



Received: 02-03-2025
Accepted: 12-04-2025

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Analyzing the Effects of Technology Change on the Labour Market in the Manufacturing Sector in Zambia: A Case Study of Zambian breweries

¹ Emmiliana Lwenje, ² Peter Silwimba

^{1, 2} Department of Social Sciences, Information and Communications University, Information and Communications University (ICU), and Zambia Research and Development Center Lusaka, Zambia

DOI: <https://doi.org/10.62225/2583049X.2025.5.2.4140>

Corresponding Author: Emmiliana Lwenje

Abstract

Technological change has significantly reshaped labor markets globally, with the manufacturing sector being particularly affected. This study examines the impact of technological advancements on the labor market in Zambia's manufacturing sector, focusing on Zambian Breweries. The research evaluates the extent to which technological advancements have led to job displacement, assesses the emerging skill requirements, examines the effectiveness of policies and interventions addressing skill gaps, and investigates the impact of technological changes on wage structures and employment stability. Employing a mixed-methods approach, the study reveals that while automation and digitalization have improved production efficiency, they

have redefined workforce requirements, emphasizing technical and digital competencies. Job displacement is noted in repetitive roles, but new opportunities have arisen in technology-driven positions. Existing policies and training programs partially address skill gaps but require alignment with evolving labor demands. Additionally, technological changes have influenced wage structures, creating disparities between traditional and technology-intensive roles and affecting employment stability. These findings underscore the need for strategies to balance productivity gains with equitable labor market outcomes in Zambia's manufacturing sector.

Keywords: Technological Change, Labor Market, Manufacturing Sector, Job Displacement, Skill Requirements, Wage Structures, Employment Stability, Zambian Breweries, Automation, Digitalization, Policy Interventions

1. Introduction

1.1 Background

Technological change, defined as the introduction and adoption of new technologies and processes, has historically driven significant transformations in various sectors, including manufacturing.

Globally, technological advancements have led to increased productivity, efficiency, and competitiveness. The industrial revolution, for example, marked a profound shift in production methods, moving from hand production to machines and significantly altering labor markets (Mokyr, 1998) ^[11]. In more recent times, the advent of automation, artificial intelligence, and the Internet of Things (IoT) has further revolutionized manufacturing processes, resulting in the creation of smart factories and Industry (Kagermann *et al.*, 2013) ^[9].

In the context of Zambia, the manufacturing sector has been pivotal in driving economic growth and providing employment opportunities. The Zambian government, recognizing the importance of industrialization, has implemented policies aimed at boosting the manufacturing sector. Notable among these are the National Industrial Policy and the Seventh National Development Plan, which emphasize the need for technological innovation and adoption to enhance productivity and competitiveness (Ministry of Commerce, Trade and Industry, 2018).

Zambian Breweries, a leading player in the manufacturing sector, has been at the forefront of technological change. The company has embraced various technological innovations to streamline its operations, improve product quality, and increase production efficiency. Historically, Zambian Breweries transitioned from manual brewing techniques to automated processes, significantly enhancing its production capacity and operational efficiency (Mwiinga, 2020) ^[12]. This transformation mirrors global trends where technology has reshaped labor markets, altering the demand for specific skills and job roles (Autor, 2015).

The effects of technological change on labor markets are multifaceted. On one hand, technology can lead to job displacement, as automated systems and machines replace human labor in performing routine and repetitive tasks. On the other hand, technological advancements create new job opportunities that require different skill sets, thus altering the nature of employment. In Zambia, the adoption of new technologies in manufacturing has had significant implications for the labor market. While some jobs have become obsolete, new roles have emerged, necessitating a workforce with advanced technical skills and competencies (World Bank, 2019)^[13].

Moreover, the consequences of technological change extend beyond job creation and destruction. It impacts wage structures, labor productivity, and the overall employment landscape. For instance, workers with skills relevant to the new technologies tend to command higher wages, while those with obsolete skills may face unemployment or lower wages (Acemoglu & Restrepo, 2019). This dynamic necessitates continuous upskilling and reskilling of the workforce to keep pace with technological advancements.

