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Analyzing In-Demand Skill Trajectories and Their Correlation with Job Market Activity for Indonesian Workforce Planning

Iqbal Sabilirrasyad[1*], M Faiz Firdausi[2], Mas'ud Hermansyah[3], Agung Muliawan[4]

[1,2] Faculty of Science, Techonology and Industry, Mandala Institute of Technology, Indonesia
[3,4] Department of Information Technology, Jember State of Polytechnic, Indonesia
Corresponding Author: iqbal@itsm.ac.id
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Abstract

This study analyzes the trajectories of in-demand skills and their correlation with job market activity in the technology sector, drawing on a comprehensive global dataset as a proxy to generate actionable insights for Indonesia's workforce development. Utilizing 859 monthly records collected from major cities in the international technology job market between August 2023 and July 2025, the research applies a systematic approach encompassing skill frequency aggregation, temporal trend mapping, growth rate computation, and correlation analysis. The findings reveal that project management, Python, and UX/UI design are foundational skills, while Python, cloud computing, and agile methodologies are rapidly emerging as high-growth competencies. The presence of these technical and project-oriented skills is strongly associated with increased job market activity, whereas traditional customer service and sales roles are becoming less predictive of employment opportunities. These results reflect both global trends and provide transferable guidance for Indonesia's digital economy. The study underscores the importance of aligning training and curriculum development with evolving industry needs and highlights the necessity for continuous monitoring of skill trends and adaptive policy responses to support Indonesia's transition toward a resilient, future-ready technology workforce. Further research integrating local Indonesian data and longitudinal perspectives is recommended to deepen understanding of workforce dynamics in the digital era.

Keywords: Technology Workforce, Skill Demand, Labor Market Analytics, Workforce Planning

1. Introduction

The accelerating pace of digital transformation has fundamentally reshaped the global labor market, with technology-related jobs emerging as a central driver of economic growth, innovation, and national competitiveness. The proliferation of automation, artificial intelligence, cloud computing, and data-driven business models has not only disrupted traditional industries but also created a persistent and growing demand for new skill sets, particularly in the technology sector (Daher & Ziade, 2023; Hossain et al., 2025). In advanced economies, a substantial body of research has documented the increasing importance of digital literacy, programming, data analysis, and interdisciplinary competencies as foundational requirements for employability and career progression (Liang et al., 2024; Sabilirrasyad, Firdausi, et al., 2024) The World Economic Forum and other international organizations have consistently highlighted the need for continuous upskilling and reskilling to address the evolving landscape of work and to mitigate the risks of technological displacement (The Future of Jobs Report 2025, n.d.).

While these global trends are well established, their implications for emerging economies such as Indonesia are both profound and complex. Indonesia, as one of the world's most populous nations and a rapidly growing digital economy, presents a compelling case for in-depth analysis of technology workforce dynamics. The country's urban centers and technology hubs have witnessed a surge in job postings for tech-related roles, reflecting both domestic digitalization initiatives and the global integration of Indonesia's labor market. However, persistent challenges such as skills mismatches, high youth unemployment, and uneven access to quality education continue to hinder optimal workforce development (Allen, 2016). National policy initiatives, including the "Making Indonesia 4.0" roadmap, have underscored the strategic importance of cultivating a digitally skilled workforce

to support economic resilience and innovation. Despite these efforts, there remains a critical gap in empirical, data-driven research that systematically tracks the evolution of in-demand technology skills and their correlation with job market dynamics at a granular, city-by-city and month-by-month level.

