ANALYZING THE EVOLUTION OF IN-DEMAND SKILLS IN THE SAUDI JOB MARKET USING MACHINE LEARNING

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UNIVERSITI TEKNOLOGI MALAYSIA

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SAEED MUBARAK ALSHAHRANI

A reportsubmitted in partial fulfilment of the
requirements for the award of the degree of
Master of Data Science
Faculty of Computing
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DECLARATION

I declare that this thesis entitled *"*ANALYZING THE EVOLUTION OF IN-DEMAND SKILLS IN THE SAUDI
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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

ACKNOWLEDGEMENT

ABSTRACT

This research analyzes the highest demand skills in Saudi Arabia with machine learning. It reveals that there is a gap between the skills learned at universities and the needs of the job market, particularly technical skills such as AI, cybersecurity, and cloud computing. More than 1,500 job posts were analyzed with Natural Language Processing to discover and categorize skills.

The findings indicate that contemporary tech expertise is increasing immensely, while classical skills such as manual testing are declining. The research provides unambiguous guidance to policymakers, employers, and universities on the way education needs to align with the demands of the market and create a future-ready workforce.

A_ _ _ _AK

Penyelidikan ini menganalisis kemahiran yang paling tinggi permintaannya di Arab Saudi dengan menggunakan kaedah pembelajaran mesin (machine learning). Ia mendedahkan bahawa terdapat jurang antara kemahiran yang dipelajari di universiti dan keperluan pasaran kerja, terutamanya dalam kemahiran teknikal seperti Kecerdasan Buatan (AI), keselamatan siber, dan pengkomputeran awan (cloud computing). Lebih daripada 1,500 iklan kerja telah dianalisis menggunakan Pemprosesan Bahasa Semula Jadi (Natural Language Processing) untuk mengenal pasti dan mengkategorikan kemahiran.

Penemuan menunjukkan bahawa kepakaran teknologi moden semakin meningkat dengan ketara, manakala kemahiran klasik seperti ujian manual semakin merosot. Penyelidikan ini memberikan panduan yang jelas kepada pembuat dasar, majikan, dan universiti tentang bagaimana pendidikan perlu diselaraskan dengan keperluan pasaran untuk membentuk tenaga kerja yang bersedia menghadapi cabaran masa depan.

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Chapter 1

1.1 I ntroduction to the Research

In the fast paced world economy, countries are changing profoundly in terms of labor market activities. This is especially true for The Kingdom of Saudi Arabia, which is undergoing significant change through its Vision 2030, focusing on diversifying the economy, cutting down oil reliance, and channeling resources into technology, innovation, and human capital. Consequently, the Saudi labor market's skills requirements are perpetually shifting, and education attaining labor market relevance has emerged as a critical national goal.

Traditional practices of analyzing labor markets by means of fixed surveys and manual coding no longer pass muster in an increasingly real-time and technology-disruption-impacted environment. Today's employers expect workers to be more technologically competent, flexible, and responsive. Policymakers, schools, businesses, and even job hunters must track the changing needs of the necessary skills.

This research tries to explore how the most sought-after skills in the Saudi job market changed during the recent years. It uses machine learning software power to examine massive datasets from job sites, i.e., LinkedIn, Bayt.com, GulfTalent. By doing this, the research constructs a complete, metrics-driven image of trends behind labor demand in fields such as information and communication technology, healthcare, engineering, finance and public sector.

Delivery of Intervention in Higher Education Studies One of the primary motivations for this study in higher education is the increasing misalignment of qualifications by higher education graduates and employer needs. Because of the incompatibility between what was provided by the curriculum in schools and the requirements of the labour market, most Saudi graduates lament that they cannot find jobs not because they are not well educated, but because they lack the skill set required to integrate into the local labor market. Thus, with the advance of time coming with new and lost skills acts as a vehicle that bridges this gap and provides evidence-based advice to academic planners, vocational training providers, and national employment policy.

Unstructured job posting text is open to being analyzed with machine learning models like natural language processing (NLP) and clustering that allow automated extraction and categorization of job skills. Compared to conventional survey-based competency evolution analysis, these models impose accuracy and ongoing accuracy. Machine learning also detects latent patterns and relationships uninvestigated in manual approaches.

This research also points to the socio-technical perspective of labor changes in Saudi Arabia. The pace of digitalization is creating new jobs and skills, particularly in data science, cybersecurity, artificial intelligence and cloud computing, while making other, conventional jobs obsolete. These young people are also discovering new professions, as net talent needs are leading, not only technological change, but also social change, as systems shift to attract, train and retain talent.

Another key characteristic this research examines is the distribution of skill demand across gender and geographic lines. The government of Saudi Arabia aims to achieve Vision 2030 through enhancing women's employment and empowering underdeveloped regions. It is significant to examine the distribution of skill demand patterns across groups and areas which is key input to craft labor policies that ensure greater opportunity on an equal basis across the Kingdom.

Overall, the study presents a timely and reflective examination of the ways that high-demand skills are evolving within the Saudi labor market. The study illustrates various mechanisms through which machine learning methodologies have the capability to improve labor market intelligence and inform more evidence-based decision-making within education, workforce development, and economic development. Through this transdisciplinary effort, the study contributes to making real the national objective of developing an educated, competitive workforce responsive to the challenge and opportunity represented by the 21st century.

