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BRIDGING SPATIAL AND SKILL MISMATCHES IN SOUTHERN MEDITERRANEAN COUNTRIES : A JOB MAP DIGITAL SOLUTION FOR TUNISIAN LABOUR MARKET

Amani zaouali & Anis Bouabid

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BRIDGING SPATIAL AND SKILL MISMATCHES IN SOUTHERN MEDITERRANEAN COUNTRIES : A JOB MAP DIGITAL SOLUTION FOR TUNISIAN LABOUR MARKET

CONTENTS

ABSTRACT

This paper addresses the persistent issue of spatial and skill-job mismatch in Tunisia, with a focus on the challenges faced by young graduates in accessing suitable employment opportunities. Despite significant investments in youth employment policies, regional disparities continue to hinder labor market efficiency, particularly in interior and less-developed areas. The study explores the spatial mismatch hypothesis between job seekers and available positions, exacerbated by economic and socio-cultural factors.To mitigate these mismatches, this paper introduces the "Job Map" web application, an innovative tool designed to reduce spatial barriers in the labor market. The application leverages large-scale datasets and geolocation technology to match job seekers and employers based on proximity and skill compatibility. Through data-driven analysis, it recommends policies to improve job accessibility for marginalized groups, including youth, women, and residents of rural areas.The study presents a detailed account of the conceptualization, development, and deployment of the Job Map application, including technical specifications, data integration, and user testing. Policy implications are discussed, emphasizing the need for targeted regional development, enhanced labor mobility, and technology-driven labor market solutions. The findings suggest that the Job Map application can play a critical role in addressing unemployment and regional economic disparities, with potential scalability to other Southern Mediterranean countries facing similar challenges.

RÉSUMÉ

Cet article traite de la problématique persistante des inadéquations spatiales et entre compétences et emplois en Tunisie, en mettant l'accent sur les difficultés rencontrées par les jeunes diplômés pour accéder à des opportunités d'emploi adaptées. Malgré des investissements importants dans les politiques d'emploi des jeunes, les disparités régionales continuent de freiner l'efficacité du marché du travail, notamment dans les régions de l'intérieur et les zones moins développées. L'étude explore l'hypothèse du décalage spatial entre les demandeurs d'emploi et les postes disponibles, aggravé par des facteurs économiques et socioculturels. Afin de réduire ces inadéquations, cet article présente l'application web « Job Map », un outil innovant conçu pour réduire les barrières spatiales sur le marché du travail. L'application exploite des bases de données à grande échelle ainsi que des technologies de géolocalisation afin de mettre en relation les demandeurs d'emploi et les employeurs selon la proximité géographique et la compatibilité des compétences. Grâce à une analyse fondée sur les données, elle propose également des recommandations politiques visant à améliorer l'accès à l'emploi pour les groupes marginalisés, notamment les jeunes, les femmes et les habitants des zones rurales. L'étude présente en détail la conception, le développement et le déploiement de l'application Job Map, y compris ses spécifications techniques, l'intégration des données et les tests utilisateurs. Les implications politiques sont également discutées, en soulignant la nécessité d'un développement régional ciblé, d'une mobilité professionnelle renforcée et de solutions innovantes basées sur la technologie pour le marché du travail. Les résultats suggèrent que l'application Job Map peut jouer un rôle clé dans la lutte contre le chômage et les disparités économiques régionales, avec un potentiel d'extension à d'autres pays du sud de la Méditerranée confrontés à des défis similaires.

الملخّص

تتناول هذه الورقة البحثية الإشكالية المستمرة المتعلقة بعدم التوافق الجغرافي وعدم التوافق بين المهارات وفرص العمل في تونس، مع التركيز على التحديات التي يواجهها الشباب من خريجي الجامعات في الوصول إلى فرص عمل ملائمة. وعلى الرغم من الاستثمارات الكبيرة في سياسات تشغيل الشباب، لا تزال الفوارق الجهوية تعيق كفاءة سوق العمل، خاصة في المناطق الداخلية والأقل نمواً. وتستكشف الدراسة فرضية عدم التوافق الجغرافي بين الباحثين عن العمل والوظائف المتاحة، والتي تتفاقم بفعل عوامل اقتصادية واجتماعية وثقافية

وهو أداة مبتكرة تهدف إلى الحد من ،«Job Map» وللتخفيف من هذه الاختلالات، تقدم هذه الورقة تطبيق الويب العوائق الجغرافية في سوق العمل. يعتمد التطبيق على قواعد بيانات واسعة النطاق وتقنيات تحديد المواقع الجغرافية من أجل الربط بين الباحثين عن العمل وأصحاب العمل وفقاً للقرب الجغرافي ومدى توافق المهارات. ومن خلال تحليل قائم على البيانات، يقدم التطبيق أيضاً توصيات سياساتية لتحسين الوصول إلى فرص العمل للفئات المهمشة، بما في ذلك الشباب والنساء وسكان المناطق الريفية

وتعرض الدراسة بشكل مفصل مراحل تصميم وتطوير ونشر تطبيق «Job Map»،بما في ذلك المواصفات التقنية، ودمج البيانات، واختبارات المستخدمين. كما تناقش الدراسة الآثار السياساتية، مع التأكيد على أهمية التنمية الجهوية الموجهة، وتعزيز الحركية المهنية، واعتماد حلول تكنولوجية مبتكرة لسوق العمل. وتشير النتائج إلى أن تطبيق «Job Map يمكن أن يلعب دوراً محورياً في معالجة البطالة والفوارق الاقتصادية الجهوية، مع إمكانية توسيع نطاقه ليشمل دولاً أخرى في جنوب المتوسط تواجه تحديات مماثلة

INTRODUCTION

The Mediterranean is a strategic area that concentrates all the world's challenges: security geopolitical, economic, migratory, and environmental and energy issues. In the current international context, the duality of the Mediterranean, both north and south, illustrates inequalities and discrepancies. Why has the goal of "shared prosperity in the Mediterranean region" not been achieved? Gross Domestic Product (GDP) per capita in the Southern Mediterranean is, at best, still less than 40% of the EU-28 level. Not only that, but its trajectory has been, for all intents, flat since 1995.

There are still pronounced country-to-country differences in the numbers of people living in poverty and tremendous vulnerability for some population groups to fall under extreme poverty, especially when external shocks hit unexpectedly. There is also much more income disparity within the Southern and Eastern Mediterranean countries than within Europe, with the top 10% commanding more than 50% of total income. This situation needs to change.

The Middle East and North Africa region has one of the highest youth unemployment in the world: 25.7% (2020, ILO).[1] Spatial mismatch has a significant adverse effect on unemployment, especially for disadvantaged workers. According to the European institute of the Mediterranean (IEMed),[2] the unemployment rate in the Southern Mediterranean region is about 9.1%. This rate is higher than the EU-28 average of 7.4%. However, the proportion of people living below the poverty line in the Southern Mediterranean countries (SMC) is 20.9%, which is significantly higher than the global average of 10.7%. In addition, there is a trend increasingly precarious employment in the region. This trend is also observed in the SMC labour market where the share of temporary contracts is 27.9%, and the share of non-regular employment is 21.8% (IEMed 2021). "Skills forecasting in the South Mediterranean region: approaches and lessons learned from pilot projects" (delivered by UNESCO 2021), pay attention to the imbalances in SMC's labour markets caused by skill and spatial mismatch and the inefficiency of the matching process.