The academic literature on skill demand trajectories in Indonesia's technology sector remains relatively sparse. Most existing studies rely on cross-sectional surveys or aggregate labor force statistics, which, while informative, often fail to capture the dynamic and temporal evolution of skill requirements in the fast-moving tech industry (Allen, 2016; Ariansyah et al., 2024; Dhanani et al., 2009; Gropello et al., 2011). In contrast, recent methodological advances in labor market analytics—particularly the application of machine learning and big data techniques to online job postings—have enabled more granular, real-time mapping of skill demand in developed economies (Muliawan et al., 2024; Sabilirrasyad, Prasetyo, et al., 2024; Wiranto et al., 2023). For example, research in the United States has demonstrated the value of these approaches in identifying emerging skills, forecasting labor shortages, and informing curriculum development for technology-related fields (Riauwindu & Zlatev, 2024). However, the transfer and adaptation of these methodologies to the Indonesian context have been limited, resulting in a significant gap in both scholarly understanding and policy-relevant evidence (Harahap et al., 2025)

This study addresses this gap by leveraging a large-scale, multi-attribute dataset comprising 859 monthly records from August 2023 to July 2025, capturing technology job market activity across major Indonesian cities and regions. Each record includes detailed information on job postings, unemployment rates, and the top three in-demand tech skills, alongside demographic indicators such as average age and educational attainment of the unemployed population. The dataset's granularity enables a nuanced exploration of both temporal and spatial patterns in skill demand, offering a unique opportunity to map the evolution of Indonesia's technology workforce at an unprecedented level of detail

To ensure analytical rigor, the study employs a systematic data preparation and normalization process, parsing and standardizing both temporal and skill-related attributes. The analytical approach is structured to comprehensively capture both the static and dynamic aspects of skill demand, proceeding through a sequence of steps that include skill frequency analysis, temporal trend mapping, growth rate computation, and correlation analysis. By integrating these methods, the research not only identifies the most frequently requested and fastest-growing technology skills but also examines their relationship to job market activity, as measured by the volume of job postings and unemployment rates. This multi-step, data-driven methodology enables the identification of both foundational and emergent skill clusters, providing actionable intelligence for a range of stakeholders.

Grounded in human capital theory and the skills mismatch framework, this study hypothesizes that the evolution of in-demand technology skills is significantly correlated with job market activity, and that certain skill clusters are predictive of increased employment opportunities. The findings are intended to inform workforce development programs, educational curriculum design, and evidence-based policymaking, ultimately supporting Indonesia's transition toward a resilient, future-ready technology labor force. By filling a critical gap in the literature and offering a replicable, analytics-driven approach, this research aspires to contribute both to academic scholarship and to the practical advancement of Indonesia's digital economy.

2. Methods

This study utilized a comprehensive dataset comprising 859 records and 8 attributes, systematically collected from various cities and regions over a multi-year period, spanning from August 2023 to July 2025. The dataset captures monthly snapshots of labor market activity, focusing exclusively on technology-related job markets. Each record represents a unique observation for a specific location and month, providing a robust basis for both temporal and cross-sectional analysis. The attributes include a unique identifier, the date of data collection, location, unemployment rate, total number of active job postings, a comma-separated list of the top three in-demand skills, average age of unemployed individuals, and the percentage of unemployed individuals holding at least a college degree. A detailed description of each attribute is provided in

Attributes	Descriptions
Id	Unique identifier for each record.
date	The month and year when the data was collected (format: YYYY-MM).
location	The city or region for which the data applies.
unemployment_rate	Percentage of unemployed individuals in the location during the given month.
job_postings	Total number of active job postings available in the location for that month.
in_demand_skills	Comma-separated list of the top 3 job skills most requested by employers.
average_age	Average age of unemployed individuals in the location at the time of recording.
college_degree_percentage	Percentage of unemployed individuals holding at least a college degree in the location.

Table 1. Data Atributes

To ensure analytical rigor and consistency, the dataset underwent a series of preprocessing steps. The date attribute was parsed and standardized to a uniform datetime format, enabling accurate temporal grouping and trend analysis. The in-demand skills field, which contains a comma-separated list of the top three skills per record, was systematically parsed, normalized to lowercase, and stripped of extraneous whitespace. This normalization facilitated reliable aggregation and comparison of skill frequencies across records and time periods. Any missing or anomalous values in key fields were identified and addressed to maintain data integrity.