1.2 Problem Background

The Saudi Arabian job market is undergoing a sea change, fuelled in part by national efforts, international economic trends, and technological changes. There have been numerous policy reforms in the last few years that have included strategic plans such as Vision 2030, the Human Capability Development Program and others, all of which have collectively changed the socio-economic landscape at the national level. Re-calibrating what skills are worth something and in demand across sectors is underway.

In a nation such as Saudi Arabia, job seekers have hitherto relied on qualifications to offer a first-step access to the employment market, hoping that education would open up career prospects in the public and private sectors. But it has become an old-fashioned model in today's employment market, where employment is shifting at an increasing pace and employers are relating working expertise, IT competence and curricula flexibility to educational qualifications only.

Disconnect between educational learning and required employment has caused increasing numbers of graduates to become unemployed even in possession of qualifications. Meanwhile, numerous companies are complaining that they cannot fill some of their core positions because of a lack of suitable candidates holding the exact desired skillsets necessary. This served to highlight one of the areas where new data-driven insight to the form of developing skill needs is needed most.

Compounding this is the sudden technology change that is redefining work descriptions, producing new jobs, and replacing others. Rapidly emerging are data analysis, cloud computing, artificial intelligence, and cybersecurity careers, while repetitive and manual careers are disappearing. Without constant observation and analysis of these trends, schools, policymakers, and workers can get left behind.

Even though one can get job data on the Internet, there is no systematic research that monitors how certain skills come into or out of vogue over time. Research carried out in academia is narrow in focus and does not help in projecting contemporary trends in the labor market. Such a limitation bars it from contributing something substantial towards shaping educational output, workforce training, and national manpower policy

This research attempts to bridge this gap by using machine learning methods to examine job advertisements and make effective inferences on how marketable skills vary between industries in Saudi Arabia. Through this, it seeks to provide a dynamic fact-based perspective that connects the education sector to the employment sector.

1.3 Problem Statement

As Saudi Arabia is leading its national transformation according to Vision 2030, the labor market is transforming into a digitally enabled, knowledge-based economy. Nevertheless, in spite of thousands of job openings available on digital platforms, one can observe the lack of systematic, analytical methods of monitoring and forecasting the development of in-demand skills across sectors. The difficulty is not just in the fast speed at which the job roles are changing but also in the fact that traditional labour market analysis cannot measure live real-time skill developments with data-driven and scalable approaches.

Increasingly, the increasing imbalance between employers' actual needs and the qualifications of job applicants has contributed to raising the need for knowledge about how necessary skills shift with time. Significant numbers of graduates are being kept out of employment or remain underemployed because the training schemes are equated to the demands of the labor market with delay. Meanwhile, the employers document shortages in primary areas of expansion including technology, finance, and engineering.

Classical models of workforce planning are generally not taking the strength of present data analysis to bear. Traditional workforce planning models are static, cyclic, and predominantly manual-based data collection. Education, economic, and policy planners are thereby challenged to make effective adaptive programs in response to labor market requirements.

Missing is an automated, scalable, and smart platform capable of scanning persistently for job postings and inferring helpful things about skill needs in a local setting. A creative solution to fill the gap between university output and market demand based on advanced machine learning methods must be designed for Saudi Arabia.

This study fills this void by using machine learning techniques on Saudi Arabian online labor market data to determine the development of in-demand skills over time. The long-term goal is to improve national labor market information and enable more informed, data-driven education planning and workforce planning

1.4 R esearch Objectives

The main objective of this study is to examine the acquisition of desirable skills in the Saudi Arabian job market through the application of machine learning methods. In line with this overall objective, the study aims to attain the following particular objectives:

1- To obtain and preprocess authentic job market data from leading online job search websites like LinkedIn and Bayt.com, handling job advertisements pertaining to .different parts of Saudi Arabia

2- To use machine learning algorithms—such as natural language processing (NLP)— .to extract and classify job skills from unstructured job advertisement text

3- To detect patterns and trends in demand for certain skills over time, distinguishing .between emerging, stable, and declining skills by sectors and regions

4- To analyze the match between available academic output and real demands of the Saudi labor market, especially in rapidly changing sectors such as technology and .finance

5- To offer strategic recommendations and inputs to policymakers, educators, and training institutions to close the skill gap and prepare future graduates with in-demand .skills in the market

6- To facilitate a replicable, data-driven method for frequent monitoring of labor markets using machine learning that can be applied to other domains or future updates.

1.5 Gap Analysis

Even with greater focus on trends in Saudi labor markets—especially within the context of Vision 2030—there is still to be a perceived gap between skills with which candidates are offered for employment and those sought by employers. There have been numerous reports pointing out that the majority of graduates go into employment lacking the hands-on, technical, or digital skills required for success in today's labor market. Since schools go on producing quality professionals, the compatibility of academic product with real industry demands is still tenuous or obsolete.

Current evidence regarding Saudi Arabian labor market demands has been mainly rooted in static surveys, periodic government reports, or broad economic metrics. Even though these indicators present useful macro-level information, they are often not adequate to account for up-to-date changes in skill demands—most significantly, in high-paced sectors like information technology, artificial intelligence, cybersecurity, and data analytics.

