The Use of Advanced Technology in Job Matching Platforms: Recent Examples from Public Agencies

MAY 2023

S4YE SOLUTIONS FOR YOUTH EMPLOYMENT

JOBS

The Use of Advanced Technology in Job Matching Platforms: Recent Examples from Public Agencies

KEY MESSAGES

- *Despite proliferation of online job portals, obtaining the right kind of information remains a challenge for both job-seekers and employers.*
- *Job matching platforms aim to respond to these challenges – they go beyond just listing or aggregating jobs, and use more advanced technology to match job-seekers and employers in a more targeted and meaningful way.*
- *Sophisticated technology like artificial intelligence and big data facilitate this shift by providing a bi-directional best-fit match between job-seekers and employers.*
- *The shift from simply collecting information about a job-seeker's formal qualifications and work experience to a more holistic approach that looks at skill-based profiling and matching underpins the use of job-matching platforms.*
- *The private sector is the creator of jobs and hence as potential employers, their role and participation in the design of job-matching platforms is important to ensure that the platform is meeting their hiring needs. Moreover, governments also turn to technology companies for technical support in the design of these platforms.*

This report is part of the Solutions for Youth Employment (S4YE)[1] Knowledge brief series and highlights examples of job matching platforms used by public agencies that use advanced technology to match job-seekers and employers. It identifies key trends in the technical features, deployment and implementation of job-matching platforms, and is targeted to practitioners looking to understand the practical implications of adopting technology-driven employment solutions. Most examples discussed in the report are from advanced countries as they could provide rich insights for developing countries embarking on this approach. The research methodology used in this report is a combination of desk review and focused interviews with focal points involved in the design and roll-out of the job-matching platforms.

[1] Solutions for Youth Employment (S4YE) is a multi-stakeholder coalition that aims to provide leadership and resources for catalytic action to increase the number of young people engaged in productive work. The S4YE Secretariat is housed in the Jobs Group within the Social protection and Jobs Global Practice at the World Bank. The production and publication of this report has been made possible through a grant from the World Bank's Jobs Umbrella Multidonor Trust Fund (MDTF), which is supported by the Department for International Development/UK AID, the Governments of Norway, Germany,
Austria, the Austrian Development Agency, Italy, and the Swedish International Development Cooperation Agency.

1. INTRODUCTION

Rapid changes in the labor market have also changed the way the young people find work. The economic framework used to explain the process of finding a job is based on the 'search and matching model' created by economists Dale Mortensen and Kenneth Burdett. In his nobel prize winning paper, Mortensen says that 'finding an acceptable job is the outcome of an information gathering process', and that 'worker-job matching takes time as a consequence of information frictions'.[2] Matching job-seekers with the right employer requires information about both parties – which often tends to be imperfect and expensive.[3] This information asymmetry is particularly challenging for youth who lack social capital and networks, who may find themselves excluded from job opportunities that aren't openly advertised.

Despite proliferation of online job portals, obtaining the right kind of information remains a challenge for job-seekers and employers. Over the last 20 years, there has been a proliferation of online job portals, that have made it easier and cheaper for both recruiters and job-seekers to find information about jobs. However, despite the burst of information, the response rate on large job boards is low and employers have reported receiving a high volume of low quality applicants that apply through online searches.[4] A lot of online websites simply list job openings or aggregate job openings from various websites, that makes it difficult for both employers and job seekers to sift out the useful matches from 'noise'. Job matching platforms aim to respond to these challenges – they go beyond just listing or aggregating jobs, and use more advanced technology to match job-seekers and employers in a more targeted and meaningful way.

For long, the private sector has been far ahead of the public sector in creating and adopting technology innovations in employment services. Private sector companies are partnering with technology start-ups to use cutting edge technologies to improve their recruitment processes. For example, companies like Unilever and JP Morgan are using the games-based platform Pymetrics[5] to hire entry-level employees using neuroscience-based games to measure inherent traits.[6] (See Box 1)

Recently, there has been an increase in public sector initiatives that use AI-based job matching platforms in their employment services. For example, various countries in Europe, Australia, and Canada use fairly sophisticated job matching platforms in their public employment service. Most examples highlighted in this report are from developed countries, however there is a growing interest in developing countries to adopt a similar approach. More recently, the Ministry of Labor in Paraguay collaborated with the Swiss-based tech firm Janzz technology to launch 'Para Empleo[7]' – a job matching platform that uses Artificial Intelligence and Deep Learning Algorithms to analyze occupation and employment data along

[2] Markets With Search Friction And The DMP Model , Dale.T Mortensen Northwestern University and Aarhus University https://www.nobelprize.org/uploads/2018/06/mortensen-lecture.pdf
[3] Finding a Job in the Internet Age, Christine Fountain University of Washington https://www.jstor.org/stable/3598276?seq=1#metadata_info_tab_contents
[4] Online Labor Exchanges and Advanced Job Matching, Real Time Talent http://www.realtimetalent.org/wp-content/uploads/2016/09/RTT_2016_August_MN_OnlineLaborExchange_Special.pdf
[5] https://www.pymetrics.com/employers/
[6] https://www.businessinsider.com/unilever-artificial-intelligence-hiring-process-2017-6
[7] https://paraempleo.mtess.gov.py/en/

with social skills, education, experience, time and geographical availability to match job seekers with employers. [8] Various other countries like Mexico, Chile, Barbados are in the process of developing one.

Box 1: How Unilever is using neuroscience-based games to recruit candidates

Overview: Unilever, one of the world's leading consumer goods company, partnered with Pymetrics, a talent matching platform, to screen candidates using cognitive neuroscience and predictive machine learning technology. This was part of their overall strategy to digitize the first steps of the recruitment process.

Key features:

- Candidates find the job posting either on the Unilever website or other social media platforms, where a link to the screening games is provided. At this stage, candidates are not required to upload a CV.
- Candidates play 12 games for a duration of 20 minutes that test their memory, aptitude, attention and learning style. The candidate's performance is compared with the performance of other employees in the organization, whose results are used as a benchmark to determine is a new candidate is a good fit.
- The results are immediately shared and the candidate is notified if they have advanced to the next round. For those who haven't, the Pymetrics algorithm directs them to other companies that might be a better fit.
- Shortlisted candidates advance to a virtual interview via another platform that records their responses to pre-determined automated questions. The technology analyzes their body-language, speaking styles and keywords and makes notes for the hiring manager to consider.
- After the 2-step digital screening process, an in-person interview is conducted before the final decision.

Results: According to Unilever, the average time for a candidate to be hired decreased from four months to four weeks, and the spent reviewing applications decreased by 75%.

Source: https://www.businessinsider.com/unilever-artificial-intelligence-hiring-process-2017-6

1.1 WHAT IS A JOB MATCHING PLATFORM?

There is no standard nomenclature for advanced job-matching platforms. Different reports and organizations use different terminologies when referring to job-matching platforms (see Table 1 in appendix)**.** A key feature of job-matching platforms is their ability to use advanced technology to match job seekers with job opportunities using more nuanced parameters beyond key word matching from their CVs. For the purpose of this note, advanced technology refers to the application of Artificial Intelligence (AI) in job matching.

[8] https://www.iadb.org/es/mejorandovidas/algoritmos-que-te-consiguen-empleo-en-paraguay

A useful way of classifying online job portals is on the basis of their functionalities. Usually, 'job platform' is used as an umbrella term while referring to online job portals. The Minnesota Department of Employment and Economic Development and RealTime Talent in their 2016 report on 'Online Labor Exchanges' provide some useful definitions. The matrix below highlights some of the key differences.