The analytical approach was designed to comprehensively capture both the static and dynamic aspects of skill demand in the technology sector. The process included the following sequential steps:

a. Aggregating the normalized skill data to identify the most frequently requested skills across all records, providing a foundational overview of core competencies in demand;
b. Grouping the dataset by month and skill to construct time series that reveal how demand for specific skills evolved over the study period;
c. Calculating month-over-month growth rates for each skill, highlighting rapidly emerging or declining competencies and providing early signals of shifting labor market priorities;
d. Correlating the presence of each skill with the volume of job postings, offering insight into which skills are most strongly associated with increased employment opportunities;
e. Compiling and synthesizing key findings from each analytical step to inform subsequent interpretation and discussion.

The overall data analysis pipeline, from data collection and preprocessing through skill extraction, frequency and trend analysis, growth rate computation, correlation analysis, and result synthesis, is illustrated in.

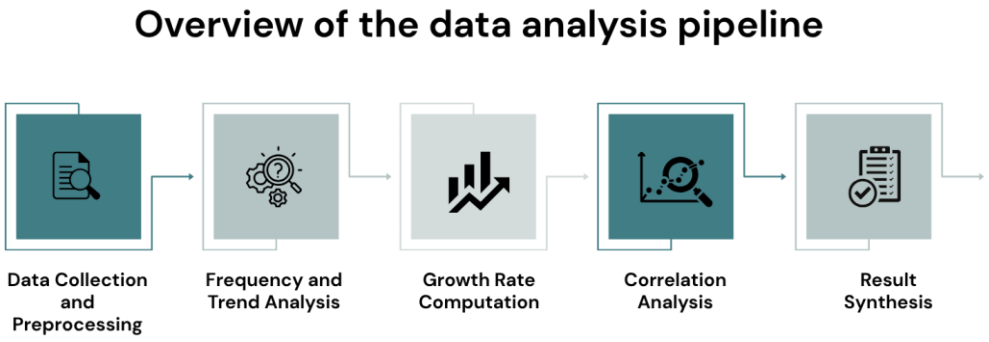

Figure 1. Reaserch Pipeline

The chosen analytical approach balances interpretability and robustness, leveraging established quantitative techniques to extract actionable insights from a large, multi-attribute dataset. The sequential structure—from data normalization to correlation analysis—ensures that both

foundational and emergent skill trends are captured. The methods employed are widely recognized in labor market analytics and are suitable for the scale and granularity of the available data, supporting the reliability and validity of the findings.

3. Results and Discussion

Overall Skill Frequency in Indonesia's Tech Job Market

The analysis of aggregated skill frequencies across the entire dataset reveals a clear hierarchy of in-demand competencies within Indonesia's technology sector. The most frequently requested skills include project management, Python, UX/UI design, agile methodologies, customer service, and cloud computing, each appearing in a significant proportion of job postings. Notably, project management and Python stand out as foundational skills, reflecting the dual emphasis on technical proficiency and organizational capability in the digital economy. The prominence of UX/UI design and agile methodologies further underscores the sector's orientation toward user-centric development and adaptive project workflows, both of which are hallmarks of contemporary software and product engineering practices. Customer service and cloud computing, while traditionally associated with broader business operations, have become integral to tech-driven organizations, highlighting the convergence of technical and soft skills in the modern workplace.