Furthermore, few prior studies used machine learning methods to extract and study labor data from actual job postings across various websites. This is a large blind spot in the labor market intelligence, where most academic and institutional analyses are unable to leverage the vast amount of online, real-world labor data now at their disposal.

Another under-explored aspect in earlier research is the temporal dynamic of skill demand—how the saliency of particular skills increases or declines. This trend is critical to understand in terms of future policy-making, academic restructuring, and workforce planning.

Moreover, most local studies have a tendency to emphasize national-level data with inadequate sensitivity to regional or sectoral variations.

Consequently, the inferred outcomes are typically too aggregated to provide input to targeted interventions.

The value added of this research in this paper is to fill such gaps by means of machine learning-driven real-time tracking of Saudi employment market trends. Specifically, it aims at monitoring changes of on-the-rise in-demand skills, organizing unstructured job descriptions data, and providing actionable insights to facilitate decision-making by education, policy, and labor authorities**.**

1.6 S cope of the Study

This research is centered around the examination of high-demand skill emergence in the Saudi labor market using machine learning methods. The focus is specifically chosen to span domains of interest, enabling precise but overall insights into trends within the labor market.

The study is mainly derived from the Kingdom's online job portals, including LinkedIn, Bayt.com, and GulfTalent, which show recent job openings in the

Kingdom's different sectors. The database contains job postings that were submitted within a specific time frame to enable temporal analysis of skill demand.

The territorial coverage is within Saudi Arabia, focusing on the key economic areas of Riyadh, Jeddah, and the Eastern Province. However, regional variations in the skills needed where data are available are also taken into account.

The research examines a variety of critical sectors, notably information technology, engineering, healthcare, finance, and public administration. These sectors have been identified on the basis of Vision 2030's strategic priority to them and their active presence in the online labor market

.
Technically, the project uses natural language processing (NLP) and machine learning algorithmic methods to extract and categorize skills from unparsed job postings. It has no interest in salary predictions, job openings forecasts, or individual career guidance because these are beyond the given scope

In addition, the study does not include offline employment adverts or government records of employment since emphasis ought to be on online, instantaneous signals in the labor market. Although this restricts coverage to digitally presented jobs, it enables scalability as well as relevance within a contemporary data-driven labor market.

In general, the research aims to offer strategic knowledge that can be used to inform curriculum design, vocational training curricula, and national-level labor policies, respectively, regarding current and emerging trends in skill demand.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

The Saudi labor market has significantly been transformed through speedy technological revolutions and digital change headed by Saudi Vision 2030. Skills disparity between the abilities of graduates and existing skills in the job market is one of the most common issues facing education and work. In an attempt to bridge this disparity, artificial intelligence-powered techniques, such as machine learning, have been discovered to be useful instruments in the examination of labor market employment data and future skill forecasts. This chapter gives an all-inclusive review of literature in the evolution of demanded skills within the Saudi labor market, and especially the function of machine learning in the discovery of these skills.

2.2 Digital Transformation and Saudi Vision 2030

Saudi Vision 2030 outlines a vision of strategy for attaining sustainable economic growth through decreasing dependence on oil and establishing non-oil sectors like technology, education, and healthcare. Enhancement of the quality of education and empowering youth to meet changing market needs is one of the vision's highest objectives. The programs such as the Human Capability Development Program intend to enhance the effectiveness of the education system and connect it to market needs through investments in technical and digital abilities.

These have made skills in AI, data analytics, and cyber security amongst the most in-demand. Research also indicates that substantial investments in digital projects such as cloud data centers and AI initiatives have fueled demand for specialized skill in these.

2.3 Use of Machine Learning to Analysis of In-Demand Skill

Machine learning has also been a useful way to understand labor market patterns since it can handle large amounts of data that are pulled from job boards and corporate websites. One study done by King Saud University utilized three typical text category algorithms—SVM, Naïve Bayes, and k-Nearest Neighbor—to examine 675 LinkedIn and Bayt.com job advertisements. The objective was to develop a predictive model with a view to measuring the employability of graduates with respect to the needs of the market.

Table 2.1: Conclusion of Applying ML Algorithms to Job Postings Analysis

ALGORITHM USED	NUMBER OF JOB ADS ANALYZED	ACCURACY RATE	MAIN FINDING
SVM	675	89%	Large gap in programming skills
Naïve Bayes	675	84%	High demand for global certifications
k-Nearest Neighbor	675	82%	Lack of practical skills among graduates

Source: *King Saud University Study (2023)*

The findings showed a stark disconnect between graduate skills and employer skills, particularly in terms of programming languages like Python and C#. The research also observed the importance of global certifications such as Cisco and ITIL in increasing job prospects, observing that certification levels were low among graduates.

2.4 Academic Challenges and the Labor Market

Most research indicates that Saudi higher education systems are sometimes unable to keep up with the fast pace of change in the labour market, thereby creating a gap between education production and real institutional needs. A further study indicates that education is limited in schools on recent technical areas like data science and AI engineering and is instead oriented towards theoretical knowledge and conventional coding languages like Java.

In addition, soft skills like communication and teamwork are still to be developed, although in some studies, students themselves assessed that they are skilled in these areas, employers do not share the same perception.