Name/ Function	Advertises or lists job openings directly received from employers	Aggregates job openings from multiple sources, including job boards	Scans CVs for key words and pull job postings that make reference to those key words	Offers 'Applicant tracking system' and back-end data dashboards for labor force analysis	Matches job-seekers on parameters beyond key word searches using advanced technology
Job Boards (e.g. Craigslist, Careerbuilder)	✓				
Job Search Engines (e.g Indeed, Glassdoor)		✓			
Classic Online Labor Exchanges (e.g Monster)	✓		✓	✓	
Advanced Job Matching Platforms (e.g, Revelo)	✓		✓	✓	✓

Source: the Minnesota Department of Employment and Economic Development and Real Time Talent, 2016.

Job-matching platforms are different from online marketplaces that connect freelance labor with employers. This report does not include online marketplaces like Upwork and Freelancer in its analysis. OECD defines online marketplaces or gig economy platforms as two-sided digital platforms that match workers on one side of the market to customers (final consumers or businesses) on the other side on a per-service ("gig") basis.[9] It is interesting to note that OECD does refer to them as job-matching platforms as well. However, a key distinguishing feature of online marketplaces is that workers are often self-employed and hired on an ad-hoc task basis. This note focuses on platforms that match 'employees' with 'employers' instead of matching 'self-employed contractors' with 'clients'.

[9] Gig Economy platforms: Boon or Bane, OECD Economics Department Working Papers https://www.oecd-ilibrary.org/economics/gig-economy-platforms-boon-or-bane_fdb0570b-en

2. SALIENT FEATURES OF JOB MATCHING PLATFORMS

2.1 HOW DO JOB MATCHING PLATFORMS MATCH JOB SEEKERS AND EMPLOYERS?

Various public agencies use machine learning tools in their job-matching platforms to make the matching more targeted. Public employment services in Singapore, Paraguay, Belgium, Malta, France, Canada among others are using machine learning technologies to improve their job-matching platforms. In essence, the underlying framework of a job-matching platform is to search through information from both job-seekers and employers, and provide a bi-directional best-fit automated match (versus uni-directional search) using advanced technology. Most platforms yield a set of estimated matches ranked in order of the degree of match. Usually, an estimated match percentage or score is calculated to reflect the degree of match.

A commonly used tool is deep learning. For example, Vlaamse Dienst vor Arbeidsbemiddeling (VDAB)[10], the public employment service in Flanders, Belgium is using deep learning algorithms in their job-matching platform to provide more targeted matches for job-seekers. Deep learning is a type of machine learning that enables machines to mimic human behaviour by learning from data and identifying patterns (Najafabadi, 2015). In traditional job matching tools, a match occurs only if the CV contains the exact words and phrases used in the job description. This is called a rules-based or one-to-one match model. While this might work in some cases, but it may not always yield accurate results. For example, if a job description mentions the phrase 'driver of change', a rules-based matching model might match it with a professional driver. Deep learning algorithms learn how jobs are spoken of, compare search behaviours and similar job profiles, and use this data to generate more targeted and accurate matches. (AWS Partner Story: VDAB & Radix.ai, 2020)

Figure 1. Applications of AI and big data in job matching platforms.

Name of tool	Applications	Country
Jobnet	Predicts the degree of match between job-seeker and job vacancy using deep learning algorithms	Belgium
AMAS	Estimates a job-seeker's probability of becoming short term and long-term unemployed using statistical modeling	Austria
Competence Seeker	Deduces the classification of occupations from text and extracts hard and soft skills from CVs and job descriptions using natural language processing	Belgium
La Bonne Boîte	Determines a company's hiring potential in the next 6 month-period using machine learning	France
Forma'diag	Identifies skill-demand based on location	France

Source: Owalgroup: Artificial Intelligence in Employment Services – A Mapping, 2019; OECD Statistical Profiling in Public Employment Services: an international comparison, 2018

[10] https://www.vdab.be/vindeenjob/vacatures?sort=standaard

Another interesting way that machine learning is being used by public employment agencies is in determine the hiring potential of a company. For example, Pôle Emploi, the public employment service in France uses machine learning to identify companies that have a high potential for recruitment even before they officially announce a job vacancy. In France, companies are mandated to make pre-employment declarations before they recruit. The tool, called "La Bonne Boîte" uses this pre-employment declaration database, and its algorithm ranks companies based on positions, location and calculates their likelihood of hiring during the next 6-month period. The tool aims to help job-seekers target their job search towards companies that have the maximum hiring potential. (Owalgroup Aritificial Intelligence in Employment Services - A mapping, 2019)

Feedback loops are critical to a well-functioning job-matching platform. As more data is entered, and the more the platform is used, the easier it is for the machine learning technology to identify patterns, learn from usage, compare job-seeker profiles and match more intelligently. Therefore, an important pre-requisite for job-matching platforms to be effective is good quality data and frequent usage.

Most advanced job-matching platforms have a skills-based matching component. A skills or competence-based matching approach moves away from simply collecting information about a job-seeker's formal qualifications and work experience to a more holistic approach that looks at both the technical skills, generic skills and the soft skills that a job-seeker possesses (The European Commission Mutual Learning Programme for Public Employment Services, 2014, p. 2). The aim of this approach is to map the actual skills required in a job to a job-seeker's skills, rather than focusing on the formal qualifications earned. This approach enables job-seekers to broaden their job search and allows them to transfer their skills to new occupations. This also helps employers find the right candidates based on their specific requirements.

Various European countries like Italy, Netherlands, Finland, Hungary and Iceland are using the European classification of Skills, Competences, Qualifications and Occupations (ESCO) (European Commission ESCO use cases, 2020). ESCO provides a classification of 2,942 occupations and 13,485 skills linked to these occupations relevant to the EU labor market (Euopean Commission What is ESCO, 2019). ESCO works as a common dictionary of professional occupations and skills that builds on individual country-level classifications (European Commission, 2019). For example, ESCO draws from UK's Jobcentre Plus [11] that uses the National Occupational Standards (NOS)[12] and France's Pole Emploi[13] that uses the Operational Directory of Trades and Jobs (Répertoire opérationnel des métiers et des emplois or ROME). [14] (See Figure 2)

By mapping existing classifications, ESCO aims to standardize occupational frameworks and competencies across the EU, allowing for easier job mobility and better information sharing. Other countries have developed their own frameworks. For example, Singapore's SkillsFuture[15] skills framework is co-created by employers, industry associations and education institutions to make it more relevant to the labor market. The Skills Framework templates are available in editable formats for employers and firms to use as they prepare job descriptions and develop job profiles and roles. (Skillsfuture SG, 2019).

[11] https://findajob.dwp.gov.uk/
[12] https://www.ukstandards.org.uk/
[13] https://www.pole-emploi.fr/accueil/
[14] https://www.pole-emploi.org/opendata/repertoire-operationnel-des-meti.html?type=article
[15] https://www.skillsfuture.sg/skills-framework