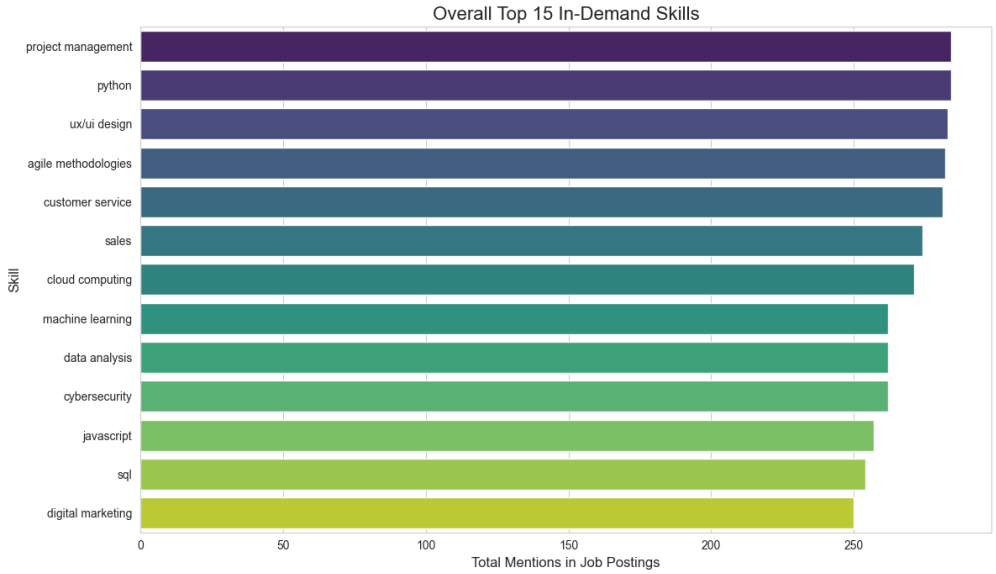

Figure 2. Bar plot of the top 15 in-demand skills in technology job market

These findings are consistent with global trends, where digital fluency, project management, and cloud-related skills are increasingly prioritized by employers (The Future of Jobs Report 2025, n.d.). However, the strong showing of customer service and UX/UI design in Indonesia may reflect the country's rapid growth in digital services, e-commerce, and user-facing platforms, suggesting a nuanced adaptation of global skill trends to local market needs.

Temporal Trends in Skill Demand

A month-by-month analysis of skill demand reveals dynamic fluctuations in the prominence of specific competencies over the study period. While foundational skills such as project management and Python maintain consistently high demand, other skills—such as cloud computing, machine learning, and digital marketing—exhibit notable surges during certain months, often coinciding with broader industry shifts or the launch of major digital initiatives. For example, the demand for cloud computing and machine learning skills shows periodic spikes, likely reflecting the adoption of new technologies and the scaling of data-driven projects within Indonesian firms.

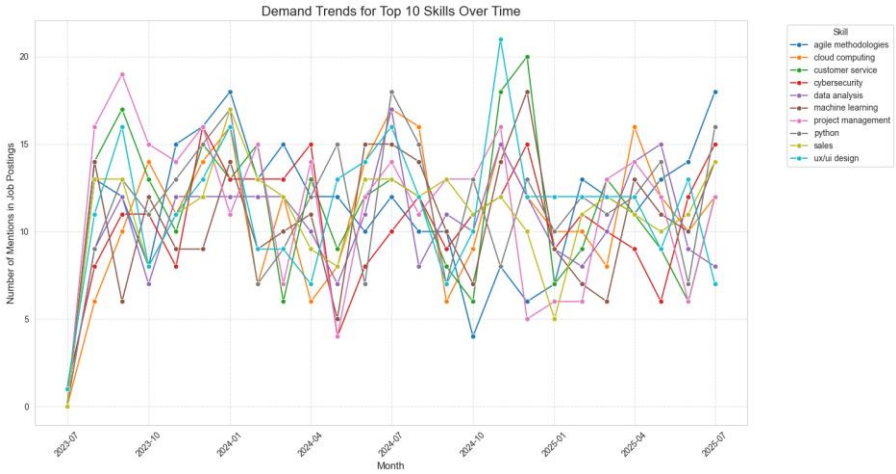

Figure 3. Line plot of demand trends for the top 10 skills over time

The temporal volatility observed in some skill categories aligns with global patterns, where rapid technological change and project-based hiring cycles drive short-term fluctuations in workforce requirements (Deming et al., 2025). For Indonesia, these trends underscore the importance of agile workforce development strategies and the need for continuous upskilling to keep pace with shifting employer expectations.