[1] International Labour Organization. (2020). Global employment trends for youth 2020: Technology and the future of jobs. International Labour Office

[2] European Institute of the Mediterranean. (2021). IEMed Mediterranean yearbook 2021. IEMed

The spatial mismatch hypothesis examines whether labour supply skills align with job opportunities across locations. Evidence from Southern Mediterranean Countries remains limited but highlights important spatial and structural imbalances. Banerjee and Sequeira (2020, 2023) show that spatial mismatch and imperfect information contribute to both spatial and occupational mismatches. Trabelsi (2016) finds regional disparities in Tunisia, with inland graduates more exposed to mismatch than those in coastal areas. Similarly, Siala and Ben Ammar (2013) and Dibeh et al. (2019) highlight the role of education, individual characteristics, and regional factors in unemployment and skill mismatch. All these frameworks emphasize the challenges of job creation, high unemployment rates among specific groups, the mismatch between skills and market needs, and the need for reforms and innovative solutions to address these issues in Tunisia's labour market.

The growing importance of data science and artificial intelligence lies in their potential to enhance youth employability and transform labour market opportunities worldwide. Weeler and Dillahunt (2018) find that online resources support job seekers in finding relevant jobs via search, but do not help them identify opportunities to improve their job search process or increase their chances of securing employment. Authors recommend the use of systems aiming to support low-resourced job seekers. Banerjee and Sequeira (2023) reported on learning by searching. Youth unemployment in southern labour markets is high due to spatial mismatches between jobs and job seekers, as well as high search costs. The need to a data mining solution is necessary in the developing world. Same researchers from Southern Mediterranean countries emphasize the need for innovative solutions to address spatial mismatch and improve employment prospects. Mezzzour (2020) in the Seventh International Conference had mentioned such a need on e-Democracy & e-Government held in Morocco in 2020. The author sheds the light on the importance of Data Sciences and Artificial Intelligence for Improved Youth Employability in Morocco.

Regarding to Tunisia, the European Training Foundation (2020) reported the significant mismatch between the skills acquired by young Tunisians and employers' needs, which represents an obstacle to their employability. The report marks the growing diffusion of services for online recruitment (e-recruitment) which make it possible to publish the job request through various Web sources, such as online newspapers, employment agencies, specialized websites and job vacancy aggregators.

The use of Labour Market Intelligence (LMI), by which we mean the definition and implementation of Artificial Intelligence and Big Data techniques for the labour market information processing and synthesis, aim at supporting the decision-making process in Tunisia.

Referring to Weeler and Dillahunt (2018), low-resourced job seekers in Tunisia do not identify their opportunities going from their local labour markets to the urban labour markets. Job online employment platforms like TanitJob, Keejob, Option carriere, Tunisie Travail and LinkedIn do not take into consideration the distance factor and the proximity obstacle for low-resourced job seekers in interior and disadvantaged regions.

Our paper focuses on a digital tool that was developed and designed to address spatial mismatch in the job market by providing information on job locations and accessibility. This tool called: “The Job Map Web Application” is particularly beneficial for low-income job seekers in Tunisia who often face difficulties in accessing job opportunities due to the geographical distribution of job opportunities. The Job Map Web Application operates by using large-scale datasets to evaluate the job location mismatch and accessibility based on different age, income, and industry group. It then provides recommendations for improving job accessibility, which can be used by public officials to develop policies that increase job accessibility. To the best of our knowledge, the literature lacks data mining–based approaches to address spatial skill mismatch in Tunisia. The proposed Job Map solution seeks to bridge this gag.

In this framework, we review the literature on spatial and skill mismatch, with a focus on Tunisia and the Southern Mediterranean region. We then examine the concept of spatial mismatch, its causes, and the challenges faced by Tunisian graduates, highlighting the need for solutions to better align skills with job opportunities. Next, we present the design and development of the Job Map application, including its data sources and key technical aspects, along with testing and validation. We also explore its scalability in Tunisia and potential replication in other Southern Mediterranean countries.

Finally, we discuss the policy implications of this solution and summarize its contribution to reducing spatial mismatch and improving youth employability.

LITERATURE REVIEW

SPATIAL AND SKILL MISMATCH IN TUNISIA

Spatial mismatch and skill-job mismatch are widely discussed in labour economics, focusing on the geographic and qualitative gaps between labour supply and demand. The concept originates from John F. Kain (1968), who argued that the spatial separation between low-income populations and job opportunities contributes to persistent unemployment. This framework has since expanded to include educational and skill mismatches.

A substantial body of literature examines these issues in Tunisia, highlighting both spatial and structural labour market inefficiencies. Studies such as Bousnina and Badr Gabs (2022) analyse the determinants of unemployment, emphasizing the mismatch between training and employment opportunities. Similarly, Jeguirim (2021) identifies regional disparities in unemployment, pointing to education and socio-cultural constraints particularly for married women as key contributing factors.

Spatial mismatch in Tunisia is strongly linked to regional inequalities. Empirical evidence shows that inland regions offer fewer employment opportunities compared to coastal areas, leading to higher mismatch rates and longer job search durations. Trabelsi (2016) confirms that graduates in inland regions are more exposed to educational mismatch than those in coastal regions. This finding is consistent with data from the International Labour Organization, which highlights the disconnect between the education system and labour market needs, resulting in underemployment and lower job quality among graduates. Further research emphasizes structural labour market barriers. Angel-Urdinola (2014) identifies distortions, barriers to competition, and excessive administrative constraints as key obstacles to job creation in Tunisia. Likewise, Assaad and Boughzala (2018) underline the persistent mismatch between the skills produced by the education system and those demanded by the labour market, particularly affecting youth, women, and university graduates.

Additional studies highlight the role of broader economic and institutional factors. Defay (2016) points to structural inefficiencies, weak resource allocation, and low productivity as key drivers of regional disparities and unemployment. Agili (2020) further discusses graduate employability, emphasizing issues such as over-qualification and the gap between theoretical education and practical labour market requirements. At a broader level, Banerjee and Sequeira (2020) highlight how spatial mismatches and imperfect information in job search processes contribute to both occupational and geographic mismatches, stressing the importance of improving access to labour market information.

Overall, the literature consistently shows that spatial mismatch in Tunisia is driven by a combination of regional disparities, structural labour market inefficiencies, and misalignment between education and employment. These factors contribute to higher unemployment rates, longer job search durations, and lower job quality, particularly among young graduates.

YOUTH UNEMPLOYMENT AND SKILL MISMATCH IN TUNISIA

Youth unemployment in Tunisia remains a critical issue, with rates for young graduates substantially higher than the national average. The World Bank's "Tunisia - Labour Market Profile" (2021) reported that the overall youth unemployment rate was around 34.8% in 2020, underscoring the severity of the problem. The high unemployment rate for graduates can be linked to several factors, including educational mismatches, regional disparities, and labour market rigidities.

