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ORIGINAL RESEARCH PAPER

Empowering skill development through generative AI bridging gaps for a sustainable future

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Abstract

Discovering and addressing skill gaps is key in today's knowledge-driven economy, enabling economic growth while reducing inequalities. Here, I present a novel approach using Generative AI for resume analysis, skill extraction, and personalized recommendations based on cutting-edge research directions. Utilizing high-end natural language processing and data analytics, this method integrates person-specific skills with evolving industry phenomena.

The method is designed to combat urgent issues in education and employment, providing key data on skill gaps and improvement routes. Using practical case studies, it illustrates how bespoke guidance can empower individuals in their pursuit of meaningful careers, contributing to sustainable development. This aligns with SDGs 4 (Quality Education), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation and Infrastructure) and 10 (Reduced Inequalities).

The paper highlights the revolutionary role that AI can play in making career guidance available to all. Integrating resources for skill enhancement to provide access allows learners from varying backgrounds to gain knowledge from pioneering research and practice. Furthermore, the proposed system is also centered on lifelong learning, which prepares a future-ready workforce to ensure innovation and resilience in a fast-evolving global economy.

The implications encourage the inclusion of generative artificial intelligence in educational systems and professional development to optimize human capital. This can minimize opportunity gaps, empower underserved communities, and increase global productivity. The research offers a practical pathway to advance SDGs and build sustainable futures by mapping the direct impact technology has on education, employment, and equity.

Keywords: Generative AI, Skill development, Sustainable development goals, Workforce innovation, Education, Economic growth

Introduction

Background and context of the research problem

The 21st-century industries have evolved in ways that have turned the world workforce pattern upside down. Due to advances in technology and globalization, the job market is constantly changing in today's fast-paced world. While a traditional career guidance system might work well in structured circumstances, it often neglects the nuanced needs of those undergoing these complex transitions. This divide has widened existing skill gaps, especially in emerging economies, exacerbating unemployment, underemployment, and economic inequality (Card *et al*., 2002; Krueger *et al*., 2004; Escobari *et al*., 2019).

The issue lies at the core of conventional approaches, which fail to align individual capabilities with industry needs. These approaches primarily rely on static assessment tools, historical job trajectory data, and general recommendations, resulting in a lack of flexibility that is crucial for addressing contemporary realities (Institute of Vocational Training, 2025; Visual Workforce, 2024). Moreover, these methods often remain inaccessible to underserved communities, exacerbating disparities in skill development and career opportunities (Institute of Vocational Training, 2025).

The arrival of Generative AI is a game-changer that could help solve these problems. Using state-of-the-art techniques of natural language processing and machine learning, Generative AI can process large amounts of data, identify relevant aspects of the insights, and provide personalized

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career guidance (Duan *et al*., 2024; Singh *et al*., 2024). This three-fold process bridges individuals' potentialities and industry needs, providing insights that use the individual's data as a reference to understand their profile better and align them with the professional trend.

The research explores how Generative AI can be utilized for skill extraction, gap identification, and custom skill development. The study highlights how AI-driven methodologies to democratize career guidance can contribute towards the sustainable development of human capital, harmonizing this approach with the targets and goals of Sustainable Development Goals, including but not limited to SDGs 4 (Quality Education); 8 (Decent Work and Economic Growth); 9 (Industry, Innovation and Infrastructure); and 10 (Reduced Inequalities). This helps us contextualize some of the ways AI is influencing the future of work and education.

Research Question

The question we answer in this paper is, *"How can Generative AI bridge skill gaps effectively to empower individuals and support the achievement of Sustainable Development Goals (SDGs)?"*

The rapid evolution of most industries, coupled with advancements in technology, has made traditional methods of developing and sustaining skills insufficient. With static assessment methods, one-size-fits-all recommendations, and limited adaptability, conventional approaches do not align well with the needs of a more dynamic contemporary market. They can result in a waste of resources and failure to keep up with the skills needed for economic growth and innovation (World Economic Forum, 2023). Furthermore, the lack of access to customized advice creates inequity between social strata and disadvantages some people in terms of meeting their skill needs according to the job requirements (World Economic Forum, 2024; Financial Express, 2024).

Generative AI has the transformative potential to automate skill assessments, identify gaps, and create personalized pathways for development. By utilizing machine learning models with large datasets, prevailing skills can be aligned with industry needs (Rotatori *et al*., 2021; Weritz, 2022). This methodology encourages equality of access to career guidance and cultivates adaptability in the workforce, aiding directly toward the following SDGs.

SDG 4 - Quality Education

Generative AI provides personalized learning experiences that promote inclusive and equitable quality education (Nyhan & Marshall, 2024).

SDG 8 - Decent Work and Economic Growth

AI addresses skill gaps, enabling individuals to obtain decent work while promoting sustainable economic growth (World Economic Forum, 2023)

SDG 9 - Industry, Innovation, and Infrastructure

AI-generated solutions strengthen workforce preparedness and protect industry innovation and infrastructure development.

SDG 10 - Reduce Inequalities

Generative AI can help resolve disparities in education and employment opportunities by providing scalable, tailored solutions.

Answering this research question aims to demonstrate how Generative AI can democratize skill development and contribute to sustainable human capital growth, creating a more inclusive and adaptive global workforce.

Importance or significance of the research

Strategies that directly pertain to the type of workforce that would assist in building a sustainable and equitable workforce with personalized learning being at the heart of it. By aligning individual learning pathways with the demands of industry in today's rapidly changing global economy, we ensure that our workforce development is both dynamic and equitable. The purpose of this research is to highlight how personalized learning can be a cornerstone of our approach against disparities in education and employment, creating pathways to opportunities for our most underserved communities and skills needed to meet the demands of tomorrow.

Personalized learning helps to maximize education based on personalized strengths, needs, and career goals, allowing learners to gain skills that translate directly to industry needs. Such a model improves employability and mitigates the skills mismatch that traditional academia so often perpetuates. This has highlighted what we already knew about personalized and adaptive learning models, which enhance engagement in the learning process as well as knowledge and skill retention, thus leading to sustainable economic development (Pane *et al*.).

In addition, the gap in education and employment has long impeded social equity and economic growth. Using tools such as Generative AI to develop individualized learning pathways makes education and skills building more widely accessible in a way that can bridge inequalities and contribute to SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 10 (Reduced Inequalities).

It can help upskill professionals, particularly those looking for career transitions or new market opportunities, by providing an in-depth analysis of individual learning patterns, career paths, and emerging economic trends. This aids in personalized career development and a shift toward a lifelong learning ecosystem. Not only does this allow people to stay competitive, but it also guarantees that the workforce changes with technological progress and global economic shifts.