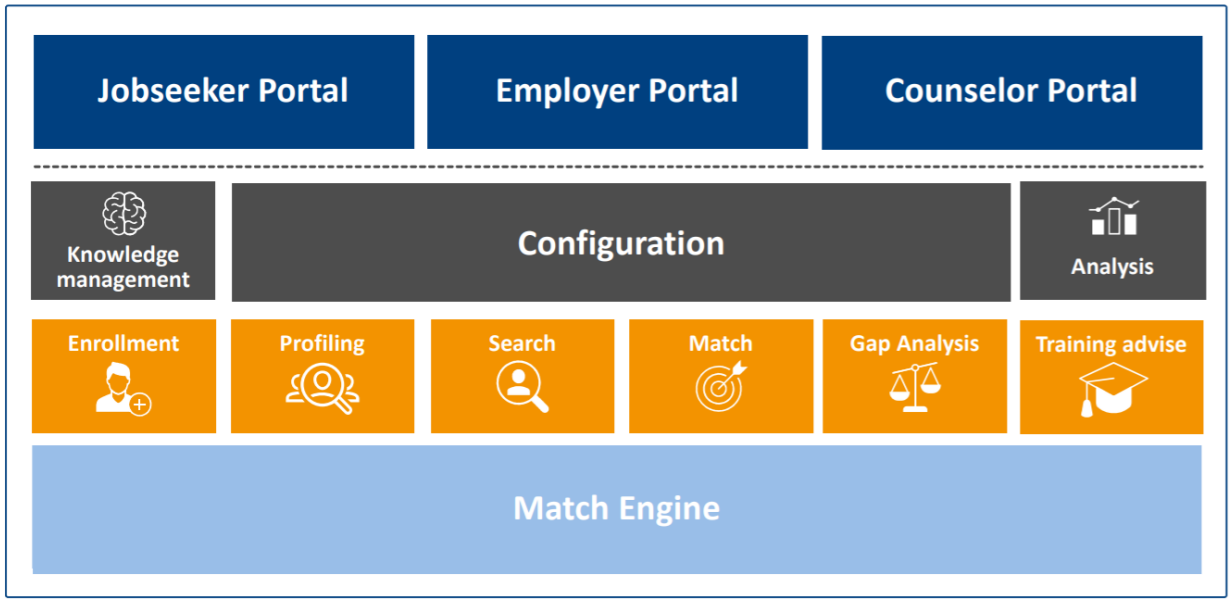
Figure 2. Examples of Skills Classification Frameworks used in different countries

Classification Framework	Country
European classification of Skills, Competences, Qualifications and Occupations (ESCO)	Finland, Hungary, Iceland, Italy, Ireland, Netherlands
Operational Directory of Trades and Jobs (Répertoire opérationnel des métiers et des emplois or ROME)	France
Berufenet	Germany
National Occupational Standards (NOS)	United Kingdom
COMPETENT	Belgium
Central Competence Database (CDK)	Czech Republic
Skills Future Skills Framework	Singapore

Source: European Commission Skills-based profiling and matching in PES,2014; ESCO Handbook, 2019; SkillsFuture,Govt of Singapore

Most job-matching platforms have an automated matching process, that integrates skills and competences into the matching algorithm. For example, the PES in various European countries including France, Netherlands, Luxemburg, Slovenia, Italy, Malta among others use the ELISE search and match platform, a solution developed by WCC, a software company headquartered in the Netherlands that allows for pre-configured or customizable skill-taxonomies. (See Figure 3 and Box 2).

Figure 3. Architecture of the ELISE platform



Source: WCC Technology in Public Employment Service, 2019

Box 2: The ELISE Search and Match platform

Overview: The ELISE search and match platform is a software solution developed by a Dutch technology company WCC, and is used by various European countries including France, Luxemburg, Austria, Germany among others in their PES to match job-seekers and employers. The overall architecture of the platform is standard, but customizable to include specific features unique to each agency and country.

Key Features:

- The ELISE platform is a server-based matching engine and has a separate dedicated portal for job-seekers, employers and counsellors, each with a separate log in.
- The match engine profiles and matches job-seekers using established skill-taxonomies and competency frameworks based on which the job-seeker is assigned a ranked 'match score'. The platform has 10 integrated classifications including ESCO, ROME2, O*NET among others. It is also available in different languages.
- Employers post their vacancies specifying the required skills needed to perform the job. To improve vacancy descriptions, the platform provides a gap-analysis of the job-description and the labor market offering to ensure there is minimum mismatch between the two.
- The software conducts a gap analysis for job-seekers on competences, soft skills and technical skills using labor market information and provides personalized advice on they can be more employable

Results: In addition to countries in Europe, Singapore, Saudi Arabia, the state of West Virginia in USA are using this platform in their employment services.

Source: WCC https://www.wcc-group.com/employment/public-employment-services

2.2 HOW IS INFORMATION GATHERED FROM JOB-SEEKERS AND EMPLOYERS?

Job-seeker information is collected usually through a combination of digital and in-person/phone interviews. In Flanders, Belgium, the "digital first" approach has been used since October 2018. In this approach, job-seekers are expected to use online tools to register on the VDAB job-matching platform. The purpose of this approach is to ensure that VDAB officers have enough time to serve and assist people who have low digital skills (VDAB Annual report, 2018, p. 8). Similarly, in Paraguay, for job-seekers who may not have access to internet, information is collected on the phone and fed into the system. [16]

Some public employment agencies also try to assess a priori the level of support each job seeker would require. For example, in Brussels, job-seekers self-report their digital capability or "autonomy" on a scale

[16] Interview with Gloria Ortega, Senior Consultant, SIPAIL project, Ministry of Labor, Paraguay

from 1-5, which determines their ability to use the MyActiris[17] job-matching service without assistance.[18] The lower the digital capability of a job-seeker, the more support they receive from the PES. For job-seekers who do not have the digital capability or resources to use the platform, a counsellor assists and coaches the job-seeker to register and input the required information.

Some countries use advanced technology to profile job-seekers for targeted support to those at highest risk of becoming long-term unemployed. For example, Austria's profiling tool statistically evaluates the job-seeker's probability of being employed in the short term (for at least 3 months in the first seven months after the start of unemployment) and in the long term (for at least six months over 24 months). Based on their likelihood of being employed, job-seekers are classified into three groups: high, medium and low chance of finding a job. Depending on the category a job-seeker is classified under, they will be offered differing support in (re)entering the labor market (Allhutter Doris, 2020, p. 1). This statistical profiling tool uses available labor market history information for the job-seeker, including, age, education, prior work experience, frequency and duration of unemployment, and participation in active labor market programs. However, this kind of in-depth history and information is typically not available for individuals outside the labor market, for example migrants and youth, and therefore skill profiling for them is difficult to achieve (OECD Profiling tools for early identification of jobseekers who need extra support, 2018).

Belgium's profiling tool uses machine learning algorithms and predictive big-data analytics to estimate the probability of becoming long-term (>6 months) unemployed. This tool also uses an innovative "click data" functionality, which tracks jobseekers' click-activity on the job-matching platform, including the number of clicks on job vacancies. This is used as a proxy for job search behavior and motivation and feeds into the profiling model (OECD Profiling tools for early identification of jobseekers who need extra support, 2018). This information is used to screen job-seekers who have registered at the PES and help case-workers prioritize their services to job-seekers at a higher risk of being unemployed. (see Figure 4)

Lately, the use of game-based psychometric assessments for profiling and screening job-seekers has increased. While the private sector has been adopting these tools in their recruitment process (refer to Box 1), some public agencies are also exploring game-based techniques to assess candidates. For example, in India, National Skill Development Corporation (NSDC)[19] partnered with KnackApp[20] to profile candidates enrolled in vocational training programs by assessing their behavioral skills, traits, and entrepreneurship potential through cognitive games (NSDC India, 2019). This is used to guide students to career opportunities and jobs best suited to their interests. (See Box 3).

