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Recruitment Methodology based on a "Reskilling" and "Upskilling" Strategy

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Dissertation presented as partial requirement for obtaining the Master's degree in Information Management

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RECRUITMENT METHODOLOGY BASED ON A "RESKILLING" AND "UPSKILLING" STRATEGY

by

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Dissertation presented as a partial requirement of the degree of Master of Information Management, with a specialization in Information Systems and Technologies Management

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ABSTRACT

In the era of "Digital Transformation", new technologies have emerged in recent years, which have provided organizations with the opportunity to efficiently evolve their operations, transform their business models or even create new ones. The possibilities are enormous, but for this digital transformation process to happen, digital skills are essential, particularly highly qualified ICT professionals capable of implementing new technologies. The demand for these professionals is high, especially in Europe, and the scarcity is increasing. To face this shortage and respond to organisations' needs, a reskilling and upskilling strategy can be a solution to bring more qualified professionals to the ICT labour market with these new technologies. However, hiring professionals to be trained in new technologies is challenging and risky to succeed. Therefore, the recruitment process needs to be more precise to select and validate candidates who can quickly and successfully acquire new technological skills. This research intends to create a method that can help in this process, applying a systematic approach to selecting and validating candidates with the most adequate technical and interpersonal skills for their requalification in new technologies. With the application of this method, a competency model is created for the target job, candidates are evaluated, and gaps are identified. In case of the feasibility of requalifying the candidate, a training plan is developed to acquire new technological skills.

KEYWORDS

INDEX

LIST OF FIGURES AND TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

HRM   Human Resources Management

ICT   Information and communications technology

EU   European Union

DSR   Design Science Research

1. INTRODUCTION

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

1.1.1. Context

Organizations are increasingly looking to transform their services and business models, incorporating new digital technologies into their processes. In response to this challenge, technology has evolved in recent years, emerging with new solutions and tools, which motivate the interest of companies in its adoption (Jain & Ranjan, 2020).

"Big Data & Analytics", "Internet of Things", "Big Data & Analytics", and "Cloud Computing" are some of the disruptive technologies that are transforming how organizations operate and deliver value to their customers. Digital transformation is an inevitable process for the success of companies. In the last years, new technology adoption has been accelerating (Zahidi et al., 2020).

The challenge of digital transformation is relevant for companies and citizens, particularly in Europe, where the European Union (EU) recognises its importance in transforming society in the next decade (*The Digital Compass*, 2021). European Union aims to empower society, and on March 9 2021, the European Commission presented a vision of Europe's digital transformation by 2030 around four cardinal points: skills, government, infrastructures, and business (*Europe's Digital Decade*, 2021).

Digital skills are essential to implementing the digital transformation process. The demand for highly qualified ICT (Information and Communications Technology) professionals with new technology competencies have increased. (Zahidi et al., 2020). However, there is an increasing shortage of these professionals in the labour market once technological evolution is faster than acquiring knowledge and experience in these new technologies. According to the EU, "as of 2019, there were 7.8 million ICT specialists with a prior annual growth rate of 4.2%; however, if this trend continues, the EU will be far from the projected need of 20 million experts in 2030" (*Europe's Digital Decade*, 2021).

In this way, it will not be easy to find qualified professionals in the new technologies that can implement the companies' digital transformation strategy. On the other hand, adopting new technologies also requires new skills for those who use them. All jobs now require a complementarity of digital competencies. The new digital economy is transforming the way workers perform their jobs. The new technologies are used in all types of jobs, even in ones not traditionally related to digitalization, like farming or healthcare (*Shaping Europe's Digital Future*, 2021)

Digitally skilled workers and highly skilled digital ICT professionals are essential to embracing digital transformation. Europe's Digital Decade will succeed if digital competencies are available to transform the economy and society. In particular, the competition for highly ICT-skilled professionals in Europe is increasing within countries (ICF. & European C, 2018). Even though attracting talent from all over the globe can be a short-term solution, this is not sufficient for Europe's challenge upfront. To address this challenge, reskilling and upskilling the current workforce is the key to answering of lack of digital competencies necessary to transform businesses and change society (Group (BCG), 2018a; Illanes et al., 2018; Sivalingam & Mansori, 2020).

1.1.2. Motivation

Organizations want to empower their teams with ICT professionals with new technical skills and technological solutions. The companies may follow internal or external recruitment or subcontract outsourcing services that temporarily provide the necessary qualified resources (Machado & Portugal, 2013). In either approach, a recruitment process is conducted to attract candidates to the market and select those that best match the required skills for the vacancy.

Recruiting an ICT professional is primarily based on identifying and evaluating the competencies demonstrated by candidates in a specific set of technologies requested in the job description (Szyjewski, 2020). With this approach, the success in finding candidates will essentially depend on offering professionals in the labour market with these new technological skills. Knowing that emerging technologies are not yet widely used, searching the job market for professionals with experience in these new technologies will be hard and painful. (Kolding et al., 2018b).

Therefore, it is essential to follow a new methodology for sourcing, screening and validating candidates focused on analysing the skills needed to acquire a new technological competence, taking advantage of their current technical and interpersonal skills, or simply identifying and evaluating candidates with adjacent skills requested and complement it with the new ones (Sivalingam & Mansori, 2020).

Training the selected candidates in new technologies may answer the growing demand for qualified ICT professionals (Majovski & Davitkovska, 2017). However, it is necessary to follow an appropriate methodology to find and select candidates with the necessary technical and interpersonal skills to evolve for the target technological skills (Edward E. Lawler, 2017). Using this methodology to better select candidates is expected to reduce the training time and increase the success rate in acquiring new technological skills.

The strategy of reskilling and upskilling the companies' workforce is already used to solve the lack of digital skills (Kolding et al., 2018a). However, hiring new employees to train them for a target set of skills is a risky strategy that requires a more assertive process to attract and select candidates with technical and interpersonal skills that leverage their capacity to acquire new technological skills. Applying a methodology that can support the recruitment process in this objective seems to be relevant in the current context of high demand for professionals with competencies in emergent technologies.

1.2. OBJECTIVES AND RESEARCH QUESTION

This research aims to define a methodology for recruiting candidates based on "Reskilling" and "Upskilling" strategies. The methodology should help identify, select, and validate candidates with the technical and learning skills that enhance their success in being requalified for new technological skills. To achieve the results of the research, the following objectives were defined:

- Understand the ICT labour market and the reasons for the shortage of skills in the new technologies

- Make a literature review on the Human Resource Management processes, namely in the recruitment and selection process

- Define a competency model required for a target job role

- Assess the skills required to perform tasks associated with the skill matrix defined in the competency model

- Define a process to map the candidate skills to the target skills matrix, identifying matches and gaps

- Define, test, and validate a strategy for viable candidates' reskilling or upskilling pathways, considering gaps identified

The methodology should help answer the following research question: How do we identify the best candidates that fit in terms of learning and technical skills that leverage their capacity to acquire new technical skills quickly and with success?

In particular, the methodology to be proposed should be able to:

- Create a matrix of skills needed by the job role identified

- Identify candidates with similar skills and assess their skill gaps

- Additionally, it should address issues related to the candidate's potential, namely learning skills, cognitive abilities, and personal traits that enhance completing a learning new skill

- Define a candidate's requalification plan for new skills based on the identified gap.

1.3. STUDY RELEVANCE AND IMPORTANCE

With the application of this methodology, it is expected to improve the recruitment process of ICT professionals in the companies, applying a systematized approach to selecting and validating candidates with the most adequate technical and interpersonal skills for their requalification in new technologies.

The requalification of professionals has significant benefits in the labour market, as it allows professionals to be reoriented to new technological areas. Consequently, increasing professionals with the necessary technical qualifications to implement the companies' digital transformation strategy partially solves the skills shortage in the new technological domains.

This methodology can be extended to the current workforce in companies, contributing to the requalification of ICT professionals and avoiding the reduction of staff and the need to hire new employees with new technological competencies.

Additionally, the creation of this methodology may contribute to a better knowledge of the practices of recruiting highly qualified professionals in technological areas, helping to improve this process. It is also intended that this research contribute to possible future works in this area of knowledge.

2. METHODOLOGY

This research aims to design a methodology that helps answer the research question: "How to identify the best candidates that fit in terms of interpersonal and technical skills that leverage their capacity to acquire new technological competencies quickly and with success "?". Following this objective, the idea is to create an artefact, particularly a method, set of steps (guidelines and practices) to understand and answer the formulated question. (March & Smith, 1995).

The present research is a problem-solving paradigm, considering the objective identified. Therefore, it seems that Design Science Research (DSR) is the best research methodology to conceptualize, build, evaluate and produce a method (artefact) that, applying it, will help to identify the best candidates to be reskilled or upskilled.

2.1. DESIGN SCIENCE RESEARCH (DSR)

With DSR, it is possible to answer questions by creating artefacts and applying them to find a solution. DSR methodology is here presented in Figure 2.1 as a process model consisting of six activities (Peffers et al., 2020), not necessarily sequentially.
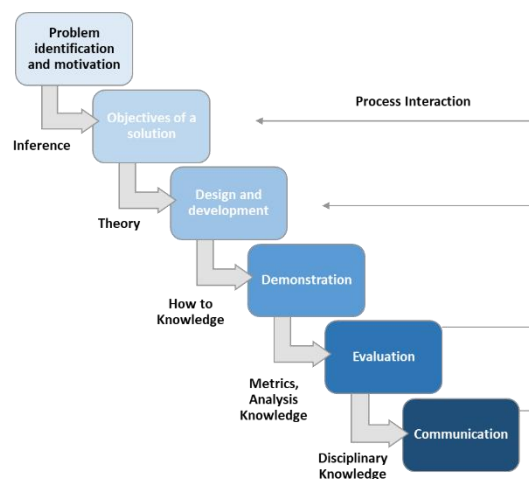
Source: Adapted from (Peffers et al., 2020)
Figure 2.1 - DSR Method Adaption

1) Problem identification and motivation – the problem is defined and justified why a solution is relevant to be found

2) Objective's definition – the objectives of a solution are inferred from the problem definitions

3) Design and development - determines the artefact such as constructs, models, methods, or instantiations (Hevner et al., 2004)

4) Demonstration – demonstrates the use of artefacts to solve the instances of the problem

5) Evaluation – evaluates how the artefact supports the solution to the problem

6) Communication - communicates the problem, its importance and how the artefact supports its solution

(Hevner, 2007) analyses DSR as an image of three cycles of activities closely related. The author states that what defines "good design science research is the synergy between the relevance and rigour cycles and their contribution to the research project".

As represented in Figure 2.2, the design science activities provide requirements from the contextual environment for the research project. The researcher's understanding of the environment helps to identify opportunities and problems that will be addressed in the design cycle to build the artefact. In the design cycle, the results of artefact field testing may force us to get back to environment analysis due to incorrect inputs or some deficiencies in the artefact. (Hevner, 2007) calls to these interactions the relevance cycle.
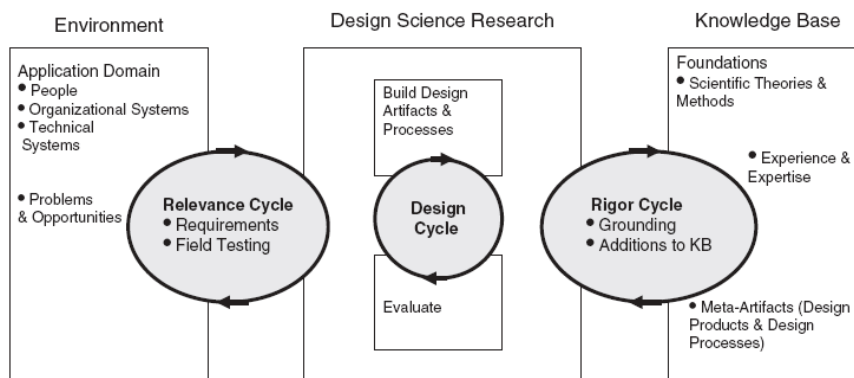
Source: (Hevner, 2007)
Figure 2.2 - DSR Cycles

On the other hand, the Rigor cycle provides a knowledge base to support design science research. It can be theories and methods, previous experiences related, expertise on the subject matter or existing artefacts and processes in the same domain. The Rigor cycle will provide foundation knowledge to build the artefact in the design cycle.

2.2. RESEARCH STRATEGY

The previously described DSR methodology and DSR cycles will be applied in the present research. Starting with the "Problem Identification and Motivation" phase, a literature review will be carried out to better understand the problem and justify the importance of finding a solution. The statement of the demand and shortage of ICT professionals in the current context of Digital Transformation will be demonstrated with some recent relevant studies. Additional academic studies will be reviewed to highlight the challenge of ICT recruitment and how upskilling and reskilling strategy can be a possible solution to the problem of recruiting ICT professionals.

Based on previous studies and literature review, once the problem has been stated, the objectives of the solution are defined, as well as a list of requirements necessary to achieve these objectives. At this stage, theoretical bases for the artefact design are prepared based on an in-depth literature review on Human Resources Management (HRM) concepts and processes that will support the design research.

In the "Design and implementation", the artefact will be designed and developed. The idea of creating a methodology for recruiting candidates based on a strategy of "Reskilling" and "Upskilling" is designed and developed supported by the grounding knowledge from the literature review. The activities for the artefact development are then detailed, and the conceptual design of the artefact is developed. The objectives may be reviewed and realigned according to the results desired. The results may require more interaction with inputs from the environment (relevance cycle) as well as more ground knowledge needed to build the artefact (rigour cycle).

In the "Demonstration" phase, a prototype of the methodology created is used in field experimentation to prove the concept. An open occupation will be selected, and a candidate selection process will be conducted using the artefact created.

The information collected from the experimentation is analysed in the "Evaluation" phase. The artefact results are presented to a group of people responsible for HR processes, and the feedback is collected to evaluate the effectiveness of the artefact proposed.

After the "evaluation phase", the communication phase is carried out, emphasizing the conclusions and limitations of the developed artefact. A final document will be delivered for academic evaluation and feedback-gathering purposes.

3. ICT HR MANAGEMENT ENVIRONMENT

The ICT HR Management environment is presented in four thematic groups. The first group globally presents the themes of new emergent technologies that drive Digital Transformation, causing a high demand for digital competencies and forcing organisations to adopt upskilling and reskilling strategies to fill the gaps in digital skills. A similar analysis in the second group focuses on the Portuguese context. In the third thematic group, the recruitment of ICT specialists is analysed through recent statistics to understand the main difficulties of filling vacancies for these profiles. The current approaches to attracting these profiles are presented, and finally, it is introduced how the recruitment process can be integrated into an upskilling and reskilling strategy. The fourth group highlights the main challenges and opportunities of recruitment based on upskilling and reskilling strategy.

3.1. CONTEXT

Business Competitive pressures, globalization, and technology changes are causing organizations to re-evaluate how work is done. (Rotundo & Sackett, 2004). This sub-chapter explains the emergence of new technologies and how they transform organizations, boosting digital transformation. It also clarifies how the digital transformation has created a demand for new digital skills and why this demand is causing a shortage of these skills. Finally, it briefly introduces the concept of upskilling and reskilling to address the skills gap.

3.1.1. Emerging new technologies

Emerging technologies in the last years, such as the Cloud, Internet of Things (IoT), Big Data, Mobile and Artificial Intelligence, are driving organizations towards new models of digital customer engagement, new business opportunities and changing the way we work and live (Brynjolfsson & McAfee, 2014).

The Internet of things (IoT) extends the capabilities of the Internet by enabling machine-to-machine (M2M) communication. By incorporating some intelligence (e.g. sensors and actuators) into the equipment and devices connected to the Internet, they can share information, receive inputs and invoke actions, take decisions, and provide services (Chopra et al., 2019). The IoT can change several sectors, like energy, manufacturing and transport (Gluhak et al., 2011). The application of IoT is endless. Some applications could be designing smart cities and smart homes, creating more efficient transport systems, and monitoring medical devices or industrial equipment (Chopra et al., 2019).

According to the definition supplied by NIST, the National Institute of Standards and Technology, Cloud computing is a model that allows universal access, on-demand and self-service, to an extensive pooling network of computing resources, such as servers, storage, networks, servers, applications and services, that can be elastically provisioned and released, with reduced effort management or service provider (Mell & Grance, 2014). Cloud computing technology brings organizations some benefits (Xue & Xin, 2016):

- flexibility, as applications and data can be deployed and used anywhere, no matter the location where the users are,

- cost reduction, as the organizations only pay for what they use, have no responsibility for maintaining systems and shift their capital expenses to operating expenses,

- agility, as it can adapt quickly to respond to the needs of the business,

- scalability, as it allows for adjustment of the resources based on the changes in business needs.

Big data is an abstract concept that embodies how to process large-volume data and derives value from it. In recent years, the massive utilization of the internet and mobiles, social networks, and the emergence of the IoT has generated a large volume of structured and non-structured data (images, text, speech). This data's perceived value guided the development of new technologies for generation, acquisition, storage, and data analysis. These technologies allow to capture and interpret data to enable organizations to access details of their operations and make strategic decisions (Chen et al., 2014).

Mobile allows us to manage and access information anywhere, anytime. Mobile technologies (devices and applications) brought multiple uses and collaboration to individuals and organizations, supporting new business models (Brynjolfsson & McAfee, 2014). Smartphones, laptops, notebooks, or GPS devices have increased over the last few years and changed business activities and people's lives. The mobile feature of access anywhere and anytime leverage new opportunities for software applications and new business models (Sousa & Rocha, 2019).

Artificial intelligence brings the capacity of computers to execute a task that usually requires human intelligence. This capacity brings enormous applications such as robotics, autonomous drive, medical devices, business intelligence and process automation. (Brynjolfsson & McAfee, 2014).

3.1.2. Digital Transformation

New technologies have allowed organizations to explore and integrate their benefits, mainly using them to transform and improve their business models and operations (Matt et al., 2015). This phenomenon has been known as "Digital Transformation" (DT), which according to the literature review by (Morakanyane et al., 2017), can be understood as "an evolutionary process that leverages digital capabilities and technologies to enable business models, operational processes and customer experiences to create value".

Following the previous definition, digital capabilities and technologies are the drivers of the transformation. With the new technologies, organisations with digital capabilities (skills and culture) can reshape their business models, enhance operations and offer a better customer experience. (Matt et al., 2015). By implementing a digital transformation strategy, organizations benefit from its impacts through value creation, such as competitive advantage, strategic differentiation or cost savings (Morakanyane et al., 2017).

The phenomena of digital transformation are relevant not only for private organizations but also for public organizations and citizens, particularly in Europe, where the European Union (EU) recognizes its importance in transforming society in the next decade (*The Digital Compass*, 2021). European Union aims to empower society for the digital age and plans for Europe's digital transformation by 2030 around four cardinal points: skills, government, infrastructures, and business (*Europe's Digital Decade*, 2021). The increase of digitally skilled citizens and highly skilled digital professionals, more digitalisation of public services, secure, performant and sustainable digital infrastructures, and digital transformation of businesses are the main goals to ensure the EU's digital ambitions for 2030 (*The Digital Compass*, 2021).

3.1.3. Demand and Shortage of new Digital Skills

The demand for highly skilled digital professionals

Digital Transformation has created a demand for new digital skills to implement and operate after the transformation (Matt et al., 2015). Furthermore, the skills needed are in technologies and how to manage transformation and change (Wolff et al., 2019). As stated in the European e-Skills Forum's 2004 Synthesis Report (Frinking et al., 2005), three types of digital skills are required:

- Practitioners skills, like ICT specialists with the ability to implement new technologies,
- User skills, the ones will use the technology itself,
- Business skills, managers responsible for adapting or transforming the business with new technology.

According to World Economic Forum's published report (Zahidi et al., 2020), the acceleration in adopting new technologies has increased (see Figure 3.1).
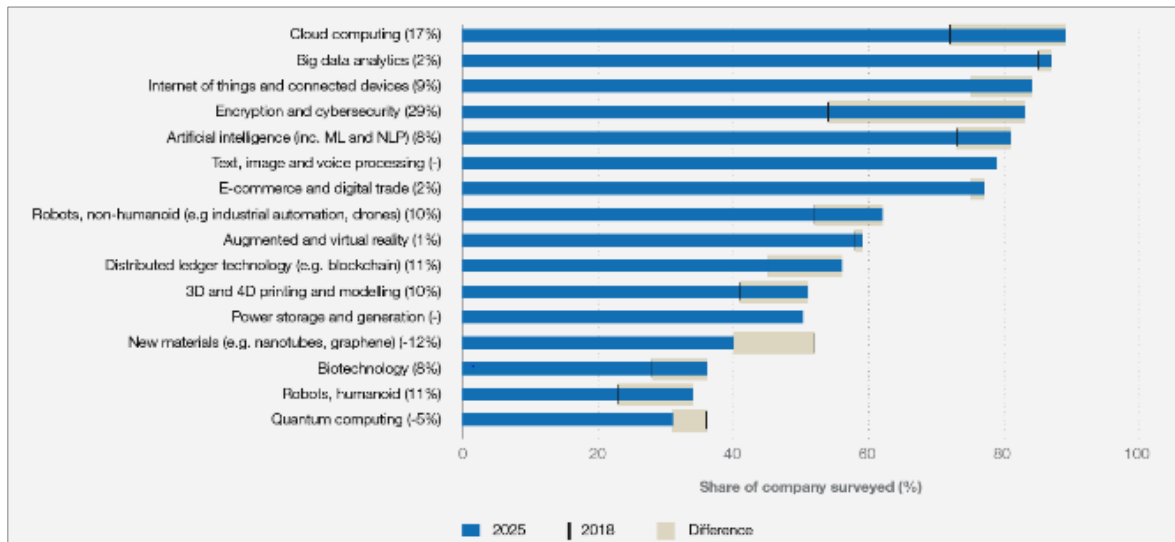
Source: Future of Jobs Survey 2020, World Economic Forum
Figure 3.1 - Technologies likely to be adopted by 2025

These new technologies are driving the future of the organizations and increasing the demand for new job roles and skills. Data Analysts, Machine Learning Specialists, Robotics Engineers and Software developers are examples of job roles with growing demand (see Figure 3.2).

1 Data Analysts and Scientists	11 Project Managers
2 AI and Machine Learning Specialists	12 Business Services and Administration Managers
3 Big Data Specialists	13 Database and Network Professionals
4 Digital Marketing and Strategy Specialists	14 Robotics Engineers
5 Process Automation Specialists	15 Strategic Advisors
6 Business Development Professionals	16 Management and Organization Analysts
7 Digital Transformation Specialists	17 FinTech Engineers
8 Information Security Analysts	18 Mechanics and Machinery Repairers
9 Software and Applications Developers	19 Organizational Development Specialists
10 Internet of Things Specialists	20 Risk Management Specialists

Source: adapted from Future of Jobs Survey 2020, World Economic Forum
Figure 3.2 - Top job roles in increasing demand across industries

Besides technical skills, critical thinking, problem-solving and self-management is also perceived as a skills group with increased demand by 2025. Figure 3.3 demonstrates the skillset required across emerging jobs of the future.