Overview of the paper's structure

This structured flow of the paper allows us to methodically witness the revolution Generative AI can bring to the table for skill development and career guidance. It starts with an abstract summarising the main goals of the research, the methods applied, and the linkage to the Sustainable Development Goals (SDGs). It begins with the introduction, where it talks about the importance of closing the gap between educational attainment and industry needs. Challenges in traditional systems are being discussed with an introduction to Generative AI as a transformative solution leading to the research question.

The literature review explores state-of-the-art references and current AI-based educational tools and highlights their drawbacks. It outlines the demand for targeted and feasible answers and the gaps in current scholarship, especially concerning accessibility and applicability in real-world contexts.

In the methodology section, I describe the multi-stage process I used: Skill Extraction using NLP and GPT-4o, Role Recommendation through Generative AI, and Research mapping to identify skill gaps in response to industry shifts. Integrating research platforms such as ResearchGate personalizes and temporizes AI recommendations.

The system testing methodology corroborates the approach by using it on historical resumes and comparing the system's predictions against actual career trajectories. This keeps the model reliable and relevant over time.

The results show the system's actual schedule output, such as role recommendations and skills gap analyses. By providing real-world correlations to the findings, the paper clearly illustrates the proposed solution's effectiveness.

This paper discusses the implications of this system for employability, equity, and academic collaboration. It also touches upon issues such as inclusion and bias, stressing the importance of properly validating AI models.

Lastly, the conclusion summarises the main findings, underscores the potential to scale the solution, and lays out future research and development directions. This overarching framework is pivotal in ensuring the in-depth and actionable nature of the study, which can be applied to academia, industry, and policymakers alike.

Literature Review

Current Landscape

The relationship between education and industry has changed, especially due to technological advancements and evolving economic demands. Research consistently highlights the importance of aligning academic programs with industry-specific skills to address the skills gap. According to the World Economic Forum, 50% of all employees will need major reskilling by 2025 (World Economic Forum, 2023). The OECD also stresses the need to promote "lifelong learning" to prepare a workforce for the changing nature of work due to automation and globalization (OECD, 2019).

This is where AI tools have come into the picture. The proposed automated solutions like adaptive learning platforms, personalized career guidance and data-driven educational content to bridge these gaps. Systems like Coursera's Skills Compass leverage AI to make suggestions as to which courses would be best-suited for a user based on their profile and the demands of the industry (Coursera, 2021). Nonetheless, these tools have two major shortcomings: a need for personalization and a lack of real-world simulation. Conventional AI systems usually work on fixed datasets and do not adjust to changing market trends or to individualized learning results (Luckin *et al*., 2016; West & Allen, 2018).

Research Gap

Despite the spread of AI in education, few tools use Generative AI to unlock truly personalized, actionable recommendations. Generative AI can offer personalized insights because it can process large amounts of diverse data, including real-time labor market analysis, individual skill sets, and industry requirements. Yet, there remains a gap in diagnosis literature, where most system emphasis is on predictive analytics but not prescriptive and generative models that support skill building at scale.

Additionally, much existing research is technocentric and equity-blind. Marginalized groups are often not provided with the necessary access to quality skill development resources, which continues to widen the economic divide (UNESCO, 2022). Addressing this missing aspect is essential to making strides toward SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 10 (Reduced Inequalities).

This paper aims to fill those gaps by proposing a framework integrating Generative AI with labor market data. The goal is to build a scalable, equal, and flexible framework for upskilling people as the global economy evolves.

Methodology

The process for addressing skill gaps with suggested careers is divided into stages, as shown in the flowchart in Figure 1. At each stage, the methods adopt innovative technologies and platforms to facilitate a comprehensive, data-backed, and customized program. It is a pipeline that combines natural language processing (NLP), Generative AI, and Web Scraping to extract information about skills, process it, and analyze it.

Step 1: Skill Extraction

Let us understand the input at this stage, the processing performed, and the output produced.

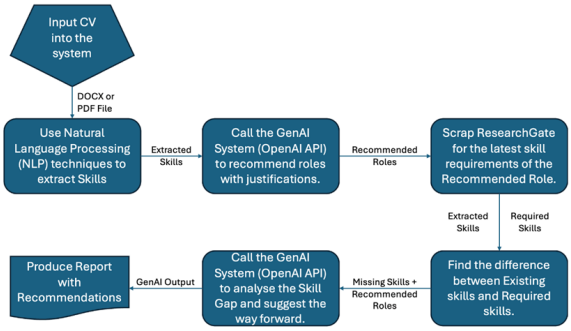

Figure 1: The System Flow

Input

The process begins with the upload of a resume in either DOCX or PDF format.

We avoided using sources of career information like LinkedIn. The reasons are as follows.

Privacy Concerns

Platforms like LinkedIn store sensitive user information, including personal and professional details that may not be willingly shared to process through these systems. Legal and ethical issues surround the use of data from these platforms without prior user consent, which could include violations of data privacy legislation such as GDPR or CCPA.

Inconsistent data structure

Some LinkedIn profiles are very organized (positive), and some are very disorganized (negative). This inconsistency can make it challenging to extract data and perform skills analysis automatically.

Explicit and Implicit Skills Focus

LinkedIn also emphasizes roles, job titles, and endorsements, which might overlook implicit skills that companies can deduce from detailed resumes. Resumes can provide explicit and contextual data—not only the skills listed but also the achievements, responsibilities, and expertise associated with a skill.

LinkedIn Public Data Scope Limitations

API limitations also exist, and data scraping is against LinkedIn policy. Hence, it is not suitable for large-scale and regular data collection.

User Consent

Users enter data voluntarily by uploading their resumes, being aware of their intended purpose. This reflects the system's transparency, ethical operations, and respect for user autonomy.

Focused Analysis

The resume serves as the only source of data for the skill extraction and recommendation process, helping to keep the results relevant to the user's skill set.

Privacy Protection

The system does not save uploaded resumes or extracted data. This alleviates fears about unauthorized data access or misuse, increases user trust, and meets privacy regulations. By processing data in real time and discarding it, the system eliminates storage overheads and provides a higher level of data security.

The benefits of this approach are as follows.

Transparency

Users are always aware of how their data is being used.

Security

With no stored data, there is no chance of breaches or leaks.

Personalisation

Resumes give a lot of rich, detailed, personalized information for an accurate analysis.

Ethics and Compliance

The system also protects privacy laws and ethical standards and completely avoids the risks of using data from third-party sourcing databases such as LinkedIn.

This approach guarantees that the system stays user-centered, ethical, and successful in providing accurate career guidance and skill recommendations.

Process

The skill set extraction process is conducted in two stages – one using NLP and the second complementing with analysis using GPT-4o.

