



Reskilling and Upskilling the Workforce: Text Mining to Identify Patterns and Trends in Research

Maayan Nakash

Department of Management, Department of Information Science, Bar-Ilan University, Ramat Gan, Israel

Abstract

In the aftermath of the Fourth Industrial Revolution and the seismic shifts triggered by the COVID-19 pandemic, the labor market has undergone a significant transformation, compelling a reassessment of workforce competencies. This study delivers a comprehensive analysis of the emerging trends in reskilling and upskilling initiatives, which are pivotal for adapting to these shifts. Employing text mining techniques through Voyant Tools, we meticulously examined a corpus of 68 academic articles from the Web of Science database, all related to workforce development. Our methodological framework encompassed a thorough statistical analysis to distill and scrutinize term frequencies, inter-term relationships, and the overarching sentiment within the scholarly dialogue. The outcomes of this inquiry provide a sophisticated understanding of the prevailing academic terrain, accentuating the central themes and lacunae in the extant research corpus. The revelations from this preliminary study make a significant contribution to the domain of human capital development. The findings lay down an empirical groundwork for future studies in this sphere, poised to furnish strategic insights crucial for crafting robust career development programs. By illuminating the imperative of perpetual learning and skill enhancement, this paper adds to the conversation on equipping a resilient workforce, ready to excel in the dynamic, tech-centric economy that lies ahead.

Keywords: Reskilling, Upskilling, Skills, Human Capital, Text Mining

1. Introduction

The advent of the Fourth Industrial Revolution, also referred to as 4IR, Industry 4.0, or Digital Revolution, has marked the beginning of an era in which rapid advancements in automation and digital technologies are reshaping the global workforce landscape (Abe et al., 2021; Oladele et al., 2021). In particular, the progression of artificial intelligence and cognitive computing has triggered a significant reconfiguration, extending beyond industrial realms to the complex network of social interactions within the workplace. As a result, the

workforce is thrust into an ongoing evolution, mandating the fostering of a culture of lifelong learning (Bodea et al., 2024; Sofia et al., 2023). The COVID-19 pandemic has expedited this shift, rendering it essential for workers to promptly adapt to novel roles and skill sets. This shift has accentuated the importance of reskilling and upskilling initiatives in response to the dynamic demands of the labor market (Li, 2022). The pronounced changes in employment structures require a strategic approach to mitigate skill gaps and rectify training shortcomings, which stand as formidable challenges in this contemporary industrial landscape (Agarwal et al., 2022).

Text mining, an innovative analytical method, serves as a pivotal tool in deciphering complex patterns and extracting salient information from vast amounts of unstructured text. By employing sophisticated algorithms, text mining facilitates the identification of linguistic patterns and lexical frequencies that often elude traditional analysis (Kumar & Bhatia, 2013; Miller, 2008). Despite its widespread application across various domains, its utilization within the sphere of human capital (HC) development remains relatively unexplored. The current study aims to bridge this gap by employing text mining techniques to discern patterns and trends within the corpus of research dedicated to reskilling and upskilling.

Leveraging the capabilities of Voyant Tools, a cutting-edge text analysis platform, our research delves into a meticulously curated corpus comprising 68 scholarly articles. These articles, sourced from the esteemed Web of Science (WoS) database, span the interdisciplinary domains of reskilling and upskilling. Through this comprehensive analysis, we endeavor to illuminate the prevailing research trajectories and emergent themes that characterize this burgeoning field of study.

2. Theoretical Background

In the contemporary labor market, reskilling and upskilling represent two pivotal strategies for occupational development. Reskilling is defined as the process of learning entirely new skill sets aimed at different career trajectories, often necessitated by the obsolescence of previous roles (Adepoju, 2022). Upskilling, on the other hand, refers to the enhancement of an employee's current skill set to bolster their performance and adaptability within their existing position (Sivalingam & Mansori, 2021). These processes are instrumental in fostering internal mobility within organizations, serving not only to attract but also to retain talent by aligning employee competencies with the evolving demands of the job market (LinkedIn, 2023).