Bousnina (2022) highlights the characteristics and underlying factors contributing to unemployment among graduates in Tunisia, including the mismatch between their training and available job opportunities. Jeguirim (2021) further elaborates on regional unemployment disparities, indicating that education and socio-cultural constraints (such as the mobility limitations of married women) are significant contributors. Gender disparities are also evident in the Tunisian labour market. According to the ILO's "Tunisia Labour Market Profile - 2017," female graduates face distinct challenges, particularly in conservative regions where cultural norms limit their employment opportunities. This adds another layer to the spatial mismatch issue, as gender-based employment disparities are often linked to regional socio-cultural differences.

The "Tunisia Economic Monitor: Navigating Turbulent Waters" (2019) by the World Bank underscores that many graduates are compelled to accept informal employment due to the scarcity of formal job opportunities. Informal jobs are typically characterized by lower wages, job insecurity, and inadequate social benefits, further aggravating the issue of underemployment. This trend reflects the misalignment between the skills obtained through formal education and the actual demands of the labour market, particularly in less developed regions.

Long-term unemployment is a significant consequence of spatial mismatch in Tunisia. The National Observatory of Employment and Qualifications (ONEQ), as outlined in the "Employment Outlook 2020" report by the Tunisian Ministry of Vocational Training and Employment reveals that many graduates remain unemployed for extended periods. This situation highlights the limitations of existing labour market policies and suggests the need for innovative approaches to mitigate spatial and skill mismatches.

BEST PRACTICES FOR ADDRESSING SPATIAL MISMATCHES OF SKILLS

Drawing from international experiences, several best practices have emerged to address spatial mismatch and skill-job mismatches effectively:

- Decentralized Job Creation: Countries like Germany and Sweden have implemented policies to encourage businesses to establish operations outside metropolitan areas. Such policies often involve tax incentives, subsidies for job creation, and support for infrastructure development in rural regions. This approach can be adapted for Tunisia by promoting investment in less-developed governorates.
- Improving Labour Mobility: Policies aimed at increasing labour mobility, such as housing subsidies, transport infrastructure improvements, and flexible relocation assistance, have proven effective in reducing spatial mismatch. For instance, Japan's government has incentivized relocation to less populated areas by providing financial support to families and individuals willing to move.

- Regional Skills Development Programs: Countries with regional economic disparities, such as Spain and Italy, have implemented localized skills training programs tailored to the specific demands of regional labour markets. These programs involve collaboration between local governments, educational institutions, and businesses. For Tunisia, regional vocational training centres could be expanded and adapted to match the unique economic profiles of different governorates.
- Use of Information and Communication Technology (ICT): Leveraging ICT to bridge spatial gaps by providing online job matching services can improve labour market efficiency. South Korea's Job World and Denmark's Job net platforms connect job seekers to employers across regions, reducing the geographical barriers to employment. Tunisia could develop similar digital platforms to facilitate job searches, especially for graduates in rural areas.
- Active Labour Market Policies (ALMPs): Targeted ALMPs, such as job-search assistance, wage subsidies, and public works programs, have been successful in several countries, including the Netherlands and Finland, in addressing both skill and spatial mismatches. Tunisia could strengthen ALMPs to provide targeted support to unemployed graduates, especially in disadvantaged regions.

JOB MATCHING PROCESS

BRIEF LITERATURE REVIEW

A growing body of literature has endeavoured to identify the labour market impediments that could elucidate these statistics. One plausible explanation is that the available job opportunities necessitate a greater skill set than most workers possess. However, it is evident that even job seekers with relatively high levels of education, such as those who have completed secondary and tertiary schooling, encounter difficulties in finding suitable employment (Pritchett, 2000 and Kraay and Mckenzie, 2014). Hence, it is improbable that the skill mismatch can fully account for this situation. Another conjecture is that there exists a discrepancy between the preferences of workers in terms of job types and the actual availability of such positions. This could clarify the remarkably high turnover rate in jobs, even in an environment characterized by high levels of unemployment, to the extent that companies express concerns about the lack of reliability among their employees and unexpected resignations (Banerjee et al., 2008). Workers might voluntarily leave their jobs due to an overestimation of their likelihood of securing occupations that are more desirable.

The persistence of inaccurate beliefs may arise from a combination of factors such as deficient urban infrastructure, exorbitant transportation costs, and residential segregation, which tend to place low-income groups at a significant distance from the city centre where most employment opportunities are concentrated. This spatial disconnect compromises the ability of job seekers to effectively search and target suitable jobs. Moreover, the physical separation between individuals can exacerbate social divisions and foster homophile in both social and professional networks. Consequently, the information received by job seekers from their networks regarding the labour market may be less accurate. Notably, prevailing labour search models, including those proposed by Diamond (1982), Mortensen and Pissarides (1994), Acemoglu and Shimer (1999), Pissarides (1985, 2000), and Burdett and Mortensen (1998), all share the untested assumption that job seekers possess unbiased beliefs about their employment prospects.

The evolution of technology has changed the way people find jobs and the way firms receive applications. The Internet has made applying for jobs more convenient, and as applicants often consider the more applications, they make, the higher the chances of being selected, sometimes leading to a huge number of applications per job that the recruiter has to screen (Singh et al. 2010). The automatic matching of vacancies with job applicants is a major problem for a number of firms and job seekers that if successfully addressed, could have a positive impact in many countries around the world. Martinez-Gil et al (2016) and Pombo (2019) use the Machine Learning as a new method of automatic matching of job vacancies and suitable candidate profiles. These authors do not take into account the spatial dimension in the selection process. This paper tries to fill this gap.

THE JOB MATCHING MODEL AND ITS PROPERTIES

Distinguished by Pissarides (2000), the matching process between vacancies and job seekers is modelled through the matching function; have the structure borrowed from production theory[3]. Indeed, the stock of matches ($M_{r,t}$) is described as the result of a production function whose factors are the stocks, at the end of the period, of vacant jobs ($V_{r,t}$) and of unemployed people actively looking for work[4] ($U_{r,t}$)

$$M_{r,t} = m \,.\, M(V_{r,t}\,, U_{r,t}) \quad (1)$$

where r and t indicate the region and the period, respectively , m is a parameter of efficiency of matching process, [5]. The matching function (1) is supposed to verify the following hypotheses:

1. checking Inada conditions[6] as well as the conditions at the edges,
2. homogeneous of degree 1 in each of its arguments,
3. increasing and concave,

$$M_{r,t} \leq min\{(U_{r,t})\,,\ (V_{r,t})\}$$

We note θ ≡ V / U the tension on the labour market. The rate of obtaining a job μ is thus equal to μ≡ μ (θ) = m (1, θ) while the recruitment rate of firms is η≡ η (θ) = m (1, θ) / θ.

[3] Another approach, mismatch indicators, emphasizes the measurement of mismatch unemployment, attributable to structural or frictional problems more than to insufficient demand (Abraham, 1983).

[4] In our model, job seekers include only the unemployed. In other models, job seekers also concern workers looking for another job better than the present.