1.2 Statement of the Problem

The manufacturing sector in Zambia, exemplified by *Zambian Breweries*, is experiencing significant transformations due to technological advancements. These changes offer the potential to boost productivity and competitiveness but also pose substantial challenges for the labor market. A key issue lies in the mismatch between the skills required for new technologies and the existing skill sets of the workforce. According to the *Zambian Central Statistical Office*, routine manual jobs in the manufacturing sector have declined, while positions requiring technical and digital skills are on the rise (Central Statistical Office, 2021)^[4]. Despite this shift, the pace at which the workforce is acquiring these new skills remains slow, as noted by Kalinda and Kangwa (2020)^[10]. This skills gap suggests that Zambia's education and training systems are not fully aligned with the demands of an increasingly technology-driven manufacturing sector. The impact of technological advancements on job displacement, wages, and employment stability is becoming more pronounced. Workers displaced by automation and technological changes often struggle to secure new employment, contributing to rising unemployment rates and potential social and economic challenges (Chiwala, 2019)^[5].

The impact of technological advancements on job displacement, wages, and employment stability is becoming more pronounced. Workers displaced by automation and technological changes often struggle to secure new employment, contributing to rising unemployment rates and potential social and economic challenges (Chiwala, 2019)^[5]. This situation calls for targeted interventions to address the skills gap, such as vocational training programs, partnerships between industry and educational institutions, and government-led initiatives to foster continuous learning (International Labour Organization, 2020)^[8]. Given these dynamics, this study sought to assess the effects of technological change on the labor market in Zambia's manufacturing sector, focusing specifically on *Zambian Breweries*. By examining job displacement, emerging skill requirements, and the effectiveness of current policies, the research aimed to inform strategies that support a smoother

workforce transition and enhance the resilience and sustainability of the sector.

1.3 Research Objectives

1.3.1 General Objective

To analyze the effects of technological change on the labor market in the manufacturing sector in Zambia, with a specific focus on *Zambian Breweries*.

1.3.2 Specific Objectives

1. To evaluate the extent to which technological advancements have led to job displacement at *Zambian Breweries*.
2. To assess the emerging skill requirements resulting from technological changes at *Zambian Breweries*.
3. To examine the effectiveness of current policies and interventions in addressing the skill gaps created by technological advancements at *Zambian Breweries*.
4. To investigate the impact of technological change on wage structures and employment stability at *Zambian Breweries*.

1.4 Research Questions

1. To what extent have technological advancements led to job displacement at *Zambian Breweries*?
2. What emerging skill requirements have resulted from technological changes at *Zambian Breweries*?
3. How effective are the current policies and interventions in addressing the skill gaps created by technological advancements at *Zambian Breweries*?
4. What is the impact of technological change on wage structures and employment stability at *Zambian Breweries*?

1.5 Theoretical Framework

Technology-Driven Labor Market Theory

The study was grounded in the Technology-Driven Labor Market Theory (TDLMT). This theory explores the relationship between technological innovation and labor market dynamics, particularly focusing on job displacement, skill requirements, and wage structures. The origins of the TDLMT can be traced back to the work of economists such as David Autor (2015) and Erik Brynjolfsson and Andrew McAfee (2014), who examined the interplay between technological advancements, automation, and labor market outcomes. The theory suggests that technological changes, particularly automation and digitalization, lead to the creation of new job opportunities that require advanced skills, while simultaneously displacing workers in routine manual and low-skill jobs.