1 Analytical thinking and innovation	09 Resilience, stress tolerance and flexibility
2 Active learning and learning strategies	10 Reasoning, problem-solving and ideation
3 Complex problem-solving	11 Emotional intelligence
4 Critical thinking and analysis	12 Troubleshooting and user experience
5 Creativity, originality and initiative	13 Service orientation
6 Leadership and social influence	14 Systems analysis and evaluation
7 Technology use, monitoring and control	15 Persuasion and negotiation
8 Technology design and programming	

Source: adapted from Future of Jobs Survey 2020, World Economic Forum
Figure 3.3 - Top 15 skills for 2025

Shortage of Digital Skills

Technological change can generate skill shortages by creating the need for new skills that are not instantly ready in the labour market until the education system and/or employer training can reach the new skill demands (Brunello & Wruuck, 2019).

The ability of organizations to take the advantage of the potential of new technologies and thus accelerate digital transformation is threatened by the skills gap. Skills gaps can be caused by several aspects, like rapid innovation and adoption of new technologies, education system alignment issues, and lack of digital literacy and information processing skills (Zahidi et al., 2020).

The study "The Futures Jobs Survey report" by World Economic Forum (WEF) demonstrates that the gap in skills in the market's labour and the inability to recruit the right talents are the main barriers to adopting new technologies. The skills shortage is more evident in the emergent job clusters, like Data, AI, or Cloud computing. (Zahidi et al., 2020).

There is already a shortage of ICT specialists in the EU labour market; as new jobs emerge, vacancies keep growing. In 2020, 55% of organizations that intend to recruit ICT specialists, mentioned difficulties filling ICT vacancies. In emergent jobs, such as mentioned before, the vacancies remain open for a long time (*DESI | Shaping Europe's Digital Future*, 2021).

The ambition of Europe's digital transformation by 2030 brings more challenges to the ICT labour market (*The Digital Compass*, 2021). Although there has been constant growth since 2013, with 8.4 million in 2020 (see Figure 3.4), acceleration is needed to reach the target in the coming years. The ICT specialists in the EU should reach at least 20 million by 2030 (which represents 4.3% of the labour force).
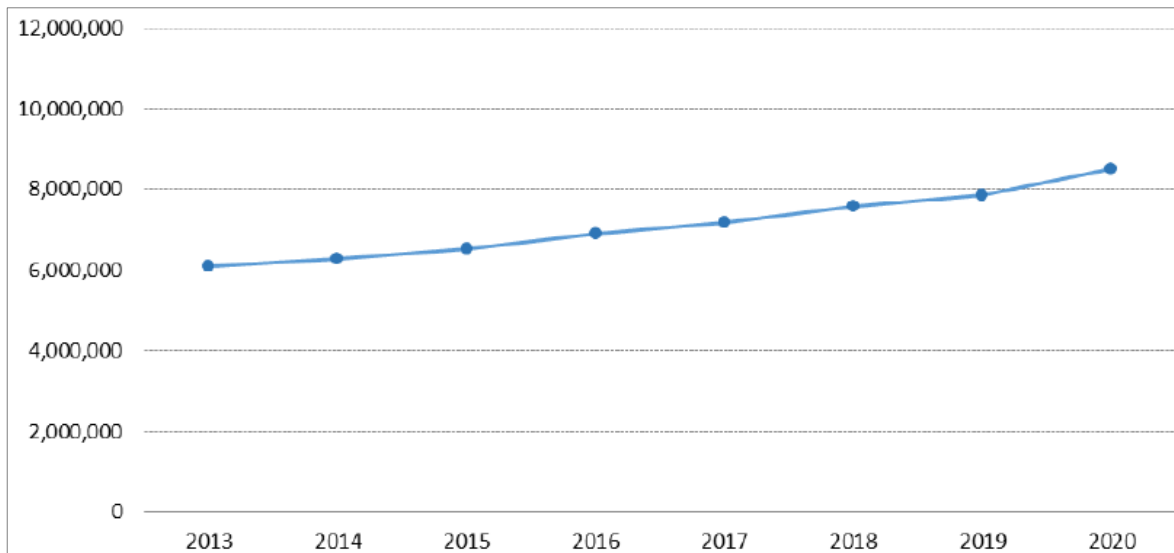
Source: Eurostat, Labour Force Survey
Figure 3.4 - ICT Specialists, 2013-2020

Jobs are becoming more driven by new technologies. Organizations are looking for ICT workers and specialists with skills to properly use and implement those emergent technologies. For that reason, the increase in students graduating in ICT domains is vital in the coming years. In the EU, it is observed an increase but slow in students following ICT graduation. As we can see in Figure 3.5, In most countries in the EU, the ICT domain was represented in 2019 by less than 5% of total graduates (*DESI | Shaping Europe's Digital Future*, 2021).
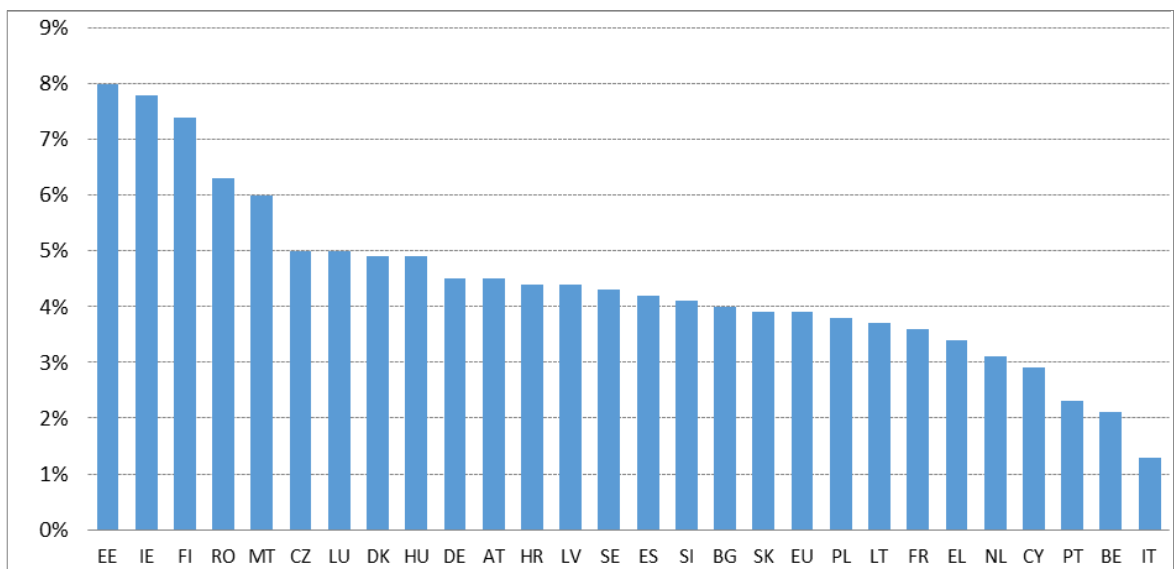
Source: Eurostat, Education, and training statistics
Figure 3.5 - % of ICT graduates across EU, 2019

Skill shortages negatively impact individuals, organizations, and society because they affect productivity and innovation. Limited availability of skills causes an impediment to organizations' investment, slows down the capacity to innovate and adopt technological developments, affects

labour productivity, and reduces average productivity due to an inefficient allocation of resources (Brunello & Wruuck, 2019). 60% of US companies believe that scarcity of skilled talent in the market is the main barrier to technology adoption by companies within the next four years (Group (BCG), 2018a)

3.1.4. Upskilling and Reskilling Strategy to fill Digital Skill Gaps

Due to skills shortages in emergent technologies, recruitment practices need to be more active. Recruiters need to be proactive and apply different recruiting methods. They need to understand the behaviours and preferences of groups holding the new technologies to identify the most appropriate communication channels to create an attractive message to reach them directly and attract their attention (Weitzel et al., 2009). Although several recruitment strategies can be created, the labour market remains limited in skills in new technologies, so it is necessary to address new strategies to fill the skills gap.

According to the survey "Talent Trends 2019: Upskilling for a Digital World" performed by (PricewaterhouseCoopers (PwC), 2019), 79 % of global CEOs say they are highly concerned about the availability of critical skills. To fill the skills gap, CEOs focus on reskilling and upskilling their workforce as the most critical strategy (46%). Organizations may invest in training and development to fill employees' skills gaps by following two strategies: Upskilling and Reskilling.

Upskilling is a learning process of new skills to perform the same job role. The motivations for that can be a change in skills required to do a job due to a technology change or adding specific skills for career progression (Group (BCG), 2018a). An upskilling example is the case of a software developer who needs to learn new technical skills (e.g., microservice architecture, message broker and virtualization using containers) to program applications that take advantage of the cloud environment. He doesn't change his role but needs to acquire new skills so that his skillset will remain relevant as his job role requirements change.

On the other hand, reskilling is a learning process of acquiring new skills for transitioning to a new job role. The reason for this transition can be motivated by roles that have become redundant or unnecessary by the organizations (Group (BCG), 2018a). For instance, the introduction of automation made some job roles redundant because machines have replaced their activities. Reskilling may be used to transfer employees with job roles in declining demand and train them to move to job roles with increasing demand.

Emerging technologies are creating such a disruptive movement that it will impact the labour market by the need for new skills to implement and use these technologies, on the one hand, and skills that are no longer relevant due to the introduction of these technologies, on the other hand (WEF & PwC, 2021).

When the skills are not readily available in the external labour market, upskilling and reskilling can be excellent strategies to fill the gaps. Some benefits and risks are detailed below (Gray, 2006).

Benefits

- Avoid paying high salaries when recruiting skills that are in increased demand
- Improve engagement and retention due to the organization's commitment to investing in training and developing its workforce.
- Ensuring scarce skills that are not readily available on the job market
- Helps to retain the business and organizations knowledge by leveraging the current workforce with new skills instead of recruiting new ones with the skills required

- Increases time to fill skills gap versus recruiting ready option
- Lack of internal knowledge to choose the best training path
- Retention can be difficult after employees have the new skills
- Training does not guarantee that employees will learn and implement these skills.

Upskilling and reskilling are not new but never appeared so important considering the effects of Digital transformation and the industrial revolution. Organizations are providing more and more training to their employees to develop their skills (see Figure 3.6).
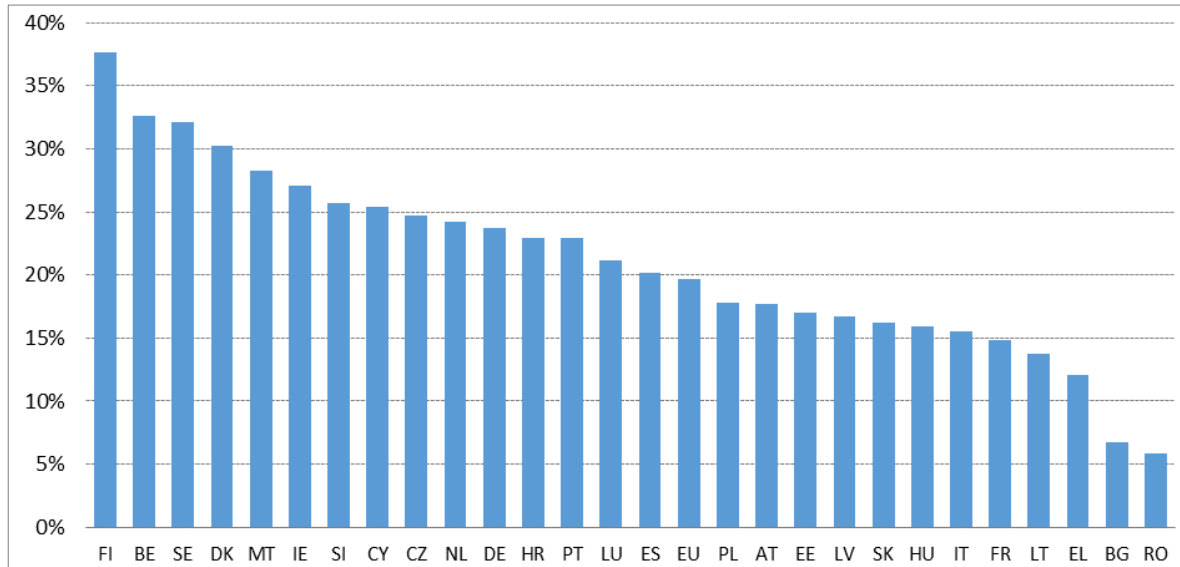
Source: Eurostat, European Union survey on ICT usage and e-commerce in organizations.
Figure 3.6 - Organizations providing ICT training (% enterprises) by EU country, 2020

Within the scope of the study carried out by (Kolding et al., 2018a), some recommendations are presented on how to solve the shortage of skills through training, like using an upskilling strategy. Some of them are described below.

- Position training at a strategic level. Good skills planning allows organizations to achieve their goals. Training should not be seen as an isolated act but as a medium and long-term initiative for developing talent.

- Take advantage of the synergy effects of training. A well-defined training plan and design improves skills and increases employee retention.

- Improve with cross-functional training. Training should not only focus on technology but also other relevant skills, such as those needed in digital transformation: business understanding and analytical or problem-solving skills.

- Make the skills available on time. As technologies evolve rapidly, there needs to be a process of planning, reviewing, and executing skills development that allows them to be available when needed.

3.2. PORTUGUESE CONTEXT

The current sub-chapter explains how Portugal is facing Digital Transformation, the shortage of digital skills and how Portugal is addressing it.

Digital Transformation in Portugal

There are few types of research on the evolution of digital transformation in companies in Portugal, nor on how the adoption of technology that supports the transformation of the business has evolved in Portuguese organizations. The EU's Digital Intensity Index (DII) (*DESI | Shaping Europe's Digital Future*, 2021) can help us understand how companies' adoption of new technologies is evolving and extrapolate to the state of digital transformation. The index DII allows for measuring companies' use of different digital technologies. The score is calculated by how many of the twelve selected digital technologies the companies use. Using this indicator, we can observe that in Portugal in 2020, 52% of organizations had at least the low level of digital intensity, against 61% in the European average and still far from the 75% defined as a target for 2030.

In the study conducted by (Pereira et al., 2019), the perception of the adoption of digital technology as a support for business transformation in Portugal is analyzed. This study conducted a survey on the General managers of organizations and from which we can find some conclusions about the state of DT in companies in Portugal. The main conclusions are presented below:

– 61% are of the perception that the introduction of disruptive technologies provides opportunities to improve the business,
– 68.9% have already explored how the digital transformation (DT) may impact their partners like distributors and suppliers,
– 62.4% agree that their organization's managers considers the return on investment with DT implementation,
– 63.7% agree that the organization has a strategy, to implement DT,
– 39% believe that the mains objective of the DT strategy is "To reach and interact with customers more effectively",
– 64.9% claim that the vision of leadership is the main factor that helps implement DT.

The main obstacles that block the implementation of DT are the organization's culture (42.9%) and inadequate budget (40.3%). It is curious that in this study, the knowledge of employees is not considered a very relevant factor for the implementation of the DT. On the other hand, the lack of necessary skills seems to be a minor obstacle in implementing the DT.

Shortage of Digital Skills

The lack of skills is a relevant factor to consider in digital transformation. Although there is progress in the capacity of resources necessary to implement and operate the digital transformation, Portugal needs to progress, approaching the European average.

According to the 2021 Economy and Society Digitality Index (DESI) (*DESI - Portugal | Shaping Europe's Digital Future*, 2021), Portugal registered an increase in ICT specialists, approaching the European average (4.3%), with 4% of the population working in ICT specialist functions. Portugal outperforms the European average in terms of more advanced digital skills. However, only 52% of the

population has minimum basic digital skills (EU is 56%). The number of graduates in ICT is still low on the EU average of 3.9%, with only 2.3% of graduates in the ICT areas (see Figure 3.7).

	Portugal			EU
	DESI 2019	DESI 2020	DESI 2021	DESI 2021
1a1 At least basic digital skills % individuals	50% 2017	52% 2019	52% 2019	56% 2019
1a2 Above basic digital skills % individuals	31% 2017	32% 2019	32% 2019	31% 2019
1a3 At least basic software skills % individuals	55% 2017	55% 2019	55% 2019	58% 2019
1b1 ICT specialists % individuals in employment aged 15-74	3.1% 2018	3.6% 2019	4.0% 2020	4.3% 2020
1b2 Female ICT specialists % ICT specialists	18% 2018	18% 2019	22% 2020	19% 2020
1b3 Enterprises providing ICT training % enterprises	19% 2018	28% 2019	23% 2020	20% 2020
1b4 ICT graduates % graduates	1.9% 2017	2.2% 2018	2.3% 2019	3.9% 2019

Source: 2021 Economy and Society Digitality Index (DESI)
Figure 3.7 - Digital Competencies evolution, Portugal, 2019-2021

How is Portugal addressing the shortage of Digital Skills?

Knowing that digital transformation is fundamental for Portuguese society's economic growth and development, following European guidelines, the Portuguese government has been developing several initiatives to promote digital development, particularly in terms of human capital. In order to coordinate Portugal's transition to a more digital country, the XXII government approved the action plan for the digital transition that reflects its strategy for the digital empowerment of citizens, the digital transformation of organizations and the digitization of public organizations (*Digital Transition Action Plan*, 2020).

This plan analyses several programs and initiatives, highlighting a set of measures that are priorities in their implementation. Regarding the strategy for the digital training of people, the creation of actions that allow:

a) the integration of technologies across the curriculum areas of primary and secondary education,
b) the increase in the training offer of higher education and closer relations with companies,
c) the promotion of employment in the digital area through training and professional re-qualification of employees and the unemployed.

In the context of digital training, the "National Digital Competences Initiative e.2030" stands out (Portugal INCoDe.2030, 2020), aiming to promote digital skills by ensuring Portuguese citizens' training and requalification, making them more capable of facing opportunities in the digital world. Within the scope of this initiative dedicated to strengthening digital skills by 2030, the following objectives are highlighted:

a) Digital skills for all citizens - 80% of individuals with essential digital skills
b) Digital skills for the labour force - To increase the number of employees who use computers or the internet to work up to 80%

c) Digital skills for ICT professionals 8% of ICT specialists in employment
d) Digital skills in education - 25 Graduates of Higher Education in STEM per thousand inhabitants (20-29 years)

Among other measures arising from the action plan for the digital transition, the intensive and specialized training program for 3. 000 professionals in the digital area – Upskill – stands out (*UPskill - Digital Skills and Jobs*, 2021). This requalification program for unemployed adults with secondary or higher education allows learning programming at a university or polytechnic and in a company context. The program secures job placement for 80% of trainees. This initiative contributes to the net increase in qualified ICT jobs.

3.3. ICT RECRUITMENT

The recruitment process is a way of attracting and selecting suitable candidates for job positions within an organization. This chapter analyses the employment status and recruitment of ICT specialists, highlighting the main reasons for difficulties in filling ICT vacancies. It is explored recruitment practices to attract and select ICT talents and how the recruitment process can be integrated into an upskilling and reskilling strategy.

3.3.1. Status of employment and recruitment of ICT specialists

As mentioned above, the demand for ICT specialists, particularly those with skills in emerging technologies, has increased. However, it has been increasingly difficult for organizations to fill their positions, as shown in the Eurostat study (*ICT Specialists - Statistics on Hard-to-Fill Vacancies in Enterprises*, 2020).

The employment of ICT specialists became more expressive in the ICT sector, with 72% of ICT specialists employed. In the EU, in 2020, 19% of organizations employed ICT Specialists, while in Portugal, there was 20%. It is also remarkable that 76% of large companies employed ICT Specialists, against a percentage much lower in medium and small companies.

In 2020, 8% of companies in the EU recruited or attempted to recruit ICT specialists (7% in Portugal). Among these companies, 55% reported that they had difficulties in filling vacancies, while in Portugal, this difficulty was felt by 44% of companies. (Figure 3.8).
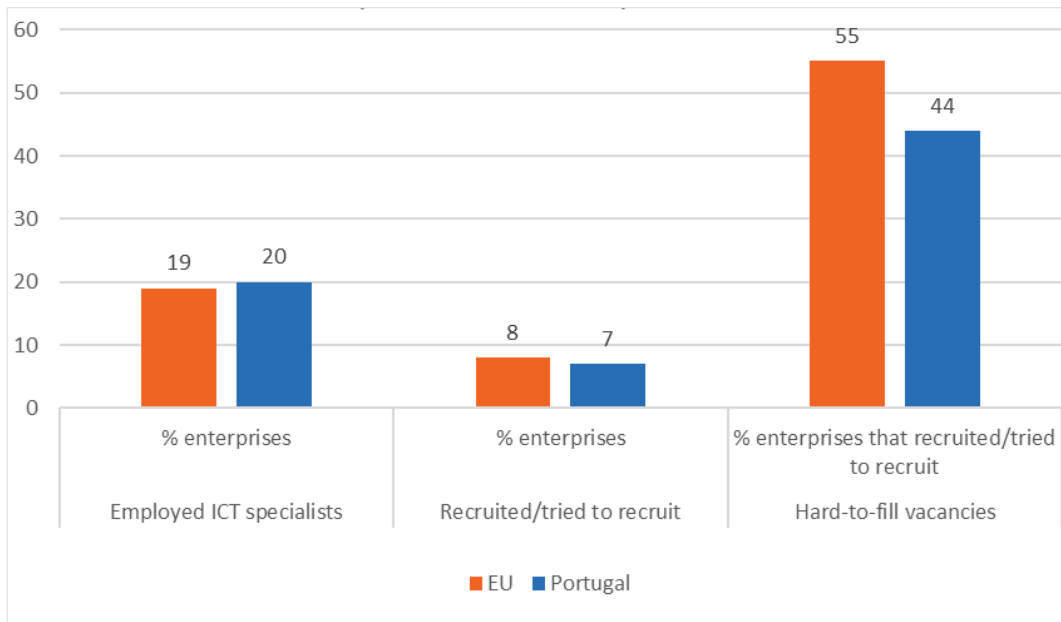
Source: Eurostat

Figure 3.8 - ICT specialists in enterprises, 2020

3.3.2. Reasons for ICT Specialists challenging to fill vacancies

The main reasons that companies reported having difficulty filling the vacancies for ICT specialists are the lack of candidates (42%), lack of relevant qualifications for the position (38%), lack of experience (37%) and very high salary expectations (Figure 3.9).
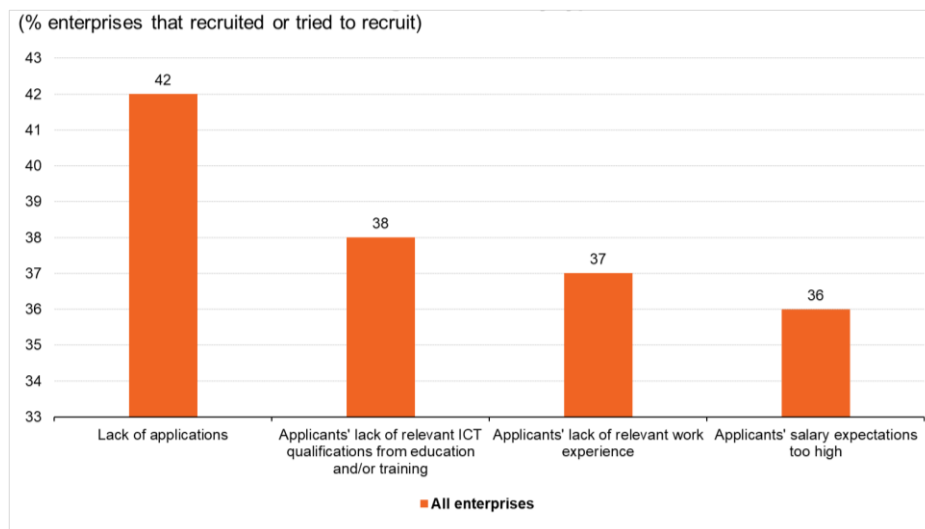
Source: Eurostat

Figure 3.9 - Reasons for difficulties in filling ICT vacancies, EU, 2019

Other studies have been conducted to understand why vacancies are difficult to close. In a study conducted by (Fajčíková et al., 2018) about new trends in recruiting employees in Czech ICT organizations, it is interesting to find similar results announced by Eurostat, as explained before. In a total of surveyed organizations, 85,3% identify the lack of candidates as the main difficulty in hiring ICT

candidates, followed by high salary requests of the candidates (50%), lack of knowledge or education (29,4%) and insufficient work experience (20,6%) (Fajčíková et al., 2018). Important to notice in this study is the result of developing and training staff (61,8%) as the primary method used by organizations to overcome the lack of skills. In fact, training is critical to acquiring new ICT skills, especially for ICT specialists and also for non-ICT specialists.