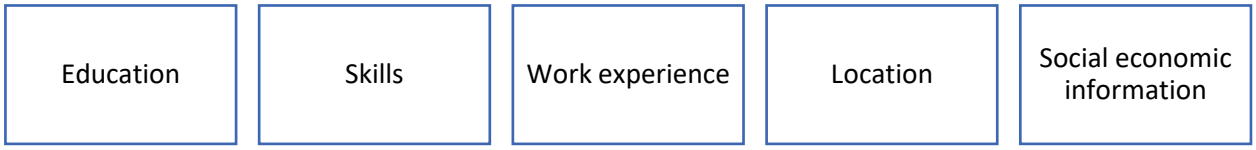
[17] https://my.actiris.brussels/registration-selection
[18] Interview with Miller Benoit Digital Transformation Manager, Actiris, Brussels
[19] NSDC is a public-private partnership set up by the Ministry of Finance in India; https://nsdcindia.org/
[20] KnackApp, Inc. is a US-based tech startup that uses neuroscience-based games to connect people with jobs https://www.knackapp.com/

Figure 4. Examples of profiling tools

Country	Tool	What they measure
Austrian Public Employment Service (AMS), Austria	Statistical profiling using big data	Probability of a job-seeker being employed in the short term and long term
VDAB, Belgium	AI-based statistical profiling that uses "click data" functionality to job-seekers' click-activity and behavior	Probability of becoming long-term (>6 months) unemployed using search as a proxy for job-seeker motivation among other data points
National Skill Development Corporation (NSDC), India	AI-based behavioral gamification techniques	Skills, abilities, and behavioral traits of job-seekers

Typically, personally identifiable information (PII) from job-seekers is either not collected at all, or not used in the matching process. Most job-matching platforms refrain from collecting information on race, gender, religion and other PII from job-seekers to mitigate potential biases that may arise in the matching process. Even if this information is collected, it is generally not used in the matching process. Other information collected varies by country. For example, in Singapore, the nationality of the job-seeker is collected as the MyCareersFuture[21] job platform is only available to Singapore nationals and permanent residents. Additionally, if an employer wishes to hire a foreign worker, the Ministry of Manpower mandates that the company post their job vacancy for a minimum of 14 days on the platform. (Frequently Asked Questions for MyCareersFuture.Sg).

Figure 5. Types of information collected from job-seekers



Employers usually can create their own job profile to specify their requirements for the job and are able to see anonymized job profiles of candidates through the employer portal. In most cases, they are assisted by officials from the public employment agency to help them fill out job vacancies to ensure that they clearly describe the expected competences of the job. A standardized skills framework can reduce information asymmetry between job-seekers and employers. For example, the skills taxonomy - "Competent" used in Belgium has an open API that can be integrated in other systems. This allows employers to align their job-descriptions to the standardized Belgian competency framework, thus making the matching more accurate and efficient. Similarly, Singapore's SkillsFuture[22] Skills Framework templates are available in editable formats for employers and firms to use as they prepare job descriptions and develop job profiles and roles.

[21] https://www.mycareersfuture.sg/
[22] https://www.skillsfuture.sg/skills-framework

BOX 3. Skill profiling using game-based technologies: KnackApp and NSDC pilot

Overview: Government of India's National Skill Development Corporation (NSDC) partnered with KnackApp, Inc., a US-based technology company, to do a pilot that uses game-based technologies to conduct skill-profiling for candidates in vocational training programs. KnackApp developed an AI-based mobile app that combines "Knack mobile games" to identify hidden talents, competency, and entrepreneurship potentials of students. By playing mobile games, students are matched with relevant skill development programs and career opportunities across a wide range of industry sectors, from sales, retail, construction, hospitality services to data science.

Key Features: Knack's predictive data models based on neural and behavior science-based algorithms measure 35 specific traits, abilities, and skills and over 90 occupations. The mobile game app engages players in digital experiences and draws about 2,500 micro-behaviors of players, such as active and passive decisions, reactions, or exploration. This micro-behavioral data helps to measure the strengths of the person's behavioral skills, traits, and potential. Moreover, the games can be accessed by all socioeconomic backgrounds, including those with a low level of literacy, as it requires simple instructions. The games are also available in English and Hindi.

Reach: In 2019, the pilot was done with 20,000 vocational graduates under the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Ministry of Skill Development & Entrepreneurship's flagship program.

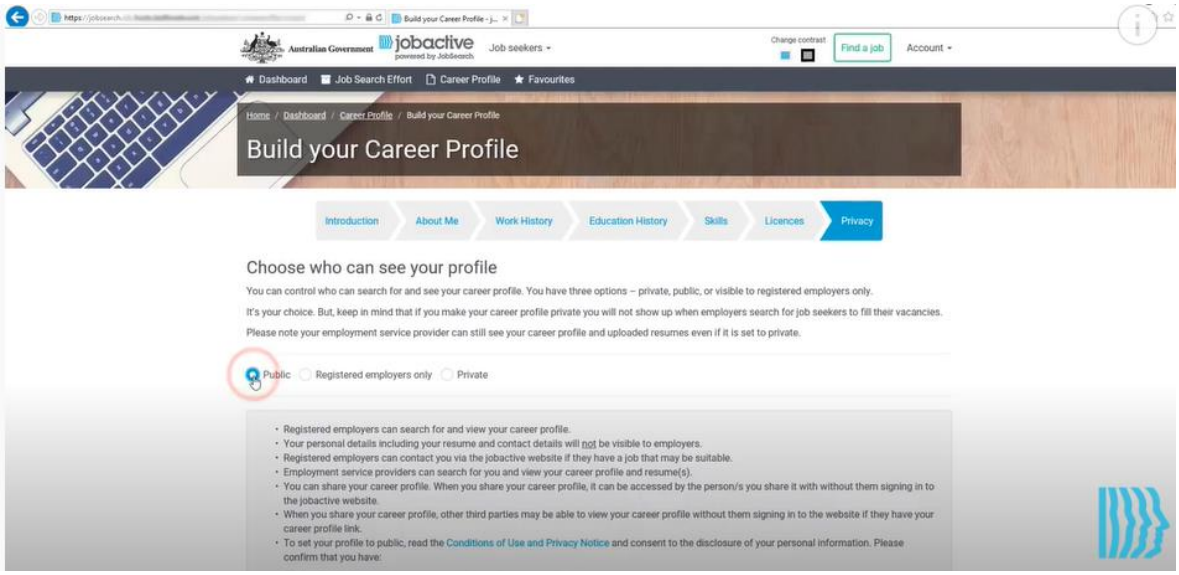
Source: https://nsdcindia.org/sites/default/files/NSDC-partners-KnackApp.pdf

2.2 ADDITIONAL SERVICES PROVIDED BY JOB-MATCHING PLATFORMS

In addition to generating matches, job-matching platforms may also provide additional support to job-seekers. Job-matching platforms like Jobactive[23] in Australia, Mycareersfuture[24] in Singapore, JobHelp[25] in UK help job-seekers create a CV based on the information provided they enter. For example, in Australia's Jobactive portal, job-seekers who do not have a CV are asked a series of questions related to their work experience, education, skills and courses that is ultimately fed into their digital career profile. At each step of the way, the platform prompts the user with hints and tips to make their profile more attractive. (See Figure 5).

[23] https://jobsearch.gov.au/
[24] https://www.mycareersfuture.sg/
[25] https://jobhelp.campaign.gov.uk/

Figure 5. A screenshot of Australia's Jobactive portal



Source: https://jobsearch.gov.au/

Other additional services provided by job matching platforms include access to online training courses, credentialing, interview preparation and skill-gap analysis. An interesting example is Google's Kormo app in Bangladesh[26]. The app provides job-seekers access to both online and offline resources, like quizzes, videos and courses, to prepare them for the job they are considering. If a job-seeker completes watching a certain number of videos, they get a badge that indicates the level of knowledge gained through completion of a video lessons. (See box 4).

Job-matching platforms have resources for employers to assist them in finding a suitable candidate. In addition to resources on how to advertise a vacancy, tips for growing businesses etc, some job-matching platforms like Jobactive in Australia and VDAB in Belgium also provide information on wage subsidies and other government benefits to employers.