[5] From a strictly methodological point of view, the resemblance between the production process and the matching process is striking, which explains why the latter is generally modeled using a production function.

[6]The conditions of Inada on behalf of the Japanese Ken-Ichi-Inada are the assertions on the form of a production function guaranteeing the stability of economic growth. The six conditions are as follows: 1 / the function is 0 in 0, 2 / the function is continuously differentiable, 3 / the function is strictly increasing, 4 / the second derivative of the function is negative therefore concave, 5 / the derivative tends positively towards infinity in 0 and 6 / the limit of the derivative tends positively in infinity is 0.

$$\lim_{\theta\to\infty} \mu(\theta) = \lim_{\theta\to 0} \eta(\theta) = \infty\, \mu(\theta) = \lim_{\theta\to\infty} \eta(\theta) = 0$$

The functional form chosen by most authors is that presented by a Cobb-Douglass function[7]:

$$M_{g,t} = m\, V_{g,t}^{\alpha}\, U_{g,t}^{\beta} \qquad (2)$$

$$0 < \alpha < 1, 0 < \beta < 1$$

where the parameters α and β measure the elasticity of the matches with respect to the stock of vacant jobs and job seekers.

APPLICATION OF THE JOB MATCHING MODEL FOR THE CASE OF GRADUATES

De la Croix et al. (2002)[8]provide a framework for analysing the qualified labour market by means of the matching function. He notes that the market where the workforce is qualified; is characterized by a framework of imperfect competition. In particular, the matching process is such that at equilibrium wages the probability of a firm finding the required number of skilled workers and the probability of a skilled worker finding a position are both less than 1 (the same conditions as the canonical model). Formally, the matching function is written as follows:

$$M_{g,t} = B\,.\,M\left(V_{g,t}\,, U_{g,t}\right) \quad (3)$$

Where M is the number of positive meetings, ie having generated the attribution of a qualified work station, B a parameter expressing the efficiency of this market, V is the number of firms present on this market and U is the number of qualified workers.
The logarithmic form of the model is given as follows:

$$\log M_{g,t} = b + \alpha\, log V_{g,t} + \beta\, \log U_{g,t} + \varepsilon \quad (4)$$

[7] Among others, the work of Blanchard and Diamond (1989), Layard et al. (1991), Van Ours (1991)

[8] The book is "Human capital and dualism on the labor market" Edited by David de la Croix and Frederic Docquier and Christine Mainguet and Sergio Perelman and Etienne Wasmer, published by De Boeck Supérieur, collection "Économie, Société, Région" in 2002.

ANETI: THE ONE AND ONLY PUBLIC EMPLOYMENT INTERMEDIATION AGENCY IN TUNISIA

The National Agency for Employment and Self-Employment (ANETI) is a public institution under the supervision of the Ministry of Vocational Training and Employment. Its main mission is the implementation of the government's policy on the promotion of employment. However, the ANETI is in charge in particular of:

- Intermediation between job seekers and vacancies via its network of Employment Regional Offices,
- Giving information on employment and professional qualifications,
- Informing, training and integration job seekers into working life with the Active Labour Market Policies, and
- Organising and ensuring the implementation of operations for the placement of Tunisian labour abroad as well as facilitate the reintegration of immigrant workers into the national economy.

Since 2011, the ANETI has been at the heart of the renewal of the public employment system designed for the most vulnerable groups, particularly young people. In this context, ANETI's advisers directly participated in setting up new specialized services and improving new procedures. It is clear that, despite the undeniable investment by the public authorities in youth employment, the performance of the measures could be improved. To do this, it appears necessary to strengthen the ANETI's training and employment programs and capacities at the micro level. Inaccessibility to information is the most common obstacle for job seekers and employers. Thus, the Regional Employment Offices have insufficient coverage of job vacancies among the local labour market. They only broadcast offers sent directly by employers and neglect offers published in social networks, public places and other media. In addition, they neglect temporary jobs, which can nevertheless represent a stepping-stone to permanent jobs.

THE DEVELOPMENT OF THE JOB MAP APPLICATION

DATA BASE MANAGEMENT SYSTEM FOR THE LABOUR MARKET

The identification of labour market issues depends on the availability of data, information and analysis. Labour market information systems provide an essential basis for employment policies by guiding the design, the implementation, the monitoring and the evaluation of policies. These systems also help to reduce the transaction costs of labour markets. Most countries are committed to developing labour market information systems. However, in developing countries, many obstacles, including insufficient database, hamper the functioning of such systems. This includes not only complex issues such as informality and employment protection, but also labour market indicators published in more developed economies on a monthly or quarterly basis, such as employment and unemployment indicators. In developing countries, inadequate data are due, for example, to resource scarcity, insufficient analytical capacity and structural factors.

In addition, labour market institutions, such as workers and employers' organizations, are weak in many Southern countries to translate information analysis into policy decisions. These difficulties prevent adequate job matching, thus undermining efforts to achieve development and labour market objectives.

RELATIONAL SCHEMA FOR THE JOB MAP APPLICATION

The Job Map Application was developed as a decision-making tool tailored to address spatial and skill mismatches in the Tunisian labor market. To achieve this, the application integrates geospatial data and machin learning algorithms within a relational schema designed to optimize job-matching processes. Specifically, the system matching the job seekers with vacancies.

The relational schema is implemented using MySQL, enabling the efficient organization and retrieval of data. The schema consists of interconnected tables, including Jobseekers, Employers, Job Offers, Skills, and linking tables such as Jobseekers kills and Job Offer Skills. This schema allows for seamless integration of job seeker profiles, employer needs, and job opportunities, creating a dynamic database that evolves, as new data is added. To enhance the user experience, the application employs a user-friendly graphical interface, which simplifies interaction for job seekers and employers. A core component of the interface is the algorithmic engine that incorporates geospatial analysis, calculating Euclidean distances between job seekers and job locations. By ranking matches based on proximity and skill alignment, the system prioritizes accessibility and relevance.

Incorporating decision-support algorithms, such as machine learning models and ordered logistic regression, the application mimics human reasoning processes, including inference, analogy, and deduction. These algorithms are continuously refined using data provided by the National Agency for Employment and Self-Employment (ANETI). Through this intelligent decision-making system, the application empowers public intermediaries to better advice job seekers, monitor unemployment trends, and evaluate the effectiveness of labour market interventions.
The system is also designed to support automatic updates to the database. For example, whenever a new job seeker or job vacancy is registered, the database is incrementally updated, ensuring real-time accuracy in matching calculations. Validation algorithms are integrated to maintain the consistency and reliability of the relational schema, while symbolic and connectionist modules further enhance the system's ability to manage complex data.

This relational schema lays the foundation for transforming the Job Map Application into a comprehensive labour market management tool. By automating and optimizing job matching processes, it enables public employment agencies to fulfil their mission of improving labour market efficiency, reducing unemployment duration, and promoting economic inclusion across all regions in Tunisia.

Figure 3 illustrates the physical schema of the database, highlighting the interconnectedness of key components and their role in facilitating intelligent decision-making.