To enhance their ICT-related skills (Figure 3.10), in 2019, 10% of EU companies trained ICT specialists and 17% trained other employees. In the information and communication sector, training provided to ICT specialists employees was higher than the ratio of enterprises providing training to non-ICT specialists (Figure 3.10).
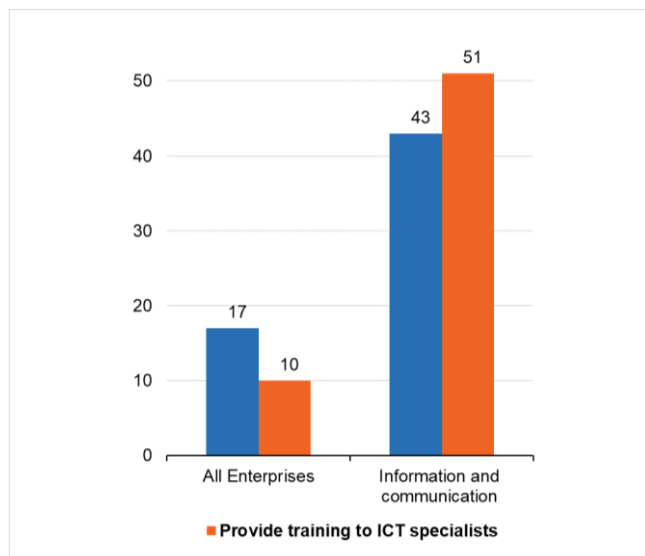
Source: Eurostat
Figure 3.10 - % of Enterprises that provide training to their employees EU, 2019

3.3.3. ICT Recruitment in Actual Context

The shortage of ICT specialists leads organizations to transform their recruitment process, forcing them to find different communication channels and adapt methods to attract job candidates (Fajčíková et al., 2018).

Organizations can recruit quicker, more efficiently, and less expensive by adopting online recruitment methods (Mashiah, 2021b). Currently, organizations prefer online communication channels when communicating with ICT candidates. They use their corporate website to share job opportunities, get candidates' attention, and resumes. Job portals are also commonly used to post job advertisements. Organizations are becoming more active on social media, and many of them have a profile on social media, such as LinkedIn, Facebook or Glassdoor, to attract more potential hires. (Fajčíková et al., 2018).

Web-based recruiting has become one of the most used recruitment methods by organizations today and social networks and social media to search, collect information about candidates, and attract them to a qualification and selection process. These methods attract candidates more quickly and

effectively than traditional methods. They allow candidates to find more job opportunities, and organizations can reach a large number of candidates in a short time (Baykal, 2020b).

As the demand for ICT professionals increases, organizations can use these methods to proactively reach out to candidates and not wait for them to apply for open positions. Social networks such as LinkedIn can be used as an alternative channel to interact with professionals who are not looking proactively for a job but are open to hear about new job opportunities. Another method that can be used is posting job advertisements on corporate websites through a web career page, which allows organizations to attract candidates and, at the same time, provide relevant information about themselves and the vacancy, increasing candidates' interest in applying. (Baykal, 2020b)

Corporate websites are good channels to explore Employer branding as a method of developing and maintaining the organization's reputation as an employer (Lievens & Slaughter, 2016). The internet and social media allow brand to be closer to potential candidates as they can easily access information about organizations with positive messages aligned to attract targeted candidates. Building a strong employer brand on corporate websites accelerates brand awareness, attracts the audience organizations want to reach and makes recruiting more effective (Mashiah, 2021b).

ICT job seekers have values and goals that determine how they look for job opportunities and select their employers. Employer image, career development opportunities, work-life balance, work environment or job security are some factors that influence candidates' decision for a job opportunity. Knowing their behaviours helps organisations understand how they identify vacancies, prioritize them, and apply (Keim & Weitzel, 2006). As the competition grows for ICT talents, organizations must invest more to persuade the audience to attract the target candidates (Mashiah, 2021a). For that reason, it is essential for organizations to spread content on corporate web site and social networks, emphasizing messages around their technology expertise, publishing projects successes supported by testimonials from clients, and on the other hand, promoting the organization as a reference employer announcing good work conditions, benefits, and opportunity to grow.

The recruitment process is focused on attracting candidates for open positions. On the other hand, the selection process involves selecting the most suitable candidates from the pool of candidates received. The selection is more complex than recruitment and needs to be prepared in advance. Knowing the selection criteria helps to align the recruitment methods to adopt and make the process transparent to the candidates (Baykal, 2020a).

The selection aims to verify the candidate's skills against the job description and create a compatible match. The most used methods for selecting candidates in ICT are interviews, analysis of CVs, verification of references and proficiency tests (Fajčíková et al., 2018). Based on these methods, a skills gap is identified, and the hiring decision is made considering the size of the gap assessed. An in-depth analysis of these skills gaps and how they can be filled can reduce rejected candidates by moving them into an upskilling or reskilling program to prepare them for the desired level needed when they join the organization.

3.3.4. Recruitment in an upskilling and reskilling strategy

To deal with a lack of digital skills, employee training is the better approach to fill the skills gap (PricewaterhouseCoopers, 2020). For organizations, upskilling/reskilling strategies will be the way to

prepare the workforce of tomorrow (Group (BCG), 2018b). Upskilling and reskilling must be considered a practice inside organizations. By adopting a strong learning culture in organizations, it is possible to maintain employees immersed in lifelong learning (Paine, 2021).

As technology is constantly changing, recruiting candidates with strong interpersonal skills is essential to engage them in a continuous learning program (Frankiewicz & Chamorro-Premuzic, 2020). Besides learning skills, employers select candidates for their adaptability, culture fit, and growth potential (LinkedIn's 2017 U.S. Emerging Jobs Report, 2017). Considering the previous comments, organizations need to recruit and select candidates with good interpersonal skills, like learning abilities and flexibility to change, to succeed in upskilling and reskilling strategies.

Organizations are becoming more interested in candidates' potential in terms of technical and interpersonal skills instead of their experiences and qualifications (Maurer, 2021). A competency-based hiring approach prioritizes the candidate's skills to perform the job role over evidence of previous experiences, roles performed, or academic degrees directly related to the open position. The recruitment and selection process does not ignore the candidate's experience or degree (Gallagher, 2018); however, they recognize that these factors are not always decisive for the performance of the proposed job role. Candidates received from other industries, with other academic credentials or previous different experiences or roles, are not excluded because what matters is whether the candidates can demonstrate that they have the necessary skills to perform the job (Arnold, 2018).

Assessing skills to perform a job role is becoming more vital to evaluating a candidate. Removing any bias related to previous candidates' qualifications, experiences, or roles and focusing on assessing their skills to perform a job can allow organizations to access a larger pool of candidates. Those candidates might not match the job description requested, but the skills assessment effectively demonstrates the candidates' skills gap. The organization can then analyse candidates' potential and decide to hire and involve them in an upskilling or reskilling program to leverage their skills to the target level.

Organizations that take a competency-based approach, combined with an upskilling strategy, improve candidate recruitment by increasing the candidate pipeline on the one hand and planning training for candidates to improve their identified skill gaps on the other hand. In particular, the recruitment of ICT specialists can benefit from this approach as they need more candidates and constantly fill technology skill gaps due to frequent technological changes.

3.4. CHALLENGES AND OPPORTUNITIES

In practice, recruiting ICT specialists based on an upskilling and reskilling strategy represents some challenges that need to be anticipated. However, this approach can be a solution to solve previously mentioned problems, such as the shortage of ICT specialists and the gaps in digital skills due to technological changes. In this subchapter, some of these challenges and opportunities are mentioned.

3.4.1. Challenges

Recruiting someone who does not entirely fit the skills required to perform the job and who needs training after being hired is an approach that generates uncertainties that need to be mitigated. Afterwards, some challenges are briefly explained.

Adopt Competency-based hiring

A competency-based hiring approach (also referred to as Skills-based hiring) prioritizes the candidate's skills to perform the job. A competency model is created to identify the skills required to execute a job with effective performance. Candidates are then evaluated through the competency model, and skill gaps are identified. The gap is analysed to assess whether the candidate should move on to an upskilling or reskilling program, and the training plan needed to fill these gaps is identified. This analysis quantifies the effort (cost and time) to determine if the candidate should be hired and proposed for the identified training plan (Lawler III, 1994; Marrelli et al., 2005).

Moving to competency-based hiring, as explained before, requires some reconfiguration in the recruitment process. Instead of job analysis, recruitment becomes more focused on competency analysis, and the technical and interpersonal skills assessment becomes more accurate and scrutinized. Additionally, classifying tasks and jobs around skills facilitates the promotion of qualification and re-skilling programs.

Select the right interpersonal skills

In the upskilling and reskilling approach, the learning and flexibility to change are the essential abilities that candidates must have to succeed in that program. The recruitment process must select candidates with a strong learning aptitude to efficiently progress in the learning path resulting from skills gap evaluation. In another way, in the context of technological change, it is vital to ensure the candidate demonstrates flexibility and attitude to change as the skills for their job role also may change (Chamorro-Premuzic & Swan, 2016)

Interpersonal skills are in increasing demand. Besides active learning and flexibility, as stated before, critical and analytical thinking and problem-solving are other skills in demand across multiple emerging job roles, such as Data Analysts and Scientists, Machine Learning Specialists or Cloud Computing Developers (Zahidi et al., 2020). These interpersonal skills should also be assessed in the recruitment process.

Select similar technical skills for upskilling

There is a set of skills in demand in many multiple emerging jobs. Some of those skills are common in other job roles or have similarities that can quickly evolve into new ones. For example, in emerging cloud computing-connected job roles, some specialized skills are required, such as web development or data storage management, which can be found in other software development-related job roles. In addition, there are new technologies with significant similarities to existing ones. Knowing these similarities, it is possible to identify candidates with a good level of proficiency in these skills with which they can accelerate their learning of new technologies. Identifying applicable and easily transferable skills between job roles is the key to defining an appropriate upskilling strategy in a job transition (Zahidi et al., 2020).

Investment in upskilling and reskilling

Recruiting someone who doesn't entirely fit the skills to perform a job role generates additional costs. The investment in the upskilling and reskilling strategy needs to be carefully prepared to get its return in a short time and with the expected results. However, organizations still have difficulties quantifying the investment (Zahidi et al., 2020).

Retention after an employee retrained

Employees acquiring skills in new technologies become attractive to the market, so organizations must take care of their new talent. Difficulty in retaining the talents can harness the investment done in upskilling strategy. Although upskilling can increase employee engagement, there is a risk of losing employees after training.

Upskilling/Reskilling biases

The idea of recruiting the perfect candidate that matches almost the job description criteria is a mainstream recruitment process. There is some resistance to hiring candidates for job roles without previous similar experience, different academic degrees, missing skills or mismatch to the ones required. Analysing the candidates as owning a skill set that can be leveraged to a target level can help transform this mindset.

3.4.2. Opportunities

Despite some challenges, recruitment based on an upskilling strategy, besides addressing the shortage of ICT specialists, can also leverage new opportunities, as described below.

Promote engagement and retention

According to the study performed (PwC, 2020), by implementing upskilling programs, behind delivering more skills to their employees, organizations can benefit from a more robust corporate culture and engagement and improved talent acquisition. PwC research demonstrates that organizations can achieve more than 5% improvement in overall employee retention by implementing upskilling programs.

Requalify dismissed employees

Emerging technologies have a relevant impact on organizations, forcing them to adapt quickly with an impact on their workforce. WEF's Future of Jobs Report 2020 forecasts that redundant jobs will be displaced by 2025 due to automation, whereas emergent jobs will rise (WEF & PwC, 2021). Emergent skills are in high demand, while other skills are becoming obsolete. Through reskilling and upskilling, job transitions are expected from declining to emerging roles, helping requalify dismissed employees.

Benefits for Employees

The upskill strategy can be seen as a perk for the employee, strengthening their engagement and loyalty to the organization. In this perspective, the upskill is a factor of attractiveness for candidates, as they see an opportunity to leverage their skills in a future employer.

Move from a job-based to a competency-based organization

In a competency-based organisation, individuals' capabilities to acquire and develop skills are more relevant than the activities they can perform in a fixed job role. The work design descriptions are built around individuals. Hence, instead of having a detailed job description, organisations need to develop competencies and person descriptions that describe the skills that an individual should have to be effective in a particular work area inside the organization (Lawler III, 1994).

The upskilling and reskilling strategy in recruitment perfectly aligns with this organisational structure. More than holding a job role in such organisations, the employee is seen as holding skills that can be leveraged. Therefore, following this recruitment strategy may impulse the idea of transforming the HRM function based on skills development instead of finding candidates that best fit a job role. (Lawler & Ledford, 1992).

4. LITERATURE REVIEW

The theoretical background is presented in four groups of subjects. The first relates to Human Resources Management (HRM), which explains the main HRM processes and concepts. The topics of competency analysis and modelling and the competency-based organization approach are explained in detail, considering their relevance to the present study. A second group is dedicated to recruitment and selection, where the methods to attract and select candidates are briefly explained, with particular emphasis on methods applied to ICT candidates. In the third group, the success factors for upskilling and reskilling are explored through the concepts of similarities between skills and learning abilities. Finally, in the fourth group, the training process briefly explains the methods and techniques most used.

4.1. HR MANAGEMENT CONTEXT

Firstly, this chapter introduces Human Resources Management (HRM) in general, explaining the main processes. Then, the job analysis as a process of identity functions and competencies required to successfully execute a job is presented in general. After those main concepts are introduced, the relevance of a competency model and how to create it is explained. A comparison between a job-based and competency-based organization is highlighted to demonstrate the advantages of this approach in an environment of change and flexibility. Finally, some relevant competency frameworks are presented, focusing on ICT frameworks.

4.1.1. HRM Processes

Human Capital are fundamental for organizations to survive and succeed. Human Resources management is one of the functional areas of organizations responsible for attracting, selecting, developing, and retaining the human capital needed to prosecute the organisation's objectives (Rego et al., 2015). Briefly, HRM implements the following processes:

- Planning – determination of the HR needs
- Recruitment – attraction of candidates, potential new employees
- Selection – screening, assessment and contract
- Training and development – related to competencies development
- Appraisal Performance – employee performance evaluation
- Career Planning - predict and support the evolution of employees from one function to another, allowing their professional progression
- Compensation – reward and motivation
- Implement HR policy procedures

Regarding the HRM activities in the organization, the first challenge is to prepare and create the necessary ground to attract and select the human capital and ensure the correct alignment among people and the organization. This can be achieved through the recruitment and selection processes (Rego et al., 2015). The second challenge is training and developing competencies to support the organisation's strategic needs. The processes mainly concerned with human capital development are training, competency development, and retention (Rego et al., 2015).

4.1.2. Job Analysis Process

Organisations are groups of persons joining forces to achieve a common objective. These groups are organized in connected structures and common processes represented by functions like Finance, Marketing, Operations, etc. In the organisation, the work is divided into activities and functions assigned to persons. This sub-chapter details how the functions are identified and described through the process of job analysis. Additionally, it is introduced the main competency concepts.

4.1.2.1. Job Analysis Relevance

As soon the Business strategy of an organization is set up, and the objectives are defined to achieve them, the essential functions are delineated, and each function is detailed in a set of processes and activities. The major work roles are then described to execute those functions and associated processes; identifying what is done and which competencies are required is known as job analysis.

Job analysis allows formulating of an understanding of the job to be performed and the characteristics required for a person to be successful in the job execution. According to (Brannick & Levine, 2002), job analysis is a structured and systematic process of collecting and organizing information about the tasks and operations performed by one person or group of people as part of their work.

Job analysis and knowledge of the function are essential to support decisions in the HRM processes. According (Lees & Cordery, 2000), job analysis gives relevant information to perform decisions in HRM activities, so, in this way, job analysis can be applied in:

- HRM planning to give an organization an understanding of the knowledge, skills and abilities required now and, in the future,
- Recruitment and selection to allow the candidates to understand the work to be done and the competencies required. Knowing the function, is it possible to communicate the job ads and inform candidates about what is expected to be done and what competencies are required. During the selection process, is it possible to compare the candidate's competencies with the ones required for the job
- Appraisal Performance, to identify the activities to be executed, how they should be evaluated and against which performance patterns. Knowing the job, is it possible to determine if the holder of the job executes it according to what is expected
- Training and development, to know and define training requirements for job holders. Knowing the job, it is possible to direct the appropriate training to the practitioner of the job in order to complement their skills to perform it
- Career Planning to define professional groups in which the various functions are articulated, allowing the employee to move from one level of functions to the next, promoting their professional development
- Compensation, to understand the amount and compensations adequate for each job position. The job analysis makes it understand the similarities and the differences in job positions, helping in providing an adequate salary structure

To understand jobs, there are several methods available. (Fine and Cronshaw, 1999) explore in detail the functional Job Analysis process.

4.1.2.2. Job Description and Competency Concepts

As a result of job analysis, a description and specification of the functions are defined. The job description concerns what is done, that is, what duties and tasks are to be performed and what behaviours are expected. The specification of a job refers, in turn, to the competencies required to execute a job effectively, which can be divided into knowledge, skills and abilities (Fine & Cronshaw, 1999). The jobs can be aggregated into families based on their similarities.

Competency is a capability required to execute one task and can be measured at the performance level. Competency can be formed by knowledge, skills, abilities, or behaviours (Marrelli et al., 2005).

- **Knowledge** is facts, principles, theories, concepts, or processes required to effectively perform the tasks of a job and is the basis for the skills. Knowledge is acquired through learning and experience that can be assessed through formal examination in a limited period (Marrelli, 1998).

- **Skill** is physical, mental, and social capabilities to perform specific job tasks with a specified result. Skill is acquired and strengthened through practical experience. A performance test can measure a skill to determine your proficiency (Marrelli et al., 2005).

- **Ability** is an innate physical and cognitive capability required to successfully perform a job role. An ability can be observed and measured through behaviours (Marrelli et al., 2005).

- **Behaviours**, like personal traits, values, or attitudes, can influence performance. These behaviours can appear through a combination of learning, experience, or innate predisposition. These measures provide insight into a person's abilities (Marrelli et al., 2005).

Some individual competencies can be developed through training and professional development over time; however, there are others, such as some abilities, that are innate, therefore, impossible or more difficult to change (Newell, 2005).

4.1.3. Competency Analysis and Modeling

A list of competencies required to execute a job with effective performance is organized in a competency model. According to (Sampson & Fytros, 2008), a competency model can be defined as "a descriptive tool that identifies the competencies needed to perform a role effectively in the organization and help the business meet its strategic objectives".

The competency model can be organized in several formats, like by type of competency (e.g., leadership, interpersonal relationship), job family (e.g., hr, finance, or marketing) or job level (e.g., manager, supervisor, operational staff). A competency model can be developed for a job, a function, a business unit or even an entire organization. The objective of a competency model is to create a common language to identify competencies that can be used along with HRM processes, like, as recruitment and selection, training and development or appraisal performance (Marrelli, 1998). In the competency analysis and modelling, three different approaches have been applied:

- Differential psychology: an approach that focuses on the differences between superior performers and others who have innate abilities (e.g., cognitive, physical traits) that are difficult to develop

- Education and behaviour psychology: this approach focuses on all the competencies required for successful job performance. They see that competencies can be trained and developed, although some are innate

- Management science/industrial engineering: this approach focuses on duties and task analysis aligned with job analysis. The job description includes the knowledge, skills, and other attributes needed to do the job itself rather than on competencies for the individual performance

Following an education and behaviour psychology approach, according to (Marrelli et al., 2005), a competency model can be created using seven steps:

1) Define the objectives of the competency model through the following perspectives:

   a. Identify the problems to be solved and the benefits expected
   b. Defines the unit of analysis, like a specific job or a job family
   c. Define the timeframe analysis; that is, it should focus on the skills needed now or in the future
   d. Identify the HRM process that should be applied, like selection, training or career development

2) Obtain sponsorship from the executive management. Creating a competency model demands resources, but also a new organizational mindset focuses on the competencies

3) Implement a communications plan to get all stakeholders involved

4) Plan the methodology

   a. Select people to identify competencies (e.g., job incumbents, managers, supervisors, high performers)
   b. Select data collection methods to identify the competencies (interview, focus groups, survey, observations, etc.)

5) Identify competencies and create the competency model

   a. Define the job role. A complete definition is essential to understand the competencies required for effective performance in that role.
   b. Identify the list of competencies required for effective job performance (knowledge, skills, abilities and behaviours)
   c. Getting together similar knowledge, skills, abilities, and behaviours into a set of competencies organized by type makes up the competency model
   d. Create behavioural examples to illustrate how the competencies are demonstrated. For each competency, a behavioural example should be created, with at least three levels of proficiency

6) Application of the competency model. Competencies identified as necessary to perform a job with effective performance are used in the selection, training, development, or reward of an employee

7) The competency model is assessed and improved, as competency analysis and modelling are an ongoing process

4.1.4. Competency-Based Organization

Competency-based organizations are mainly focused on identifying the competencies needed for effective performance and how to develop those competencies in their employees to meet the organization's objectives (Marrelli, 1998). They differ from job-based organizations, which have a more mainstream approach; they are more concerned about the duties and tasks of the job performed by an employee. In these organizations, the focus is the job description. The HRM processes are designed to ensure the employees are well prepared to do the job, so they are selected to fit the job perfectly, trained to perform it and rewarded for how they performed it well. There is an assumption that organizations will perform well if they fill jobs with the most qualified employees to perform their job roles (Lawler III, 1994).

Emerging technologies and global competition force organizations to respond more quickly to market changes and often forces them to change their organizational structure. These changes mean that workers must quickly change what they are doing and sometimes learn new skills. A job-based organization with a fixed structure has more difficulty being agile and flexible. A competency-based organization may result in a more flexible and customer-oriented organization (Lawler III, 1994).

A competency-based practice is best suited for organizations where competencies may change more frequently. Organizations where employees have broad skills and processes that allow them to acquire new skills continuously are more prepared for change. Thus, some benefits of a competency-based approach can be emphasized (Lawler III, 1994):

1) focus on individuals,
2) flexibility to adjust to transformations in the business and customer needs,
3) culture of continuous learning,
4) opportunity to develop and apply new competencies
5) attract new employees and improve retention
6) drive for a competitive advantage

The main differences between those approaches are detailed in Table 4.1.