Figure 6. Types of additional Services offered by job-matching platforms

Additional services	Job Help (UK)	VDAB (Belgium)	Mycareersfuture (Singapore)	Jobactive (Australia)	Google Kormo (Bangladesh, India, Indonesia)
Create a CV	✓		✓	✓	✓
Personalized career recommendations	✓	✓		✓	✓
Skill gap analysis	✓	✓	✓	✓	
Certification/credentialing					✓

[26] https://kormo.google.com/index_en.html

Access to Online/offline training courses	✓	✓			✓
Industry Insights		✓	✓		
Interview Preparation		✓	✓	✓	✓
Apply for unemployment benefits	✓	✓		✓	
Resources for employers like help with advertising a job, recruitment tips, etc	✓	✓	✓	✓	

BOX 4. Google's Kormo app for informal workers

Overview:
Kormo is a mobile app that connects blue or grey collar workers and entry-level job seekers to job opportunities in Bangladesh. The app is funded by Google's Area 120, an in-house incubator for experimental products, and expanded its operations to India and Indonesia in 2019. Kormo isn't a traditional job-matching platform deployed by a public agency, but offers interesting insights into the design and implementation of a job-matching solution targeting informal workers.

A large part of the workforce in developing countries belongs to the informal sector. The Kormo app provides a way to match job-seekers with entry level opportunities in retail sales, food delivery, hospitality, contact center positions among others. Google partners with employers across various industries and compiles word-of-mouth vacancies that aren't posted online. Users find job opportunities that match their specific interests, abilities, and preferred locations. Potential candidates are able to follow their job application progress in the Kormo app, including cv creation, interview preparation to finally selection.

Key Features:
Kormo has in-built features that allow job-seekers to create and maintain a digital CV in the app. It uses machine learning to recommend jobs and training content to job-seekers to help them prepare for interviews and learn new skills.

On the demand side, Google works with local companies to directly post their open positions on the platform, which allows job seekers to make direct applications and get faster updates and gives employers access to a marketplace of job seekers with standardized CVs. On the supply side, they use social media platforms, community outreach and word-of-mouth to enroll job-seekers. In India, they use Google Pay's supply pool to acquire job-seekers. Google Pay is a peer-to-peer online payments service used by over 80M users in India, and serves as a potential supply pool for the app.

Kormo also has additional features such as interview preparation and up-skilling tools for job seekers. For instance, a "Learn" tab in Kormo offers free resources such as online videos, articles, and other resources. If a job-seeker completes watching a certain number of videos, they get a badge that indicates the level of knowledge gained through completion of a video lesson. In India, Google has partnered with NSDC on their Skill India program[27] as part of which when a job-seeker completes a NSDC course, the credential

[27] https://skillindia.nsdcindia.org/

reflects in their Google Jobs app profile online. The app allows job-seekers to signal their skills and competencies to potential employers via a dynamic digital CV.

Reach:
Kormo has helped employers match over 100,000 jobs. In Dhaka, Bangladesh, Kormo has matched 25,000 people to jobs, including retail sales, delivery, and contact center positions. In India, Google launched the app for jobs in the Delhi – National Capital Region, where they partnered with 25 companies including grocery and food delivery apps like Zomato, 24 Seven, Swiggy among others. In Indonesia, the app connects job-seekers to jobs in Jakarta, Bali, Surabaya in East Java and Yogyakarta.

Source: https://kormo.google.com/about_en.html and interview with Bickey Russel, Project Lead and Founding Member of Kormo

2.3 DATA PRIVACY AND OWNERSHIP

Most European public agencies deploying job matching platforms follow the General Data Protection and Regulation (GDPR)[28] . The GDPR is a law implemented in 2018 by the EU that requires organizations to safeguard personal data and uphold the privacy rights of anyone in EU territory (GDPR Compliance , 2020). Job matching platforms in Europe conform to the GDPR and obtain user consent before collecting any information, and allow users to delete their profiles at any time. Most job-matching platforms are conscious of the data they collect, and usually refrain from collecting Personally identifiable information (PII). If PII is collected, users are usually able to withhold information they are not comfortable sharing.

Figure 7. Data protection measures

Application of guidelines on data protection and privacy at regional and country level	User consent on data collection and usage: allow users to delete their profiles at any time	Protection of personally identifiable information	Establishment of specialized unit dedicated to privacy and security issues

Countries outside of EU have their own data protection laws or draw from the GDPR. For example, Korea's job matching service follows their own Personal Information Protection Act and have a dedicated unit within the Korea Employment Information Service dedicated to privacy and security issues. (Korea Employment Information Service Personal Information Processing Policy, 2020).

The ownership of data is somewhat complicated. Job-seekers own the data they share, and can delete their profiles at any time. Usually, the data is hosted in government run servers, and the custody of the analysed data is with the government for reporting purposes. For example, in Paraguay, ParaEmpleo is permitted to anonymise the data and "process, use, publish and pass it on, for academic and statistical purposes." Interestingly, the Para Empleo data is stored and processed in a data centre in São Paulo, Brazil, protected on dedicated servers of Paraguay in Brazil. Since Para Empleo is also available to users from countries outside of Paraguay, if data is transferred to a country with insufficient data protection, the

[28] General Data Protection Regulation is a data protection and privacy law drafted and passed by the European Union- https://gdpr-info.eu/

platform has contractual obligations to ensure that user data is protected. (ParaEmpleo Data Protection, 2020)

3. IMPLEMENTATION

3.1 HOW IS OUTREACH TO JOB-SEEKERS AND EMPLOYERS DONE?

The coverage of job-matching platforms usually depends on which agency is deploying it. In most cases, they tend to be operated by the federal government and hence have a national coverage. For example, Para Empleo[29] in Paraguay is operated by the Ministry of Labor, Mycareersfuture[30] in Singapore is operated by the Ministry of Manpower, Job Bank[31] in Canada is operated by Federal Employment and Social Development and include listings from all over the country. Interestingly, Belgium is federally divided into 3 regions, each with its own PES and job-matching platform – VDAB for the Flanders region, ACTIRIS[32] for the Brussels Capital region, Le FOREM[33] for the Walloon region and a fourth one ADG[34] targeting the German community.

The outreach strategy for job-seekers is usually a combination of 'feet on the street' agents, social media and word-of-mouth. For example, In South Africa, the Gauteng provincial government launched the Tshepo 1Million youth empowerment initiative to connect under-served unemployed youth in Gauteng to job opportunities. The Gauteng government has partnered with Harambee – a youth employment accelerator – to implement the initiative. Youth are recruited into the program via Harambee's feet-on-the-street agents, or through social media outreach. Youth are required to register on the registration website, following which a Harambee agent contacts the job-seeker and initiates them into the job-matching process. [35]

Usually, there is no legal requirement for employers to advertise their vacancies on government job-matching platforms. In Germany for example, although it is not mandatory for companies to register their vacancies on the federal job matching platform, it is actively used by both smaller and larger companies as it is free of cost and houses a large supply pool of job-seekers[36]. Currently, the German platform - Virtueller Arbeitsmarkt[37] has 1.1M job vacancies and 3.8M applicant profiles (European Commission Database of labour market practices, 2019). The German job-matching platform also collects job vacancies from various company websites and posts them on the PES platform. In Brussels on the other hand, it is mandatory for SMEs that have received any kind of financial assistance or grants[38] from the Brussels Economy and Employment Public Service to register their job-vacancies on the MyActiris job platform[39]. The platform does not pull in vacancies from other external websites and sources yet although this is part of the future enhancement plan.

---

[29] https://paraempleo.mtess.gov.py/en/
[30] https://www.mycareersfuture.sg/
[31] https://www.jobbank.gc.ca/home
[32] https://www.actiris.brussels/fr/citoyens/offres-d-emploi/
[33] https://www.leforem.be/
[34] http://www.adg.be/
[35] Interview with Rob Urquhart, Research Lead at Harambee Youth Accelarator
[36] Interview with Haben Gebremedhin, Arbeitsagentur, German Federal Employment Agency
[37] https://www.arbeitsagentur.de/eservices
[38] The Brussels Economy and Employment Regional Public Service supports SMEs and entrepreneurs through financial grants - http://werk-economie-emploi.brussels/en/home
[39] Interview with Miller Benoit, Digital Transformation Manager, Actiris, Brussels

In Australia, a new initiative called "prepare-trial-hire" was announced to expand the job-matching portal – Jobactive[40], to allow employers to advertise internships in addition to jobs. The objective of this initiative is to introduce new ways for job-seekers to find employment.