IMPLEMENTATION OF THE "JOB MAP" WEB APPLICATION

DATA INTEGRATION

We used individual database for 200 jobseekers and 200 employers obtained from the National Agency of Employment and Self Employment ANETI for the year 2020. In our study, we have imported a database already prepared in Excel. This database is obtained from the National Agency for Employment and Self Employment (ANETI). We select a sample of 200 job seekers and 200 vacancies. Geographic information and mapping software such as ArcGIS and Arc-Map for example, are not publicly available because the creative company pays for them. In the absence of this constraint, we will use the OSM for the projection of the matches on the map of Tunisia in ascending order. The open world map “Open Map Street” makes the results of the job matching process visible on the Tunisian map.

THE PROCESS

The Job Map Application has been implemented to address the specific challenges faced by poor and marginalized job seekers in Tunisia, particularly those residing in rural and interior regions. By integrating various data criteria such as geographic location, skillsets, and job availability, the application provides two main outputs: first, precise matches between job seekers and job vacancies based on proximity and qualifications; second, a comprehensive analysis of unemployment patterns, focusing on disadvantaged groups.

For instance, the system analyses unemployment durations for job seekers in marginalized regions, filtering data by demographic attributes such as age, income level, and educational background. If the database includes 150,000 registered job seekers, the application could highlight an average unemployment duration of 125 days for low-income candidates. Focusing on individuals in rural governorates, like Kasserine, aged 18–25, with minimal vocational training, the system may reveal even longer durations, such as 180 days for 12,000 individuals. This granular data is vital for identifying regions and groups most in need of intervention.

The application provides actionable recommendations to improve job accessibility for these underserved populations. The first set of recommendations focuses on geographic mobility, suggesting nearby districts or areas with higher job availability. The system ranks job opportunities by distance and accessibility, highlighting locations that minimize commuting costs and travel time, which are critical considerations for low-income job seekers.

In addition, the application proposes recommendations tailored to the skills and qualifications of job seekers. For individuals with limited or mismatched skills, the system identifies gaps and suggests vocational training programs. For example, a youth in rural Tataouine with no formal qualifications might be directed toward short-term training in masonry or agriculture, which align with local market needs. Such targeted recommendations increase the likelihood of employment while reducing unemployment durations for marginalized groups.

By combining these geographic and skill-based recommendations, the Job Map Application serves as a decision-making tool for public employment agencies like the National Agency for Employment and Self-Employment (ANETI). The dashboard functionality enables policymakers to monitor regional unemployment trends, evaluate intervention effectiveness, and prioritize resource allocation.

Moreover, the application dynamically updates its database with new job offers and registrations, ensuring real-time relevance. By integrating intelligent algorithms and leveraging geographic data, the Job Map Application becomes an essential tool for reducing unemployment among poor and marginalized job seekers, while promoting equitable access to economic opportunities across Tunisia.

This innovative solution aligns with national efforts to reduce inequality and foster inclusive economic development, empowering disadvantaged job seekers to overcome barriers and achieve sustainable employment.

EXAMPLE OF THE JOB MAP APPLICATION USE

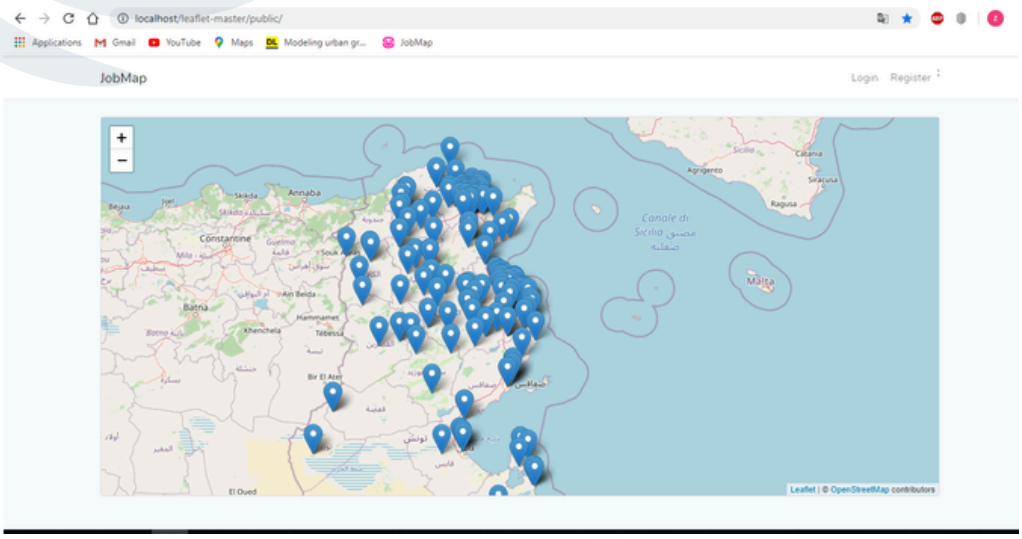
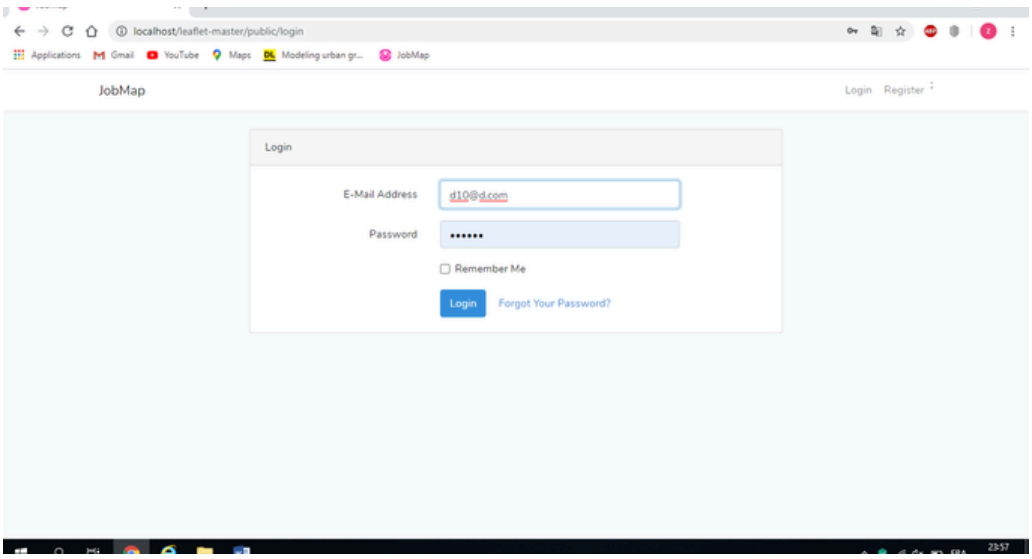