HRM Process	Job-based organization	Competency-based organization
Work Design	Focus on Job	Focus on Individual
	Job description	Skills and Person descriptions
Selection	Finding candidates who fit a particular job position	Finding candidates who can learn and follow various career paths
	Required skills for the job position are assessed	The capability of learning the organization types of skills is assessed

HRM Process	Job-based organization	Competency-based organization
Reward	Pay employees according to the job they hold	Pay employees according to the skills they have (maybe rewarded by skills they learn)
Appraisal	Hierarchal Managers assess job performance	Skill sets are assessed by peers and experts
Training		Well-developed training systems and time available for training
Career Planning	Career plan based on the hierarchical move between job positions	Career plan based on the acquisition of multiple skills

Source: Adapted from (Lawler III, 1994)

Table 4.1 - Comparison between job and competency-based organization

In a competency-based organisation, competency models become more relevant because it acts as a conceptual framework enabling employees to understand the competencies they need to acquire and develop to achieve the business goals and objectives of the organisation (Marrelli, 1998). The competency models are applied in each organisation's HRM process, including workforce planning, recruitment and selection, training and development, appraisal, career development, compensation, and succession planning (Marrelli et al., 2005).

4.1.5. Competency Frameworks

Organizations can build their competency model from scratch or based on an existing competency framework in a specific domain. Competency frameworks are used in many jobs as a guide for defining competencies and levels of performance. In the present research context, the most representative ICT frameworks are detailed here, focusing on ICT European frameworks e-CF and ESCO.

Competency Frameworks ensure that competencies such skills, knowledge, or job profiles are used with a common language. They provide a better understanding between job offers and job seekers, job offers or training content. To support better coordination of the ICT labour market, the EU has promoted ICT frameworks such as the "European e-Competence Framework" (e-CF) and the "European Competence, Skills, Qualification and Occupations" (ESCO) (Fernandez-Sanz et al., 2018).

e-Competence Framework (e-CF)

e-CF provides a common language for ICT Professionals in a work context. The e-CF is divided into four dimensions, as described below:

1. Dimension 1: identify five e-Competence areas based on ICT business processes: Plan, Build, Run, Enable and Manage (see Figure 4.1)

2. Dimension 2: provides 41 e-Competences references of IT professional competence in the IT work context (contains a competence title and a generic description) (see Figure 4.1)

3. Dimension 3: defines five proficiency levels that can be evolved on autonomy, context complexity, influence, and typical behaviours.

4. Dimension 4: present examples of knowledge and skills related to each e-Competences.

Dimension 1				
Plan	**Build**	**Run**	**Enable**	**Manage**
IS and Business Strategy Alignment	Application Development	User Support	Information Security Strategy Development	Forecast Development
Service Level Management	Component Integration	Change Support	ICT Quality Strategy Development	Project and Portfolio Management
Business Plan Development	Testing	Service Delivery	Education and Training Provision	Risk Management
Product / Service Planning	Solution Deployment	Problem Management	Purchasing	Relationship Management
Architecture Design	Documentation Production		Sales Proposal Development	Process Improvement
Application Design	Systems Engineering		Channel Management	ICT Quality Management
Technology Trend Monitoring			Sales Management	Business Change Management
Sustainable Development			Contract Management	Information Security Management
Innovating			Personnel Development	IS Governance
			Information and Knowledge Management	
			Needs Identification	
			Digital Marketing	

Source: adapted from (Fernandez-Sanz et al., 2018)

Figure 4.1 - e-CF ICT Business Plan vs Competences

Based on e-CF, 30 ICT Profiles (roles) cover all ICT Business processes (dimension 1) and are organized in 7 families, as exemplified in Figure 4.2.
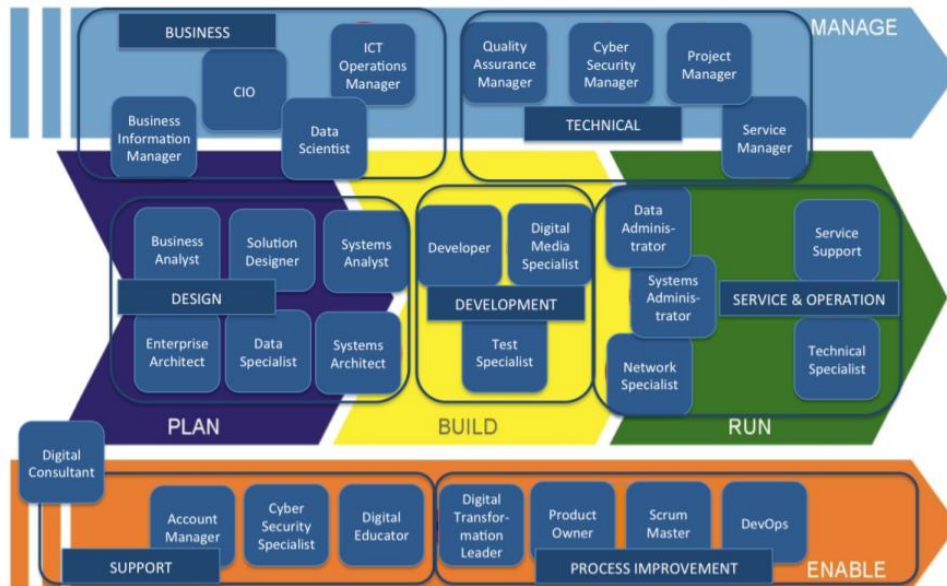
Source: ("Get the E-CF & ICT Profiles Standard," 2018)

Figure 4.2 - 30 ICT Professional Role Profiles

European Classification of Skills/Competences, Qualification and Occupation (ESCO)

ESCO comprises skills/competencies, occupation profiles, and qualifications. (Fernandez-Sanz et al., 2018):

– Skills/competencies contain four sub-classifications: knowledge, skills, attitudes/values, and language skills

– The occupation profile explains the occupation and includes the relevant knowledge, skills and competencies. Occupational profiles specify whether skills and competencies are optional or essential and which qualifications are relevant to each occupation

– Qualifications are formal outcomes issued by a competent body that assesses and determines an individual learning achievement. A qualification is mainly defined by category, title and awarding body

ESCO can connect the labour market and the education/training sector and enhance recruitment by improving competency-based job matching. Each dimension has its hierarchical structure and is interconnected representing the relationships between them. ESCO can connect the labour market and the education and training sector and can enhance recruitment by contributing to improving competency-based job matching (Fernández-Sanz et al., 2017).

4.2. RECRUITMENT & SELECTION

In this chapter, the recruitment and selection process is detailed, covering topics related to the following issues: how to attract candidates, what are the most used methods to attract candidates, how recruitment deal with a shortage of ICT candidates and how to select and assess candidates.

4.2.1. Recruitment and Selection Process

According to APQC (American Productivity & Quality Center), the recruitment and selection process is represented by five main processes (see Figure 4.3):

1. Defining and managing employee requirements.
2. Recruiting or sourcing the candidates as per the requirements.
3. Screening and selecting the most suitable candidates.
4. Take care of the newly joined employees.
5. Maintained records of information for all applicants.
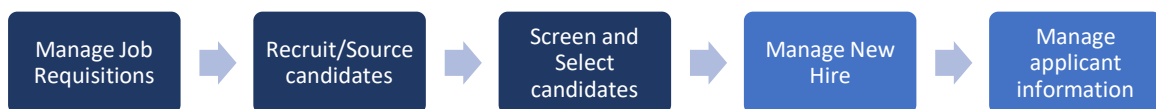
Source: adapted from APQC
Figure 4.3 - Recruitment & Selection Process

The first three processes are covered in this literature review. Manage Job Requisitions is the first process and includes the activities like planning resource needs, developing, opening, posting and modifying job descriptions and notifying the hiring manager about the candidate's pipeline progress. The subsequent process is related to recruiting and sourcing candidates. The following activities are considered: identify recruitment methods and channels, perform recruiting activities/events, manage recruitment vendors, manage employee referral programs, and manage recruitment channels. In the screening and selecting candidates process, the activity of identifying and deploying candidate selection tools is initially performed, and subsequently, the candidates are interviewed, tested and selected or rejected. In Figure 4.4, we can see a resume of these three main processes we can see a resume of these three main processes.

Manage job requisitions	Recruit/Source candidates	Screen and select candidates
• Planning resource needs • Develop job descriptions • Open job requisitions • Post job requisitions • Modify job requisitions • Notify hiring manager	• Determine recruitment methods and channels • Perform recruiting activities/events • Manage recruitment vendors • Manage employee referral programs • Manage recruitment channels	• Identify and apply candidate selection tools • Interview candidates • Validate candidates • Select or reject candidates

Source: adapted from APQC

Figure 4.4 - Recruitment and Selection process detailed

In the previous chapter, HR Management Context, some of the concepts and activities of the "manage job descriptions" process have already been explored. The following two chapters explain the recruitment and selection process in detail.

4.2.2. Recruitment (how to attract candidates)

Regardless of the organisation's job or competency-based approach, the recruitment process intends to attract candidates who can meet the job requirements defined for a vacancy. Recruitment is defined as a set of actions that an organization uses to identify and attract potential candidates with the capacity to support the organization in achieving its strategic objectives (Saks, 2017). The recruitment can occur internally, attracting current employees for new positions, or externally, bringing candidates from outside. Some advantages and disadvantages are explained in Table 4.2

Internal recruitment	External recruitment
Candidates already know the organization's culture and how they operate	Adaptation to the organization's culture and operation can take a long time
Fewer costs in job advertisements or agency fees	Risk, Costs, and time to recruit increase
Helps to relieve employees from areas with excess capacity to areas with more significant needs	Main suitable when an organization is in expansion mode
Increase employee motivation as they see opportunities for growth	The current employees can see external candidates as a threat to their positions
Prevents bringing talents with new ideas to the organization	Opportunity to introduce new competencies in the organizations

Source: adapted from (Newell, 2005)

Table 4.2 - Internal and external recruitment (dis)advantages

Recruitment can also be direct or indirect. Direct recruitment occurs when the company has the necessary internal resources to execute the recruitment process. On the other hand, indirect recruitment arises when companies do not have the means to do so and, therefore, are forced to subcontract external services to support them in the recruitment and selection process (e.g., headhunting agencies) (Rego et al., 2015).

4.2.2.1. Methods applied for Recruitment

Methods for attracting candidates may change depending on the scarcity of candidates and the time needed to fill a vacancy. In particular, the scarcity of candidates implies organizations implementing new strategies like expanding the network to attract, capitalizing on the use of technology, use of financial incentives or promoting the organization as a better place to work (Taylor & Collins, 2000). Strong employer branding is also relevant to attracting candidates as it helps the organization distinguish itself from other employers. Candidates are more attracted to organizations with brand recognition (Lievens & Slaughter, 2016).

In addition to traditional methods of attracting candidates, such as job advertisements in the print media (newspapers and magazines), the use of employee referrals, job fairs or even specialized recruitment agencies, the organizations had to adjust to the new practice of online recruitment, known as e-recruitment (Lievens & Chapman, 2019). e-recruiting is defined by (Chapman & Gödöllei, 2017) as "the use of communication technologies such as websites and social media to find and attract potential job applicants, to keep them interested in the organization during the selection processes, and to influence their job choice decisions".

The Internet plays an essential function in recruitment. Nowadays, organisations mainly use the Internet for job advertisements to attract candidates and manage direct recruitment through their websites. E-recruitment allows organisations to reach a broader range of applicants and candidates who were not actively looking for a job. Online recruitment has become a regular practice because it is a fast and effective way to submit applications, gather applicant data, and make initial pre-selection decisions. Screening and assessment tests can be performed online and, if successful, can be referred immediately for an interview with a recruiter, reducing the recruitment cycle time (Bach, 2005). Additionally, job advertisement costs can be significantly reduced using third-party online job boards (e.g., Monster.com, Indeed) (Lievens & Chapman, 2019).

Social media such as LinkedIn and Facebook act as online tools in the recruitment process. They are sources of information for recruiters to identify potential candidates and decide whether it is meaningful to invite them for an interview. Those social media are resume repositories where the recruiter can check the CVs of candidates that may be interested in the open vacancy. For instance, LinkedIn is an alternative channel for professionals who are not actively looking for a job but are open to new opportunities (Baykal, 2020b).

Employer-rating websites such as Glassdoor are also important sources of potential applicants. By accessing insider information about particular company culture and working environment, the potential candidates might be interested in applying for jobs (Lievens & Chapman, 2019).

Table 4.3 shows a resume of recruitment methods and channels more commonly used to attract candidates.

Method	Channel
Job Advertisement	Print media (e.g., newspapers, magazines), agencies, company notice boards, federal employment
	Careers sites (intranet/internet), corporate websites
	Online Job Boards (e.g., Monster, Indeed)
Employee Referrals	Internal communication, word of mouth
Social Media	Social Networks (LinkedIn, Facebook), Employer rating sites (e.g., Glassdoor), Blogs
Offering Internships and Apprenticeships	Schools/ Universities, professional associations
Attending recruitment events	Schools/Universities Job Fairs, Hackathon
External recruitment	Recruitment agencies, executive search recruiters, headhunting companies

Source: adapted from (Lievens & Chapman, 2019), (Rego et al., 2015)

Table 4.3 - Recruitment Methods

4.2.2.2. ICT Recruitment Challenges

As mentioned, digital transformation puts pressure on the demand for ITC skills, and recruiters are increasingly competing for scarce skills. In addition, computer science graduates are not growing at the same pace, and older IT specialists are reaching retirement age.

It is required an innovative and practical approach to hiring IT talent. Some questions are raised like "where to find new digital skills", "which methods should be applied (passive or more active approach) or "what message and channels are required to communicate".

In the study conducted by (Weitzel et al., 2009) on how Siemens had hired during 20 years, they developed a framework to guide the recruitment of scarce IT skills based on two dimensions: scarcity (availability of IT skills in the market) and timescale (time needed to hire new IT talent). In this framework, the suitable methods for recruitment are analysed and proposed in four quadrants of analysis. The short-term and long terms activities to recruit are evaluated against the more scarcely or readily available skills in the market to determine the most suitable recruitment methods to be applied (see Figure 4.5)
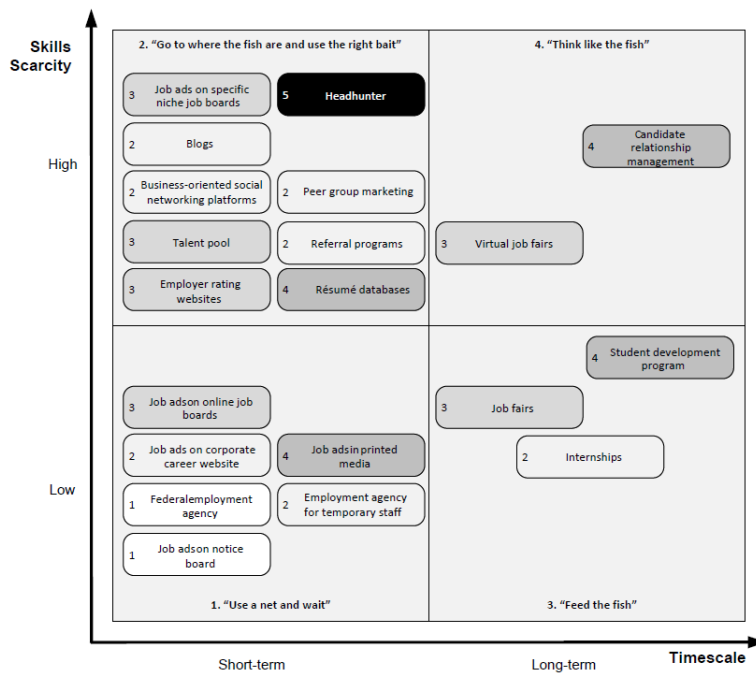
Source: (Weitzel et al., 2009)
Figure 4.5 - FIT Framework

In the first quadrant, skills are readily available on the market, and recruitment must take place in the short term. As skills are widely available, recruiting practices are more passive, so mass job advertisement communication is adopted, posting vacancies, and waiting for candidates. Commonly used channels are job advertisements posted on online job boards and corporate websites, as well as in print media.

In Quadrant II, recruitment should also last in the short term, but skills are scarcely available. In that case, recruiting practices need to be more active, and recruiters must take a proactive approach. The recruitment methods applied need to have a previous understanding of the behaviours and preferences of the group with scarce skills. Knowing the proper communication channels to approach candidates, as well as an attractive message, is critical to reaching that group directly and recruiting fast. In this quadrant, the following recruitment practices are proposed:

- Search online CV Databases (e.g. from online job boards),
- Post job ads on niche online job boards,
- Explore and maintain talent pool (including present and previous employees)
- Referral programs (using employee social network of friends)
- Explore web 2.0 platforms, like business social networks (e.g. LinkedIn), blogs (e.g., with subject matters related to scarce skills interests) and employer rating platforms (e.g. glassdoor)
- Peer grouping marketing (exploring employees' social networks)
- Subcontract services of Head-hunters.

In the third quadrant, skills are readily available, but long-term recruitment is implemented. In such cases, the organization wants to attract applicants at an early stage and bind them over a long

row. Recruiters are interested in capturing interested candidates and positioning the organization as a future employer choice. The strategy is to have IT talent available when the organization needs it. So, a recruiting approach is more focused on:

– Attending job fairs (e.g., in universities to attract future graduates)
– Offering internships (e.g., internships during graduation)
– Student development program (e.g., the most promising students are included in special programs sponsored)

In the last quadrant, the long-term recruiting approach is applied to the scarce skills available. Recruitment involves identifying and maintaining a pipeline of candidates to hire when the organization needs it. In this case, candidate relationship management is used to maintain contact with candidates and former employees (e.g., invite to events, share relevant information, etc.). To create a long-term relationship, the recruiter must have accurate information about potential candidates (environment, interests, or values).

As we can see in the FIT framework, diverse recruitment approaches exist. Depending on skills' scarcity and time to recruit, the approach can be more passive (post job ads and wait), active (search proactively and attract directly) or strategic (maintain a candidate's pipeline for future needs).

More recent studies have been performed to understand the impact of digital transformation on the recruitment process. The study (Gilch & Sieweke, 2021) looked at the role of recruitment in an organization facing a digital transformation. They explore how recruiters must change how they attract digital talent, forcing them to adapt recruitment measures and processes, the role and mindset of recruiting, and the organization itself.

Furthermore, given the challenge of digital talent shortages, the recruiter must deal with their characteristics, attitudes and values considerably different from traditional candidates. The study mentioned above identified four primary differences in digital talent:

– They are different in terms of educational background and gain more knowledge through online and self-instructed learning programs
– They are more motivated by their personal development and work content than a long-term relationship with the employer
– They make more and different demands on the employer
– They screen much more the potential employer; therefore, recognition of employer banding is more relevant

Apart from the differences mentioned, digital talent remains passive and expects employers to approach them. They realized that recruiters and organizations must adapt to attract digital talent based on that analysis. They should adapt recruitment methods, like collecting more information about new digital talent habits and characteristics to better understand their demands; increase their employer familiarity, promote organization employer branding and experiment with new channels and content to meet the preferences of digital talent, more focused on professional know-how.

Besides new methods, the role and mindset of recruitment also need to adapt. The recruiters should involve internal actors in recruitment to help attract talent. For instance, recruiters can create employee referral programs and invite highly motivated digital employees to act as job ambassadors

or participate in employer branding teams. Moreover, instead of recruiting candidates with exact qualifications and experience to fit vacancies, recruiters need to search for candidates with the "right attitudes" to fill the digital gap through an internal training path. Recruiting from new geographical areas and new types of contracts (e.g., freelance contracts) should also be a solution to face the shortage.

4.2.3. Selection (how to select and validate candidates)

After the recruitment process, a selection process is necessary to reduce the pool of previously identified candidates, evaluate the pre-selected candidates and decide which one should go into the hiring process. Selection is the process through which organizations select candidates with the most appropriate attributes (competencies demonstrated) for the adequate performance of the function. The analysis of these attributes enables organizations to predict the candidate's future performance. The collection and analysis of these attributes are carried out using different selection methods. (Rego et al., 2015).

The selection methods are effective if their reliability and validity can be confirmed. The effectivity is presented in terms of a correlation coefficient result. The correlation is determined between two scores related to one predictive evaluation criteria at different points in time (see Table 4.4)

reliability	a method is reliable if it is consistently used to select individuals
	"if the results of a personality inventory indicate an extrovert personality, it should generate the same result six months later"
	"if two people interview a person for a job, but one concludes that the candidate is suitable while the other concludes that she/he is not, the selection method is not reliable"
validity	"a method is valid if it can discriminate between candidates in terms of subsequent performance on the job"
	"those candidates who were predicted to be 'good' potential employees, on a selection method, should subsequently perform well."

Source: adapted from (Newell, 2005)
Table 4.4 - Effectivity measure of a selection method

In selection methods, two primary predictive validity evaluation criteria are used: job performance and learning performance. (Robertson & Smith, 2001) analysed the validity of methods considering those evaluation criteria. In this study, the methods are positioned in terms of hierarchical validity related to job performance and learning criteria (Figure 4.6). The accuracy of the selection method helps to understand which method better predicts how well candidates will perform their jobs and how they will learn to develop their competencies.
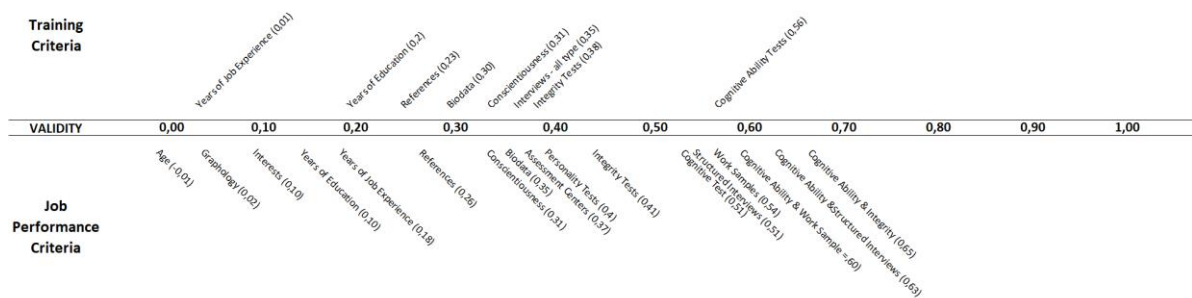
Source: Adapted from (Robertson & Smith, 2001)

Figure 4.6 - Accuracy of Selection Methods

4.2.3.1. Methods used for Selection

There are several methods for making decisions about candidate selection, which can be combined to increase the predictive validity of the selection process. Likewise, several dimensions of analysis can be combined. The weighted sum of the results of the different dimensions contributes to the final assessment. However, this is not possible for some jobs because some competencies must have a minimum level of proficiency evaluated (Rego et al., 2015).

The choice of selection methods should consider whether the organization has a more job-based or competency-based approach. In a job-based organization, the selection is primarily concerned with finding candidates that best fit the job description. In contrast, a competency-based organization is more focused on finding candidates capable of learning the competencies needed for the organization. (Lawler III, 1994)

The most used method of selecting candidates is the interview, but various other methods can complement it. The candidates are shortlisted at the early stage of the selection process based on CV analysis. The biographical candidate information included in the CV (past experiences and accomplishments) is analysed and used to predict the candidate's future job performance (Rego et al., 2015). A list of methods is presented in Table 4.5.