NLP-Based Skill Extraction

The uploaded CV's DOCX or PDF files are processed using Natural Language Processing (NLP) techniques. Tools such as SpaCy tokenize the text, discern linguistic patterns, and extract relevant information.

The important steps are as follows.

Tokenization

The text gets segmented into smaller parts (tokens), including terms or phrases.

Part-of-Speech (POS) Tagging

The token is labelled with a POS Tag (noun, verb, adjective, etc.). Skills are usually related to nouns and proper names.

Filtering

Only skills (represented as nouns and proper nouns) remain. It discards unnecessary tokens like conjunctions and prepositions. Also, proper nouns representing a person's name and names of places, etc., are filtered out.

Frequency Analysis

Categorising these tokens to find frequently referenced skills.

Enhancement with Generative AI (OpenAI GPT-4o API)

OpenAI's GPT-4o API is employed as an additional step for contextual skill extraction to overcome the shortcomings of traditional methods.

Deducing Implicit Skills

If a skill or quality is not directly mentioned but can be inferred from the context (e.g., "managed a software development team" implies the person has leadership and project management skills), GPT-4o identifies and extracts such skills.

Completeness

GPT-4o also ensures a well-rounded skill list, capturing skills not necessarily listed or obvious from the text by grasping the holistic context of the CV.

Reason Behind Merging NLP and GPT-4o

Let us look at the strengths of NLP and GPT-4o.

NLP Strengths

- Processes structured text seamlessly and picks out distinct patterns.
- Lightweight and computationally efficient for explicit skill extraction.

GPT-4o Strengths

- Advanced contextual understanding
- Deduces nuanced or user-inferred skillets that improve overall accuracy and exhaustiveness.

The combined approach provides a strong and working skill extraction pipeline while also allowing for the complexity and vastness of the CV data.

Output

A list of extracted skills will be the output.

- Explicit skills (skills extracted using NLP).
- Implicit skills (inferred through GPT-4o).

This list is used as a foundation for future steps of role recommendation and skills gap analysis.

Step 2: Role Recommendation

The Role recommendation process uses Generative AI (OpenAI GPT-4o) to identify and recommend the job roles that best suit the extracted skills from the candidate's CV. This way, one can be certain that the recommendations are data-driven, contextualized to the specific customer use case, and based on a rich knowledge base of industry roles and skills needed to fill those roles.

Extracted skills from the NLP-based pipeline are fed into OpenAI GPT-4o. This knowledge serves as the foundation for role identification when assessing a candidate's strength, expertise, and suitability for viable markets. The system understands these nuances and provides recommendations that match the candidate's skills.

Prompt engineering plays a significant role in the quality and relevance of such role recommendations. This prompt is immaculately curated in order to help GPT-4o precisely understand what it needs to do, that is, provide relevant recommendations of roles. This training makes sure that the candidate's skills are correlated with job requirements in the industrial domain so that the system can output the required output efficiently. On top of this, the prompt also asks for both the role being suggested as well as a detailed explanation of why that role would be a good fit, adding further value to the recommendations.

GPT-4o's familiarity with vast amounts of training data allows it to understand industry roles, skill sets, and job market trends globally. This knowledge base helps the system map the candidate's skills to the most appropriate roles while ensuring that the recommendations are fresh and reflect changing workforce needs. Since global trends and industry needs are clearly understood, the output is highly contextual and applicable.

For skills input, the system recognises the best possible roles as per the inputs given by candidates. For every recommended role, GPT-4o suggests a clear job title and then explains exactly why. These explanations emphasize certain skills-related role matches, e.g., problem-solving skills required to be a Management Consultant role or leadership experience needed for a Project Manager role. This generates greater transparency around the reasoning behind each recommendation, giving candidates not just the opportunity but also the ability to understand their career growth better.

Benefits of Generative AI for Role Recommendation

The following are the benefits of using Generative AI for role recommendation.

Efficiency

This Generative AI processes the input skills and suggests roles within seconds, freeing up a lot of manual work and time needed for career guidance.

Contextual Understanding

The inference of implicit skills and contextual subtleties means that the CV does not have to represent all skills perfectly.

Broad Coverage

GPT-4o, tapping its vast training data, proposes roles in different industries and levels, from junior to boardroom.

Dynamic Updates

The system is good at looking at current trends, making recommendations, adapting to modern job markets, and the talent required in the field.

Step 3: Research Mapping

Adding new research trends and skill requisites to role recommendations improves their relevance, and Research

Mapping does just that. The system uses advanced scraping techniques to extract relevant data from sources such as ResearchGate, an ideal source of academic and industry research. This guarantees that the suggested roles not only align with the candidate's present skill set but also resonate with emerging trends and demands within the job market.

This phase gathers domain-specific data focusing on the relevant competencies, frameworks, and technologies relating to the recommended roles. Say, for instance, the recommended role is "Data Scientist." In such cases, the system fetches insights into variations of machine learning algorithms, data visualization tools, or statistical methods in present emphasis in academic and industrial research. In the context of management or consulting, it chooses to extract information regarding evolving business frameworks, strategies, and leadership trends. This incorporation of current knowledge keeps the candidate's profile relevant in the dynamic job market.

The recommendations are enriched by the data extracted from the research. The model maps the expectations of the candidate's skill set against the closest match of what skills their potential role might require, reducing the gap between the current and future skill sets.

The output of this step is a crisp list of skills that do not exist but are most desired for the recommended role. These skills are essential for the candidate to address the skills gap between their existing knowledge and what the role requires. If a candidate has strong analytical skills for consulting but lacks project management experience, for example, the system identifies project management as an important skill the user should acquire.

This output equips the candidate with focused guidance on the skills they should acquire to shine in their recommended role. By doing so, the candidate will have the confidence to chase opportunities that align with his ambitions while remaining competitive in an ever-changing workforce. This personalized method assists the candidate's development as a professional and creates a career trajectory based on personal and market needs.

Step 4: Skill Gap Analysis

The final step in the system is to recommend the skill gap with justifications. This step has three sub-steps – comparing existing and recommendation skills, skill gap analysis and recommendation, and generating the final recommendation report.

Comparison

The system conducts an in-depth comparison to determine which skills extracted from the candidate's resume are lacking and were identified as necessary during the research mapping phase. This is a pivotal point in the process because it clarifies how the candidate's strengths and capabilities fit with the needs of the role recommended for them.

Using the extracted skills, the system assesses whether the candidate has the knowledge and expertise for the position. Missing or underdeveloped skills are methodically identified and flagged as areas for development. For instance, if project management skills are required, but the resume only shows basic organizational abilities, the system marks project management as a gap to fill.