In previous studies, scholars such as Choi and Lee (2020) and Frey and Osborne (2017)^[7] have applied the TDLMT to understand how technological changes in various sectors, including manufacturing, affect employment patterns. Choi and Lee (2020) explored the impact of automation on the South Korean manufacturing sector and found significant shifts in the labor force, with lower demand for routine manual labor and an increased need for workers skilled in robotics and digital technologies. Similarly, Frey and Osborne (2017)^[7] examined the implications of artificial intelligence on employment in the UK and concluded that low-skill, repetitive jobs were most at risk of displacement, while high-skill, cognitively demanding jobs were less affected. Their findings highlight the dual nature of

technological change: while it can reduce employment in certain areas, it also creates demand for new types of labor. The justification for using the TDLMT in this study lied in its relevance to the technological shifts occurring at Zambian Breweries. As the company embraces automation and digitalization to improve efficiency and productivity, the theory offers a framework for understanding how these technological changes may lead to both job displacement and the need for new skills. The theory's focus on the labor market dynamics in response to technology aligns with the study's objectives of assessing the impacts of technological change on employment stability, wage structures, and skill requirements. By applying this theory, the study was able to analyze the broader implications of technological adoption in Zambia's manufacturing sector, providing valuable insights into the workforce challenges and opportunities that arise in this context.

Human Capital Theory

Another theory that was applied in this study was the Human Capital Theory (HCT), which focused on the role of education, skills, and training in enhancing worker productivity and addressing labor market changes. Originating from the works of economists such as Gary Becker (1964) and Theodore Schultz (1961), Human Capital Theory posited that investments in human capital, such as education and vocational training, increased the productivity of workers, making them more adaptable to technological changes in the labor market. According to this theory, the ability of workers to acquire new skills and competencies in response to technological advancements was a critical factor in determining how well they could adapt to shifts in job requirements, including those driven by automation and digitization.

In previous research, scholars such as Psacharopoulos and Patrinos (2018) and Cedefop (2020) applied Human Capital Theory to understand how education and training programs influenced workers' ability to transition into new roles created by technological innovation. Psacharopoulos and Patrinos (2018) highlighted the importance of investing in education and vocational training programs to equip workers with the skills necessary to thrive in a rapidly changing labor market. Their study emphasized that countries that invested in human capital tended to have more resilient labor markets in the face of technological disruptions. Similarly, Cedefop (2020) found that upskilling and reskilling initiatives were crucial for mitigating the negative effects of technological displacement, particularly in sectors like manufacturing, where automation was increasingly prevalent.

Human Capital Theory was particularly suitable for this study as it allowed for an examination of the role of skill development in responding to the technological changes at Zambian Breweries. Given that technological advancements often required new skill sets, this theory enabled the study to assess how well the existing workforce at Zambian Breweries was equipped to adapt to these changes. It also provided a framework for evaluating the effectiveness of training and education initiatives aimed at addressing the skill gaps created by technological disruption. By using Human Capital Theory, the study was able to provide insights into how investing in human capital through education and vocational training programs could help mitigate job displacement and enhance the productivity and

employability of workers in Zambia's manufacturing sector.

2. Literature Review

This chapter reviews literature on the effects of technological change on the labor market within Zambia's manufacturing sector. It examines key themes such as job displacement, emerging skill requirements, and the impact of technological advancements on wage structures and employment stability. The chapter also explores relevant theories, such as the Technology-Driven Labor Market Theory and Human Capital Theory, to provide a theoretical foundation for understanding how technological changes influence labor dynamics. Additionally, the review examines the effectiveness of policies and interventions aimed at addressing the skills gap created by technological advancements in the manufacturing industry. Insights from this literature review will inform the research methodology and data analysis in subsequent chapters. Key themes include the relationship between technological advancements and labor market outcomes, the role of skills development programs, and the policy responses necessary for adapting to technological disruptions. The review aimed to establish a context for the study, emphasizing how technological change can reshape the workforce and create both challenges and opportunities for the labor market in Zambia's manufacturing sector.

2.1 Technological Advancements and Job Displacement

Globally, numerous studies have explored the impact of technological advancements on job displacement. Autor, Levy, and Murnane (2003) conducted a seminal study in the United States to understand how computerization affects labor market outcomes. Using longitudinal data from the Current Population Survey, they found that routine manual and cognitive jobs were most susceptible to automation, leading to significant job displacement in these categories. The study employed a quantitative research design with a large sample size of over 150,000 observations.