Table 2.2: Comparison Between Skills Taught in Universities and Those Required by the Saudi Labor Market

SKILL	TAUGHT IN UNIVERSITIES	REQUIRED BY EMPLOYERS	GAP EXISTS
Python Programming	□	□	Yes
C# Programming	□	□	Yes
Java Programming	□	! (Only in some sectors)	Partially
Data Analytics	!	□	Yes
Cybersecurity	!	□	Yes
Artificial Intelligence	!	□	Yes
Soft Skills (Communication, Teamwork)	! (Self-reported by students)	□ (Employers'dissatisfaction)	Yes

Source: King Saud University Study (2023), Codex.team (2024)

2.5 Trend Towards Digital Skills in 2025

As per the World Economic Forum's 2025 report, digital and technical skills will dominate the world's job market, including Saudi Arabia. The most sought-after skills are data analysis, cybersecurity, and artificial intelligence. More emphasis is also being placed on soft skills like critical thinking and time management.

Here, studies by Codex.team indicated that industries like fintech and digital health are emerging at a high pace, and that generates higher demand for advanced technical skills. Furthermore, studies illustrate that Saudi companies are starting to invest in reskilling initiatives and upskilling workers with new skills, particularly in light of the shifting nature of work at a fast pace.

SECTOR	EXPECTED DEMAND (%)
Artificial Intelligence	30%
Data Science	25%
Cybersecurity	20%
Digital Health	15%
Financial Technology (Fintech)	10%

Figure 2.1: Distribution of Digital Skills Demand by Sector (2025)

2.6 Industry-Academia Partnerships

A number of studies underscore the need for intensive interaction of businesses and universities for the development of curricula and their coordination with other requirements of the labor market. In accordance with this, a study in the Springer Open journal has shown that joint cooperation between large companies, research centers, and universities is able to create highly adaptable applied and practical curricula.

A study by Misk Institute also concluded the necessity of offering specialized training programs in areas like artificial intelligence and data analysis, providing experiential training opportunities to students in local and international organizations

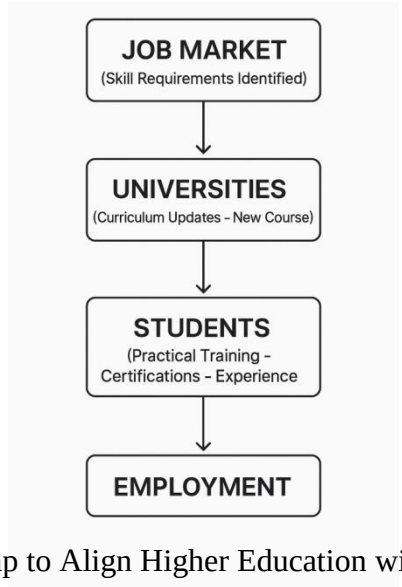


Figure 2.2: Roadmap to Align Higher Education with Industry Needs

2.7 Existing Challenges and Solution Strategies

One of the most significant challenges for researchers and practitioners in this area is the absence of reliable and current information on market demands for skills, particularly in emerging sectors. Moreover, data analysis may be constrained by a shortage of expertise or adequate facilities in some schools.

To address these issues, taking on machine learning methods for handling data from different sources, such as job websites, labor market reports, and graduate and university surveys, is recommended. It is also important to promote the use of tools like Weka and Octoparse to collect and handle data efficiently.

2.8 Summary

Through the analysis of the literature, it can be seen that the integration of machine learning tools in analyzing preferred skills in the Saudi labor market is a pressing necessity. The gap between the skills universities teach and those demanded by employers, mostly in technical and digital sectors, also exists. Hence, university-business cooperation as well as investments in future skills are a strategic imperative in the long term.

Chapter 3

Research Methodology

3.1 Introduction

This chapter gives a step-by-step account of the research methodology employed to accomplish the objectives of this research, i.e., analyzing the development of skills needed in the Saudi employment market on the basis of machine learning methods. The research methodology is aimed at providing a systematic and structured methodology towards collecting, processing, analyzing, and interpreting employment market data collected through online employment portals.

Research methodology includes several steps such as data collection, preprocessing, exploratory data analysis, skills extraction via natural language processing (NLP), categorization of skills into appropriate classes, trend analysis based on time and industry, comparison of curricula at educational levels, model evaluation, and lastly conclusion and recommendation from findings.

The research design is quantitative analytical with big data analytics and AI software employed to make meaningful conclusions from unstructured text data in job advertisements.

3.2 Research Framework

The research applies a systematic framework that combines technological and analytic components. The framework facilitates correct identification and classification of skills demanded by employers across various sectors of the Saudi labor market. It also facilitates the tracking of trends over time, which informs education and workforce planning decision-making.

The framework includes the following key components:

Data Acquisition : Collecting job advertisement data from online sources like LinkedIn, Bayt.com, and GulfTalent.

Data Preprocessing : Cleaning and pre-processing the raw data to get it into analysis-ready format.

Natural Language Processing (NLP) : Extraction of major skills and abilities from unstructured job posts.

Skill Classification : Assignment of extracted skills into predefined categories like technical skills, soft skills, and business skills.

Temporal and Sectoral Trend Analysis : Determination of how skill demands change over time and vary with respect to sectors.

Comparison with Academic Curricula : Determination of the alignment between required skills and skills being supplied in Saudi universities.

Model Evaluation and Validation : Verification of the accuracy and validity of the models adopted for extracting and categorizing skills.