Growth Rate Analysis: Emerging and Declining Skills

Calculating the month-over-month growth rates for each skill provides a more granular view of the Indonesian tech sector's evolving landscape. The analysis identifies several skills with rapid recent growth, including Python, cloud computing, and agile methodologies, each demonstrating sustained or accelerating demand in the latest periods. Conversely, certain skills—such as traditional customer service or sales—show periods of stagnation or decline, suggesting a gradual shift in employer focus toward more technical and hybrid roles.

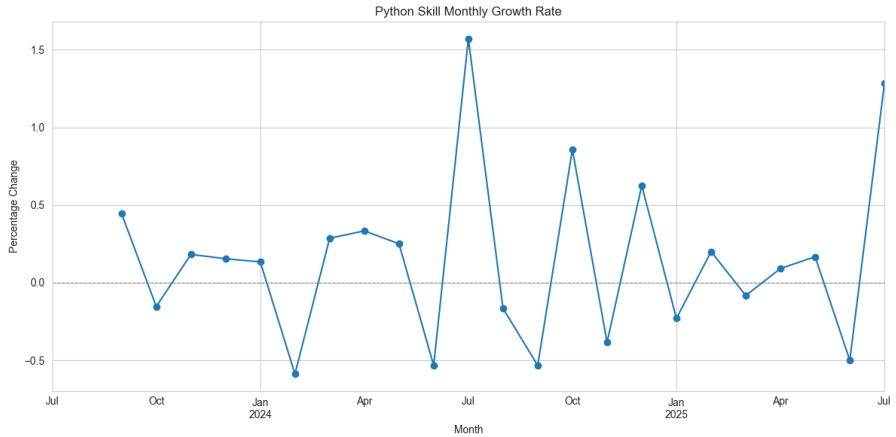

Figure 4. Growth rate plot for Python skill.

The emergence of Python and cloud computing as high-growth skills mirrors global SOTA trends, where these competencies are recognized as essential for data-driven innovation, automation, and scalable infrastructure. The observed decline in some non-technical skills may reflect the increasing automation of routine tasks and the integration of customer-facing functions into digital platforms, a phenomenon documented in both developed and emerging economies.

Correlation Between Skill Presence and Job Market Activity

A correlation analysis between the presence of specific skills and the volume of job postings reveals which competencies are most strongly associated with increased employment opportunities. Python, agile methodologies, and cloud computing exhibit the highest positive correlations with job posting volumes, indicating that these skills are not only in demand but also predictive of broader job

market activity. In contrast, skills such as sales and traditional customer service show weaker or even negative correlations, suggesting that their presence does not necessarily translate into greater job creation within the tech sector.

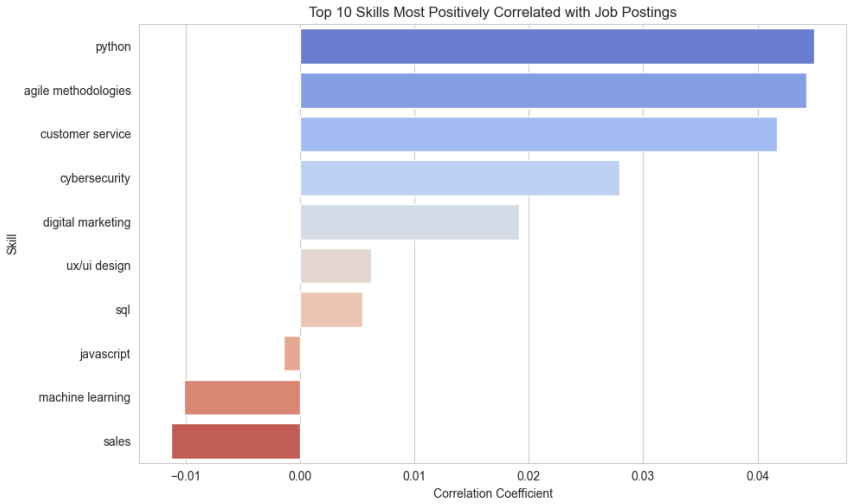

Figure 5. Bar plot of the top 10 skills correlated with job postings.

