizenship behavior (prosocial behavior), legal provisions that require employee behavior, integrity.

Definitions of professional behaviors

Individual performance: obtain results of individual work per unit of time used.

Commitment to objectives: align individual results with the objectives of the work team and the company.

Work environment: achieve informal relationships between members of the work team that help improve work performance.

Integration into culture: get many employees to share the mission, values, policies and basic methods of the company.

Employee stability: achieve a period of permanence of employees in the company.

Acceptance of new challenges: have an adequate number of employees to work on new projects, and/or in difficult environments.

Agile organization: achieve efficiency in managing current work and simultaneously manage future changing demand.

Appendix 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

Expert	Classification	Company or institution	Position
10	Professional	IIE	Training Director
11	Professor	Domingo Savio CVT Center	Training Consultant
12	Professor	Rey Juan Carlos U	Computing teacher
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 U	Computing teacher
30	Professor	Rey Juan Carlos U	Professor of industrial engineering
31	Professional	Repsol	IT Department
32	Professor	Rey Juan Carlos U	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

Appendix III: Graphical Results of SEM Analysis

E1: Individual performance
 E2: Commitment to objectives
 E3: Work environment
 E4: Integration into the culture
 E5: Employee stability
 E6: Acceptance of new challenges
 E7: Agile organization

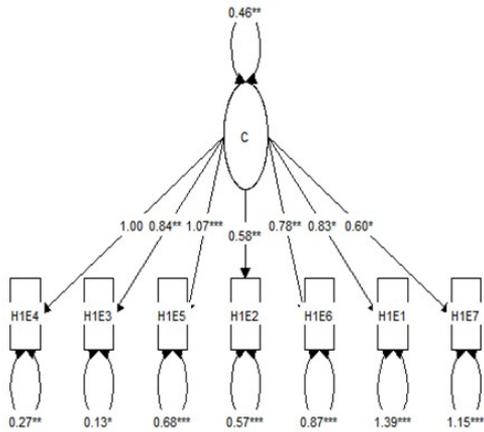


Figure 1. Communication (H1)

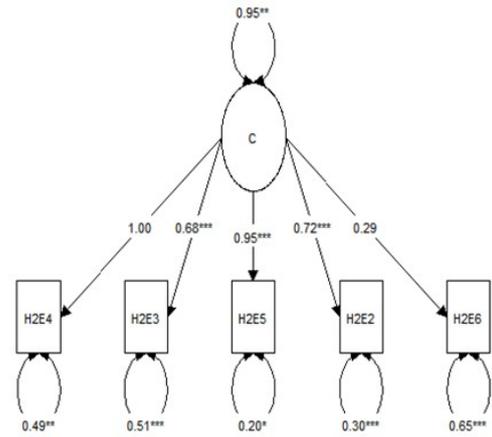


Figure 2. Problem-solving (H2)

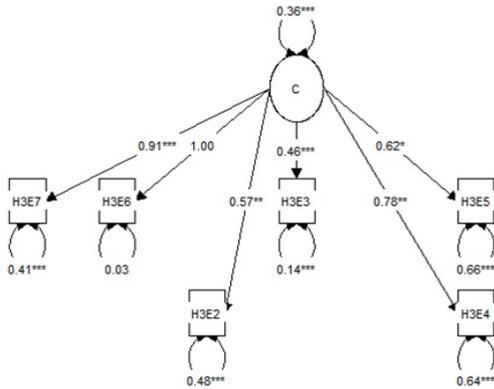


Figure 3. Teamwork (H3)

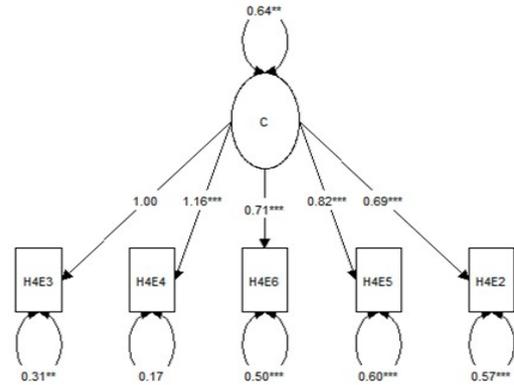


Figure 4. Self-management (H4)

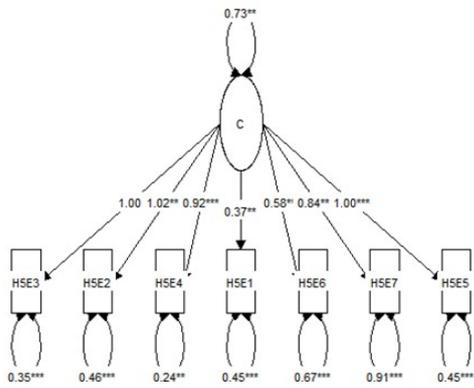


Figure 5. Cognitive-skills (H5)

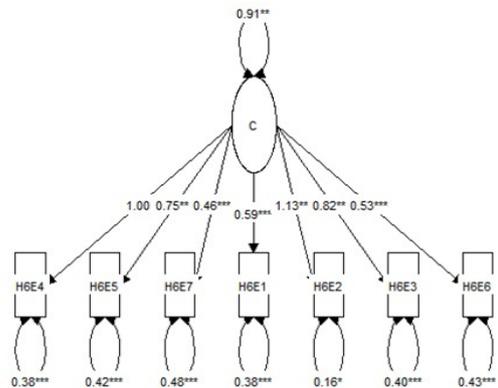


Figure 6. Management (H6)

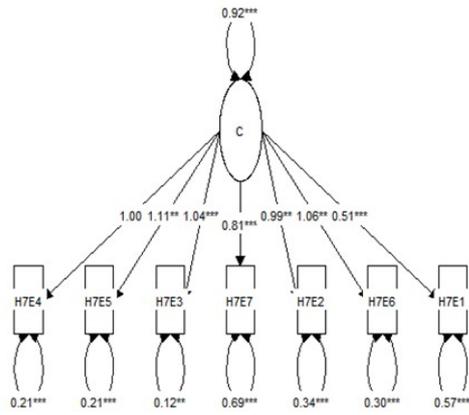


Figure 7. Basic language skill (H7)

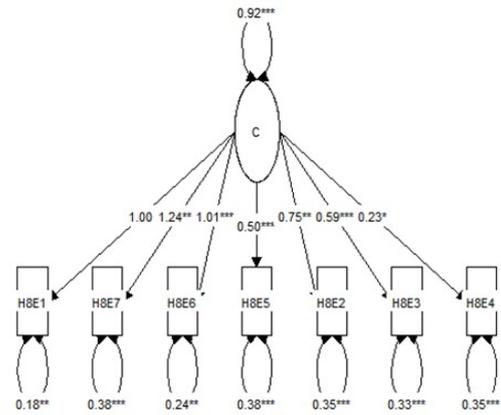


Figure 8. Conduct (H8)



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