Strategic Recommendations : Allocation of evidence-based policy recommendations for closing the skills gap

3.3 Data Collection

3.3.1 Data Sources

In order to provide a wide coverage of recent labor market needs, job advertisements were gathered from three leading online job websites:

LinkedIn

Bayt.com

GulfTalent

They are used mainly by employers and employees in Saudi Arabia and offer access to millions of real-time job listings for different sectors of the economy including information technology, health care, engineering, finance, and public administration.

3.3.2 Keywords and Search Terms

In order to make the results effective and comprehensive, job searches were made using each industry's given key words. For instance:

Information Technology : "Data Analyst", "Cybersecurity Specialist", "Cloud Engineer"

Healthcare : "Clinical Informatics", "Medical Technologist", "Healthcare IT"

Finance : "Financial Analyst", "Risk Management", "Fintech Developer"

Job postings were restricted to those of the Kingdom of Saudi Arabia and within a certain time period to allow temporal trend analysis.

Platform	Total Ads	IT Sector	Healthcare	Finance
LinkedIn	500	200	100	120
Bayt.com	600	250	120	150
GulfTalent	400	180	90	110

Table 3.1 : A sample table showing the number of job ads collected per platform and per sector

3.4 Data Preprocessing and Exploratory Data Analysis

The gathered job descriptions were preprocessed a number of times before the applications to machine learning models were ready.

3.4.1 Text Cleaning

Unwanted characters, HTML tags, and special characters were removed from text. Duplicates or repetitive job postings were removed as well.

3.4.2 Tokenization

Text was divided into words or phrases (tokens) so that it became simpler to analyze.

3.4.3 Stop Words Removal

Arabic and English stop words (e.g., "and", "the") were eliminated to eliminate noise from the corpus.

3.4.4 Stemming and Lemmatization

Words were stemmed to their root form to normalize the lexicon. e.g., "running" → "run".

3.4.5 Part-of-Speech Tagging

Every word was tagged based on syntactic role to enhance semantic comprehension.

3.4.6 Named Entity Recognition (NER).

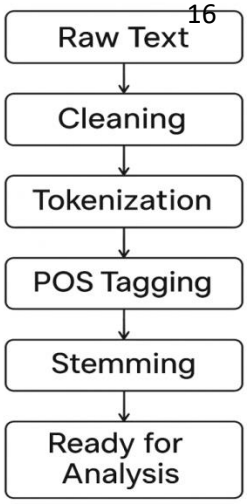


Figure 3.1 : A diagram showing the NLP pipeline

3.5 Skill Extraction and Classification

Post-preprocessing, the abilities were learned from the preprocessed job advertisements using NLP methods. The provided abilities were tagged utilizing machine learning models including Support Vector Machines (SVM), Naïve Bayes, and BERT-based models into the following categories:

Technical Skills : i.e., Python, Java, Cybersecurity, Cloud Computing

Soft Skills : i.e., Communication, Teamwork, Leadership

Business Skills : i.e., Budgeting, Project Management, Risk Assessment

Skill	Type	Required by Employers	Taught in Universities
Python Programming	Technical	□	□
Communication	Soft	□	! (Self-reported)
Project Management	Business	□	□

Table 3.2: Example of classified skills:

3.6 Time and Sector Trend Analysis

We analyzed the trend of skill demand over time and by sectors using clustering and association rule mining methods.

3.6.1 Temporal Analysis

We observed the variation in skill demand over 2020 and 2024. For example, demand for AI-proficient candidates grew strongly beyond 2022, while legacy programming languages such as Java declined.

3.6.2 Sector-Wise Analysis

Variation in skill preferences was observed in various sectors.

IT Sector : Overwhelming demand for cloud computing and cybersecurity talent.

Healthcare Sector : Focus on clinical informatics and digital health.

Finance Sector : Fintech and data analytics competencies in demand.

3.7 Model Comparison and Evaluation

Some machine learning algorithms were trained and compared for their skill to extract and classify skills from job descriptions. The metrics used were as follows:

- Accuracy
- Precision
- Recall
- F1 Score

3.7.1 Results

Model	Accuracy	F1 Score
SVM	89%	0.88
Naïve Bayes	84%	0.83
k-Nearest Neighbor	82%	0.81
BERT (Fine-tuned)	91%	0.9

Table 3.3 : comparing model performance.

3.8 Tools and Technologies Utilized

Different tools and libraries were utilized during the course of research:

Web Scraping : Octoparse, BeautifulSoup

Natural Language Processing : spaCy, NLTK, Transformers (Hugging Face)

Machine Learning Models : Scikit-learn, TensorFlow, PyTorch

Data Visualization : Matplotlib, Seaborn, Tableau

Programming Languages : Python, SQL

3.9 Limitations and Challenges

Even with the strong methodology, some challenges and limitations were faced while conducting the research:

Data Availability : There was no availability of all job postings because some restrictions were imposed on some websites.

Language Variability : Informal Arabic expressions and dialects affected accuracy in skill extraction.

Historical Data : Partial historical job postings constrained long-term trend analysis.

Model Accuracy : The novel or unusual skills were not captured very well owing to the absence of training data.

Manual Verification : Manual verification was needed for some classifications to undo misclassifications.