Method	Description	Examples
Personality Test	Assessment of how people act in a particular form in specific situations the predictive validity of these tests is considered moderate	Big Five personality traits MMPI-2 Minnesota Multiphasic Personality Inventory self-descriptive surveys
Cognitive Test	Assessment of intellectual abilities in terms of general intelligence or specific skills, such as memory, numerical/verbal fluency, and abstract reasoning. The predictive validity of these tests is high.	General mental ability tests, like general aptitude tests, employee aptitude survey
Interview	Process of questions and answers, with limited duration, to identify knowledge, skills, abilities	

Method	Description	Examples
	and behaviours in a candidate so that they can predict their future performance The structured interviews are better predictors of future candidate performance	
Biodata	analysis of biographical information about a person's past experiences and achievements	get biodata from CV from self-describe interview detailed inventory survey
CV analysis	provide a first overview of candidate compliance with job requirements	
References	letter of recommendation about previous experiences and achievement	
Graphology	handwriting analysis with an attempt to determine personality traits	
Physical tests	measure strength, flexibility, and endurance	
Psychomotor test	measure aspects such as reaction time, coordination, and manual agility	
Perceptive test	measure sensory aspects such as attention, hearing acuity, sensory location, peripheral and chromatic vision	
Knowledge test	provide an assessment of knowledge in function	Language tests
Work samples and simulations	observe the candidate in similar situations (work samples or simulations) to better predict the future performance focus on know-how	In-basket Business case Code Testing
Assessment Centre	refers to using several different selection methods over a specified period (1-4 days) for multiple evaluators to assess candidates across identified competencies or behavioural dimensions	

Source: adapted from (Newell, 2005; Rego et al., 2015)

Table 4.5 - Selection Methods

4.3. Upskilling and Reskilling Success Factors

As already mentioned, digital transformation requires new technological skills, which are difficult to find in the market. For this reason, finding professionals with the closest skills to the necessary ones and training them in the gaps identified could be a solution to respond to the shortage of these technological skills. This chapter explores two aspects of when an individual needs to be successfully trained in a new skill. The first is related to identifying existing skills sufficiently close to the new skill,

the second is related to the individual's ability to learn, and the third is the influence of cognitive abilities and personality traits on the learning path.

4.3.1. Skills Similarities

The success of an upskilling or reskilling approach is laid on identifying individuals who do not have the necessary target skills but, considering their existing skills, could potentially do the job with quick or no training (Singh et al., 2017). The challenge is to identify an individual's propensity to be successfully retrained to a target skill.

The recruitment and selection of candidates for an open position can be approached by exploring job transitions based on the same skills shared. In this approach, common skills are identified in the candidate's resume and job requirements, and gaps are analysed to find out what skills are needed to fit the target job. For example, let's think of a target job as "Fullstack Engineer" or "Software Engineer" applicants may be considered for this position because they may have similar technical skillsets such as Java or C#. These skills are then complemented with those needed to work as a "Full Stack Engineer", for example, JavaScript, html5, or react. A match is calculated by considering the percentage of skills shared between the candidate's profile and the job requirements.

The previous approach aims to find candidates with an exact match regarding skills needed for the job, but skill similarities are ignored in the match. This means that, for example, if in a job skills requirement, "Kotlin programming" is identified, but the candidate has only "Java programming experience", the match will be ignored, even knowing that these programming languages are closely related. By exploring the similarities between the skills, it is possible to identify candidates with skills closer to those required and upskill them to the target level (Ramamurthy et al., 2015).

Combining skills similarities into a measure of adjacency or fungibility between skills enables estimating a skill substitution with minimal upskilling (Vasudevan et al., 2018). Skills similarities are mainly explored in e-recruitment, online job search and job recommender systems using the advancements in machine learning. In the literature, we find various approaches for discovering skill similarities to estimate the individual propensity to be retrained (Guo et al., 2016).

The author (Ramamurthy et al., 2015) addresses this subject, presenting an analytics-driven framework to identify employees for reskilling, considering if their knowledge and existing skills are enough closes to the new skill and if they have high learning capacity. In this approach, the author uses the historical employee skills data to create a model of similar skills as a weighted combination of other skills. The model assumes that a presence of a target skill in an employee profile can be scored based on her adjacent source skills. The score is then used to predict the transition of someone with similar source skills to the target skill. This approach is limited to the employee's job-role history, which limits applying the model to employees with no prior job history. (Singh et al., 2017) to overcome this issue, propose a new model that combines the job role with features extracted from resumes.

Another analogous approach is presented by (Vasudevan et al., 2018) based on computing similarities between skills from numerous sources and combining them into a measure of fungibility. The skill descriptions and employee skill data are used to compute pairwise skill similarity matrices. Then they are combined in a single measure of fungibility between skills (also a pairwise similarity matrix).

Those approaches assume that the similarities between skills can be predicted from the frequency of other skills inside on dataset with relevant information about skills owned by individuals. Techniques based on numerical statistics such as "TD-IDF" and natural language processing techniques such as "Word2vec" are used to discover skill associations and generate pairwise skill similarity scores, as shown in the example in Figure 4.7.

Skill	JS	C#	PHP	CSS	Java	Python	Ruby	Bash	SQL	C++
JS	1.00									
C#	0.36	1.00								
PHP	0.51	0.14	1.00							
CSS	0.26	0.00	0.09	1.00						
Java	0.21	0.29	0.30	0.15	1.00					
Python	0.60	0.16	0.59	0.16	0.31	1.00				
Ruby	0.60	0.16	0.55	0.16	0.31	0.79	1.00			
Bash	0.46	0.19	0.36	0.19	0.12	0.58	0.58	1.00		
SQL	0.34	0.32	0.17	0.32	0.22	0.25	0.36	0.32	1.00	
C++	0.35	0.47	0.24	0.17	0.41	0.26	0.26	0.33	0.39	1.00

Source: (Y. Balachander & Moh, 2018)
Figure 4.7 - Example of pairwise scores between programming languages

A different strategy is presented by (Y. Balachander & Moh, 2018), who proposes a knowledge-based semantic similarity approach to find skills similarities. A skills ontology is created from "DBpedia" and used to create associations between skills. Based on skills characteristics, a similarity measure is defined and used as a score to compare similarities among skills in the ontology.

In this study, the author aims to improve technology skill matching, adding a skill similarities approach to the skill matching process. The idea is to build an ontology based on "specialization and generalization taxonomy of technical skills", named Technical Skills Ontology (TSO). TSO is used to extract technical skills features to derive similarities between them. This approach is established on the concept that the semantic similarity of two concepts can be determined using their common predecessors. When two concepts in an ontology are similar, they tend to contain more common predecessors. Thus, the similarity score of two nodes that share more common predecessors is higher than two nodes that do not share many predecessors.

In Figure 4.8 it is presented an example with the "NoSQL" databases concept, where two skills, " MongoDB" and "CouchDB", have a common predecessor. In that case, they score more similarly as they share an identical predecessor. Following this approach, "Oracle" or "IBM DB2" have low similarity with "MongoDB" as they share fewer predecessors in common; in that case, they only share the "Database" concept.
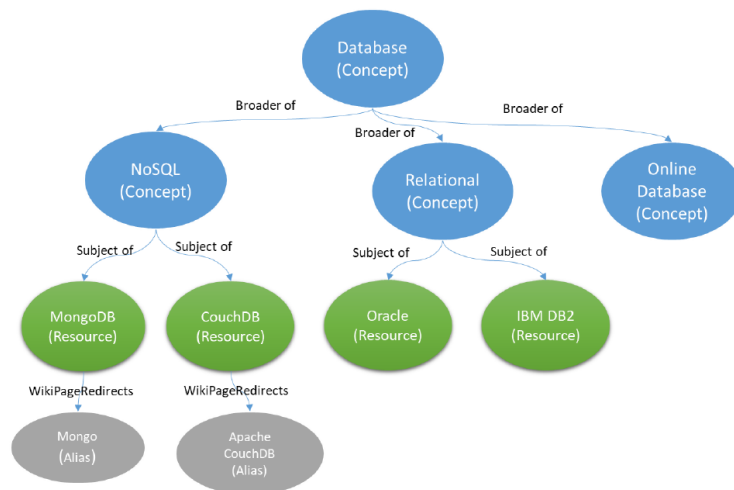
Source: in (Y. B. Balachander, 2018)
Figure 4.8 - Example of TSO

The system proposed generates a scoring pairwise skill similarity (as presented in Figure 4.7) that can be used as a reference to perform the technical skills closely matched between job seekers and open job positions.

4.3.2. Learning skills

Another important topic in the reskilling or reskilling approach is identifying individuals most likely to succeed in the learning process. The main issues raised are the following: what are the critical learning skills candidates must have to succeed in the learning process, and how to select the best candidates with those learning skills.

The individual's effective learning may depend on the learning process; however, the most relevant factor associated with effective learning is the individual himself. The learner needs to have cognitive abilities and behaviours that enhance their learning capacity. (*How People Learn*, 2000), as detailed in Table 4.6.

Cognitive abilities	make individuals understand things and the relationship between
Motivation	influences individuals' predisposition to learn
Readiness	learning starts when individuals are prepared and ready to learn
Interest	individuals learn those things they are interested in learning
Maturity	to be effective in education requires a level of individuals maturity
Aspiration	influences the achievement of individuals' learning objectives
Attention	influences knowledge retention and learning

Table 4.6 - Abilities and Behaviours that enhance the learning process

Due to technology's accelerated pace, workers, especially ICT specialists, need to adopt a lifelong learning approach to get new skills and adapt to the existing ones (Kolding et al., 2018a). The employees need to act as life-long learners. They should have the capacity and disposition for continuous learning. They have to assume learning as an ongoing process, demonstrate curiosity and

willingness to learn, be persistent and take responsibility for their learning path (Lowenthal & Dunlap, 2013). They need a new skill set related to self-directed learning and metacognitive awareness.

Self-directed learning is essential for lifelong learning (Dunlap, 2005). According to (Knowles, 1975), in self-directed learning, individuals assume the initiative and control their learning. They identify their learning needs and objectives, set up learning planning, prepare the materials required, implement learning strategies, and evaluate the outcomes.

To become effective lifelong learners, the individual need to complement self-directed learning with metacognitive awareness. According to (Biggs & Telfer, 1987), metacognitive awareness is the "awareness of one's own cognitive process rather than the content of those processes together with the use of that self-awareness in controlling and improving cognitive processes". Metacognitively aware individuals take conscious command of learning, manage knowledge, and monitor, assess and change learning and problem-solving strategies via self-assessment and review.

Due to emerging technologies and frequent demands on new skills, the capacity for self-directed learning reinforced by metacognitive awareness is key to effective lifelong learning (Lowenthal & Dunlap, 2013). Therefore, the candidates should demonstrate good learning skills.

According to (Peterson et al., 2001), learning skills include basic skills like active listening, mathematics, reading comprehension and problem-solving that facilitate learning or acquiring new knowledge. They are used to develop more skills in different domains. On the other hand, "process skills like active learning, critical thinking, learning strategies, and monitoring performance of yourself contribute to a more rapid acquisition of knowledge and skills".

4.3.3. Cognitive abilities and personality traits

Many studies document the validity of cognitive ability and personality traits tests and their combination as good predictors of job performance and learning proficiency (Schmitt, 2014). According to (Fleishman & Reilly, 1992), abilities are individual attributes that can influence effective job performance and can be detailed in Table 4.7.

Cognitive Abilities	"affect the acquisition and application of knowledge in problem-solving"
Physical Abilities	"Influence strength, endurance, flexibility, balance and coordination"
Psychomotor Abilities	"Impact on the capacity to manipulate and control objects"
Sensory Abilities	"influence visual, auditory and speech perception"

Source: Adapted from (Peterson et al., 2001)
Table 4.7 - Abilities

Considering the objective of the current work and the purpose of applying the methodology to ICT workers, it is more relevant to detail the cognitive skill (see Table 4.8).

Ability	Influences	Abilities (detailed)
Attentiveness	application of attention	Selective Attention; Time Sharing
Reasoning Abilities	application and manipulation of information in problem-solving	Category Flexibility; Deductive Reasoning; Fluency of Ideas; Inductive Reasoning; Information Ordering; Originality; Problem Sensitivity

Ability	Influences	Abilities (detailed)
Memory	recall of available information	Memorization
Perceptual Abilities	acquisition of visual information	Perceptual Speed
Quantitative Abilities	problem-solving by applying mathematical associations	Mathematical Reasoning; Number Aptitude
Spatial Abilities	manipulation of spatial information	Visualization; Spatial Orientation;
Verbal Abilities	problem-solving with acquisition and application of verbal information	Oral Comprehension/Expression; Written Comprehension/Expression

Source: Adapted from (Peterson et al., 2001)
Table 4.8 - Cognitive Abilities

Personal traits may also influence performance on the job and learning proficiency. For simplicity, we will use the Big Five personality traits model. The Big Five personality dimensions are independent personality traits that determine five general personality types: Conscientiousness, Extraversion, Neuroticism, Agreeable and Openness (Tupes & Christal, 1992). In the following study from (Barrick & Mount, 1991), it is possible to correlate some personality dimensions with job and training performance. In Table 4.9, we state the main conclusions of this study.

Dimension	Includes traits such as	Valid predictors of
Conscientiousness	hardworking, careful, thorough, responsible, organized, persistent, methodical, dependable, and risk-averse	• higher job performance, as individuals have some important attributes to accomplish job tasks (generalized to all jobs) • more performance in the training programs
Extraversion	sociable, talkative, gregarious, assertive, active, ambitious, and expressive	• better job performance for jobs such as management and sales • more training proficiency where highly interactive training is required
Neuroticism (or emotional stability)	anxious, depressed, angry, embarrassed, emotional, worried, and insecure	• less job performance, as these individual attributes don't facilitate the accomplishment of tasks to perform well. Emotional stability, on the other hand, predicts a better job performance
Agreeableness	Cooperative, flexible, courteous, trusting, good-natured, forgiving, and tolerant	• better Job performance for jobs such as management and sales
Openness	cultured, imaginative, curious, original, broad-minded, artistically sensitive and intelligent	• performance in the training programs, as predicts individual readiness to participate in learning experiences

Source: Adapted from (Barrick & Mount, 1991)
Table 4.9 - Big Five personality dimensions

4.4. TRAINING

After the skills gap is identified, it is necessary to create a training plan to fill those gaps. In this phase, suitable learning content is identified and prepared. One or more training methods are selected according to the skills proficiency level desired to achieve. Individuals' learning progress is evaluated, and training adjustments can be made according to acquired knowledge. The skills proficiency is then re-assessed after the practice of knowledge acquired. This chapter explores the training practice, essential training methods, and techniques.

4.4.1. Training Process

The training strategy and policy determine the orientations in the training process. The training process can be described in four phases: identification of needs, programming and planning, execution, and evaluation (see Figure 4.9 below).
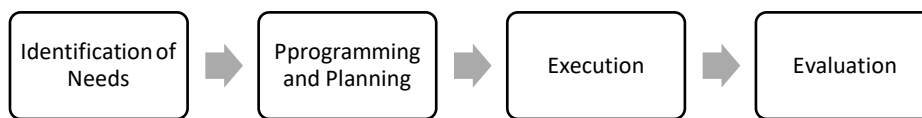
Source: adapted from (Rego et al., 2015)
Figure 4.9 - Training Process

The training identification needs phase involves organizational, operational and individual analysis. At the organizational level, needs more transversal to the organization are identified and can be determined by structural changes, production changes, new businesses or regulatory standards. At the operational level, the type of work, the tasks and the skills needed to carry it out are analyzed; in this way, the training needs arise from the skills identified to perform the work. Finally, individual training needs are analyzed. Training needs are identified by the deviation in the individual's skills based on the skills needed to perform the job. In particular, training needs arising from skills gaps can be identified from production needs or process changes, the skills assessment process or the initial recruitment process (Rego et al., 2015).

The planning and programming phase is essential to define training objectives; this means what knowledge and skills should be acquired at the end of the learning process. Once the objective has been defined, training must be planned and programmed, considering the target audience, the content to be used, the methods and techniques to be used, who should train, where and when to train and inevitably, the expected cost of the training (Rego et al., 2015).

In the execution of the training, it depends on the adequacy of the program to the needs, quality of the contents and materials used, the quality of the trainers and the motivation of the trainees.

In the last phase, it is crucial to evaluate the success of the training. Kirkpatrick Model defines the evaluation training program in the following assessment levels: trainees' reaction to the training, the effectiveness of the training in learning outcomes of knowledge and skills, and performance assessment by observing the trainee's behaviour in performing his/her role with the acquired skills and

finally, the results of the training are evaluated, namely at the operational and financial level (Falletta, 1998)

4.4.2. Training methods and Techniques

Some principles of learning are essential when a training program is designed. Learning in the context of training will be most effective if trainees know the objectives to achieve, receive regular feedback about their progress, learn by observation, and practice the knowledge acquired. Moreover, they can also benefit from progressive learning through components with an adequate duration and continuity depending on the content (Cabrera, 2006; Rego et al., 2015).

Training methods can be classified by the objectives purposed. Consider the objective is to transmit knowledge or information; in that case, the method is content-centred, and techniques for exposing information (e.g., reading, classes, e-learning) or systematic observation are applied. On the other hand, if it intends to change attitudes or develop interpersonal skills, the methods focus on process- or procedure-based learning using techniques such as role-playing, case studies, or group work. The methods can also be combined when intended to transmit knowledge and change attitudes; in these cases, techniques such as on-the-job training, coaching or job rotation can be used (Rego et al., 2015). Figure 4.10 identifies the most appropriate techniques for each type of competence and the level to be achieved.

| | | Type of Competencies to be Acquired | | |
		Basic skills	Interpersonal Skills	Integrative and Conceptual Skills
Level of Comptencies to Aquire	Fundamental Knowledge	Classes Computer-assisted training e-learning Function Rotation Tutoring Mentoring	Classes Role Playing Coaching	
	Skills Development	Computer-assisted training e-learning Simulations Virtuall Reality Assessment Centers Function Rotation Mentoring	Role Playing Coaching Simulations Virtuall Reality Assessment Centers Function Rotation Tutoria	Case Studies Simulations Virtual Reality Assessment Centers Function Rotation
	Use of skills developed	Simulations Virtuall Reality Assessment Centers Function Rotation Mentoring Function Rotation Tutoring Mentoring		

Source: adapted from (Rego et al., 2015)
Figure 4.10 - Training Methods by Type and Level of Competencies

The choice of methods and techniques to apply depends on several factors, including the type of content, audience characteristics, available time and the costs involved. For the choice of training methods, (Dolan et al., 2003) proposes a model based on the type of competence to be acquired by the trainee. The model considers three types of competencies to be developed, the basic, the interpersonal and the integrative and conceptual ones. Three competence levels are proposed for each of these competencies: fundamental knowledge, the development of these competencies and their use.

5. METHODOLOGY FOR RECRUITING BASED ON A STRATEGY OF "RESKILLING" AND "UPSKILLING

In this chapter, the methodology itself is detailed. First, it is identified some assumptions about the methodology proposed. After that, the methodology is explained as a process with inputs and outputs required emphasizing the relevance of competence model creation. A use case based on the job description with cloud-native technologies is prepared to demonstrate the application of the methodology. Finally, the use case demonstrated is validated by some individuals connected with HR processes to get additional feedback and insights into the methodology applied.

5.1. ASSUMPTIONS

The methodology presented here is based on information collected during the literature review. It mainly focuses on the IT domain, considering the shortage of professionals in new technologies and the potential to apply an upskilling approach to hire and improve the skills of ICT professionals afterwards.

The utilization of the methodology assumes that the organization is open to recruiting candidates without the exact skills to perform the job role at a specific level of proficiency and is prepared to take some investment in their learning process. In another way is also expected that candidates are open to embracing a journey of learning to achieve proficiency in skills that they don't have at the recruitment phase.

The approach presented here is more suitable to recruit in a context when the skills are scarcely available in the market. However, it can be applied in any other context where the organizations embrace an HR competency-based approach, focused on identifying the skills needed for effective performance and how to develop those skills in their employees to meet the organization's objectives.

The presented methodology considers the similarity between skills based only on expert analysis of technological skills. This approach is acceptable if there is no other way to correlate similar skills. In the literature review, other approaches have been appointed to create this correlation between skills, like using algorithms to discover and generate pairwise skill similarity scores. That approach can be applied in future works over the methodology presented here.

Another assumption is that upskilling methodology does not intend to recommend the best assessment type to apply or the training type required to achieve the proficiency requested. The selection of assessment tests and training plans should be defined according to the context of the job role and related competencies according to the organization's objectives.

Proficiency levels used for competencies are examples of classification. In the competency model proposed, the proficiency levels are used to demonstrate the methodology and cannot be considered a unique reference when evaluating skills. Some other different approach to proficiency level definitions is also acceptable.

No academic background or years of experience are evaluated in this methodology. The idea is to assess candidates according to their competencies to perform the job effectively without bias or predefined opinions about the candidate.

5.2. PROPOSAL

The recruitment methodology based on upskilling/reskilling strategy is built on six processes, as described in Figure 5.1.

The first step is creating the competence model (or skill matrix) that describes the knowledge and skills required to effectively perform the job at different proficiency levels. The competence model also introduces the learning competencies and similar skills that bring a set of insights into the upskilling/reskilling success.

The second step is the assessment of the candidates through the competence model designed. This assessment gives an overview of the candidate's competencies and appoints him for a level of proficiency in the job role.

Following the assessment, a set of proficiency skills gaps are identified. An upskilling/reskilling program is set up to fix the current proficiency gaps and move to the next target skills proficiency. A training plan is prepared to improve the skills proficiency until the new reassessment date. The proficiency of the skills is then reassessed to check their progress.

The last step is to reward progress in acquiring new skills and/or improving your proficiencies. The methodology detailed is described in the following subchapters.
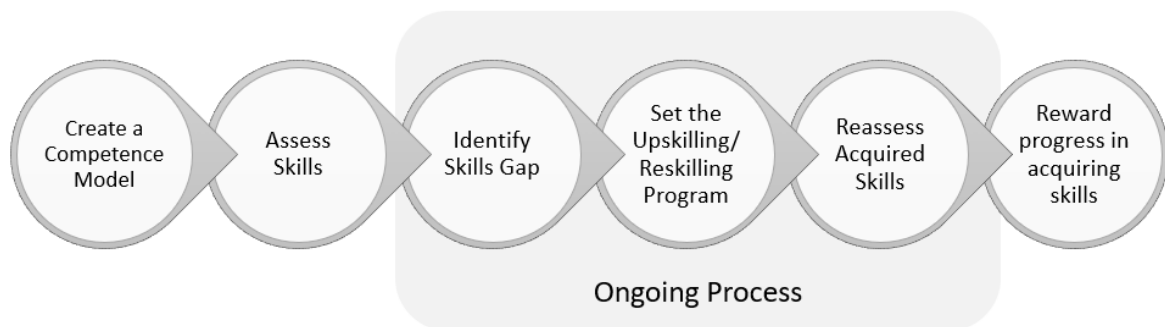
Figure 5.1 - Recruitment Methodology based on Upskilling/Reskilling

5.2.1. Create a Competency Model

The methodology proposed starts with the construction of the competence model following an education and behaviour psychology approach, as proposed by (Marrelli et al., 2005). The competency model is a part of the methodology that sets out the specific competencies (Knowledge, Skills, Abilities and Behaviours) that enable an individual to perform their job effectively.