The rapid pace of technological innovation, particularly in the wake of Industry 4.0, has created a discernible skills gap. This gap reflects the discrepancy between the current capabilities of employees and the swiftly changing requirements of their roles, thus highlighting the urgency for effective talent development strategies (Whysall et al., 2019). The dynamic nature of job functions, propelled by advancements in automation and digital technologies, underscores the growing imperative for continuous reskilling and upskilling of the existing workforce (Agarwal et al., 2022; Rangarajan & Rubasree, 2024; Sofia et al., 2023).

The disruptions wrought by the COVID-19 pandemic have led to projections that, within five years, half of the global workforce will require reskilling due to technological progress. Moreover, it is projected that by the year 2025, a substantial portion of the essential skills will encompass technological competencies that, at the time of the global pandemic outbreak, were not considered critical (Schwab & Zahidi, 2020; Whiting, 2020). Consequently,

organizations are compelled to strategically design their business models and meticulously plan for the future skills landscape of their workforce (Sivalingam & Mansori, 2021).

The imperative for reskilling and upskilling in today's rapidly evolving labor market demands that academic institutions adopt innovative educational methodologies. To remain aligned with the swift pace of technological and societal transformation, schools and higher education entities must enhance their agility and creativity, ensuring that their curricula are attuned to the multifaceted needs of a diverse learner population (Bashynska et al., 2021; Fung, 2020; Sivalingam & Mansori, 2021).

Essential competencies for the future workforce, such as complex problem-solving, active learning, critical thinking, adaptability, creativity, and emotional intelligence, have been recognized as the driving forces behind the future of work (Gray, 2016; Li, 2022; Schwab & Zahidi, 2020; Whiting, 2020). The expanded discourse emphasizes the necessity for a workforce that is not merely technically adept but also possesses the soft skills required to successfully maneuver through the complexities introduced by Industry 4.0 and beyond (Li, 2022).

3. Methodology

To fulfill the objectives of our research, we employed a methodological framework centered on text mining for textual analysis. Text mining is an automated process that extracts novel information from textual data through computational techniques. This method leverages the power of natural language processing to facilitate insight generation by quantifying term frequencies, discerning patterns of word usage, and tracking emergent trends (Kumar & Bhatia, 2013; Miller, 2008).

For our analysis, we utilized Voyant Tools, a free, open-source web-based software suite endowed with sophisticated analytical functions for statistical examination of data. This platform is equipped with diverse features that enable the exploration of contexts, relationships, and content categorization. Its capacity for visual data representation enhances our ability to detect patterns, making it a valuable asset for scholarly research (Alhudithi, 2021; Welsh, 2014).

Our research corpus comprised academic articles sourced from the WoS database, focusing on the themes of reskilling and upskilling. We selected WoS due to its reputation as a dependable and high-caliber repository for literature analysis. Initially, we queried the database using the terms “reskilling AND upskilling” within titles, abstracts, or keywords, yielding 116 results, including books, theses, and conference papers. To refine our focus on articles directly addressing our research topics and to prime them for comprehensive analysis, we filtered the results to “Document Type: article” and limited our scope to those published in English, resulting in a selection of 79 articles.

The average citation count for these articles was 5.87 ($SD = 14.74$), with the most cited paper garnering 120 citations, notably featuring both terms—reskilling and upskilling—in its title. Upon review, we identified that 11 out of the 79 articles were restricted by private or institutional access. Consequently, the final corpus for our analysis consisted of 68 academic articles. We downloaded the PDF files of each article, assigning a sequential number to each. In total, the corpus encompassed 722,846 words, with Voyant Tools identifying 53,051 as unique (7.33%). The most extensive article contained 25,887 words, 5,651 of which were unique, accounting for 22% of its content.