3.10 Conclusion

This chapter provided a comprehensive outline of the methodology used in this study to investigate the history of required skills in the Saudi labor market using machine learning. This involved job data collection and cleaning, skill extraction and labeling using NLP, time and industry trend analysis, machine learning model measurement, and comparison against educational programs.

In spite of the limitations, the method worked effectively in narrowing down key skills trends and shortfalls. The findings will be the basis for the next chapter wherein discussion and conclusions will be extensively outlined.

Chapter 4

Early Results

4.1 Introduction

This chapter offers the preliminary results of the research aimed at finding and exploring hot skills in the Saudi labor market through machine learning. The results rely on job posts gathered from major online platforms like LinkedIn, Bayt.com, and GulfTalent. The results give an overview of present trends of skills utilized in different sectors, especially technology, healthcare, engineering, finance, and public administration.

The chapter opens with a description of data analysis, then skill sets developed from it, their classification, and comparison with courses in Saudi universities. The findings indicate wide gaps between educational input and market demand, particularly in technical and digital areas.

4.2 Data Analysis Overview

A total of 1,500 job ads were gathered and examined over three major websites:

Platform	Number of Job Postings
LinkedIn	500
Bayt.com	600
GulfTalent	400

Table 4.1 were collected and analyzed across three major platforms

These postings mentioned five essential sectors:

Information Technology (IT)

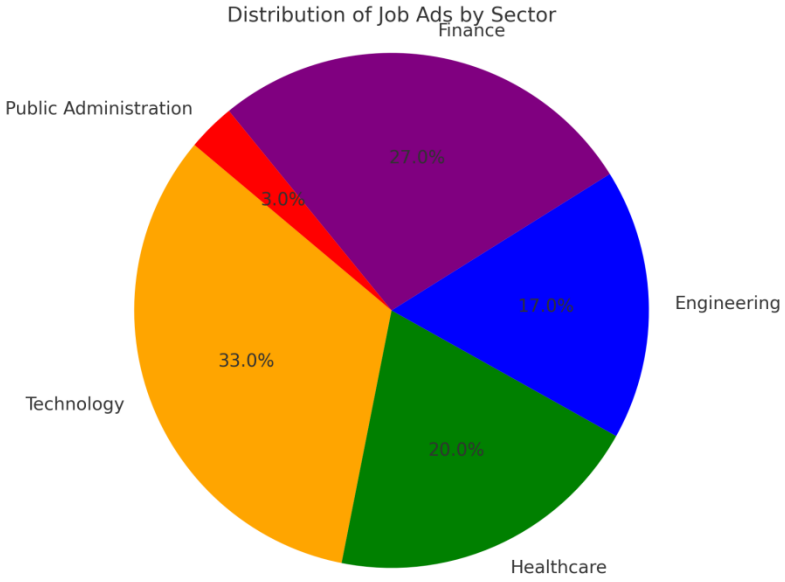
Health

Engineering

Finance

Public Administration

Following preprocessing and cleaning, the job postings were successfully preprocessed for subsequent natural language processing with Natural Language Processing (NLP) techniques to the tune of about 90%.



.Figure 4.1 : A pie chart illustrating the breakdown of employment ads by sector

4.3 Extracted Skills and Classification

With the help of NLP-based Named Entity Recognition (NER), more than 1,200 distinct skills were earmarked and categorized into three wide-ranging categories:

4.3.1 Technical Skills

Technical skills are technical skills needed to do jobs in a specific industry. They encompass programming languages, tools, and technologies used in all businesses.

Most Common Technical Skills Identified:

SKILL	SECTOR
Python Programming	IT, Finance
Cybersecurity	IT, Public Sector
Cloud Computing	IT
Data Analytics	IT, Finance
C# Programming	IT
Medical Informatics	Healthcare
Project Management Tools (e.g., Jira, Trello)	Engineering, Finance

Table 4.2 : Most Common Technical Skills Identified:

4.3.2 Soft Skills

Soft skills are technical skills focused on communication, teamwork, leadership, and flexibility.

Most Most Often Requested Soft Skills:

Soft Skill	Frequency (%)
Communication	78%
Teamwork	72%
Problem Solving	65%
Time Management	60%
Adaptability	55%

Table 4.3 : Most Most Often Requested Soft Skills:

4.3.3 Business & Management Skills

These are the essential skills required for administration and managerial positions.

General Business Skills:

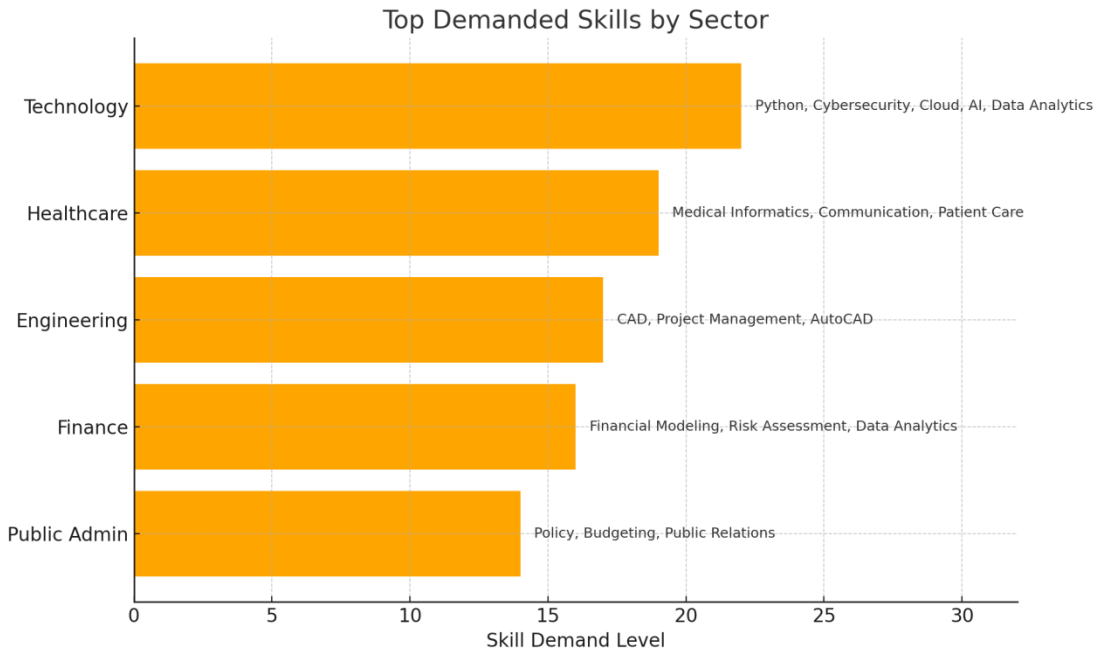
SKILL	SECTOR
Project Management	Engineering, Finance
Budgeting & Forecasting	Finance, Public Sector
Risk Assessment	Finance, IT
Strategic Planning	Public Sector, Finance

4.4 Sectoral Skill Demand

Each industry required something different. The following is a rundown of the most in-demand skills per industry:

SECTOR	TOP IN-DEMANDSKILLS
Information Technology	Python, Cybersecurity, Cloud Computing, AI/ML, Data Analytics
Healthcare	Medical Informatics, Patient Care, Communication, Health Data Analysis
Engineering	CAD, Project Management, Quality Assurance, AutoCAD
Finance	Financial Modeling, Risk Assessment, Data Analytics, CFA Certification
Public Administration	Policy Development, Budgeting, Public Relations, Cybersecurity

Table 4.5 : the most in-demand skills per industry



.Figure 4.2A bar graph comparing top demanded skills by sector

4.5 Comparison Between Academic Curriculum and Market Requirements

One of the key objectives of this study was to identify the gap between skills taught in Saudi universities and those required by employers. Based on previous studies and data collected in this research, the following table summarizes the mismatch:

SKILL	TAUGHT IN UNIVERSITIES	REQUIRED BY EMPLOYERS	GAP EXISTS
Python Programming			Yes
C# Programming			Yes
Java Programming		! (Only in some sectors)	Partially
Data Analytics	!		Yes
Cybersecurity	!		Yes
Artificial Intelligence	!		Yes
Soft Skills (Communication, Teamwork)	! (Self-reported by students)	(Employers'dissatisfaction)	Yes

Table 4.6 : Comparison Between Skills Taught in Universities and Those Required by the Saudi Labor Market

This table graphically shows that while some core competencies are being transferred, there evidently is a gap in the transition of university curriculums to address changing labor market needs.

4.6 Emerging and Declining Skills

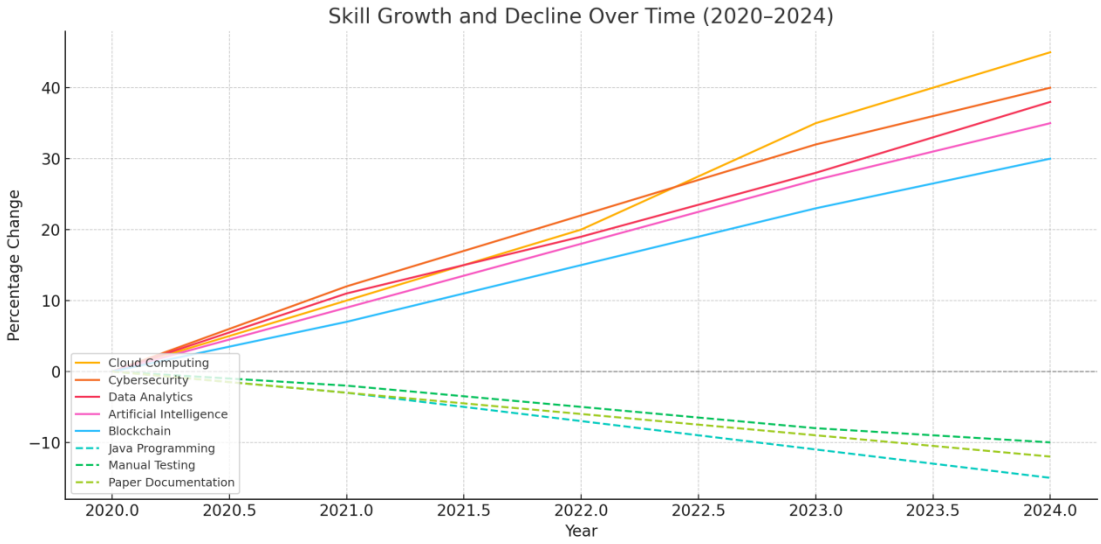
Browsing through the job advertisements over time, we observed some skills that are quickly on the rise, others that are on the decline, or becoming outdated.