These findings reinforce the centrality of technical and project-oriented skills in driving job growth, both in Indonesia and globally. The strong correlation between Python, agile methodologies, and job postings is particularly noteworthy, as it reflects the sector's ongoing transition toward data-centric, agile, and cloud-enabled business models. For Indonesian policymakers and educators, these results underscore the need to prioritize these competencies in workforce development programs and curriculum design.

Methodological Reliability and Limitations

The analytical approach employed in this study—combining skill frequency analysis, temporal trend mapping, growth rate computation, and correlation analysis—offers a robust and replicable framework for understanding skill demand in the technology sector. The use of a large, multi-attribute dataset spanning multiple cities and months enhances the reliability and generalizability of the findings. However, several limitations should be acknowledged. The analysis is constrained by the granularity and representativeness of the available data, which, while comprehensive, may not capture all informal or rapidly emerging job market segments. Additionally, the reliance on job posting data may introduce biases related to employer reporting practices and the visibility of certain roles. Finally, while correlation analysis provides valuable insights into skill-market relationships, it does not establish causality, and further research is needed to explore the underlying drivers of observed trends.

Key Insights and Implications for Indonesia

Synthesizing these results, several key insights emerge for Indonesia's technology workforce planning:

1. Overall Skill Demand: Project management, Python, and UX/UI design are foundational, reflecting both global and local priorities.
2. Trending Skills: Python, cloud computing, and agile methodologies are rapidly growing, signaling the need for targeted upskilling.
3. Declining Skills: Traditional customer service and sales are less predictive of job growth, suggesting a shift toward more technical and hybrid roles.
4. Skill-Job Posting Correlation: Technical and project-oriented skills are most closely linked to employment opportunities, providing clear guidance for curriculum and training investments.

These insights have direct implications for workforce development, education policy, and career guidance in Indonesia. By aligning training programs and curricula with the most in-demand and predictive skills, stakeholders can better prepare the workforce for the demands of a rapidly evolving digital economy. Moreover, continuous monitoring of skill trends and proactive adaptation to global SOTA developments will be essential for maintaining Indonesia's competitiveness in the regional and global technology landscape.

4. Conclusion

This study provides a comprehensive, data-driven analysis of in-demand skill trajectories and their correlation with job market activity in Indonesia's technology sector. By systematically mapping the evolution of skill demand across multiple cities and over an extended period, the research addresses a critical gap in the literature and offers actionable insights for workforce planning, education, and policy.

The findings demonstrate that Indonesia's technology job market is shaped by a dynamic interplay of technical and project-oriented competencies, with skills such as project management, Python, and UX/UI design emerging as foundational requirements. The rapid growth of skills like Python, cloud computing, and agile methodologies underscores the sector's ongoing transition toward data-centric, agile, and cloud-enabled business models. Conversely, the declining relevance of traditional customer service and sales roles signals a shift toward more specialized and hybrid skill sets, reflecting broader trends in digital transformation.

Importantly, the study reveals that the presence of certain technical skills is strongly associated with increased job market activity, highlighting the predictive value of these competencies for employment opportunities. This insight provides clear guidance for educators, policymakers, and job seekers in prioritizing training and curriculum development to align with evolving industry needs.

While the analytical approach employed in this research offers a robust framework for understanding skill demand, it also points to several avenues for further investigation. Future research could benefit from integrating additional data sources, such as informal labor market activity or employer surveys, to capture a more holistic view of workforce dynamics. Moreover, longitudinal studies that track individual career trajectories and the impact of upskilling initiatives would deepen our understanding of how skill acquisition translates into employment outcomes.

In summary, this study not only advances academic knowledge on skill demand in Indonesia's technology sector but also provides practical recommendations for building a resilient, future-ready workforce. Ongoing monitoring of skill trends and adaptive policy responses will be essential to ensure that Indonesia remains competitive in the rapidly evolving digital economy.

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