This phase is not confined to recognizing missing skills but also incorporates gradations of skill levels. It separates foundational knowledge from proficiency, allowing the analysis to be thorough and actionable. For example, suppose a candidate states familiarity with data analysis. In that case, the system can identify advanced tools or techniques (such as machine learning or predictive modeling) if they are required for the role recommended by the system.

The result of this comparison process is a concise, prioritized list of skill gaps. It illustrates these gaps in a manner that helps candidates visualize their current standings and the precise areas they need to work on. This identifies areas for improvement and gives candidates a clear roadmap for focusing their skill-building efforts to ensure they can fill any gaps and meet the demands of the role they are competing for.

Skill Gap Analysis

In the analysis and recommendation phase, the system uses OpenAI's cutting-edge potential to explore the recognized skill shortfalls further. This stage not only points out gaps but also provides practical and customized recommendations to address them. OpenAI GPT-4o analyses the candidate with respect to the recommended role and the skills gap.

The system creates customized recommendations tailored to the candidate's needs to close these gaps successfully. These recommendations typically involve certifications from reputable entities, unique training programs, and hands-on experience from projects or internships. For example, if a candidate isn't proficient in project management, the system could suggest getting a certificate such as project management professional (PMP) or taking workshops related to agile methodologies. For technical skill gaps, it might recommend online courses or coding boot camps that match industry best practices.

An important aspect of this step includes linking recommendations to broader career goals as well as global development priority areas. These recommendations are specific to contribute to the attainment of SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth) and SDG 10 (Reduced Inequalities) such that the aim is individualized but within a societal context of equal access to quality learning approaches and sustainable professional development.

Integration and Reporting

The last phase of the system is integration and reporting, where all findings and analyses from previous steps are

combined into a comprehensive report that is easy to understand for users. This report lays the foundation for the candidate's career development journey and provides a structured recap of strengths, opportunities, and suggestions for furthering their careers.

The first component of the report is the recommended roles that may suit the candidate's expertise and career path. These are followed by logical rationale linking the candidate's skills to the needs of the recommended roles. These explain why the roles work for the candidate and give candidates the credentials and self-assurance to apply for these jobs. This granularity ensures that the suggested recommendations are not vague but customised according to one's profile.

The last and most important part of the report is the identification of skill gaps and the corresponding development plans. The report highlights specific areas that need to be addressed and provides a guide for closing these gaps through focused education opportunities, such as certifications, training programs, and hands-on projects. This actionable advice allows candidates to target their efforts appropriately while also preparing to meet the demands of their desired roles.

This system utilizes state-of-the-art AI technologies to democratize career guidance. It allows access to underprivileged communities that tend to have few resources available to them. By providing a global overview, the report enables a better understanding of where to make informed career moves as well as greater equality of opportunity in achieving the desired level of professional advancement in a highly competitive market.

System Testing Methodology

The system was subjected to a rigorous testing methodology to confirm its effectiveness and reliability. This process employed a subset of resumes submitted five years ago to study the accuracy of the system's predictions of people's career paths and skill gaps. We wanted to see how the recommendations around the roles, job titles, and career positions that these people hold in 2025.

The model-based testing approach takes this process one layer deeper. It serves two purposes: first, it allows the system to be evaluated for its ability to determine relevant skills based on historical data that correspond to future roles. Second, it examines whether the system's recommendations were realistic and consistent with the actual trajectories seen over the intervening period. This methodology guarantees that the system's forecasting abilities not only work for a short period but are also strong enough to provide relevance over time (Box 1).

It started by entering historical resumes into the system to mine for skills and identify gaps. We then entered the extracted skills into the role recommendation engine to get

Box 1: Role Analysis: Product Consultant in Telecommunications

Recommended Role
Product Consultant in Telecommunications
Reasons for the Recommendation
This role is suitable because the skills and terms mentioned relate to various aspects of the telecommunications industry, such as «operator,» «tariff,» «internet,» «television,» «bundle,» and «television,» which are key elements in this sector. As a Product Consultant in Telecommunications, one would utilize expertise in product development, customer relations, and operational consulting to guide telecom companies in optimizing their services and offerings. The skills in «control,» «progress,» «risks,» and «scenario» management suggest the ability to manage projects and analyze business strategies, which are crucial for a consultant role focused on evaluating and improving products and services. Additionally, knowledge of industry-specific tools and resources further supports the capability to succeed in this position.
Skill Gap Analysis
Key Responsibilities: - Advise clients on the most suitable telecommunications products and services to meet their needs, including internet, telephone, television, and bundled plans. - Analyze customer requirements and recommend tailored solutions that optimize tariffs, resources, and operations. - Collaborate with operators and developers to ensure products meet end-user expectations and are delivered efficiently. - Manage and progress customer requests, including handling exceptions and resolving issues in a timely manner. - Conduct product demonstrations, highlighting features and benefits to potential clients. - Monitor and control the quality of service delivery to ensure customer satisfaction and minimize risks. - Provide post-sale support, addressing inquiries and maintaining customer care standards. ### Skills Typically Required: - Strong understanding of telecommunications products and industry trends. - Excellent customer service and communication skills. - Ability to analyze customer needs and recommend appropriate solutions. - Knowledge of product bundling and pricing strategies. - Familiarity with customer relationship management (CRM) systems. - Ability to work in a fast-paced environment and manage multiple tasks simultaneously. ### Identified Skill Gaps: - Customer Service Skills: While there is a mention of 'care' and 'ticket', a comprehensive focus on customer service, which includes empathy and listening skills, is crucial for handling inquiries and ensuring customer satisfaction. - Communication Skills: The extracted skills do not explicitly mention communication, which is vital for effectively advising clients and coordinating with team members. - CRM Systems Knowledge: Familiarity with customer relationship management tools is important for tracking interactions and managing customer data efficiently, but it is not covered in the extracted skills. - Product Knowledge: Understanding the specific details and benefits of various telecommunications products, beyond just 'products', is essential for making accurate recommendations to clients. - Pricing Strategy Expertise: While 'tariff' is mentioned, a deeper understanding of pricing strategies and competitive analysis is required to effectively recommend and construct suitable plans for customers.

potential job titles along with justifications based on the candidates' profiles at the time. These were then compared to the individuals' current roles and responsibilities.

The key metrics for evaluation were the system's accuracy in predicting suitable roles, the relevance of skill gaps identified, and the practicality of recommended developmental paths. Thus, the final results show whether the system provided objective feedback that was complementary to their career path (Box 2).