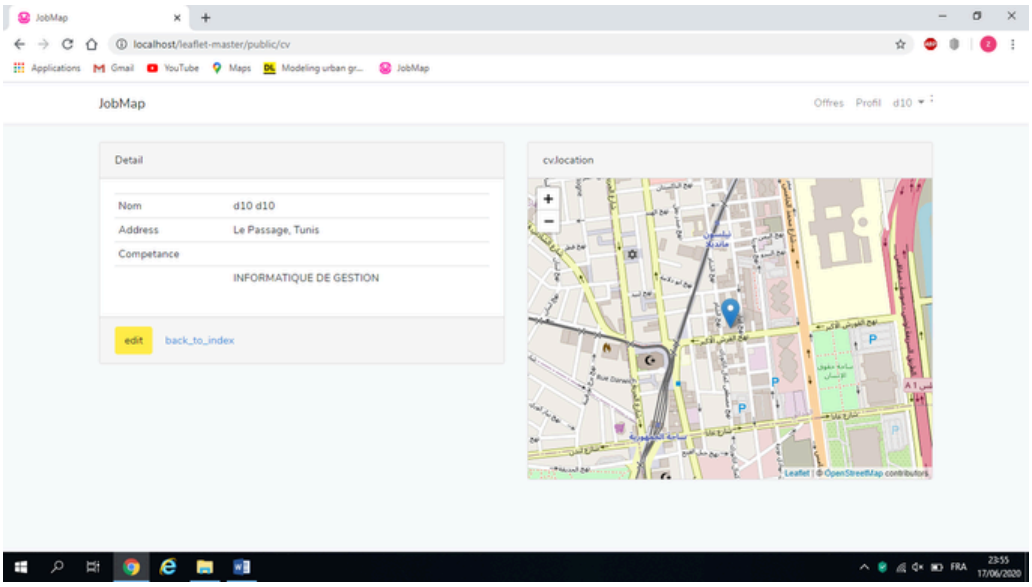
Figure 1. Interface of the "Job Map" application

EXAMPLE OF JOBSEEKER N°10 JOBSEEKER

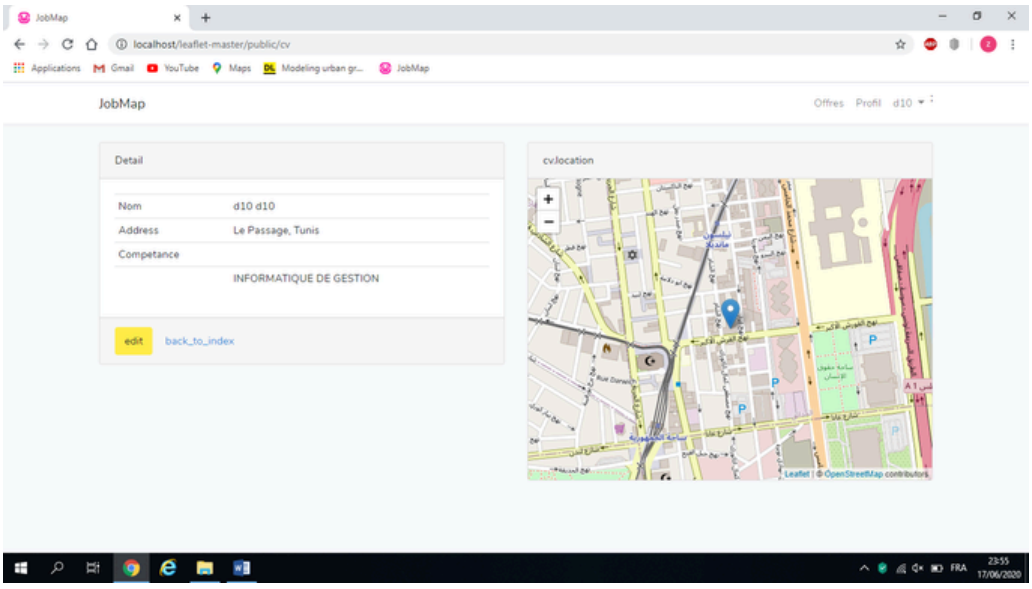
The job seeker n°10 must create an account using his email and a password (figure1).

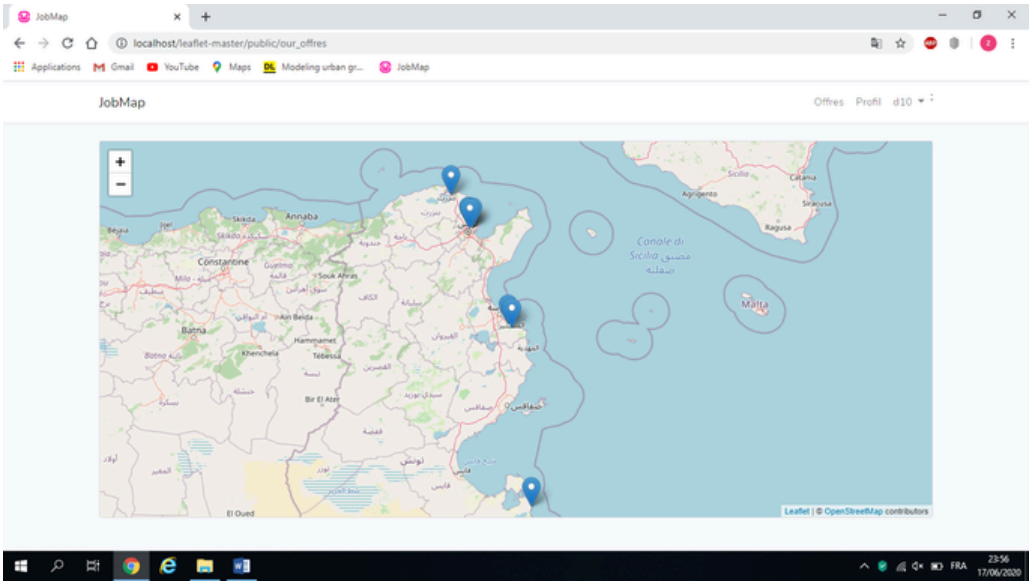


Then, he must insert his CV with the different informations: name, surname, gender, residence address, qualification, etc...



The candidate enter to his profile and insert “edit” (figure 3). Then, he will get a map with the offers placing from the near to the far vacancy matching his qualification with notification on the map (figure 4 and 5).