In Gauteng, South Africa, Harambee leverages its own network to on-board companies and recruiters. They have a dedicated business management unit that reaches out to employers and firms. Their outreach strategy to companies is interesting. A follow-up survey is distributed every 3 months for a year to all job-seekers enrolled in their program to collect data on the jobs they have found. This repository of data not only serves as a tool to track program outcomes but also provides an insight into the existing labor market and access to industry intelligence. This enables them to expand their network to companies that may not have previously been in their radar. [41]

Box 5. Singapore's MyCareersFuture platform

Overview: In partnership with JobKred and WCC, the Singapore Government, developed MyCareersFuture.sg (MCF), a job matching portal that provides free job search services and matches job seekers with relevant jobs. With the help of AI-based job market analysis, the platform can identify the jobseeker's skills and competencies and reduces potential job mismatches.

Key Features:

- The platforms uses Job-to-Skills job matching technology that matches jobseekers to jobs based on their skills. The platform displays 'job fit scores' after comparing the match between the skills keyed in by users with the skills identified from the job descriptions provided by hiring employers.
- The platform has the ability to filter jobs that are eligible for Government support and also provides resource articles on career-related tips, human capital development and industry insights, to help jobseekers and employers in their respective talent-related needs.
- Using big data and algorithms, JobKred analyzes real-time online labor market information, from boards and resume sites, to decode jobs and skills demand and predict future skills requirements.
- The platform is free, but only available to Singapore citizens and permanent residents. Although companies are not mandated by the government to post on the platform, if an employer wishes to hire a foreign worker, the Ministry of Manpower mandates that the company post their job vacancy for a minimum of 14 days on the platform.

Reach: Currently, the online jobs portal is used by 200,000 citizens every week and has more than 40,000 active listings.

Source: https://www.mycareersfuture.sg/docs/mycareersfuture_sg_user_faqs.pdf.

[40] https://jobsearch.gov.au/
[41] Interview with Rob Urquhart, Research Lead at Harambee Youth Accelarator

3.2 HOW DO PUBLIC AGENCIES PARTNER WITH THE PRIVATE SECTOR?

In most cases, the governments partner with technology companies to source the software for the job-matching platform. Various PES in Europe (France, Malta, Austria, Slovenia etc), Singapore, Saudi Arabia, and West Virginia,USA have partnered with WCC, a Dutch technology company, to source the software for their job-matching platforms. Some public agencies also partner with technology companies to add more sophisticated features to enhance the matching process. For example, VDAB Belgium partnered with Radix AI, an Artificial Intelligence agency, to develop a deep-learning model-based matching solution, Singapore partnered with JobKred, a technology company, to use machine-learning technology to quantify the skill-match between a job-seeker and an employer. (See box 5) Once the platform is set-up, the ground-level implementation including the intake, information gathering, outreach to job-seekers and employers is done by government appointed staff.

Some public agencies have a deeper partnership with private sector companies. For example, in Germany, Accenture designed, implemented and maintained the virtual labor market platform for the government of Germany. Accenture not only provided the technology support but also re-designed organizational processes in the German National Employment Agency for faster adaptation to digital services. (Accenture Integrated Virtual Labor Market: Enabling Efficient Public Employment Services for the Future, 2013)

An example of a fully privatized public employment service model is the Australian model. This is a unique contractual outsourcing model where the government has contracted out the provision of all employment services, including frontline work to private companies and NGOs. (WCC Managing Workforce Potential - A 20/20 Vision on the Future of Employment Services, 2020, pp. 122-124) The government has employed a sophisticated 'Star Ratings' systems to actively monitor the performance of its providers. The rating system evaluates the performance of a provider through a complex calculation that weighs the "size and geographical location of allocated sites, characteristics of the local job markets, and characteristics of the provider's jobseeker case load". The Australian model is interesting, as it is the only PES that has fully privatized its employment services. (WCC Managing Workforce Potential - A 20/20 Vision on the Future of Employment Services, 2020, p. 115).

3.3 COSTS OF IMPLEMENTATION

The cost of developing and maintaining job-matching platforms can be steep, **but can also increase the efficiency of the public agency**. The costs of deploying a job matching platform usually include the fixed costs of setting up the technical infrastructure (procuring the software, hosting the website, enabling additional technology features etc.) and recurrent costs of updating and maintaining both front end and back end data. Additional costs of training staff on how to use and maintain the platform will also need to be factored in. Typically, the PES itself may not have the institutional capacity to perform all these tasks, and hence may sub-contract IT consultants from other private companies to support in the maintenance of the platform.

The cost of implementation can be quite high. For example, in Germany, the implementation of the new software VerBis, which supports the placement process and assists counsellors in the payment of unemployment benefits, is estimated at approximately 115M Euros (130M USD). (Ehlert, 2013, p. 112) The implementation of the software was staggered, that started with a pilot before large scale deployment. VerBis is one of the three components of the German Virtual Labor Market. The other two components – Jobboerse and JobRobot conduct the profiling and matching of job-seekers and collation of vacancies respectively. (European Commission Database of labour market practices, 2019).

Additionally, the 2018 budget of Belgium's VDAB allocated approximately 81M Euros (90M USD) to skill matching and job placement of job-seekers, that included the cost of software, training material and staff. (Dan Finn, 2019, p. 105)

The use of advanced technology and automated matching systems can make the functioning of the employment agency more efficient by reducing overall administrative costs. In fact, one of the underlying motivations for governments to digitalize their employment services was to reduce the workload on caseworkers and optimize their services. For example, the Dutch PES announced the 'Digital First' strategy in response to the national austerity measures of 2010 that resulted in significant budgetary cuts in the PES. This strategy called for moving in-person services to online to cut down personnel costs to the extent possible (European Commission Employment, Social Affairs and Inclusion Blended Service Delivery for Jobseekers, 2014, p. 6).

Figure 8. Types of costs in setting up a job-matching platform

Items	Activities
Technical infrastructure	Procurement of software, hosting the website
Development	Software development, technology enhancements and customizations
Maintenance and upkeep	Hire/sub-contract IT consultants, technical training for staff

Among the job-matching platforms discussed in the note, none imposed a fee on job-seekers. Most of them also did not charge employers for posting job vacancies. Making it free for all is also a way to attract more employers to post their vacancies.

Some agencies may charge employers for certain services. For example, Harambee charges companies that may want to use its services to conduct additional assessments, or specialized training sessions for high-skilled jobs.[42] Harambee is the implementation partner for the Gauteng provincial government on the Tshepo 1M youth empowerment project, but the government does not own the technology platform. Harambee is able to impose a fee for its services, however, if the employer is more sensitive to price (like SMEs or companies in the retail or hospitality sector), then no fee is charged.

Interestingly, in some countries like Germany, the government can enforce a financial sanction on unemployment benefits for job-seekers who turn down jobs or fail to appear for a job interview without a valid reason. These financial sanctions however have been a recurring point of debate in Germany for many years.

4. KEY LEARNINGS AND IMPLICATIONS FOR SCALE

Costs can be reduced by opting for out-of-the box, readymade software solutions. More developed countries like Germany, Singapore, Belgium etc typically use a customized software, and have a dedicated in-house IT team to manage systems upgrades and data cleaning. Customization of software can increase the cost of the software, as well as the upkeep of the platform. Smaller countries might prefer a ready-made out-of-the-box solution, with pre-configured functionalities and data management support that can reduce the overall technology costs.