This testing approach highlights transparency and validity, demonstrating the system's potential to provide users with meaningful career advice. By examining real-

Box 2: Role Analysis: Software Quality Assurance Engineer

Recommended Role
Software Quality Assurance Engineer
Reasons for the Recommendation
This role is suitable because the skills listed align well with the responsibilities and competencies expected from a Software Quality Assurance (QA) Engineer. QA Engineers are responsible for ensuring the quality and functionality of software products by testing them for bugs and ensuring they meet specified requirements. - **End, bugs, test data, test case, conditions**: These keywords relate directly to the testing process and formulating various test cases and scenarios to ensure the software is free of defects. - **Modules, features, enhancements**: QA Engineers work closely with developers to ensure each module and feature is developed as specified and performs as intended. - **Design, implementation, environments, networks, platform**: These skills indicate an understanding of different software environments and platforms which is crucial for testing software applications in environments they will be deployed in. - **Hardware, operating, device, desktop, PC**: Knowledge of hardware and operating systems is necessary for testing software compatibility with different hardware and operating systems, which is typical of QA roles. - **Developers, engineers, vendor, support**: Collaboration with various stakeholders including developers, support teams, and vendors is essential for a role that bridges different departments to ensure quality. - **Product, market, gaming**: Understanding the market and specific product categories like gaming can help a QA Engineer perform more targeted testing, ensuring the software product meets market expectations and user needs. - **Criteria, norms, requirements**: QA Engineers must verify software products meet the necessary criteria, standards, and requirements before release. Overall, these skills suggest a need to focus on ensuring the compatibility, functionality, reliability, efficiency, and security of software products, all of which are central to the responsibilities of a Software Quality Assurance Engineer.
Skill Gap Analysis
Key Responsibilities: - Develop and execute test plans and test cases. - Identify, document, and track software defects. - Collaborate with developers to ensure software features meet specified requirements. - Conduct functional, regression, and performance testing. - Maintain and update test environments and test data. - Work with cross-functional teams for quality assurance throughout the software development lifecycle. - Monitor and report on the quality of software products and system functionalities. ### Skills Typically Required: - Strong understanding of software development life cycles (SDLC). - Experience with test management tools and bug-tracking systems. - Proficiency in writing and executing test scripts. - Knowledge of automated testing tools. - Familiarity with programming languages, such as Java, C#, or Python. - Excellent problem-solving and analytical skills. - Attention to detail and a methodical way of working. - Ability to work collaboratively in a team environment. - Understanding of networking and operating systems concepts. - Good communication skills to report issues and collaborate with development teams. ### Identified Skill Gaps: - Automated Testing Tools: Knowledge of automated testing tools is crucial for increasing test efficiency and coverage. This skill enables the engineer to execute large numbers of tests quickly and reliably. - Programming Languages: Understanding programming languages (such as Java, C#, or Python) is important to write automated scripts and understand developer tools. - Test Management and Bug Tracking Systems: Mastery of these tools is essential for organizing test cases, managing test executions, and tracking bugs effectively. - Software Development Life Cycle (SDLC): A strong grasp of various SDLC methodologies aids in understanding the development stages and aligning testing processes accordingly. - Analytical and Problem-Solving Skills: Critical for identifying, diagnosing, and solving complex problems within the software. - Communication Skills: Vital for effective collaboration with team members and reporting findings in a clear and concise manner.

Table 1: Role Mapping and Skill Gap Analysis for Career Progression

Experience in CV	*Role in CV*	*Proposed Role*	*Skill Gap identified by the system*	*Current Role*	*Accuracy*
35	Director - Professional Services	Business Process Consultant	• Business Process Management (BPM) tools and software: Critical for analyzing and redesigning business processes efficiently. • Change management: Essential for successfully implementing and sustaining process changes across the organization. • Process mapping and documentation skills: Important for accurately capturing current and proposed processes for analysis and communication. • Project management skills: Necessary for coordinating process improvement initiatives and ensuring they are completed on time and within scope.	Entrepreneur	75%
12	Senior System Engineer	Product Consultant in Telecommunications	• Customer Service Skills: While there is a mention of 'care' and 'ticket', a comprehensive focus on customer service, which includes empathy and listening skills, is crucial for handling inquiries and ensuring customer satisfaction. • Communication Skills: The extracted skills do not explicitly mention communication, which is vital for effectively advising clients and coordinating with team members. • CRM Systems Knowledge: Familiarity with customer relationship management tools is important for tracking interactions and managing customer data efficiently, but it is not covered in the extracted skills. • Product Knowledge: Understanding the specific details and benefits of various telecommunications products, beyond just 'products', is essential for making accurate recommendations to clients. • Pricing Strategy Expertise: While 'tariff' is mentioned, a deeper understanding of pricing strategies and competitive analysis is required to effectively recommend and construct suitable plans for customers.	Senior Project Manager	95%
10	Tester	Software Quality Assurance Engineer	• Automated Testing Tools: Knowledge of automated testing tools is crucial for increasing test efficiency and coverage. This skill enables the engineer to execute large numbers of tests quickly and reliably. • Programming Languages: Understanding programming languages (such as Java, C#, or Python) is important to write automated scripts and understand developer tools. • Test Management and Bug Tracking Systems: Mastery of these tools is essential for organizing test cases, managing test executions, and tracking bugs effectively. • Software Development Life Cycle (SDLC): A strong grasp of various SDLC methodologies aids in understanding the development stages and aligning testing processes accordingly. • Analytical and Problem-Solving Skills: Critical for identifying, diagnosing, and solving complex problems within the software. • Communication Skills: Vital for effective collaboration with team members and reporting findings in a clear and concise manner.	QA Manager	95%