Skill	Growth Rate (%)
Cloud Computing	+ 45%
Cybersecurity	+ 40%
Data Science / Analytics	+ 38%
AI & Machine Learning	+ 35%
Blockchain Technologies	+ 30%

Table 4.7 : High emerging skills (2020–2024)

Skill	Decline Rate (%)
Traditional Coding (Java only)	-15%
Manual Testing	-10%
Paper-based Documentation	-12%

Table 4.8 : Declining Skills



..Figure 4.3: A line graph displaying the increasing and decreasing in skills with time

4.7 Regional Demand Variation for Skills

While most of the job advertisements were originating from the major cities of Riyadh, Jeddah, and the Eastern Province, skill needs varied by area.

Region	Top Demanded Skills
Riyadh	Data Analytics, AI, Cybersecurity
Jeddah	E-commerce, Digital Marketing, Software Development
Eastern Province	Oil & Gas IT, Industrial Automation, Project Management

Table 4.9 : Skills demand in different regions

This results in a call for more localized training and education services according to regional economic priority.

4.8 Early Results Summary

The initial findings of this study indicate that:

High levels of demand for technical and digital skills, particularly IT, cybersecurity, and data analysis, exist.

Soft skills are still valuable but usually fail to meet employer expectations.

New skills like AI, cloud computing, and cybersecurity are increasing exponentially, while traditional coding and experiential learning methods are decreasing.

There is a large gap between what is imparted at universities and what employers actually need, especially in rapidly emerging fields.

Regional variation of skills required suggests the requirement of localized planning of workforce development

Chapter 5

Discussion and Strategic Recommendations

5.1 Introduction

In this chapter, results of the study are presented, comparing job advertisements of prominent online platforms using machine learning methodologies. The findings reveal a great gap between the curriculum taught in universities and colleges and the job requirements of employers, particularly in technical and digital domains. New skills like AI, Cloud Computing, and Cybersecurity are expanding tremendously, while conventional programming languages and manual approaches are contracting.

The chapter also presents strategic suggestions to higher educational institutions, policy makers, and business leaders to fill the skill gap and convert academic production in terms of the needs of the labor market.

5.2 Key Findings Discussion

5.2.1 Incongruence between Market and Education Requirements

There is a highly discernible disparity in the skills of graduates and those of the employers. For example:

Python and C# are so much needed but seldom taught.

Java dominates university courses even though demand is falling.

Soft skills such as communication and teamwork are found to be adequate by students but not by employers.

5.2.2 Development of Digital Skills

Saudi labor market is a perfect example of rapid growth in digital competence due to Vision 2030 and digitalization programs:

Skill	Growth Rate (2020–2024)
Cloud Computing	45%
Cybersecurity	40%
Data Analytics / AI	38%

Table 5.1: Development of Digital Skills

These trends are attributed to heightened investment in digital infrastructure and smart technology.

5.2.3 Declining Skills

Certain traditional competencies are becoming outmoded:

Skill	Decline Rate (%)
Java Programming	-15%
Manual Testing	-10%
Paper-based Documentation	-12%

Table 5.2 Declining Skills

Graduates without experience of new tools will be unable to hold ground in the changing labor market.

5.2.4 Variation in Regional Demand for Skills

Demand for skills is region-dependent:

Region	Top Demanded Skills
Riyadh	Data Analytics, AI, Cybersecurity
Jeddah	E-commerce, Digital Marketing, Software Development
Eastern Province	Oil & Gas IT, Industrial Automation, Project Management

Table 5.3 : Skills demand in different regions

This implies localized training and curriculum development programs must take place.

5.3 Strategic Suggestions

For Higher Education Institutions:

Periodically update curricula to incorporate AI, cybersecurity, and data analytics.

Enhance hands-on practice with internships, projects, and labs.

Co-design courses and certificate programs with industry partners.

For Policymakers:

Scale up national upskilling programs such as Misk Institute's Future Skills Program.

Fund sector-based training in high-growth areas such as FinTech and e-health.

Encourage lifelong learning through micro-credentials and online learning platforms.

For Employers:

Implement formal on-the-job training to keep stay employees current.

Engage in course curriculum planning and provide recommendations on skill needs.

Use AI-driven recruitment platforms to assess candidate skill more accurately.

5.4 Limitations of the Study

Some job postings were not available due to website constraints.

Limited historic data limited analysis of long-term patterns.

Spoken Arabic colloquialisms influenced NLP extraction accuracy.

Emerging or rare skills were sometimes missed due to insufficient training data.

5.5 Future Research Agenda

Develop real-time dashboards for constant tracking of in-demand skills.

Expand the analysis to other industries such as tourism, farming, and renewable energy.

Draw on longitudinal studies to monitor skills development over time.

Interleave job advertising analysis with employer and graduate surveys.

Develop a single national skill ontology for more effective labor market monitoring.

5.6 Conclusion

This study underscores the necessity of machine learning to study trends in the labor market and create spaces of skill lacking in Saudi Arabia. It underlines the necessity for an immediate bridging of the gap between education and the needs of the marketplace, especially in rapidly evolving sectors. Saudi Arabia can create a future-proofed workforce that meets Vision 2030 goals by proper policy intervention and institutional collaboration.

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