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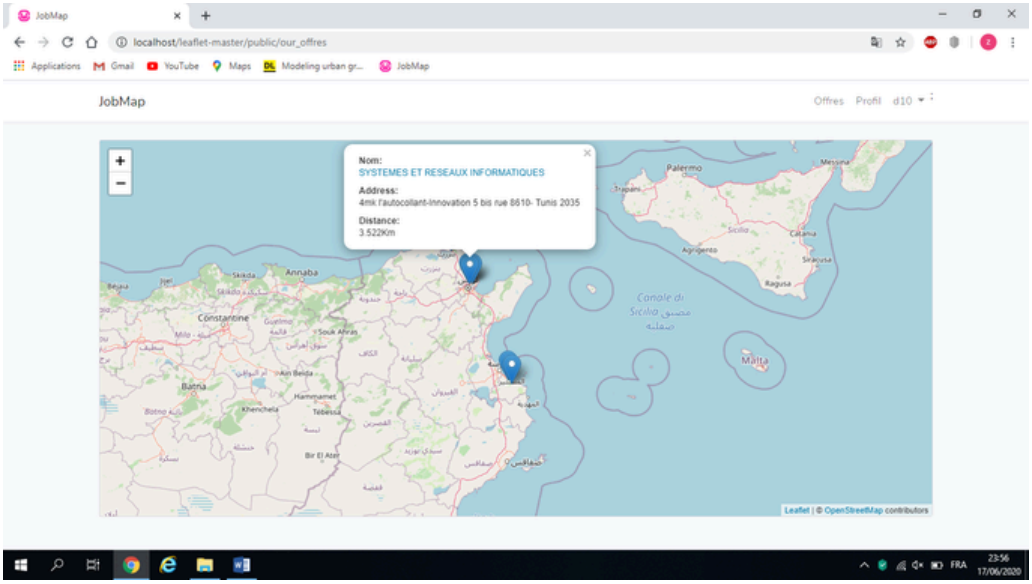
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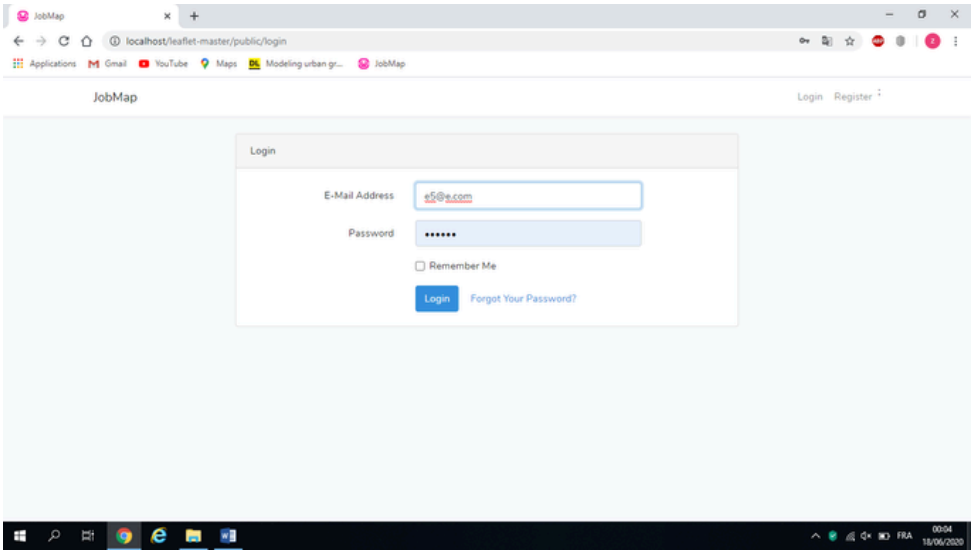
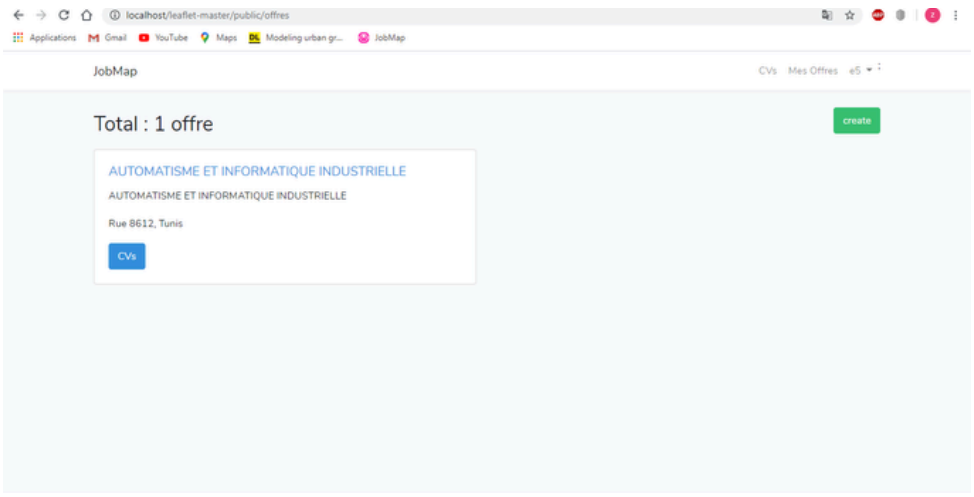
EXAMPLE OF THE EMPLOYER N°5

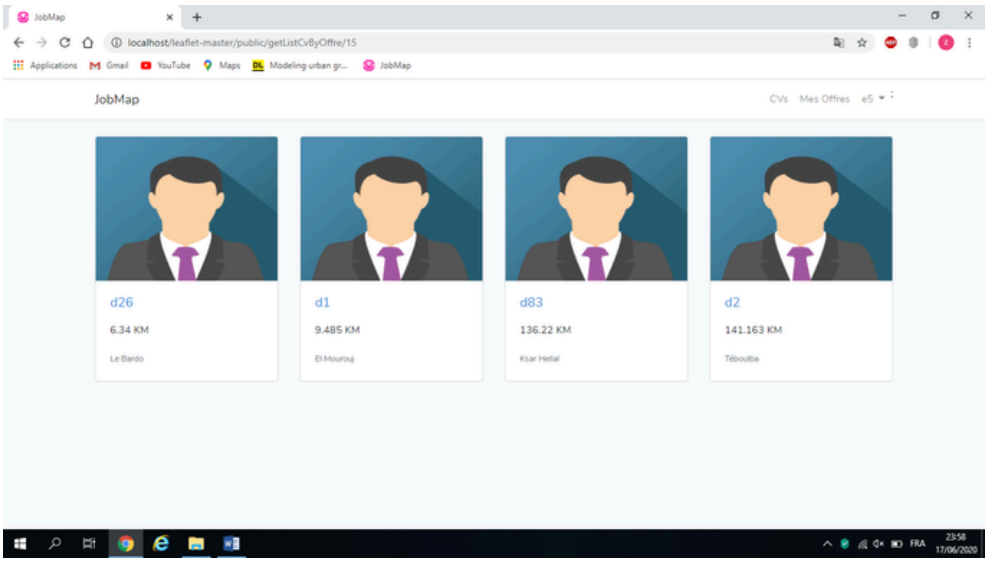
We take the example of the employer n°5. He should create an account using the firm email and a password (figure 6).



Then, the employer must create an offer (a vacancy) with the required criteria (qualification, experience, etc...) (figure 7)



Thus, by searching for adequate profiles, the employer will find different profiles for the adequate offer sorted by distance (figure 8).



DISCUSSING REGIONAL BENEFITS

ALLEVIATING UNEMPLOYMENT IN DISADVANTAGED REGIONS

The Job Map Application enhances job accessibility by offering recommendations based on the geographic location of both job seekers and employers. This helps job seekers in interior and rural areas access job openings that they might not otherwise be aware of, thereby addressing the spatial aspect of labour market disparities. By integrating with public employment agencies like ANETI, the application can provide data-driven insights for policymakers on regional employment trends and skills gaps. This can help tailor labour market policies to the needs of specific regions, promoting more targeted job creation programs and support services.