16	Senior Database Engineer	Data Engineer	• Big Data Tools: Knowledge of tools like Hadoop and Spark is crucial for handling large volumes of data efficiently. • Cloud Services: Understanding cloud storage and services such as AWS, Azure, or GCP is essential for modern data infrastructure. • Programming Languages: Proficiency in languages like Python, Java, or Scala is critical for building and automating data workflows. • ETL Processes: Expertise in designing and managing Extract, Transform, Load processes is fundamental to data engineering. • SQL and Database Management: Mastery of SQL and experience with database management is essential for managing and querying data effectively. • Data Architecture Design: Skills in data modeling and creating robust data architecture support efficient data processing and accessibility. • Workflow Management Tools: Familiarity with tools like Apache Airflow is important for automating and scheduling complex data processes.	Senior Data Analyst	85%
12	Senior Software Engineer	Project Manager	• Leadership and Communication: Essential for guiding teams and maintaining clear communication with stakeholders. • Project Management Software Proficiency: Necessary for planning, executing, and monitoring project progress. • Conflict Resolution and Problem-Solving: Crucial for addressing issues that arise during the project lifecycle. • Financial and Budget Management: Important for maintaining project costs within the approved budget. • Time Management and Prioritization: Necessary for organizing tasks efficiently to meet project deadlines. • Stakeholder Management: Key for maintaining strong relationships and ensuring all parties are aligned on project goals. • Agile/Scrum Methodologies: Important for managing projects with flexibility and iterative development. • The identified skills in the extracted list are too general or not sufficiently aligned with the specific multi-faceted competencies typically required for a successful Project Manager role.	Project Manager	95%
12	Software Engineer	Software Engineer	• Programming Languages: The extracted skills don't specifically mention any programming languages, which are crucial for writing software. • Analytical Thinking and Problem Solving: While «problem» is mentioned, analytical thinking is a broader skill set not explicitly indicated. • Software Design and Development Methodologies: While «design» is mentioned, specific methodologies like Agile or Scrum are not noted, which are vital for modern software development. • Version Control Systems: Experience with tools like Git is essential for code collaboration and version management but is not present. • Technical Debugging: Deliberate skills in debugging and rectifying software errors are necessary and not explicitly listed. • Data Structures and Algorithms: A strong understanding of these is critical and notably absent. • User Experience and Interface Design: While 'user' is mentioned, a focus on user experience design is essential in many software engineering roles. • Security Protocols: Though «security» is mentioned, detailed skills in specific security protocols and practices are not highlighted.	Senior Software Engineer	90%

18	Technical Lead	IT Support Specialist	• Risk Management: Understanding of identifying, assessing, and prioritizing risks to IT systems and being able to mitigate these risks is crucial for maintaining system integrity. • Investigation: Skill in conducting thorough investigations into IT incidents or problems to identify root causes and implement effective solutions. • Web and Gateway Design: While a basic understanding of web technologies is useful, deeper knowledge of web architecture or secure gateway design might be needed for specialized support. • Network Posture: A comprehensive understanding of network topology and its security posture to efficiently troubleshoot and secure communication pathways. • Initiator and Engagement: Skills related to proactively initiating improvements and engaging with other departments to better align IT services with organizational goals are beneficial. • End-User and People Engagement: The emphasis on more direct interaction and support for end users to improve the IT user experience and customer satisfaction.	Technical Manager	70%
14	Freelance Developer	Data Scientist	• Statistical analysis and mathematical skills: Essential for developing models that accurately interpret data. • Programming languages (Python/R): Necessary for writing efficient data analysis and machine learning scripts. • Big data technologies: Important for managing and processing large data sets. • Data visualization tools: Key for presenting findings in a comprehensible and impactful manner. • ETL processes and data warehousing: Critical for efficiently extracting, transforming, and loading large volumes of data. • The extracted skills lack explicit reference to these areas, which are fundamental for performing the core responsibilities of a data scientist effectively.	Data Analyst	95%
13	Senior Consultant	Cybersecurity Analyst	• Understanding of cybersecurity frameworks and standards: This is crucial for implementing comprehensive cybersecurity strategies aligned with industry standards. • Experience with security monitoring tools: Proficiency in this allows for effective detection and management of security threats. • Knowledge of network security protocols: Essential for understanding and fortifying network defenses. • Incident response and management skills: Critical for effectively addressing and mitigating security breaches in real-time. • Proficiency in conducting security audits: Necessary for assessing the effectiveness of security measures and ensuring compliance. • Strong analytical and problem-solving skills: Important for identifying security issues and formulating effective solutions.	Principal Consultant - Smart Governance	90%
14	Cyber Security Engineer	DevOps Security Engineer	• Threat Modeling and Risk Assessment: Essential for proactively identifying potential vulnerabilities and designing appropriate security measures. • Security Automation: While tooling is mentioned, specific skills in automating security processes to enhance efficiency and consistency are crucial. • Incident Response and Management: Specific focus on handling security incidents promptly and effectively is not explicitly identified in the extracted skills. • Application Security: The focus seems to be broader without a direct emphasis on integrating security within code and applications. • Security Awareness and Training: Educating and supporting teams is a key part of enhancing overall organizational security, which isn't directly reflected in the extracted skills.	Cyber Security Architect	95%

12	Network Analyst	Business Analyst	• Business Modeling: The ability to create visual representations of business processes is crucial for mapping out improvements and changes. • Data Analysis Software: Proficiency in tools like SQL, Excel, or Tableau is vital for an in-depth analysis of data sets. • Stakeholder Management: Effective management of stakeholder expectations and communication is key for project success. • Change Management: Skills in managing change within the organization ensure smooth transitions during project implementations. • Risk Management: Identifying and mitigating potential risks associated with business changes are essential for successful project outcomes. • Strategic Thinking: Understanding the bigger picture and aligning projects with organizational goals are critical for creating long-term value.	Technical Architect	80%
15	Database Administrator	Software Configuration Manager	• Version Control Systems: The skills list does not explicitly mention experience with version control systems like Git, which is critical for managing changes across multiple environments. • Build Automation: No specific mention of build automation tools, which are essential for streamlining the deployment process and integrating regular builds. • Script Writing Skills: Proficiency in scripting for automating tasks related to configuration and deployment is crucial but not highlighted. • Continuous Integration Tools: Tools like Jenkins or Maven are important for integrating various modules and ensuring smooth delivery workflows and are not explicitly listed. • Cross-Functional Collaboration: While general assistance and process skills are noted, the ability to work across teams and manage cross-functional projects is not articulated directly. • Documentation Skills: While documentation is mentioned, specific proficiency in creating comprehensive and understandable configuration management documentation is essential but only briefly touched upon.Security Practices: While 'security' is mentioned, an in-depth understanding of security protocols specific to configuration management is vital and not fully covered.	Database Admnistrator	50%
15	IT Operations Associate	Project Manager	### Key Responsibilities: • Plan, execute, and close projects to meet business objectives. • Coordinate cross-functional teams to deliver project outcomes on time and within budget. • Develop project plans and schedules, including resource allocation and timelines. • Monitor project progress and implement corrective actions when necessary. • Communicate project status, risks, and issues to stakeholders. • Ensure project documentation is complete and up-to-date. • Utilize project management tools and frameworks to track and report on project metrics. • Drive continuous improvement initiatives within project execution processes. ### Skills Typically Required: • Strong leadership and team management skills. • Excellent communication and interpersonal abilities. • Proficiency in project management methodologies (e.g., Agile, Waterfall).	SOC Manager	85%