This phase is essential to succeed in the upskilling and reskilling recruitment strategy. A well-defined competency model is essential to understanding which competencies are required to be effective in a job, how to achieve that and progress. The Competency model defines what performance should look like for each individual job role level. The following sub-chapters detail nine steps to create a competency model, as described in Figure 5.2.
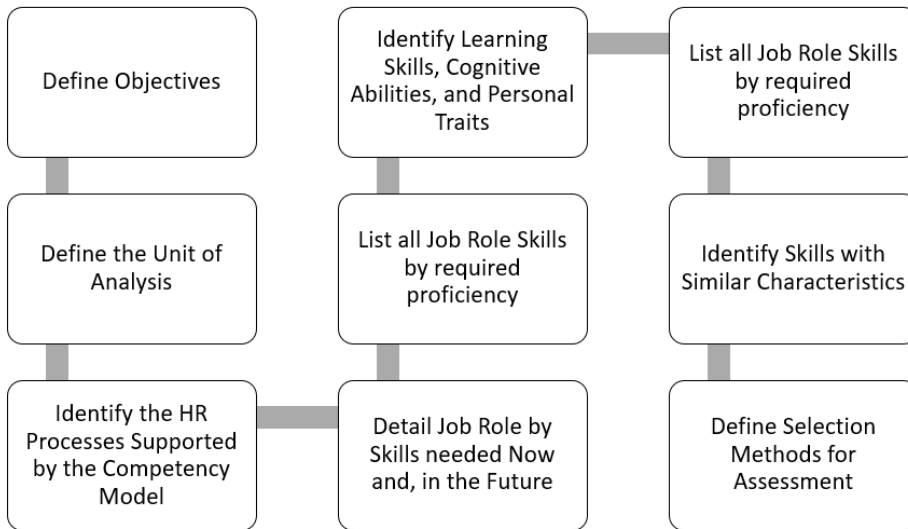
Figure 5.2 - 9 steps to create a Comptency Model

Define Objectives

Before creating a competency model, the objective must be clearly defined. Understanding the proposed competency model, its scope and where it should be applied indicates the reference and guidelines for the entire methodology.

A competency model must respond to an identified problem and define the expected benefits. The upskilling and reskilling recruitment methodology here is focused on solving the ICT labour market skills shortage in new technologies and addressing new strategies to fill the candidate's skills gap and prepare them for the job requiring those technologies. It is expected that this methodology will improve the capacity of the organizations to find and build an ICT workforce with competencies in new technologies.

Define the Unit of Analysis

The competencies to be analyzed need to be limited, avoiding having a broad and open scope of competencies that candidates must have or need to acquire. Although jobs can have similar competencies, the methodology proposed here does not intend to have a long learning path to move from one job to another due to missing competencies in the candidates. The objective is to identify candidates that can leverage their current competencies to new ones minimizing the investment and the risk of success.

Following the assumption previously explained, the unit of analysis should stay at the level of a specific job role or a job family, avoiding a broad spectrum of job roles and competencies under analysis. Focusing on one job role with a shortage of candidates, it will be easier to isolate the required skills and how they can be upskilled.

Although the organizations can follow their frameworks, to manage job families and Job roles, it is recommended to adopt one ICT framework already available, like e-cf or ESCO, as previously explained in the literature review.

Identify the HR Processes Supported by the Competency Model

A competency model can be applied to one or more HRM processes. The HR process can use the competency model to address which competencies are relevant to the process to be implemented. The competency model can be used to support:

- the management of job requisitions, helping to develop job requirements and descriptions
- the recruitment to verify the candidates' competencies according to job requirements
- the selection process, identifying the best methods to qualify the competencies of candidates
- in the training planning, defining the learning path required to perform the job effectively
- appraisal performance to evaluate the competencies acquired and their proficiency
- in career planning to clearly define the competencies and proficiency needed to progress in the career path
- reward/compensation according to the competencies achieved

Detail Job Role by Skills needed Now and in the Future,

In this step, the competencies required now and in the future to perform a job effectively are detailed. The competencies are associated with a job role, so a clear job description should first be described. For each job role, break down a set of duties, activities, and tasks should be described. Competencies set and proficiencies associated are then identified as requirements to perform the job role effectively.

The abilities and expected behaviours to perform a job are more stable, but the knowledge and skills may change and evolve. It means that the knowledge and skills required now must be complemented by what the candidate will need to have in the future to perform his job effectively. The competency model should identify all the skills needed to perform the job role from a lower level of complexity and autonomy to greater complexity and autonomy levels. A job role should be broken down into different levels of proficiency required by a skill set.

The job role can be divided by proficiency levels that describe the level of skills required. For instance, the job role can be split by proficiency levels, like a trainee, junior, intermediate, senior, and expert. Each level details the skills required to perform the job effectively at a certain level of proficiency (see Figure 5.3). With this type of detail, it is possible to have objective references on how to progress in the job role.

At this stage, the methodology proposed should state the main guidelines. The header of the competency model can be described in Figure 5.3.

Competency Model

Objectives	< issues to solve and benefist to achieve >							
Job Family	< Job family name>							
Job Role	< job role name > < job role description >							
HRM Process	Job Requisitions	Recruitment	Selection	Training	Appraisal	Career	Compensation	Reward
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
					Job Role	Job Role	Job Role	Job Role
			Proficiencies Set		A	B	C	(...)

Figure 5.3 - Competency Model (header)

The methodology's success here explained is based on identifying individuals who are more likely to succeed in the learning process. Therefore, the candidates must have some abilities and personal traits to enhance their learning capacity. As stated in the literature review, an individual's cognitive abilities and personality traits are good predictors of job and learning performance. (Schmitt, 2014).

To succeed in upskilling/reskilling, the candidates must have the capacity and disposition for continuous learning. Candidates with good learning skills and cognitive abilities have more likelihood of better performance in training programs. Table 5.1 identifies a list of learning skills and, in Table 5.2, the proficiency expected to succeed in upskilling/reskilling.

Learning Skills	Description
Active Learning	Understand the impact of new information in decision-making and problem-solving (learning by thinking, discussing, investigating, solving problems, making decisions and proposing solutions)
Critical Thinking	use reasoning and logic to evaluate information and make conclusions and find solutions
Learning Strategies	select and use training methods adequate for the situation when learning
Monitoring learning	monitor your training performance to make improvements or take corrective actions
Active Listening	pay attention to what others are saying without interruptions, take time to understand and ask relevant questions
Time Management	use of own time, a practical self and time management
Reading Comprehension	understand written text in the context of work-related documents

Source: Description according to the department of US Labor's O*Net database (Peterson et al., 2001)
Table 5.1 - Description of learning skills

The minimum proficiency level for each learning skill can be adapted according to the job role, in Table 5.2, it is highlighted the ones that can be more relevant to succeed in the learning process. A learning skill can be detailed in different levels of proficiency, each one referring to one level of maturity and/or expertise in the skill related. To evaluate the proficiency of the learning skill, the following scale has been used: 0 - no/low proficiency; 1 – beginner proficiency; 2 – Competent proficiency; 3 – Expert Proficiency.

Learning Skill	Low Proficiency	Beginner	Competent	Expert
Active Learning	0	1	2	**3**
Critical Thinking	0	1	**2**	3
Learning Strategies	0	1	**2**	3
Monitoring learning	0	1	2	**3**
Active Listening	0	1	2	**3**
Time Management	0	1	**2**	3
Reading Comprehension	0	1	2	**3**

Table 5.2 - Learning Skills Proficiency (example)

Table 5.3 highlights the proficiency of cognitive skills, which can be a good predictor of success in the candidate's learning path. The same scale of learning skills proficiency levels has been used in cognitive skills. However, according to the job role, the proficiency levels may change.

Cognitive abilities	Low Proficiency	Beginner	Competent	Expert
Attentiveness	0	1	2	**3**
Reasoning Abilities	0	1	**2**	3
Memory	0	1	**2**	3
Perceptual Abilities	0	**1**	2	3
Quantitative Abilities	0	1	**2**	3
Spatial Abilities	0	**1**	2	3
Verbal Abilities	0	1	2	**3**

Table 5.3 - Cognitive Abilities Proficiency (example)

Table 5.4 highlight the dimension of personality traits which the candidates must have to succeed in the training program or learning path. According to studies conducted by (Barrick & Mount, 1991), candidates with personality traits such as openness and conscientiousness have more capacity to learn and progress in acquiring new skills.

Personal Traits				
Conscientiousness	Extraversion	Neuroticism	Agreeableness	Openness
+++	++	+	++	+++
3	2	1	2	**3**

Table 5.4 - Dimension of Personal Traits

In terms of the percentage of achievement in proficiency, the scale presented can also be defined with the following correspondence. A percentage can be used for a more accurate assessment.

	Low Proficiency	Beginner	Competent	Expert
Proficiency Grade	0	1	2	3
% Achievement	0 - 25	26 - 50	50 - 80	80 - 100

List all Job Role Skills by required proficiency

While the required proficiencies in learning skills, cognitive skills and personal traits tend to remain stable as individuals progress through proficiency level in the job role, the technical and functional skills or knowledge needed to perform new job roles tend to change. In that context, it is essential to describe all skills required in several job roles and the expected proficiency. Our suggestion is to follow the proficiency levels as described in Table 5.5; however, any other grades may be used considering the competency in analysis. Competency proficiency level can be evaluated in dimensions of autonomy, context complexity and expected results.

Level of Proficiency	Grade	Description
Low Proficiency	0	Low or no proficiency in the competency. May have some knowledge of the task to be performed
Beginner	1	Has some proficiency in the competency, acts under guidance and performs tasks with low complexity. The output of the work needs to be supervised.
Competent	2	Has proficiency in competency, acts with autonomy and performs tasks with medium complexity. The output of the work needs to be supervised in exceptional situations.
Expert	3	Has a high level of proficiency in competency, acts with total autonomy and performs tasks with high complexity. He supervises the work of the others and acts as an advisor.

Table 5.5 - Description of Proficiency Levels

Some competencies may be mandatory for a job role, at least at the identified proficiency level. In those cases, the candidates must achieve the level of proficiency required in the competency required. Additionally, some competencies may have different weights comparing others.

Identify Skills with Similar Characteristics

One of this methodology's essential topics is identifying skills with similar characteristics. This identification will help assess candidates without the required skills for the job role. Candidates having similar skills to those needed increase the likelihood that candidates will successfully progress to the target skill.

As already explained in the literature review, several approaches to finding skill similarities exist. It is not the purpose of this study to explore strategies to get those similarities. The presented methodology will consider the similarity between skills based on expert analysis. In future works, it is recommended to complete this analysis with more precise information explored with some computational solutions already presented in the literature review.

A scoring pairwise skill similarity can be used as a reference to perform the comparison of the skills. Although this approach can be used for any kind of skill, under the scope of this master thesis, only technical skills will be considered. An ontology Database (DB) with pairwise skill similarity should be created and updated frequently, as shown in the example in Table 5.6. This database will be used to access candidates' similar skills.

Skill A	Skill B	Score
C++	C#	0,47
SQL Server	Oracle DB	0,82
C++	C#	0,71

Table 5.6 - Pairwise Skill Similarity (example)

In the competency model, similar skills with higher scores should be identified by each skill required for the job role in the analysis. This will help in the recruitment and selection process, not ruling out potential candidates for upskilling/reskilling. The candidates with similar skills, the ones required in job descriptions, have the potential to be upskilled.

The score between two skills provides a success factor for upskilling from one skill to the other. Following the example in Table 5.6, a score of 0,71 between C++ and C# provides a success factor for upskilling a candidate from C++ to C# (and vice-versa) at the same level of proficiency.

A job role requires a set of skills to perform effectively. Finding these skills or part of them on the market or in the organization can be challenging. In particular, technical skills related to new technologies are not easy to find due to their complexity or because they are not yet widely used.

Identifying the technical skills that may be hard to find is an essential step in the methodology presented here. For those scarce skills, it is required to identify the skills with high similarity scores that may improve the candidate's upskilling. With this information, the recruitment strategy should not only focus on attracting candidates that match the skills required but also on skills that potentially may be upskilled.

The sourcing strategy needs to be open enough to attract all candidates with the potential to perform the role. The published job description should state the needed skills and allow accepting similar skills. Here are some examples of how you can open the skills needed to perform a job role:

- Experience in C++ (preferable) or other OOP Language
- Knowledge in SQL Server or other RDBMS
- Experience in asynchronous messaging brokers like Kafka (preferable), RabbitMQ or Redis

Define Selection Methods for Assessment

In a competency-based approach, the candidates' selections are based on assessing their competencies for effective job performance, as also the assessment of their learning capacities and cognitive abilities that allow them to improve or acquire competencies. The candidate must be evaluated on his/her abilities as an apprentice and as a worker in the effective performance of his/her job (see Table 5.7).

Type of competencies to assess	Competencies Assessed (example)
capacities that promote learning or the more fast acquisition of knowledge	cognitive abilities, personal traits, learning skills, interests, values, etc
capacities that facilitate the job performance	social, technical, functional, language skills or other relevant skills
capabilities in skills similar to those needed for the job	similar technical skills, namely those that are scarce

Table 5.7 - Type of competencies to assess

In the competency model, a specific assessment procedure must be identified for each competency, like cognitive abilities, personal traits or technical skills. Using the identified assessment, each candidate's competency is assessed and scored.

In the present methodology, the focus is to assess competencies, no matter the candidate's experience in the job role. The objective is to assess the competencies needed for the job role and, in case the competencies are not sufficient, identify the gap and evaluate the effort to achieve the required performance in the least performing competencies.

The assessment of competencies that facilitate learning or accelerate the acquisition of knowledge will be used as a success factor for the candidate in acquiring the missing competencies and how he will progress in the future in acquiring new ones. Table 5.8 suggests some psychometric tests to assess learning skills and cognitive abilities:

	Can be assessed by
Learning Skills	
Critical Thinking	Watson-Glaser Critical Thinking Appraisal (W-GCTA)
Time Management	Time management questionnaire (TMQ) developed by (Britton & Tesser, 1992)
Reading Comprehension	Verbal reasoning test
Cognitive Abilities	
Reasoning Abilities	Numerical reasoning tests, Logical reasoning tests or Analytical reasoning tests) Watson-Glaser Critical Thinking Appraisal (W-GCTA)
Memory	Memory Test
Quantitative Abilities	McQuaig Mental Agility Test, Korn Ferry Numerical Test
Verbal Abilities	McQuaig Mental Agility Test
Personal Traits	Big Five Personality Test, Talent-Q Dimensions Test

Table 5.8 – Learning Competencies Assessment Methods (examples)

At this stage, the body of the competency model is completed and can be represented as shown in Figure 5.4. The competencies are aggregated in the following way:

1) Job Role Competencies: knowledge and skills necessary to effectively perform the job. The skills can be divided into subcategories like Social, technical, and functional skills. For some skills, similar skills can be identified
2) Learning competencies provide insights into the candidate's progress in the upskilling plan and are divided into cognitive abilities, learning skills and personal traits.

In a specified job role, each competency is defined:

1) L[r] – proficiency level requested as detailed in Table 5.5
2) Mandatory (M) – "X" in case the proficiency level required is mandatory for the job role
3) Weight (W) – proficiency weight factor. Determines the relevance of the proficiency level among the others. Values are between 0 and 2, where 1 means equal relevance with the others. Only applied to "Job Role Competencies."
4) Assessment Type (A) – for each competency, an assessment type/method must be referenced
5) Similar Skill – the most similar skills to the target one should be identified with the score of similarity as a reference for use in candidates assessment

				Job Role <Proficiency Level A>				Job Role <Proficiency Level B>				Job Role <Proficiency Level C>				Job Role (...)			
				< duties, activities & tasks >				< duties, activities & tasks >				< duties, activities & tasks >				< duties, activities & tasks >			
Category	Sub-Category	Competency	Similar Skills	Proficiency Level A				Proficiency Level B				Proficiency Level C				Proficiency Level (...)			
				Level	Mandatory	Weight	Assess	L	M	W	A	L	M	W	A	L	M	W	A
Job Role Competencies — Knowledge	Knowledge		Knowledge 1																
			Knowledge 2																
			Knowledge n																
Job Role Competencies — Skills	Skills — Social		Skill 1																
			Skill 2																
			Skill n																
	Skills — Functional		Skill 1																
			Skill 2																
			Skill n																
	Skills — Technology		Skill 1	Skill A (%), Skill B (%)																
			Skill 2	Skill C (%)																
			Skill n																
	Skills — Language		Skill 1																
			Skill 2																
			Skill n																
	Skills — (...)		Skill 1																
			Skill 2																
			Skill n																
Learning Competencies — Abilities	Cognitive		Attentiveness																
			Reasoning Abilities																
			Memory																
			Quantitative Abilities																
			Verbal Abilities																
Learning Competencies — Skills	Learning		Active Learning																
			Critical Thinking																
			Learning Strategies																
			Monitoring learning																
			Active Listening																
			Time Management																
			Reading Comprehension																
Enabling Behaviours	Personal Traits (Dimensions)		Conscientiousness																
			Extraversion																
			Neuroticism																
			Agreeableness																
			Openness																

Figure 5.4 - Competency Model (body)

5.2.2. Assess Skills

Once the competency model is defined, it can be used as a reference for candidates' assessments. The assessment is performed for a job role in 3 perspectives: job role assessment knowledge and skills, similar skills and learning competencies assessment.
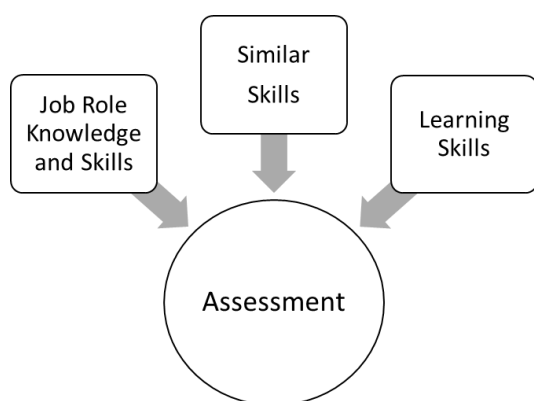

Figure 5.5 - 3 dimensions of candidates' assessment

Job role knowledge and skills are the core competencies to perform the job role. Each knowledge and skill identified in the competency model is assessed through an assessment procedure that will determine the candidate's proficiency level represented by a grade as described in Table 5.5.

The score of job role competencies can be calculated by using the formula $JRC_S = K_S + S_S$ where $K_S = \sum_{n=1}^{\infty}(KLn * Wn)$ and $S_S = \sum_{n=1}^{\infty}(SLn * Wn)$.

Legend:
JRC$_S$ = Job Role Competencies Proficiency Score
S$_S$ = Skills Proficiency Score
K$_S$ = Knowledge Proficiency Score
SL = Skill Level of proficiency
KL = Knowledge Level of Proficiency
W = Proficiency Weight Factor

The Competency Proficiency Score (JRC$_S$) must be calculated for the job role and for the candidate being evaluated. Comparing the scores will give the overall gap in skills required by a candidate to perform the most appropriate job role at a specified proficiency level.

				Assessment				Job Role <A> — < Proficiency Level A >					Job Role <B> — < Proficiency Level B >					Job Role <...> — < Proficiency Level ... >				
Category	Sub-Category	Competency	Similar Skills	L[a]	L[s]	Assessment Type	Date of last assessment	L[r]	Mandatory	Weight	Gap	Relevance of L[s]	L[r]	Mandatory	Weight	Gap	Relevance of L[s]	L[r]	Mandatory	Weight	Gap	Relevance of L[s]
Knowledge		Knowledge 1		1			01/07/2022	1		1	0		2		1	-1		3		1	-2	
		Knowledge 2		1			01/07/2022	1		1	0		2		1	-1		3		1	-2	
		Knowledge n		2			01/07/2022	1		1	1		2		1	0		3		1	-1	
Skills	Social	Skill 1		2			01/07/2022	1		1	1		1		1	1		2		1	0	
		Skill 2		1			01/07/2022	2		1	-1		2		1	-1		3		1	-2	
		Skill n		2			01/07/2022	2		1	0		2		1	0		2		1	0	
	Functional	Skill 1		1			01/07/2022	2		1	-1		2		1	-1		3		1	-2	
		Skill 2		3			01/07/2022	3		1	0		3		1	0		4		1	-1	
		Skill n		2			01/07/2022	1		1	1		2		1	0		2		1	0	
	Technology	Skill 1	Skill A %	1	2		01/07/2022	2		1	-1	TRUE	3		1	-2	FALSE	3		1	-2	FALSE
		Skill 2	Skill C %	1	1		01/07/2022	1		1	0	FALSE	2		1	-1	FALSE	2		1	-1	FALSE
		Skill n		1			01/07/2022	1		1	0		1		1	0		2		1	-1	
	Language	Skill 1		1			01/07/2022	2		1	-1		3		1	-2		3		1	-2	
		Skill 2		2			01/07/2022	2		1	-1		2		1	-1		2		1	-1	
		Skill n		1			01/07/2022	2		1	-1		1		1	-1		2		1	-1	
	(...)	Skill 1		1			01/07/2022	1		1	0		1		1	0		1		1	0	
		Skill 2		1			01/07/2022	1		1	0		1		1	0		1		1	0	
		Skill n		1			01/07/2022	1		1	0		1		1	0		1		1	0	
Job Role Competencies Score (JRC)				24				27					34					42				
Job Role Skills Gap											-3					-10					-18	

Figure 5.6 - Candidate Assessment

In Figure 5.6, an example of candidate assessment for job role competencies is demonstrated as described before. The proficiency assessment takes into consideration the following data:

- L[r] - expected level of proficiency in the knowledge/skill
- L[a] - assessed level of proficiency in the knowledge/skill
- L[s] - assessed level of proficiency in the similar skill
- Mandatory – the proficiency assessed in this knowledge/skill must be at the level expected in this job role proficiency level
- Weight – the weight of the knowledge/skill in overall competencies (by default is 1)
- Assessment Type – the type of assessment procedure applied
- Gap – the difference between proficiency expected and assessed
- Relevance of L[s] – it determines if L[s] proficiency is relevant for L[a] upskilling

While the job role competencies define the skills needed to effectively perform the job at the required proficiency level, learning competencies and similar skills provide insights into candidates' capacity to improve their skills and acquire new ones. The learning competencies and similar skills assessment represent the core of the recruitment methodology. The idea behind this methodology is to select candidates without exactly the skills at the proficiency level required for the job role and

evaluate their ability to progress to achieve the proficiency required through an ongoing upskilling/reskilling program.

Among skills required for the job role and based on the pairwise skill similarity repository available, the skills with the highest similarity (e.g., > 70%) should be considered to assess a candidate. The candidates may not have the skill required for the job; however, having a similar skill with high proximity to the one required is a good predictor of proficiency progress for the target skill. As exemplified in Figure 5.6, skill similarity proficiency is used to measure the relevance of the candidate to progress in the target skill proficiency. The relevance of the skill similarity can be defined using a TRUE logic result of formula: L[a] < L[r] AND L[s] >= L[r].