[42] Interview with Rob Urquhart, Research Lead at Harambee Youth Accelarator.

For example, Malta, one of the smallest countries in EU has adopted an innovative 'Match as a Service' approach in its job matching platform - Jobs Plus[43]. Match as a service, is a type of Software as service (SaaS) in which a third-party provider hosts application and makes them available to customers over the internet. Malta's Jobsplus platform uses the matching engine of Belgium's VDAB to match its job-seekers. In this solution, job-seeker data is anonymized in Malta and sent to VDAB's IT center in Belgium, where in a separately configured partition of Belgium's platform, data is analysed and results are sent back to Jobsplus in Malta. (WCC Match as a Service Jobsplus Malta). This approach has optimized system maintenance and application management costs, making it more cost effective for Malta to deploy its job matching platform.

Role of the private sector in the adoption of job-matching platforms is critical. In all the examples of countries discussed in the report, public-private collaboration has been key. The private sector is the creator of jobs and hence as potential employers, their role and participation in the design of such platforms is important to also ensure that the platform meets their hiring needs. Besides, governments also turn to technology companies for technical support in the design of these platforms. Most governments contract private sector companies to procure the technology infrastructure required to set up a job-matching platform. Further, even the maintenance and up-keep of the platform is often sub-contracted to local companies. In some cases, the government may also outsource the intake, training and recruitment of job-seekers to a non-government partner.

An interesting example of a public-private partnership is in Paraguay, where the government formally partnered with private employment service provider, Manpower to have them list their job vacancies on Para Empleo – the national portal in Paraguay in return for using their job-matching software. Thus, Para Empleo is able to expands its offerings nationally and companies are able to access a larger pool of jobseekers, resulting in a win-win outcome for both parties. [44]

Open APIs are important to ensure inter-operability of job-matching platforms. Open APIs (application programming interface) allow the platform to interact with other systems. An example of how inter-operability is useful can be seen in the case of VDAB Belgium. VDAB integrated its skills taxonomy - "Competent" into a database that is openly accessible through an API. This has allowed all companies in the labor market to align their job-description to the standardized Belgian competency framework. As both job-seeker profiles and job-descriptions are aligned to the same competency framework, it makes the matching more accurate and efficient.

A mobile app may be easier to scale than web-based platforms particularly in areas with low connectivity. Most platforms are web-based but also have an app-version or are in the process of developing an app version. A mobile app is easier to access, particularly for those who may not own a computer and in areas with low connectivity.

[43] https://jobsplus.gov.mt/
[44] Interview with Manuel Urquidi, Labor Market Lead Specialist, Inter American Development Bank

Appendices

Table 1: List of interviewees

Name of interviewee	Role (s)
Gary Gan	Co-founder,JobKred
Tashmia Ismail-Saville	CEO, Youth Employment Service (YES)
Rob Urquhart	Lead, Knowledge and Research at Harambee Youth Employment Accelerator
Gloria Ortega	Senior Consultant, SIPAIL project, Ministry of Labor, Paraguay
Manuel Enrique Urquidi Zijderveld	Labor Markets Lead Specialist, Inter American Development Bank
Mahesh Venkateswaran	Chief Growth Officer, KnackApp
Akshay Kashyap	Program Manager, National Skill Development Corporation
Nidhi Batra	Senior Consultant, Knowledge Management, Strategy & TVET Advisory, National Skill Development Corporation
Bickey Russel	GM, Kormo & Founding Member, *Area 120, Google*
Miguel Peromingo	Employment Policy Consultant, Miguel Peromingo Consulting
Sang Hyon	Ph.D. Human Resource Management Research Fellow Employment Service Innovation Division Korea Employment Information Service
Shanti Jagannathan	Senior Education Specialist, Asian Development Bank
Haben Gebremedhin	German Federal Employment Agency, International Relations
Miller Benoit	Digital Transformation Manager, Actiris, Brussels
Laura-Gaëlle Lemétayer	International Relations Unit, International Relations Officer, Actiris, Brussels
Aurélie Courtier	International Relations Specialist, Actiris, Brussels

Table 2: Terminologies for advanced job matching platforms

Terminology	Organization	Description
AI-based matching system	European Commission	Artificial Intelligence is a broad concept that encompasses machine learning, deep learning, and intersects with other types of analytics, such as data mining and statistics (EC, 2019, p.12). For example, 76 % of PES are now considering **the adoption of** **AI-based matching** and little over half of PES are planning to use AI for labor market forecasting and other types of LMI (EC, 2019, p.15)
Competence-based matching system	WCC (a Dutch private developer of advanced search and match technology)	---- puts forward **a skills/competence-based matching system** in preference to the usual diploma- and profession-centered matching system (WCC, 2017, p.67). Matching is made based on competences, whether they are expected, acquired, or to be acquired. This type of job matching differs from diploma- and profession-centered matching systems, which rely on specific attributes in their profiles such as diploma, profession, language, region, and driver's license (WCC, 2017, p.69-70). It enables finding affinities between professions, meaning that jobseekers without a certain diploma or experience in a particular function, still have the potential to fit into the position.
Digital job-seeking platforms	Dalberg	A key feature of these platforms is their ability to accumulate a large database of job seeker profiles, job positions, and employers. **Algorithms and automation enable both job seekers and employers to easily make personalized, sophisticated, and detailed searches**. (Chen & Haymon, 2016, p.2).
Web-based job matching tools	Real Time Talent (Minnesota PPP initiative)	It uses **complex algorithms** to customize the job search results to individual candidates, and filter for only those candidates that have the optimal match of

		interests, hard skills, soft skills, experience, and educational background for a position.
The application of artificial intelligence (AI) in job matching and public employment services	Ministry of Economic Affairs and Employment (MEAE), Finland	A single definition of AI was not used in this mapping study, but we have used those definitions that were presented in each data source. However, basic software automation was excluded from our reviews.
Online job-matching platforms	ILO, OECD	**Online job matching systems** allow employers to post vacancies, review CVs and connect directly with jobseekers (ILO, 2020, p.96).

Table 3: List of public sector led job-matching platforms

Platform Name	Country	Coverage	Technology Features	Implementing Organization	Technology Partners	Link
Para Empleo	Paraguay	National	Machine Learning and Deep Learning Algorithms to provide a best-fit matching score between job-seekers and employers	Ministry of Labor, Government of Paraguay	Janzz Technology	https://paraempleo.mtess.gov.py/en/
NSDC-KnackApp	India	Pilot is selected states	Gamification technique that uses cognitive sciences and Artificial Intelligence to match candidates undergoing vocational training program with over 90 careers opportunities spanning across 17 industry sectors	National Skill Devlopment Corporation under the Ministry of Skill Development and Entrepreneurship (MSDR)	KnackApp	Mobile App
Tshepo 1Million	Gauteng Province, South Africa	Provincial	"Pathwaying Platform"using psychometrics based assessments	Harambee Youth Accelarator	Harambee Youth Accelarator	https://www.tshepo.mobi/

			and machine learning technology to match youth.			
Job Bank	Canada	National	Occupational matching through psychometric assessments and quizzes using machine learning technology	Employment and Social Development Canada, Government of Canada	WCC	https://www.jobbank.gc.ca/aboutus
Mycareersfuture	Singapore	National	AI to understand real-time labor market demand, then personalizing recommendations to match skills supply to the skills demand.	Ministry of Manpower ,Government of Singapore	WCC, JobKred	https://www.mycareersfuture.sg/
Pole emploi	France	National	Machine learning to determine the hiring potential of a company	Government of France	WCC	https://www.pole-emploi.fr/accueil/
VDAB	Flanders, Belgium	Regional	Machine learning and deep learning based profiling tool to predict the time jobseekers are	Government of Flanders, Belgium	Radix AI, WCC	https://workinflanders.be/

			unemployed; machine learning based predictive models to segment customers based on (un)employment risks			
Myactiris	Brussels, Belgium	Regional	AI tools to match job-seekers and employers	Brussels regional Government	In-house IT	https://my.actiris.brussels/
Adnexio	Malaysia	National	AI and data analytics to match employers and employees more efficiently	Government of Malaysia	Invoke	https://adnexio.jobs/
Jobactive	Australia	National	Integrated system that offers – 1)Job matching 2) Salary level and job prospects estimates, Google maps job geolocalization; 3) Training and Apprenticeships	Government of Australia	Multiple	jobactive.gov.au
"JobNet" : Labor Market Information	Denmark	National	Specially designed interfaces and guides with interactive capabilities for	Government of Denmark	WCC	www.jobnet.dk