PROMOTING EMPLOYMENT FOR WOMEN AND YOUTH

Explain how the Job Map can be particularly beneficial for women who face cultural or logistical barriers to employment, such as limited access to transportation or safety concerns. The platform's ability to recommend job opportunities closer to home can make it easier for women to participate in the labour market, thereby promoting gender equality in employment. The application provides young graduates with personalized job suggestions, making it easier for them to find work that matches their qualifications and aspirations. This can help reduce the high youth unemployment rate, which is a critical issue in Tunisia.

REDUCING SOCIAL EXCLUSION AND LONG-TERM UNEMPLOYMENT

The Job Map can help break the cycle of long-term unemployment by connecting job seekers to opportunities that are geographically accessible and match their skills. This reduces search time and effort, making it easier for individuals who have been out of work for extended periods to re-enter the labour market. By making formal job opportunities more accessible, especially in underserved regions, the platform can help reduce reliance on informal work and provide more stable and secure employment options.

INTEGRATING THE JOB MAP WITH BROADER DEVELOPMENT STRATEGIES

Link the project to Tunisia's national employment strategies and economic development plans. Explain how the Job Map aligns with government priorities for reducing unemployment and fostering regional development, particularly with technology and data-driven solutions. Discuss the potential for the Job Map to be replicated in other Southern Mediterranean countries facing similar challenges, thus contributing to regional development goals and promoting cross-border cooperation in tackling youth unemployment and labour market inequalities.

By explicitly linking the Job Map Application to these SDG[9] goals and emphasizing its potential regional and social benefits, the paper will demonstrate the project's relevance to sustainable development efforts. This approach not only strengthens the academic contribution but also positions the application as a practical tool for achieving broader economic and social objectives in Tunisia.

The Job Map Application supports SDG 8 by facilitating better job matching, which can lead to more efficient labour market functioning and reduced unemployment. By connecting job seekers with opportunities based on geographic proximity and skill compatibility, it helps ensure that workers can access suitable employment without facing excessive barriers related to distance or lack of information. The Job Map Application contributes to SDG 10 by reducing inequalities in access to employment across different regions in Tunisia. It helps bridge the spatial gap by making job information available to job seekers in disadvantaged regions, which often have fewer employment opportunities.

[9] The TunisianSustainable Development goals (SDG) 2015-2030 has 17 goals

CHALLENGES, FUTURE DIRECTIONS, POLICY IMPLICATIONS & RECOMMENDATIONS

Our Job Map web application faces both technical and labour market related challenges, each requiring distinct responses in terms of future development and policy relevance.

TECHNICAL CHALLENGES AND FUTURE DEVELOPMENT OF THE APPLICATION

From a technical perspective, the platform must prioritize improvements in user experience and system performance. This includes enhancing responsiveness, reducing loading times, and improving the overall interface design to ensure accessibility and usability. Building user trust is also essential, particularly through reliable performance and transparent functionality.

Scalability remains another key challenge, as the application must be able to handle increasing user traffic efficiently. This can be addressed through AI-based or consensus-driven scaling mechanisms that ensure higher throughput and lower latency. In parallel, improving the quality of crowd sourced geospatial data is essential; as current limitations in data reliability can affect system, accuracy and user trust.

To address these issues, future development should focus on:

- Investing in user experience and interface design
- Implementing scalable AI-based infrastructure solutions
- Improving data quality through better understanding of contributor behaviour and validation mechanisms
- Enhancing system reliability and performance under high demand

LABOUR MARKET CHALLENGES

Beyond technical aspects, the application also responds to broader labour market challenges, particularly the global digital skills gap and structural inefficiencies in job matching. Workers increasingly face difficulties adapting to changing labour market conditions, especially in contexts where skill mismatch and spatial mismatch are persistent.

To address these issues, the platform should evolve to support labour market adaptation by integrating soft skills development modules, career guidance tools, and personalized job recommendations. Such features can enhance employability and improve the matching process between job seekers and employers.

In this regard, key recommendations include:

- Incorporating soft skills training and career development support
- Providing personalized job recommendations and career mapping tools
- ·Developing tools that facilitate efficient matching between job seekers and employers

POLICY RECOMMENDATIONS

Innovative solutions to youth unemployment and spatial mismatch have important policy implications. Governments should encourage youth-led innovation, which is often driven by creativity, adaptability, and risk-taking, through targeted policies that address the motivations and barriers faced by young innovators. The Tunisian government, for example, should promote public transportation, car-sharing schemes, and other mobility solutions to reduce spatial barriers between residences and employment locations, a key driver of youth unemployment linked to spatial mismatch.

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Innovation policies should also address social and environmental challenges with inclusion at their core, ensuring that the benefits of innovation are accessible to all groups, particularly those who are currently marginalized. Collaboration between governments, firms, and local communities is essential to provide mentorship, skills development, and networking opportunities for young innovators, thereby improving employability and reducing labour market gaps, especially for women and minorities.
In addition, innovative spatially targeted employment strategies such as linking job opportunities to the population within a defined radius of residence can help reduce mismatches by taking into account local unemployment rates and vulnerability factors.

Finally, these policy approaches should be designed with sustainability in mind, including continuous monitoring, evaluation, and adaptation to changing labour market conditions. Importantly, although these recommendations are developed in the Tunisian context, they are highly transferable to other Southern Mediterranean Countries (SMCs), where similar challenges of youth unemployment, spatial inequality, and skill mismatch persist.

CONCLUSION & FURTHER PERSPECTIVES

This new IT tool for data management therefore provides a managerial solution intended in particular for the ANETI. Indeed, in order to fight against spatial inequalities, the government must improve accessibility to territories and services. The "Job Map" application can be considered as a policy of positive territorial discrimination. The latter allows all users (job seekers and firms) to associate the requested profile without taking the trouble to distance.

Sheltered from the geography of employment and poverty, the need for such an application is imperative for a country like Tunisia, where the majority of job seekers belong to needy families. All you have to do is consult your account by phone and avoid going to employment offices where the staff are sometimes more or less helpful. In another step, the application will fully play its role of database management for ANETI. In fact, the essential role of this job promoter becomes the management of the database rather than the search for the appropriate matches.

At the same time, the "Job Map" application offers a solution for the problems of spatial mismatch and qualification mismatch in the cities of origin. Overall, this allows policy makers to determine which university courses generate jobs and which should be eliminated. We join here two practical sides of the thing, one on an individual scale, and the other on a more macroeconomic scale. The platform directly addresses the high youth unemployment rate in Tunisia by providing targeted recommendations that consider the specific challenges faced by young graduates. For example, the application helps reduce search costs for job seekers and supports their transition into the labour market by making employment opportunities more accessible.

Furthermore, the Job Map can contribute to reducing informal employment by directing job seekers towards formal job opportunities listed in the database, thereby promoting decent work conditions and economic stability. Moreover, the application specifically targets groups that are often marginalized in the labour market, such as women, youth, and people in rural or underdeveloped regions. By prioritizing job matches within a feasible commuting distance, it helps overcome mobility challenges that can disproportionately affect low-income job seekers.

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