In addition to similar skills, the learning competencies are fundamental to measuring the candidate's ability to progress in acquiring new skills and/or to improve the proficiency in skills required for the job role. In the methodology presented here, the learning competencies assessed are grouped into cognitive abilities, learning skills and personal traits. Figure 5.7 presents a proposal to assess learning competencies.

Figure 5.7 - Learning Competencies Assessment

The proficiency level of cognitive abilities and learning skills required that improve the success of acquiring knowledge and skills can be adapted according to the job role to be assessed. In the methodology proposed and based on the literature review, a set of abilities and skills has been identified that, at a specified level of proficiency, are good predictors of candidate learning capacity.

The score of cognitive abilities and learning skills can be easily calculated by using the following aggregation formulas:

	expected level of proficiency [r]	assessed level of proficiency [a]
Cognitive Abilities	$\sum_{n=1}^{\infty}(CAr\,n)$	$\sum_{n=1}^{\infty}(CAa\,n)$
Learning Skills	$\sum_{n=1}^{\infty}(LSr\,n)$	$\sum_{n=1}^{\infty}(LSa\,n)$

A personal traits assessment can also help identify the dominant personality trait of the candidate. According to the literature review, conscientiousness and openness personality traits are more able to succeed in the learning process. Those learning competencies assessed will provide

insights into the candidate's capacity to progress in the learning path of the knowledge and skills required to perform effectively in his job role.

5.2.3. Identify Skills Gap

Identifying weaknesses and strengths with skill assessments enable one to understand the candidate's proficiency alignment to the target skill. The results will tell where to start within a learning path if a gap is identified due to skill proficiency not matching the target level. The gap analysis will help to decide which candidates must be selected for the target job role or has the potential to be upskilled with low risk and investment.

In recruiting based on the upskilling/reskilling strategy, gap analysis is used to define the level of proficiency a candidate in a job role should be positioned. The candidate is then assigned an upskilling/reskilling plan for progressing through the different job proficiency levels. Candidates' learning competencies will act as insights to predict how the candidate successfully will progress in this process. Some guidelines during a gap analysis should be taken into consideration:

1) Candidates without all skills required for the target proficiency level of the job role can be repointed for a lower level and be promoted through an upskilling program.
2) Learning skills, cognitive abilities and personal traits are essential drivers of candidates' success in upskilling and define the speed at which they can progress
3) Candidates' previous skills, like those required, can improve the success of your upskilling plan
4) In gap analysis, a skill assessed with a higher value than requested is considered to have no gap (value 0 is assigned)

5.2.4. Set up the Upskilling/Reskilling Program

As soon as the candidate skills gap is identified, an upskilling plan must be set up for each level of proficiency in a job role. Based on the job role competencies score (JRC) obtained from the assessment, the candidate is positioned in the job role with the nearest score.   In addition, the total "job role skills gap" and the "number of missing skills in the job role" gives an overview of how far the candidate is from the target level of proficiency expected for the job role identified.

This first analysis helps to rank the candidate in the career path, appointing him the job role with the most aligned proficiency level with their competencies and defining how to progress in the career plan. In Figure 5.8, the methodology introduces a simple way to identify the skills that need to be trained to achieve the target level of proficiency in the job role and which skills are required to progress to reach the following job role proficiency level. The training proposed to achieve the proper proficiency, respective duration, and next date to reassess the proficiency are also identified. The upskilling plan takes into consideration the following data:

- Missing Target Level – identify the skill proficiency level missing when $L[a] < L[r]$
- Next Target Level - identify the next skill proficiency level to achieve when $L[a] >= L[r]$ AND ($L[r]$ job role n > $L[r]$ job role n+1)
- Training – defines the training required to fix the current gap or progress to the next proficiency level of the skill
- Duration – duration planned in months to complete the skill level of proficiency

Figure 5.8 - Upskilling Plan (example)

The training content and plan should be set up in a competency model for each job role. Explicit training content and learning path previously identified make it easier for candidates to understand how they can progress to the next level. The methodology does not intend to define which training should be followed. The method only emphasizes that the training and learning path must be well defined to inform the plan needed to advance to the next level.

5.2.5. Reassess Acquired Skills

Recruitment based on upskilling/reskilling strategy assumes that candidates may not have all the required competencies. They must integrate a continuous learning process to fill the gaps in existing skills and acquire new ones to perform the job role effectively. In that way, the skills are continually reassessed in an ongoing process that improves their proficiency.

This methodology focuses on the ability of the candidate in acquire and progress in skills proficiency instead of validating only the skills needed to perform a job role at a defined proficiency level.

5.2.6. Reward Progress in Acquiring Skills

A new skill acquired gives a sense of victory. A reward employee program must be set up to promote the willingness to progress in skills proficiency and acquire new ones. An individual reward compensates for the success achieved and pushes the employee to move on to continuous learning. The publication of these new skills gives public recognition and attracts other employees to participate in this continuous learning process.

New skills and the improvement of their proficiency open new opportunities for work. This is important not only for the employee because they progress in their career path but also for the organization that increments its team capacity to deliver better results.

5.3. USE CASE – DEMONSTRATION

Digital transformation is driving the new adoption of applications development and deployment approach called Cloud native computing, an approach to developing and running applications that fully use the power of the cloud because it takes advantage of many modern techniques, including PaaS,

microservices, agile methodology, containers, CI/CD, and DevOps. The public cloud platforms like AWS, Azure or Google Cloud provide additional tools to develop and run applications that will benefit from the cloud environment.

This new approach to developing and delivering applications brought a demand for new competencies required to build those applications. The knowledge of microservices architecture and the ability to work with containers, languages and tools adapted to this new architecture are some competencies (knowledge and skills) required to develop the current applications.

Organizations are considering developing and deploying applications on the cloud due to their benefits. Therefore, organizations are looking for competencies to help them in this process. However, some technologies are pretty new, and the labour market lacks competencies as the demand is growing. This creates a shortage of ICT professionals immediately prepared to work in organizations that want to embrace the new approaches for developing and deploying applications that use the best in the cloud.

In that case, it seems that recruitment based on an upskilling/reskilling strategy can be applied using the methodology presented. In the following sub-chapters, the methodology is applied in the context of a job role called the Cloud Native Application Developer.

Following the proposed methodology, the first step is to create the Competency Model for the Job role identified, setting up its objectives and benefits and the HR processes that should be applied. The Job role is globally detailed in terms of responsibilities, activities, and tasks. Figure 5.9 presents the Competency Model for Cloud Native Application Developers.

Competency Model								
Objectives	to recruit and develop people with competencies in the cloud, to build applications that follow the approach of cloud-native computing. A detailed competency model will help identify the required competencies and how the individual can progress in their proficiency level. Following this competence model, the candidates will be evaluated on how they can acquire and progress in the competencies required for the Job role. This competency model will provide a guidence to better recruit candidates that want to progress in the job role of Cloud Native Application Developer							
Job Family	Application Development							
Job Role	**Cloud Native Application Developer**							
	Interprets the customer needs, designs and develops applications for Cloud							
	Responsible for software development, responsible for documenting code and contributing to software design description, test procedures and user experience design. Can be responsible for selecting and advising the appropriate cloud solutions, optimising the applications developed and validating the results with users.							
	The main tasks in the cloud environment are application development, component integration, software testing and documentation. In the application run phase, the main tasks focus on resolving issues and documenting.							
HRM Process	Job Requisitions	Recruitment	Selection	Training	Appraisal	Career	Compensation	Reward
	(X)	(X)	(X)	(X)		(X)		(X)

Figure 5.9 - Competency Model for Cloud Native Application Developer

The job role competencies identify the knowledge and skills required. The Cloud Native Application Developer, in the context of this example, will be focused on the Amazon Web Services (AWS) platform, so the technical skills will be related to technologies and tools used in AWS.

In Figure 5.10, the Competency Model is updated for the job role in different levels of proficiency: Junior, Middle and Senior. This competency model will give the basis for assessment and the roadmap on how the individual can progress as Cloud Native Application Developer in AWS. A job role competency score (JRC) is calculated, which gives a reference of proficiency required to start working on that job role level.

Category	Sub-Category	Competency	Similar Skills	Cloud Native App Developer Junior — Proficiency Level	Mandatory	Weight	Assessment	Cloud Native App Developer Middle — Proficiency L	M	W	A	Cloud Native App Developer Senior — Proficiency L	M	W	A
Knowledge		Programming Logic		1	X	1,2	Q&A	2	X	1,2	Q&A	3	X	1,2	Q&A
		SOLID Concepts		1	X	1	Q&A	2	X	1	Q&A	3	X	1	Q&A
		Software Design Patterns		1		1	Coding Test	2		1	Coding Test	3		1	Coding Test
		Object Oriented Programing		1	X	1,1	Q&A	2	X	1,1	Q&A	3	X	1,2	Q&A
		SQL Databases		1	X	1,1	Q&A	2	X	1,2	Coding Test	3	X	1,2	Coding Test
		NoSQL Databases		0		0,5	Q&A	1		1	Q&A	2	X	1,2	Q&A
		Microservices		1		1,1	Q&A	2	X	1,2	Q&A	3	X	1,2	Q&A
		Event-Driven Programming		1		1	Q&A	2	X	1,2	Q&A	3	X	1,2	Q&A
		Systems Development Life Cycle (SDLC)		1		1	Q&A	2	X	1	Q&A	3	X	1	Q&A
Skills	Social	Coordination		0		1	Psychometric tests	2	X	1	Psychometric tests	3	X	1,2	Psychometric tests
		Mentoring		1		1	Psychometric tests	1		1	Psychometric tests	2	X	1,2	Psychometric tests
		Service orientation		2		1	Psychometric tests	2		1	Psychometric tests	3	X	1,2	Psychometric tests
	Technology	**Programming Languages**													
		Java 8+	Kotlin (70%); c++ (50%)	1	X	1,2	Coding Test	2	X	1,2	Coding Test	3	X	1,2	Coding Test
		Python		0		1	Coding Test	1		1,1	Coding Test	2		1,1	Coding Test
		HTML5		0		1	Coding Test	1		1	Coding Test	2		1	Coding Test
		CSS3		0		1	Coding Test	1		1	Coding Test	2		1	Coding Test
		Typescript	Javascript (60%)	1		1	Coding Test	1	X	1,1	Coding Test	2	X	1,1	Coding Test
		Frameworks													
		Spring Boot		1		1	Coding Test	2	X	1,1	Coding Test	3	X	1,2	Coding Test
		Continuous Integration / Delivery (CI/ CD)													
		AWS Codebuild	Jenkins (70%)	0		1	Q&A	1		1,1	Q&A	2	X	1,1	Q&A
		Git CI-CD		0		1	Q&A	1	X	1,1	Q&A	2	X	1,1	Q&A
		Containers and/or Serverless													
		AWS Elastic Container Service (ECS)	Docker (70%)	1		1,1	Q&A	1	X	1,1	Q&A	2	X	1,1	Q&A
		AWS ECS for Kubernetes (EKS)	Kubernetes (70%)	1		1	Q&A	1		1	Q&A	2	X	1,1	Q&A
		Databases													
		AWS DynamoDB	Mongo DB (70%)	0		1	Coding Test	1	X	1,1	Coding Test	2	X	1,1	Coding Test
		Oracle		1		1	Coding Test	2	X	1,1	Coding Test	3	X	1,1	Coding Test
		Scripting languages													
		Shell Script		0		1	Coding Test	1		1,1	Coding Test	2	X	1,1	Coding Test
		Message Queuing Service								1					
		AWS MQ	Kafka (70%	1		1	Q&A	2	X	1	Q&A	3	X	1,1	Q&A
		Other AWS Knowledge													
		EC2		0		1	Q&A	1	X	1,1	Q&A	2	X	1,1	Q&A
		VPC		0		1	Q&A	1		1,1	Q&A	2	X	1,1	Q&A
		Lambda		1		1	Q&A	2	X	1,1	Q&A	3	X	1,2	Q&A
	Language	English		2		1		2		1,1		3		1,2	
Job Role Competencies Score (JRC)				21,8				49,9				86,6			

Figure 5.10 - Job Role Competencies for Cloud Native App Developer

The job role is detailed by skills with the proficiency level expected for each and weighted considering its relevance with others. Some similar skills, related to technological skills, are identified as references to look up in the candidates, and an assessment method is proposed to be used in candidate evaluation. For instance, typescript has been identified as having 70% similarity with JavaScript. This means that a candidate with this skill will have a chance to progress better if he does not have the proficiency desired in typescript but has in JavaScript.

For each job role level, a score is calculated based on the proficiency level and the weight of the skill. In the previous example, a junior in the Cloud Native App Developer role is expected to score around 21,8, a middle 49,9 and a senior 86,6. A candidate with a score near the one identified will be associated with this level of the job role as a starting point.

Additionally, the Learning Competencies are identified to effectively measure candidates' potential to succeed in upskilling/reskilling. Figure 5.11 describes, for each level of proficiency, the cognitive abilities, learning skills and personal traits that will improve the individual to progress in acquiring the job role competencies. The level of proficiency of cognitive abilities and learning skills may vary according to the job role competencies required to perform the job role effectively.

A score is calculated for each job role proficiency level. In the present example, the Cloud Native App Developer candidates should demonstrate great competency to learn in case the score for cognitive abilities achieve 7 for a Junior, 11 for a Middle and 14 for a Senior. In the same way, the

learning skills should achieve 11 for a junior, 14 for a Middle and 20 for a Senior. Also relevant are the evaluation of candidates with dominant personality traits who should position on "Openness" or "Conscientiousness".

Category	Sub-Category	Competency	Cloud Native App Developer Junior		Cloud Native App Developer Middle		Cloud Native App Developer Senior	
			Proficiency		Proficiency		Proficiency	
			Level	Assessment	L	A	L	A
Abilities	**Cognitive**	Attentiveness	2	Psychometric Tests	3	Psychometric Tests	3	Psychometric Tests
		Reasoning Abilities	1	Psychometric Tests	2	Psychometric Tests	3	Psychometric Tests
		Memory	2	Psychometric Tests	2	Psychometric Tests	3	Psychometric Tests
		Quantitative Abilities	1	Psychometric Tests	2	Psychometric Tests	2	Psychometric Tests
		Verbal Abilities	1	Psychometric Tests	2	Psychometric Tests	3	Psychometric Tests
Skills	**Learning**	Active Learning	1	Q&A	2	Q&A	3	Q&A
		Critical Thinking	1	(W-GCTA)	2	(W-GCTA)	2	(W-GCTA)
		Learning Strategies	1	Q&A	2	Q&A	3	Q&A
		Monitoring learning	2	Q&A	2	Q&A	3	Q&A
		Active Listening	2	Q&A	2	Q&A	3	Q&A
		Time Management	2	Q&A	2	Q&A	3	Q&A
		Reading Comprehension	2	Psychometric Tests	2	Psychometric Tests	3	Psychometric Tests
Enabling Behaviours	**Personal Traits (Dimensions)**	Conscientiousness	2	Big Five Test	3	Big Five Test	3	Big Five Test
		Extraversion	3	Big Five Test	3	Big Five Test	3	Big Five Test
		Neuroticism	2	Big Five Test	2	Big Five Test	2	Big Five Test
		Agreeableness	2	Big Five Test	2	Big Five Test	2	Big Five Test
		Openness	1	Big Five Test	1	Big Five Test	1	Big Five Test

(Left vertical label: **Learning Competencies**)

Cognitive Abilities Score	**7,0**	**11,0**	**14,0**
Learning Skills Score	**11,0**	**14,0**	**20,0**
Dominant Personality Trait	**Openness/Conscientiousness**		

Figure 5.11 - Learning Competencies required to progress in the Cloud Native App Dev role

Once the competency model is defined, it can be applied to assess candidates. In our example, the objective is to evaluate candidates who demonstrate the potential to evolve gradually in the Cloud Native Application Developer role based on their current competencies and learning skills.

Category	Sub-Category	Competency	Similar Skills		Assessment L[a]	Assessment L[s]	Assessment Type	Date of last assessment	Junior L[r]	Junior L[a]	Junior M	Junior W	Junior Gap	Junior Rel. of L[s]	Middle L[r]	Middle L[a]	Middle M	Middle W	Middle Gap	Middle Rel. of L[s]	Senior L[r]	Senior L[a]	Senior M	Senior W	Senior Gap	Senior Rel. of L[s]
Job Role Competencies — Knowledge		Programming Logic			2		Coding Test	01-07-2022	1	2	X	1,2			2	2	X	1,2			3	2	X	1,2	-1	
		SOLID Concepts			1		Q&A	01-07-2022	1	1	X	1			2	1	X	1	-1		3	1	X	1	-2	
		Software Design Patterns					Q&A	01-07-2022	1			1	-1		2			1	-2		3		X	1	-3	
		Object Oriented Programing			1		Coding Test	01-07-2022	1	1	X	1,1			2	1	X	1,1	-1,1		3	1	X	1,2	-2	
		SQL Databases			1		Q&A	01-07-2022	1	1	X	1,1			2	1	X	1,2	-1,2		3	1	X	1,2	-2	
		NoSQL Databases					Q&A	01-07-2022				0,5			1			1	-1		2		X	1,2	-2	
		Microservices					Coding Test					1,1	-1,1		2		X	1,2	-2,4		3		X	1,2	-3	
		Event Driven Programming					Q&A	01-07-2022	1			1	-1		2		X	1,2	-2,4		3		X	1,2	-3	
		Systems Development Life Cycle (SDLC)			1		Q&A	01-07-2022	1	1		1			2	1	X	1	-1		3	1	X	1,2	-2	
Skills	Social	Coordination					Q&A	01-07-2022				1			2		X	1	-2		3		X	1,2	-3	
		Mentoring			1		Q&A	01-07-2022	1	1		1			1	1		1			2	1	X	1,2	-1	
		Service orientation			1		Q&A	01-07-2022	2	1		1	-1		1	1		1	-1		3	1	X	1,2	-2	
	Technology	**Programming Languages**																								
		Java 8+	c++	50%	1	1	Coding Test	01-07-2022	1	1	X	1,2		FALSE	2	1	X	1,2	-1,2	FALSE	3	1	X	1,2	-2	FALSE
		Python				1	Coding Test	01-07-2022		1		1			1	1		1,1			2	1		1,1	-1	
		HTML5				1	Coding Test	01-07-2022		1		1			1	1		1			2	1		1	-1	
		CSS3				1	Coding Test	01-07-2022		1		1			1	1		1			2	1		1	-1	
		Typescript	javascript	70%		1	Coding Test	01-07-2022	1		X	1	-1	TRUE	1		X	1,1	-1,1	TRUE	2		X	1,1	-2	FALSE
		Frameworks																								
		Spring Boot					Coding Test	05-09-2022	1			1	-1		2		X	1,1	-2,2		3		X	1,2	-3	
		Continuous Integration / Delivery (CI/CD)																								
		AWS Codebuild	Jenkins	70%			Q&A	05-09-2022	1			1		FALSE	1			1,1	-1,1	FALSE	2		X	1,1	-2	FALSE
		Git CI-CD							1			1			1		X	1,1	-1,1		2		X	1,1	-2	
		Containers and/or Serverless																								
		AWS Elastic Container Service (ECS)			1	1	Q&A	06-09-2022	1	1		1,1			1	1	X	1,1	-1		2	1	X	1,1	-1	
		AWS ECS for Kubernetes (EKS)			1		Q&A	06-09-2022	1	1		1			1	1		1			2	1	X	1,1	-1	
		Databases																								
		AWS DynamoDB			1		Q&A	01-07-2022		1		1			1	1	X	1,1			2	1	X	1,1	-1	
		Oracle			1		Q&A	05-09-2022	1	1		1			2	1	X	1,1	-1,1		3	1	X	1,1	-2	
		Scripting languages																								
		Shell Script					Coding Test	05-09-2022				1			1			1,1	-1,1		2		X	1,1	-2	
		Message Queuing Service																								
		AWS MQ					Q&A	07-09-2022	1			1	-1		2		X	1	-2		3		X	1,1	-3	
		Other AWS Knowledge																								
		EC2					Q&A	07-09-2022				1			1		X	1,1	-1,1		2		X	1,1	-2	
		VPC										1			1			1,1	-1,1		2		X	1,1	-2	
		Lambda					Coding Test	07-09-2022	1			1	-1		2		X	1,1	-2,2		3		X	1,2	-3	
	Language	English			1		Test	01-07-2022	2			1	-1		2	1		1,1	-1,1		3	1		1,2	-2	

	L[r]	L[a]		Gap			
Job Role Competencies Score (JRC)	21,8	16,9		-4,9	49,9	18,4	-31,5
Job Role Skills Gap			-9,1	-31,5			
Nr of Missing Skills in the Job Role							

(Senior JRC: 86,6 / 19,3 / -86,6; Senior Job Role Skills Gap: -59,0)

Figure 5.12 - Cloud Native App Developer Assessment

The assessment of candidates is based on the Competency model defined for Cloud Native App Developers, as presented in Figure 5.12. In the example presented, the knowledge and skills of a candidate are assessed and compared with the proficiency expected in the different job roles of Junior, middle and senior. The job role competencies score (JRC) is calculated for the competencies assessed and compared with the JRC of each job role proficiency level: junior, middle, and senior. The lowest difference found in these three levels will define at which level the candidate should be positioned. The JRC requested scores of 21,8, and JRC assessed scores of 16,9 for a junior job role, so the difference is -4,9, the lowest difference when compared with other job roles, like middle and senior. Following that evaluation, the candidate is positioned as of Junior Cloud Native App Developer.

After this first evaluation, the next step is understanding the job role skills gap. As a junior Cloud Native App Developer, the candidate has a gap of -9,1 in proficiency expected for the job role. This means that candidate needs an upskilling plan to achieve the requested level of proficiency as a junior. The gap needs to be evaluated in detail to understand the effort required to progress. Each competency with a gap is evaluated to see if it is mandatory and what the weight is related to the other competencies. As junior, the candidate has gap on Software Design Patterns (-1), Microservices (-1,1), Event-Driven Programming (-1), Service Orientation (-1), typescript (-1), spring boot (-1), AWS MQ(-1), AWS lambda (-1) and English (-1). Excluding Microservices, all other competencies have the same weight as others.

The similarity skills can now be evaluated to see the potential. The typescript is 70% similar to JavaScript, based on expert analysis. This similarity is relevant for the candidate evaluation because having an equivalent level of proficiency in JavaScript, the gap can be reduced due to an upskilling for

typescript easier and faster. In that case, the skill is marked as TRUE in the column, "Rel. for L[s]", which means the assessment of similar skill JavaScript, is relevant to evaluate the progress of the target skill TypeScript.

Another necessary evaluation is to identify gaps in the skills with a mandatory level of proficiency requested and with different weights. In the example presented, we can identify a gap in the microservices knowledge, which has more weight among other skills. This skill should have more attention during the upskilling plan.

The learning competencies of the candidate are also evaluated, as presented in Figure 5.13. In the example, the Junior Cloud Native Developer candidate has a gap of -1,0 in cognitive abilities score and -2,0 in learning skills score. This evaluation is almost aligned with a candidate that demonstrates good learning competencies not so far from the scores requested for a Junior. Additionally, his dominant personality trait is Openness, one of the personality traits more open to learning and progress. The assessment of the candidate's learning competencies demonstrates his ability to progress in an upskilling program that will fit the gaps already identified in the job role competencies.