			• Ability to manage resources, budgets, and timelines effectively. • Strong analytical and problem-solving skills. • Experience with project management software (e.g., JIRA, MS Project). • Capability in risk management and mitigation strategies. • Understanding of performance metrics and evaluation techniques. ### Identified Skill Gaps: • Posture: Priority focus on strategic thinking and clear communication to align projects with company goals. • Correlation: Emphasizing the importance of connecting project outcomes to business objectives for measurable success. • Tipping: Opportunity to enhance skills related to prioritizing and decision-making to ensure timely project delivery. • Ticketing: Focus on efficient issue tracking and management to streamline project workflows. • Web: Leveraging web-based project management tools to facilitate remote collaboration and efficiency. • Initiation: Strengthening skills in project initiation to set clear goals and expectations from the onset. • Enhancement: Concentrating on continuous improvement strategies to optimize project processes and results.		
9	Team Lead - Information Security	Business Continuity Manager	• Risk assessment and management: Essential for evaluating potential threats and their impacts on the business. • Project management: Important for coordinating and implementing business continuity plans effectively. • Strong analytical and problem-solving skills: Critical for analyzing complex situations and devising solutions during a crisis. • Communication and interpersonal skills: Necessary for conveying plans and coordinating with diverse teams and stakeholders. • Leadership and team management: Required for guiding and motivating teams during a crisis and in preparation phases. • Knowledge of regulatory requirements and industry standards: Ensures all continuity plans comply with relevant laws and standards. • Technical understanding of IT and business infrastructure: Vital for addressing technical issues that may arise during a crisis.	Senior Manager - Cyber Security	60%
11	Network Security Engineer	Product Manager	• Leadership and Communication: Essential for managing teams, communicating vision, and ensuring all stakeholders are aligned. • Analytical and Strategic Thinking: Necessary for making data-driven decisions and long-term planning. • Technical Understanding: Helps in bridging the gap between technical teams and business units, essential for effective product development. • Organizational and Problem-solving Skills: Crucial for maintaining product timelines and addressing issues efficiently.	Principal Consultant	85%
13	Senior Testing Engineer	Cybersecurity Analyst	• Experience with Security Tools and Technologies: Essential for efficiently monitoring and responding to potential threats. • Incident Detection and Response: Critical for identifying and mitigating security incidents in a timely manner. • Knowledge of Security Frameworks and Regulations: Necessary to ensure that the organization adheres to legal and industry standards.	Assistant Manager - Product SME	70%

			• Communication and Interpersonal Skills: Important for effectively coordinating with other teams and communicating findings and recommendations. • Understanding of Network Protocols and Technologies: Vital for analyzing and securing the organization's IT infrastructure.		
15	IT Operations Executive	IT Systems Analyst	• Analytical Skills (specifically «in-depth analysis»): Required for understanding complex systems and processes to effectively identify and solve issues. • Communication Skills (specifically collaboration with stakeholders): Essential for managing expectations, explaining technical concepts clearly, and driving system improvements. • IT Systems Knowledge (broader than «equipment» and «installation»): Involves understanding various components of IT infrastructure beyond basic installation tasks. • Project Management Skills (specifically «planning» and «strategy»): Important for developing and executing plans that align IT systems with organizational goals.	IT Operations Manager	90%
8	Technical Lead	Full Stack Developer	• Proficiency in specific programming languages: The extracted skills list mentions «language» but does not specify key programming languages such as JavaScript, Python, or HTML/CSS, which are critical for full stack development. • Experience with web frameworks: Terms such as React, Angular, or Node.js are not included, which are important for developing dynamic web applications. • Understanding of RESTful services and APIs: While «understanding» is mentioned, the specific domain knowledge in RESTful API design and integration is missing. • Knowledge of software development best practices: There is no mention of tools or practices like Git for version control or Agile methodologies, which are key for a successful development process. • UI/UX design skills: «Web» and «application» are noted but specifics related to UI/UX design principles and tools are not listed, which are essential for creating user-friendly interfaces. • Security and data protection knowledge: Essential for protecting user data and application security, yet not explicitly mentioned in the skills list. • Performance optimization techniques: Skills related to ensuring high performance and scalability of applications are not detailed but are crucial for handling high traffic and large user bases effectively.	IT Development Manager	95%
5	Software Engineer - Java	Business Analyst in Insurance and Banking Sector	• Analytical and Problem-Solving Skills: While 'defect' and 'issue' are mentioned, there's a need for a stronger emphasis on analytical skills, critical for identifying areas for process improvements. • Stakeholder Management: Although 'communication' is listed, the specific element of managing stakeholders effectively is crucial for meeting business needs and facilitating collaboration. • Industry Knowledge: A deeper understanding of the 'insurance and banking industry regulations' is essential, as it guides compliant business operations. • Data Analysis Tools: Skills related to specific 'data analysis and business intelligence tools' are missing, which are vital for interpreting complex datasets and making informed business decisions. • Project Management: The typical requirement for direct 'project management' skills is not highlighted, yet it is essential for successfully leading and delivering projects within the insurance and banking environment.	Senior Software Engineer - Investment Banking	85%

10	Software Engineer - Data Visualisation	Business Intelligence Specialist	• Data visualization tools expertise: While 'visualization' is mentioned, specific tools like Tableau or Power BI are crucial for effectively creating engaging and insightful data representations. • SQL and database management: Critical for managing and querying large datasets efficiently, ensuring data integrity and accessibility. • ETL processes: Essential for loading and transforming data from various sources into a centralized data warehouse, which is a core function of BI specialists. • Communication skills: While 'document' is mentioned, comprehensive communication skills are necessary for conveying complex insights effectively to non-technical stakeholders. • Industry-specific knowledge: Understanding specific business sectors can enhance the relevance and impact of BI solutions provided.	Project Leader - Business Intelligence	95%

world scenarios and measuring outcomes against real-world metrics, the system finds credibility and impact in its recommendations and predictions (Table 1).

Results

Let us first examine the system's output. The system recommends a role, explains its recommendation, and analyses the skill gap. Below is an example output. It is produced for the CV of a person who worked as a developer in a giant Telecom Software development company about 12 years ago and is currently a Senior Project Manager in another giant Telecom company.

Let us look at another example: a lady who worked as a Manual Tester in a Telecom Software Development company about 14 years ago and is currently a QA Manager. She is presently an expert in creating automated testing systems.

Given below is an analysis of 20 test cases run on this system.

Figure 2 provided is the histogram of the accuracy scores.

The histogram of accuracy percentages is an interesting way to visualise the distribution of accuracy scores across the dataset. It unmistakably depicts the number of counts of various levels of accuracy, exposing trends and aggregates from the measurements. One of the most noticeable observations is the heavy tail of very high accuracy scores, with most of the values falling between 90% and 100%. This means that most of the dataset has very high accuracy.