4. Results

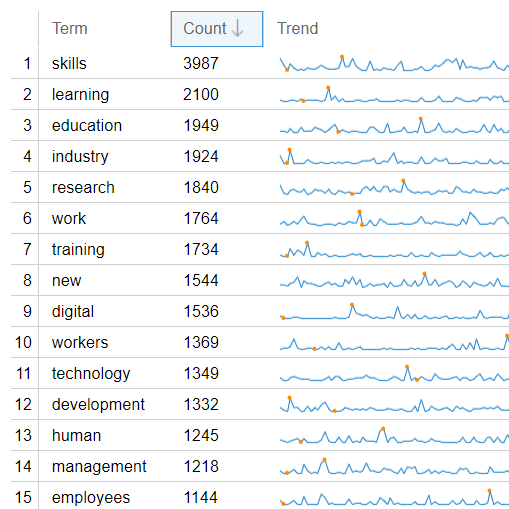
4.1 Term Frequency in the Corpus

Following data cleansing, which involved removing linking and stop words, we investigated the frequency of appearance of different terms within the corpus. Notably, the term “skills” emerged as the most prominent, with a count of 3,987, reflecting the focus on workforce development in work environments.

Figure 1 illustrates the segmentation of popular terms based on their frequency. The prevalence of terms such as “learning” and “education” with 2,100 and 1,949 occurrences respectively, aligns with the narrative that continuous learning and educational advancement are integral to HC advancement. The presence of terms like “industry,” “research,” and “work” further indicates a comprehensive exploration of professional growth and skill enhancement in response to industrial advancements.

The fluctuating trends depicted in the line graphs for each term suggest dynamic shifts in research focus over time, possibly reflecting real-world events or technological breakthroughs. Such trends may reveal how the academic community responds to changes in skill requirements within the job market, highlighting areas of growing interest or diminishing attention.

Figure 1: Frequency Segmentation of Popular Terms in the Corpus



The term “skills” is intimately linked with fundamental concepts such as “knowledge,” “development” and “workers,” a relationship that is visually articulated through the Bubblelines in Figure 2. This graphical illustration not only underscores the term's prevalence but also its pivotal role in fostering continuous learning and professional advancement amidst technological progress and shifting industry paradigms. The visual data compellingly narrates the term's prominence and its synergistic association with other key terms within the scholarly corpus.

The Bubblelines provide a lucid portrayal of “skills” across diverse texts, with the bubble sizes proportionately mirroring the term's frequency. The dispersion of bubbles along the horizontal axes, each representing a distinct document, signifies the term's sustained pertinence in dialogues concerning professional growth initiatives and the cultivation of new abilities.

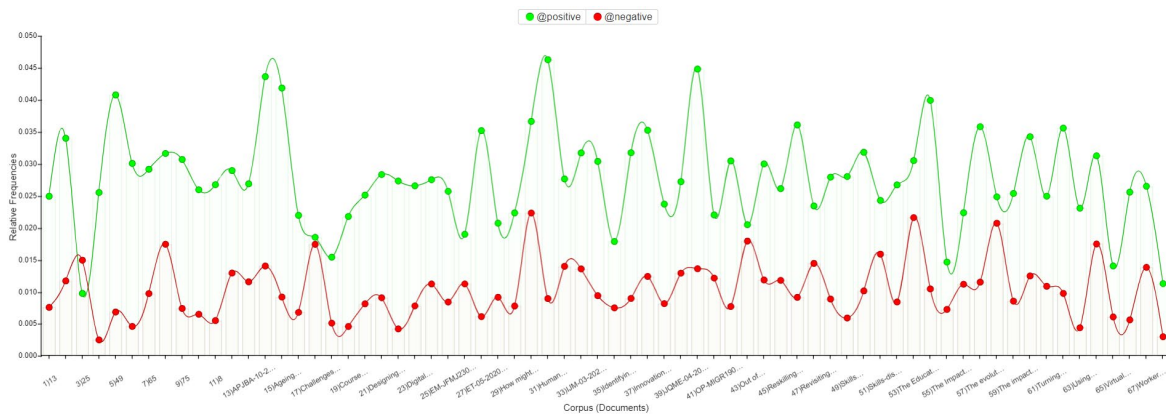
These include “learning” ($r=0.49$, $p<0.001$), “education” ($r=0.36$, $p<0.001$), and “industry” ($r=0.31$, $p<0.001$). Notably, these terms are among those most prevalent in the corpus, indicating their significant relevance to the discourse on skill development.