Portal - Denmark			youth or low skilled workers that guides the job seeker towards relevant jobs			
'Virtueller Arbeitsmarkt' (Virtual Labour Market)	Germany	National	The platform consists of three different components: Jobboerse, VerBIS and JobRobot that help in matching, collecting vacancy information from other job-portals and support to counsellors	Federal Employment Agency, Government of Germany	WCC, Accenture	https://www.arbeitsagentur.de/eservices
Workforce West Virginia (WWV)	USA (West Virgnia)	State-wide	The AI-based matching functionality presents result lists in ranked order to easily see the top matches. Since each match is scored, it's also possible to display scores to show how close the match is to the ideal.	Workforce West Virginia (WWV)	WCC	https://www.wcc-group.com/smallbutsmartworkforcewestvirginia-02.pdf

Universal Jobmatch	UK	National	Universal jobmatch is designed to provide a comprehensive one-stop-shop for jobseekers to look for vacancies, upload cover letters and CVs and apply online. It is also designed to provide employers with an easy way to publish vacancies.	Department for Work and Pensions (DWP)	Monster government solutions	https://findajob.dwp.gov.uk/
Jobs Plus	Malta	National	Jobseeker data is anonymized in Malta, respecting privacy legislation, and then sent to VDAB's IT center in Belgium (Belgian PES), where a separately configured partition matches jobseeker data with potential jobs in Malta. The results are then sent back to Jobsplus in Malta	Malta's Public Employment Service Jobsplus	WCC	https://jobsplus.gov.mt/

WorkNet	Korea	National	Big data to match job-seekers and employers	The Korea Employment Information Service (affiliated with The Ministry of Employment and Labor)		Mobile App; http://eng.keis.or.kr/eng/index.do

REFERENCES

Accenture Integrated Virtual Labor Market: Enabling Efficient Public Employment Services for the Future. (2013). Retrieved from https://www.accenture.com/pt-en/~/media/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Industries_6/Accenture-Integrated-Virtual-Labor-Market.pdf

Allhutter Doris, C. F. (2020). Algorithmic Profiling of Job Seekers in Austria: How Austerity Politics Are Made Effective. *Frontiers in Big Data*, 1. doi:10.3389/fdata.2020.00005

AWS Partner Story: VDAB & Radix.ai. (2020). Retrieved from AWS: https://aws.amazon.com/partners/success/vdab-radix-ai/

Dan Finn, M. P. (2019). *Key Developments, role and organization of Public Employment Services in Great Britain, Belgium-Flanders and Germany.* ILO.

Ehlert, C. (2013). Evaluation of German Active Labor Market Policies and their Organizational Framework. In C. Ehlert, *Evaluation of German Active Labor Market Policies and their Organizational Framework* (p. 112). Germany: Springer Gabler. Retrieved from https://books.google.com/books?id=AAX8CAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q=115M&f=false

Euopean Commission What is ESCO. (2019). Retrieved from Euopean Commission: https://ec.europa.eu/esco/portal/howtouse/21da6a9a-02d1-4533-8057-dea0a824a17a

European Commission. (2019). *ESCO handbook.* Retrieved from https://ec.europa.eu/esco/portal/document/en/0a89839c-098d-4e34-846c-54cbd5684d24

European Commission Database of labour market practices. (2019). Retrieved from Employment, Social Affairs & Inclusion: https://ec.europa.eu/social/main.jsp?catId=1080&langId=en&practiceId=12

(2014). *European Commission Employment, Social Affairs and Inclusion Blended Service Delivery for Jobseekers.*

European Commission ESCO use cases. (2020, February 23). Retrieved from European Commission: https://ec.europa.eu/esco/portal/howtouse/bfe2a816-f9dd-49df-a7d2-ec8fafcfce95

Feloni, R. (2018). *Consumer-goods giant Unilever has been hiring employees using brain games and artificial intelligence — and it's a huge success*. Retrieved from Business Insider Web Site : https://www.businessinsider.com/unilever-artificial-intelligence-hiring-process-2017-6

Frequently Asked Questions for MyCareersFuture.Sg. (n.d.). Retrieved from Myskillsfuture.sg: https://www.mycareersfuture.sg/docs/mycareersfuture_sg_user_faqs.pdf

GDPR Compliance . (2020). Retrieved from GDPR.EU: https://gdpr.eu/faq/

Korea Employment Information Service Personal Information Processing Policy. (2020). Retrieved from Korea Employment Information System: https://m.work.go.kr/main.do

Mortensen, D. (2010). *Markets With Search Friction And The DMP Model.* Northwestern University and Aarhus University. Retrieved from https://www.nobelprize.org/uploads/2018/06/mortensen-lecture.pdf

Najafabadi, M. V. (2015). Deep learning applications and challenges in big data analytics. *Journal of Big Data 2*. doi:https://doi.org/10.1186/s40537-014-0007-7

NSDC India. (2019). *NSDC partners KnackApp to counsel youth for skill discovery and career.* Retrieved from NSDCIndia.org: https://nsdcindia.org/sites/default/files/NSDC-partners-KnackApp.pdf

OECD. (2019). *Gig Economy Platforms: Boon or Bane.* Retrieved from https://www.oecd-ilibrary.org/economics/gig-economy-platforms-boon-or-bane_fdb0570b-en

(2018). *OECD Profiling tools for early identification of jobseekers who need extra support.* Retrieved from http://www.oecd.org/els/emp/OECD-Profiling-policy-brief-DEC-18.pdf

(2019). *Owalgroup Aritificial Intelligence in Employment Services - A mapping.* Retrieved from https://tem.fi/documents/1410877/15020328/Artificial+intellingence+in+employment+services+-+A+mapping/24844ede-0570-c8da-4ed3-c91ec25b8e76/Artificial+intellingence+in+employment+services+-+A+mapping.pdf

ParaEmpleo Data protection. (2020). Retrieved from ParaEmpleo: https://paraempleo.mtess.gov.py/cms/en/data-protection

ParaEmpleo Data Protection. (2020). Retrieved from ParaEmpleo: https://paraempleo.mtess.gov.py/cms/en/data-protection

Skillsfuture SG. (2019). *Skills Framework*. Retrieved from Skillsfuture SG: https://www.skillsfuture.sg/skills-framework

The European Commission Mutual Learning Programme for Public Employment Services. (2014). *The European Commission Mutual Learning Programme for Public Employment Services Skills-based profiling and matching in PES.* EUROPEAN COMMISSION.

(2018). *VDAB Annual report.* Retrieved from https://www.vdab.be/sites/web/files/in-de-kijker/VDAB-Jaarverslag-2018.pdf

WCC. (2016). *Match as a Service - Jobsplus Malta.*

(2020). *WCC Managing Workforce Potential - A 20/20 Vision on the Future of Employment Services.*

(n.d.). *WCC Match as a Service Jobsplus Malta.*

(n.d.). *WCC Match as a Service Jobsplus Malta.*

(n.d.). *WCC Match as a Service Jobsplus Malta.*