On the other hand, the lower accuracy ranges have relatively little data. Low accuracy is rare in the dataset, as information below 70% is sparse. However, the histogram also indicates a slow increase in frequency from 70% to 90% in accuracy.

The distribution is heavily right-skewed, stressing that the dataset mainly consisted of high-accuracy values. This might suggest that whatever entity is being measured is highly accurate or that the processes being measured are tuned for optimal output.

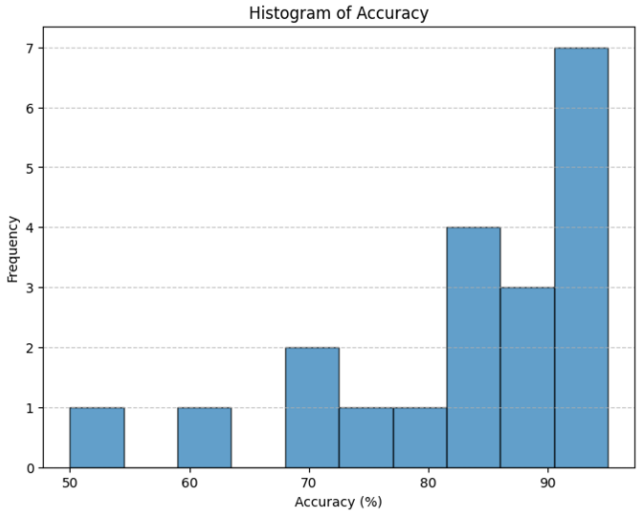

Figure 2: Histogram of the Accuracy Scores

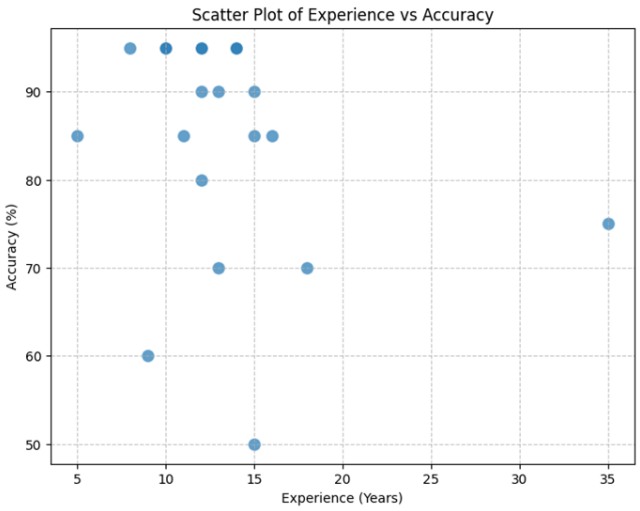

Figure 3: Correlation Char between Experience Level and Recommendation Accuracy

An interesting visualisation is a scatter plot of the years of experience against achieved recommendation accuracy (Figure 3). It is clear, from the chart that the relationship is not as simple as a linear function; there is a wide range of experience with varying levels of accuracy results.

Certain data points form a cluster with good accuracy (> 90%) for people with similar years of experience, ranging from ~8 to 15 years. This cluster reflects the top end of the range, where people perform at a very high level, revealing a sweet spot where experience correlates with a deep pool and high efficiency. This cluster suggests a time when people practice their skills in the best circumstances or reap the rewards from their learning and exposure.

This trend, however, does not persist beyond 15 years of experience when the accuracy levels start to show disparity. As you can see, the point at 35 years of experience has a relatively lower accuracy of 75%, indicating that increasing levels of expertise do not correlate with higher accuracy. This could indicate a number of things, from a shift in industry practice to a change in technology or diminishing returns from experience in certain contexts.

Conversely, certain individuals with less than 10 years of experience are outliers in the other direction (less than 70% accuracy). This implies that those with less experience could correlate with performance, as those at the beginning stages of their careers are still developing their skills and maturing into their positions.

Discussion

This system has tremendous implications for individuals and society. This has a profound impact on employability, as the ability of individual skills gap identification and customised career recommendations increases so exponentially. This aligns directly with SDG 8, which calls for decent work and economic growth. Such targeted skill development at the bottom level allows them to be industry-ready and ensures sustainable workforce engagement. Finally, the affordability and accessibility of the system provide career development tools that are no longer luxury items for the elite but become available equitably to unserved communities. This directly relates to SDG 10, which has an objective to reduce inequalities by promoting inherent access to opportunities.

This system also addresses SDG 9, which includes building resilient infrastructure, promoting inclusive and sustainable industrialisation, and fostering innovation. This education-industry linkage creates a more dynamic and synergetic interrelationship between knowledge creation and its use. The growing interconnectivity between academia and industry further guarantees that learners and professionals are aligned with the demands of an ever-advancing global economy.

However, several challenges must be overcome for it to realise its potential. A primary concern is to ensure that underprivileged communities are not left out. Although the system opens access to care guidance, more work needs to be done to ensure that marginalised groups have the technological infrastructure and resources required to benefit from such systems. Additionally, using AI-generated suggestions opens the door to creating systemic biases that exist in training data. Tackling this issue requires careful validation of AI models, making decisions made by algorithms transparent, and ongoing assessments to avoid unjust outcomes.

Addressing these difficulties, this system can greatly reform professions and skills discovery worldwide, contributing to faster, more fair, and more sustainable skill growth.

Conclusion

This study highlights how Generative AI can help bridge the growing disparities between industry demand and education supply. The system uses advanced technologies such as natural language processing and AI-driven recommendations or promotions to collate sustainable skill acquisition for job sustainability, keeping individuals in line with the competitive job market. This capability to discern nuanced skill deficiencies and suggest focused interventions offer a crucial wedge, enabling people to position their stock with employer requirements effectively. It transcends individual career progression, aligning with the larger goal of developing a more competent and versatile labour force.

In the future, the opportunity to scale this solution to different regions and demographics is an interesting area for future research and implementation. Broadening access to this technology for under-represented communities is critical for achieving the Sustainable Development Goals (SDGs) like SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 10 (Reduced Inequalities). Customising the system to suit different cultural and economic environments can help to maximise the system's impact and ensure no demographic gets left behind in the pursuit of career progress and sustainable growth.

Future system developments should focus on being inclusive and increasing accuracy. If it were possible to articulate content more relevant to the regional languages of the user or their educational level and customise corrections or suggestions based on all of that and the industry requirements that they are pursuing a career in, it would be even more enabling. In addition to this, the development of partnerships with academic institutions, industry leaders, and policymakers can further enhance its effectiveness, ensuring that the system remains relevant and impactful in addressing global workforce challenges. With ongoing innovation, research, and investment, this technology can transform skill development into a more equitable and accessible process for both people and societies.

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Conflict of Interest

The author declares no conflict of interest.

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