4.3 Sentiment Analysis for the Corpus

Utilizing Voyant Tools for sentiment analysis, we observed a significant prevalence of positive sentiments within the corpus, with a total of 20,276 instances, in stark contrast to the 7,600 instances of negative sentiments. This disparity underscores a generally optimistic tone in the discourse of the texts. Intriguingly, a solitary article diverged from this trend, displaying a higher incidence of negative sentiments, an anomaly that merits further qualitative scrutiny.

Figure 8 graphically represents these findings, offering a visual summary of the emotional tone conveyed across the corpus. The sentiment analysis, as illustrated, offers an insightful perspective on the dominant narrative tone within the scholarly discussions captured in the corpus.

Figure 8: Sentiment Analysis for the Corpus



5. Conclusions and Future Directions

The Fourth Industrial Revolution, characterized by the integration of digital technologies into all aspects of human life, has catalyzed a transformative shift in the global economy and labor market. The COVID-19 pandemic has further accelerated this transition, underscoring the urgency for a workforce that is adaptable, resilient, and equipped with the necessary skills to thrive in an increasingly digitalized world. Our findings indicate that reskilling and upskilling are not merely beneficial but essential strategies for organizations aiming to attract and retain talent, as well as to sustain competitiveness in a rapidly evolving work environment.

The current study, while exploratory, has initiated an inquiry into the automated text analysis of a corpus of academic articles centered on HC development, with a particular focus on reskilling and upskilling. This investigation represents a foundational step in discerning trends and patterns pertinent to these topics. Future studies could benefit from expanding the sample size and potentially enhancing the findings through meta-analysis, thereby enriching our comprehension of the phenomenon under study. Moreover, given the predominantly positive sentiments identified within the sample of academic articles, it is advisable to explore the challenges associated with skill mapping. Such exploration could serve as an initial phase in the development and refinement of skills within organizations.

Policymakers, by virtue of their position, are instrumental in fostering an environment that is conducive to reskilling and upskilling. They can expedite this process through strategic collaborations with educational institutions and employers, thereby ensuring that the skills imparted align seamlessly with the demands of the future economy. Educators, bearing the significant responsibility of equipping individuals for the future workforce, have the opportunity to harness innovative pedagogical approaches and state-of-the-art technologies to deliver impactful training. It would be judicious for them to integrate into their curriculum initiatives aimed not only at cultivating digital literacy but also a capacity for agility, creativity, and resilience.

Employers, who have a vested interest in cultivating a skilled and adaptable workforce, can bolster reskilling and upskilling initiatives through a three-pronged approach. Firstly, they can invest in comprehensive employee training and development programs. Secondly, they can foster a corporate culture that prizes continuous learning and skill development. Lastly, they can implement robust strategies to attract and retain talent, which may include providing avenues for career progression and acknowledging employees' efforts to enhance their skills. This holistic approach ensures a smooth transition into the future of work.

The formulation of concrete, practical programs for reskilling and upskilling processes appears to warrant further scholarly attention. We advocate for this matter to be pursued in collaboration with professionals specializing in organizational learning and development. Advancements in this area could contribute significantly to the theoretical expansion of the HC discipline. Equally important, contemporary empirical research is essential to underpin the establishment of specific practices for organizations aiming to devise effective strategies for reskilling and upskilling, integral to the successful navigation of career pathways.

Additional avenues for future research may include a deeper investigation into the specific skills that will be most valuable in the future economy, as well as the most effective methods for delivering reskilling and upskilling training. Additionally, research could explore the psychological and social aspects of workforce transformation, such as employee motivation and the impact of continuous learning on job satisfaction and career progression. Ultimately, advancing our understanding of these areas will be crucial for developing robust strategies to navigate the challenges and opportunities presented by the Digital Revolution.