			Assessment			Junior Cloud Native App Developer — Junior Proficiency Level						Middle Cloud Native App Developer — Middle Proficiency Level						Senior Cloud Native App Developer — Senior Proficiency Level					
Category	Sub-Category	Competency	L[a]	Assessment Type	Date of last assessment	L[r]	L[a]	M	W	Gap	Rel. of L[s]	L[r]	L[a]	M	W	Gap	Rel. of L[s]	L[r]	L[a]	M	W	Gap	Rel. of L[s]
Abilities	Cognitive	Attentiveness	1	Psychometric Tests	01-07-2022	2	1			-1		3	1			-2		3	1			-2	
		Reasoning Abilities	2	Psychometric Tests	01-07-2022	1	2					2	2					3	2			-1	
		Memory	2	Psychometric Tests	01-07-2022	2	2					2	2					3	2			-1	
		Quantitative Abilities	1	Psychometric Tests	01-07-2022	1	1					2	1			-1		2	1			-1	
		Verbal Abilities	1	Psychometric Tests	01-07-2022	1	1					2	1			-1		3	1			-2	
Skills	Learning	Active Learning	1	Interview	01-07-2022	1	1					2	1			-1		3	1			-2	
		Critical Thinking	1	(W-GCTA)	01-07-2022	1	1					2	1			-1		2	1			-1	
		Learning Strategies	1	Interview	01-07-2022	1	1					2	1			-1		3	1			-2	
		Monitoring learning	1	Interview	01-07-2022	2	1			-1		2	1			-1		3	1			-2	
		Active Listening	2	Interview	01-07-2022	2	2					2	2					3	2			-1	
		Time Management	1	Interview	01-07-2022	2	1			-1		2	1			-1		3	1			-2	
		Reading Comprehension	2	Psychometric Tests	01-07-2022	2	2					2	2					3	2			-1	
Enabling Behaviours	Personal Traits (Dimensions)	Conscientiousness	3	Big Five Test	01-07-2022	3	3					3	3					3	3				
		Openness	3	Big Five Test	01-07-2022	2	3					2	3					2	3				
		Extraversion	2	Big Five Test	01-07-2022	1	2					1	2					1	2				
		Agreeableness	2	Big Five Test	01-07-2022	2	2					2	2					2	2				
		Neuroticism	1	Big Five Test	01-07-2022	3	1					3	1					3	1				
		Cognitive Abilities Score	7,0			7,0				-1,0		11,0				-4,0		14,0				-7,0	
		Learning Skills Score	9,0			11,0				-2,0		14,0				-5,0		20,0				-11,0	
		Dominant Personality Trait	Openness																				

Figure 5.13 - Assessment of Candidate Learning Competencies

Based on the previous job role competency assessment, nine skills/knowledge with a missing proficiency level were identified that need a qualification plan that leverages the candidate to the desired proficiency level to perform effectively as a Junior Cloud Native App Developer.

As described in Figure 5.14, training is defined for each missing target level, and a date for a new assessment is planned to verify the achievement. For example, AWS lambda is a skill requested with proficiency level 1; however, the candidate doesn't have this skill, and the proficiency is 0. A training plan X2 is planned to achieve level 1 in 3 months. A new assessment date is scheduled for 06-12-2022.

Besides the missing target level, it is also possible to start learning on the next target level. In the example presented here, the candidate has demonstrated good proficiency in programming logic (Level=2), more than requested for a junior (level=1); this means that candidate can progress well in

this competency, so he will be encouraged to start learning for the next level (level = 3). This way, the candidate has a clear vision of progressing as a Cloud Native App Developer.

					Junior Cloud Native App Developer											
					Junior Proficiency Level						**Upskilling**					
Category	**Sub-Category**	**Competency**	**Similar Skills**		L[r]	L[a]	M	W	Gap	Rel. of L[s]	Missing Target Level	Next Target Level	Training	Duration (months)	Next Assessment Date
Knowledge		Programming Logic			1	2	X	1,2				3			
		SOLID Concepts			1	1	X	1				2			
		Software Design Patterns			1			1	-1		1		K3	6	28-12-2022
		Object Oriented Programing			1	1	X	1,1				2			
		SQL Databases			1	1	X	1,1				2			
		NoSQL Databases						0,5				1			
		Microservices			1			1,1	-1,1		1		K1	3	29-09-2022
		Event-Driven Programming			1			1	-1		1		K2	3	29-09-2022
		Systems Development Life Cycle (SDLC)			1	1		1				2			
Skills	Social	Coordination						1				2			
		Mentoring			1	1		1				2			
		Service orientation			2	1		1	-1		2		S1	6	28-12-2022
	Technology	**Programming Languages**													
		Java 8+	c++	50%	1	1	X	1,2		FALSE		2			
		Python				1		1				2			
		HTML5				1		1				2			
		CSS3				1		1				2			
		Typescript	javascript	70%	1			1	-1	TRUE	1		T1	3	29-09-2022
		Frameworks													
		Spring Boot			1			1	-1		1		T2	3	04-12-2022
		Continuous Integration / Delivery (CI/ CD)													
		AWS Codebuild	Jenkins	70%				1		FALSE		1			
		Git CI-CD						1				1			
		Containers and/or Serverless													
		AWS Elastic Contanier Service (ECS)			1	1		1,1				2			
		AWS ECS for Kubernetes (EKS)			1	1		1				2			
		Databases													
		AWS DynamoDB				1		1				2			
		Oracle			1	1		1				2			
		Scripting languages													
		Shell Script						1				1			
		Message Queuing Service													
		AWS MQ			1			1	-1		1		X1	3	06-12-2022
		Other AWS Knowledge													
		EC2						1				1			
		VPC						1				1			
		Lambda			1			1	-1		1		X2	3	06-12-2022
	Language	English			2			1	-1		2		L1	3	29-09-2022

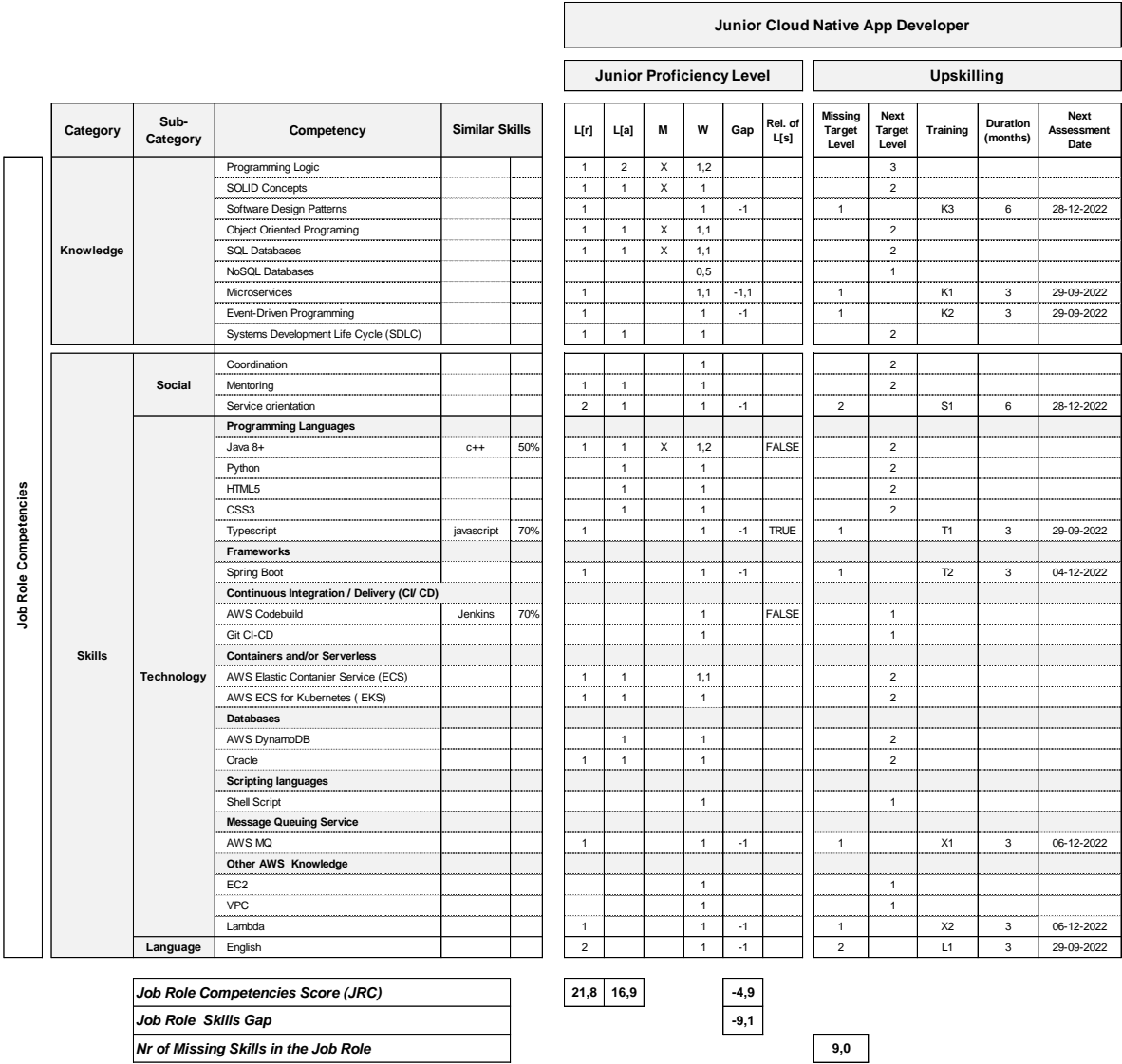|	L[r]	L[a]	Gap
Job Role Competencies Score (JRC)	21,8	16,9	-4,9
Job Role Skills Gap			-9,1
Nr of Missing Skills in the Job Role		9,0	

Figure 5.14 - Upskilling Planning

Applying the proposed methodology, the candidate in the previous example has demonstrated good signals to perform effectively as Junior Cloud Native App Developer. Although the candidate does not have all the skills/knowledge to perform immediately at the target proficiency levels required, the gaps identified can be eliminated through an upskilling plan with minimum effort, in the short term and with a small investment. The decision to recruit this candidate will be acceptable considering the foundation provided by the methodology that minimizes the risks in hiring a candidate that only partially fits all competencies required to perform the job role.

5.4. VALIDATION & DISCUSSION

The current methodology has been presented to a group of individuals responsible for HR processes and project implementation in the technology sector. Their opinions have been collected and used to refine and improve the methodology. The following interviewees were invited:

- 1 Managing Director
- 2 HR Directors
- 1 Recruitment Director
- 1 Advanced Architect

In a 30-minute interview, a brief presentation was used to present the problem statement and explain the methodology, and then four questions were raised to obtain their comments on the methodology proposed; the questions were:

1) Do you consider the recruitment methodology helpful? Please explain why or why not.
2) Would you like to comment on the methodology proposed?
3) Would you consider implementing this methodology in the recruitment process? Please explain why or why not.
4) Do you have any suggestions for additional improvements to the proposed methodology?

Based on the interviews' results, it was perceived the relevance of the methodology for recruitment considering the present context of the shortage of ICT Skills in the market. The most relevant answers and comments have been highlighted in Table 5.9.

Resuming the analysis of the answers to the questions, it is possible to verify that there is unanimity in citing the proposed methodology as applicable and that most interviewees consider implementing it. Some relevant comments reinforce the usefulness of the methodology, such as:

- it helps to reduce the uncertainty of the investment in upskilling
- it reinforces the upskilling as an investment to develop skills that are scarce in the market
- it explores the potential of candidates in terms of their interpersonal skills and existing skills
- it helps to have a mapping of competencies as people are constantly learning and evolving
- it allows understanding the candidate's skills and assessing how they can evolve
- it allows a more conscious and impartial assessment of people

However, additional challenging aspects have been raised:

- it could be challenging to implement the methodology due to the complexity
- to keep the model up to date with the evolution of individual competencies could be difficult
- implementing the methodology without some automatization could be complex
- considering the accelerating pace at which organizations are moving, implementing such a methodology could be challenging

Some additional recommendations can be considered in the methodology implementation:

- support the methodology with preloaded information
- use assessment of new skills acquired as input for the annual appraisal process
- use an information system to simplify the implementation of a methodology

– having a previous competency mapping of the organization to be used as a reference

The comments and recommendations obtained from interviews have provided good insights about the methodology. It seems that methodology can be challenging to implement due to the complexity regarding detailed information about the competencies required and the effort to make the necessary assessments. Additionally, maintaining the competency model up to date can be difficult because it requires some discipline from the employee and HR in charge to ensure that training is followed and the assessments are done according to the plan and, of course, have the results updated in the competency model, as well.

In order to limit the complexity of the methodology and, to increment the success of its utilization, it is recommended to automatize the processes to make them easy to use. For instance, a particular type of assessment can be suggested for a specific skill, and, if possible, some tests or scripts can be immediately available to be used. The same approach can be used for the training plan, suggesting the type of training to achieve the proficiency desired in a specific skill.

Implementing this methodology without an information system to support it would be arduous. Considering the difficulties already mentioned and the need to use some automatic procedures, it seems the use of methodology supported by an information system will be the key to ensuring its acceptance and correct utilization.

This methodology can also benefit from preloaded information. For instance, some job roles are already identified by the organization, so they can be used as references for creating new ones.

	Do you consider the recruitment methodology helpful? Please explain why or why not.	Would you like to comment on the methodology proposed?	Would you consider implementing this methodology in the recruitment process? Please explain why or why not.	Do you have any suggestions for additional improvements to the proposed methodology?
MANAGING DIRECTOR	Yes, considering the scarcity of competencies in the market, upskilling must be an investment between companies, governments, and people. Digital technologies changed, and individuals' competencies need to be adapted or converted. The methodology proposed based on the assessment and definition of an upskilling plan is essential for all industries.	The challenge may be how to keep the competency model alive, that is, how to update employees' competencies regularly. It is not enough to carry out the initial assessment of competencies but to create a process to keep the model up to date with the evolution of individual competencies.	We have already implemented a similar model based on embedded software competencies, but not in the recruitment phase. Only after the integration does the employee take a test to assess and map their competencies to develop an evolution plan. We want to expand to other areas of competence, but it requires a significant investment effort.	Align the assessment of new skills acquired as input for the annual appraisal process.
HR DIRECTOR (1)	Yes, all methodologies that make it possible to understand whether the investment in a future employee will have a return are important. Recruitment has changed, and the need for competent resources is much more urgent. Organizations do not hire for candidates' potential but for	The methodology allows having an exempt view, excluding, for instance, gender issues and social behaviours. It allows a more conscious and impartial assessment of people.	It already implements a similar methodology, in particular for the need to complement functional skills in candidates, in particular, more structured in the post-onboarding process	The time variable for progress is important. The time required for upskilling is essential for making or not the investment in the candidate. The tools to support the methodology with preloaded information are recommended.

	Do you consider the recruitment methodology helpful? Please explain why or why not.	Would you like to comment on the methodology proposed?	Would you consider implementing this methodology in the recruitment process? Please explain why or why not.	Do you have any suggestions for additional improvements to the proposed methodology?
	their ability to deliver much faster.			The methodology must be an integral part of the employee evaluation and development processes.
HR DIRECTOR (2)	Yes. The concept and principle of the methodology are useful because it explores the potential of candidates in terms of their interpersonal skills to evolve in the organization	It seems complex to elaborate on the competency model. It could be challenging to implement the methodology considering the accelerating pace at which organizations are moving	Consider implementing a simpler version, focusing on assessing behavioural skills and personal traits that are more adapted to the functions to perform.	Suggest moving for "insights discover" instead of the "big five" approach for personality assessment. Use of information systems to simplify the use of the methodology.
HR RECRUITMENT DIRECTOR	Yes, it is useful from a technical and behavioural point of view. People are constantly learning and evolving, so it is essential to have a mapping of competencies. Upskilling and reskilling are solutions for companies, considering the shortage of profiles.	How to automate the methodology, in particular the assessment procedure. The behaviour assessment is the most complex, and the idea is to create an automatic process to help the use of the methodology	Yes, will consider it; however, automatization is very important to avoid subjective or biased evaluation. It is essential to use objective criteria.	To have a previous competency mapping of the organization to be used as a reference. For instance, the competencies of the top performers in the organization can be used to build the competency model.
ADV. ARCHITECT	Yes, it is helpful as it allows understanding the candidate's skills and assessing how they can evolve.	It would be interesting to see how the methodology would approach a reconversion of competencies when the level of similarity is low between the	Applying for recruitment can be difficult because there is much hiring for a specific vacancy, not to bet on the candidate's potential.	This methodology can be more easily applied to upskilling a current employee. It may be a risk to apply to candidates.

	Do you consider the recruitment methodology helpful? Please explain why or why not.	Would you like to comment on the methodology proposed?	Would you consider implementing this methodology in the recruitment process? Please explain why or why not.	Do you have any suggestions for additional improvements to the proposed methodology?
	Identifying and assessing competencies similar to those needed will also allow an understanding of how to reduce the learning curve.	candidate's skills and those necessary to achieve		The learning skills should have greater weight in the candidate assessment. Some skills should also have more significant weight (e.g. skills in algorithms when we talk about programmers)

Table 5.9 - Answers to Interview questions

6. CONCLUSIONS

6.1. SYNTHESIS OF THE DEVELOPED WORK

Organizations increasingly seek to transform their services and business models, incorporating new digital technologies into their processes. Technology has evolved in response to this challenge, leading organizations to digital transformation. Digitally skilled workers and highly skilled digital ICT professionals are essential to embracing digital transformation, and demand is increasing. On the other hand, some technologies are pretty new, and the labour market doesn't have competencies available as the demand is growing. This creates a shortage of ICT professionals immediately prepared to work in organizations.

It is essential to follow a new way of sourcing, screening, and validating candidates focused on analyzing their capacity to acquire a new technological competency, taking advantage of their current technical and interpersonal skills. In that way, the following research question has been raised: how do we identify the best candidates that fit in terms of learning and technical skills that leverage their capacity to acquire new technical skills quickly and with success.

To answer this research question, a methodology for recruitment has been developed that allows a selection of candidates without exactly the skills at the proficiency level required for the job role and evaluates them in their capacity to progress to achieve the proficiency required through an ongoing upskilling/reskilling program.

A recruitment methodology was developed based on identifying the knowledge and skills required of candidates to effectively perform the role, discovering their current skills similar to target skills, and assessing their learning competencies such as cognitive abilities, learning skills and personal traits. The methodology is based on the premise that the correct assessment of the candidates' skills and ability to learn will increase the chances of finding candidates that will succeed in an upskilling/reskilling program.

The methodology proposed is defined in 6 steps. Firstly, a Competency Model is created with the knowledge and skills needed by the job role identified. This phase is essential as it details the job role by competencies needed now and in the future at different proficiency levels. The competency model is enriched with learning competencies and similar skills that can leverage the candidate to succeed in upskilling/reskilling program.

The next step is assessing candidate competencies based on the competency model previously defined. The candidate's potential, namely learning skills, cognitive abilities, and personal traits that enhance learning new skills, are also evaluated. The similar skills the candidates may have are also assessed and considered insights into their potential.

In the third step, the candidate's competencies gaps are identified, and an overall competency score is calculated to define the candidate's job role proficiency level ranking. The candidate gaps between competencies required to perform the job role in the specified proficiency level effectively are the starting points for the decision to hire and apply for an upskilling/reskilling program. The decision to select a candidate is taken considering the gaps identified and the potential of a candidate to achieve the target level of proficiency based on the insights gathered from learning competencies

and proficiency in similar skills. Applying this methodology minimizes the risk of hiring a candidate who does not have all the skills required in the proficiency level requested but demonstrates a capacity to leverage his competencies to achieve the desired level.

Considering the decision to hire, an upskilling/reskilling program is defined for the future employee, who will have a clear vision of how to progress to achieve the proficiency level desired in the skills where there is a gap. In the fourth step, the upskilling/reskilling program is set up with the missing target proficiency level, the next target level, the training/action required to progress for the next level, the duration planned and the subsequent assessment date to evaluate the proficiency achieved.

The skills are continually reassessed in an ongoing process that improves their proficiency. Recruitment based on upskilling/reskilling strategy assumes that candidates may not have all the required competencies. They must integrate a continuous learning process to fill the gaps in existing skills and acquire new ones to perform the job role effectively.

Finally, in the sixth step, the employee is rewarded for the success achieved, which encourages him to move on to continuous learning. The reward plan promotes the employee's willingness to progress in skills proficiency and acquire new ones.

The recruitment methodology based on the reskilling and upskilling strategy described here seems to be a structured method. It can help to identify candidates without the exact skills required or proficiency desired, but with good learning competencies and other similar skills have a potential to succeed in an upskilling/reskilling that leverages their competencies to the level of proficiency expected. In that way, implementing this methodology may solve the shortage of ICT skills once it increases the opportunity for more candidates to be selected and gain the required skills.

6.2. LIMITATIONS

The analysis of the methodology's success is limited to a long-time frame for candidates' performance evaluation. Verifying the methodology results takes a long time, as the candidates, after being selected, need to follow a training and evolution process until achieving the proficiency expected.

The methodology requires well-defined competency models and several assessments to verify the candidates' proficiency. The time spent in the recruitment phase can be longer than a standard process based on simple interviews, which may be a limitation for adopting the methodology.

In the presented methodology, the similarity between the skills is determined by the evaluation of an expert opinion. While this approach is valid, a personal judgment can make the analysis of the similarity between skills subjective.

This methodology does not explore other interpersonal skills like social skills or external factors that can influence the ability to learn. Cognitive abilities, learning skills and personal traits have been chosen as good predictors of a candidate's capacity to evolve in new skills; however other interpersonal skills may also influence the acquisition and leverage of new skills.

The definition of proficiency levels has not been explored in the methodology. The proficiency levels can vary considering the skill in analysis and detailed accordingly. For simplicity, our methodology only mentions four proficiency levels and has no distinction between different skills.

6.3. FUTURE WORK

Applying this methodology can be complex; an information system will be essential to manage the entire process since the job role definition and competencies are required until the assessment and upskilling/reskilling plan definition. One possible future work is to define an architecture for an information system that can support the methodology.

Building a similarity skills ontology based on computing analysis could be another opportunity to leverage the methodology presented here. The similarity between skills is an essential predictor of success in moving for a target skill. As explored in the literature review, there are several ways to create a correlation between skills and use it to evaluate the propensity of one skill to be used as a factor of success to achieve the proficiency desired in a target skill. Future work can be to create models that identify similar skills more accurately.

Based on the competencies acquired, the employees can be proposed for a different job roles. The methodology can explore the opportunities inside organizations evaluating the competency mapping of their employees and offering them another job role instead of looking up candidates outside the organization. It will be interesting to explore how to match employees' competencies with those required for other job roles in future work.

This methodology mainly focuses on assessing candidates' competencies to perform the role effectively and the similar interpersonal skills they have that leverage the ability to achieve the expected proficiency. Other factors were left out of this analysis on purpose. This methodology aims to avoid biased references, such as academic background and years of experience, which could make an assessment not exempt and limit the number of candidates. In future work, these factors can be included in the methodology and evaluated if they are relevant to the achievements.

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