References

- Abe, E. N., Abe, I. I., & Adisa, O. (2021). Future of work: Skill obsolescence, acquisition of new skills, and upskilling in the 4IR. In *Future of work, work-family satisfaction, and employee well-being in the fourth industrial revolution* (pp. 217-231). IGI Global.
- Adepoju, O. (2022). Reskilling for Construction 4.0. In: *Re-skilling Human Resources for Construction 4.0*. Springer Tracts in Civil Engineering . Springer, Cham.
- Agarwal, V., Mathiyazhagan, K., Malhotra, S., & Saikouk, T. (2022). Analysis of challenges in sustainable human resource management due to disruptions by Industry 4.0: an emerging economy perspective. *International Journal of Manpower*, 43(2), 513-541.
- Alhudithi, E. (2021). Review of voyant tools: See through your text. *Language Learning & Technology*, 25(3), 43-50.
- Bashynska, I., Garachkovska, O., Kichuk, Y., Podashevskaya, T., & Bigus, O. (2021). Smart education 4.0: Balancing dual-distance and reskilling revolution. *Studies of Applied Economics*, 39(6).

- Bodea, C. N., Papanic, M., Mogoş, R. I., & Dascălu, M. I. (2024). Artificial intelligence adoption in the workplace and its impact on the upskilling and reskilling strategies. *The AMFITEATRU ECONOMIC journal*, 26(65), 126-126.
- Fung, M. (2020). Developing a robust system for upskilling and reskilling the workforce: Lessons from the SkillsFuture movement in Singapore. In *Anticipating and Preparing for Emerging Skills and Jobs: Key Issues, Concerns, and Prospects* (pp. 321-327). Singapore: Springer Singapore.
- Gray, A. (2016). The 10 skills you need to thrive in the Fourth Industrial Revolution. World Economic Forum, January 19, 2016. <https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/>. Accessed on August 1, 2023.
- Kumar, L., & Bhatia, P. K. (2013). Text mining: concepts, process and applications. *Journal of Global Research in Computer Science*, 4(3), 36-39.
- Li, L. (2022). Reskilling and upskilling the future-ready workforce for industry 4.0 and beyond. *Information Systems Frontiers*, 1-16.
- LinkedIn. (2023). Upskilling Versus Reskilling. <https://learning.linkedin.com/resources/upskilling-and-reskilling/upskilling-reskilling>. Accessed September 20, 2023.
- Miller, A. (2018). Text mining digital humanities projects: Assessing content analysis capabilities of voyant tools. *Journal of Web Librarianship*, 12(3), 169-197.
- Oladele, K. O., Lisoyi, E. O., & Abe, I. I. (2021). Reskilling and Upskilling to Develop Global Relevance in the Fourth Industrial Revolution. In *Future of Work, Work-Family Satisfaction, and Employee Well-Being in the Fourth Industrial Revolution* (pp. 246-258). IGI Global.
- Rangarajan, R., & Rubasree, J. (2024). Up-skilling and Re-skilling: A Strategic Response to Changing Skill Demands. *European Economic Letters (EEL)*, 14(1), 765-774.
- Schwab, K., & Zahidi, S. (2020). The future of jobs report 2020. World Economic Forum, October 2020. https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf. Accessed July 31, 2022.
- Sivalingam, A. D., & Mansori, S. (2021). How organizations should view reskilling and upskilling the workforce. In *How Organizations Should View Reskilling and Upskilling the Workforce: Sivalingam, Ananda Devan | uMansori, Shaheen*. [SI]: SSRN.
- Sofia, M., Fraboni, F., De Angelis, M., Puzzo, G., Giusino, D., & Pietrantonio, L. (2023). The impact of artificial intelligence on workers' skills: Upskilling and reskilling in organisations. *Informing Science: The International Journal of an Emerging Transdiscipline*, 26, 39-68.
- Welsh, M. E. (2014). Review of Voyant tools. *Collaborative Librarianship*, 6(2), 96-98.
- Whiting, K. (2020). These are the top 10 job skills of tomorrow – and how long it takes to learn them. World Economic Forum, October 21, 2020. <https://www.weforum.org/agenda/2020/10/top-10-work-skills-of-tomorrow-how-long-it-takes-to-learn-them/>. Accessed June 7, 2022.
- Whysall, Z., Owtram, M., & Brittain, S. (2019). The new talent management challenges of Industry 4.0. *Journal of Management Development*, 38(2), 118-129.