In Sub-Saharan Africa, the impact of technological advancements on job displacement has been a critical area of study. Adebayo and Olamide (2019) investigated the effects of automation in Nigeria's textile industry. Employing a quantitative research design with a sample size of 300 workers, the study used structural equation modeling to analyze the data. The results showed significant job displacement in routine manual jobs due to automation. However, the study also highlighted the emergence of new job roles in technology management and quality control. Another study by Moyo (2020) in Kenya focused on the agricultural sector, examining the impact of mechanization on employment. Using a mixed-methods approach, including surveys and focus group discussions with 150 farmers, the study found that mechanization led to reduced labor demand in traditional farming roles. However, it also noted an increase in employment for machine operators and technicians, suggesting a shift in the skill requirements of the labor market. Adeyemi and Ogunleye (2019) focused on the automotive industry in Nigeria. Using a quantitative research design, they surveyed 300 employees across different automotive firms to assess the impact of automation on employment. Their findings showed that automation led to job displacement in assembly line positions but increased demand for skilled technicians and engineers. The study concluded that technological advancements necessitate a shift in the skill composition of

the workforce. Kamukama (2018) studied the effects of ICT adoption in the banking sector. Using a case study approach and a sample size of 200 bank employees, the research found that while ICT adoption led to job displacement in traditional banking roles, it also created new positions in IT support, cybersecurity, and data analysis. The study emphasized the need for continuous professional development and training to equip workers with the necessary skills for the evolving job market.

In Africa, research on the impact of technological advancements on job displacement is burgeoning. Banga and te Velde (2018) conducted a study in Ethiopia, examining the role of industrial automation in manufacturing. Using a mixed methods approach, including surveys and interviews with 200 manufacturing firms, the study found that automation led to job displacement in low-skilled positions. However, it also noted an increase in employment for skilled workers, particularly in roles related to machine operation and maintenance. In South Africa, a study by Fourie (2019) explored the implications of Industry 4.0 on the labor market. The study utilized a qualitative research design, conducting interviews with industry experts and policymakers. The findings indicated that while Industry 4.0 technologies are expected to displace jobs, they also hold the potential to create new employment opportunities in tech-driven fields. The study emphasized the importance of education and training programs to equip the workforce with relevant skills. Diao *et al.* (2021) studied the impact of automation on employment in Ethiopia's manufacturing sector. Using a panel dataset of 500 firms from 2010 to 2019, they applied a fixed effects regression model to analyze the effects of automation on job displacement. The study found that automation led to significant job losses in lowskilled positions but also resulted in productivity gains and increased demand for skilled labor. The authors emphasized the importance of education and vocational training in mitigating the negative effects of automation. In Ghana, Osei and Agyapong (2020) examined the implications of digitalization in the agricultural sector. Through a qualitative study involving focus group discussions with 150 farmers, they found that digital technologies reduced the need for manual labor in farming but created opportunities for jobs in technology management and data analysis. The study highlighted the potential of digital technologies to transform traditional sectors and the need for policies to support this transition.

2.2 Emerging Skill Requirements Resulting from Technological Changes

Globally, technological advancements have significantly altered the skill requirements in the manufacturing sector. A study by Bessen (2019) ^[3] in the United States examined how new technologies affect the demand for different skills. Using a longitudinal dataset from 1980 to 2015, the study employed a quantitative research design with a sample size of 5,000 manufacturing firms. The findings indicated a substantial increase in the demand for technical skills, such as programming and machine operation, and a decline in the need for routine manual skills. Bessen concluded that the workforce must adapt through continuous education and training to meet these new demands.

Brynjolfsson, Rock, and Syverson (2020) conducted a comprehensive study on the future of work in the context of artificial intelligence and machine learning. Their mixed-

methods research included surveys and interviews with industry experts and a sample size of 1,000 firms across various sectors. The study found that advanced technologies necessitate a combination of technical skills (e.g., data analysis, machine learning) and soft skills (e.g., problem-solving, collaboration). The researchers emphasized the importance of interdisciplinary education to prepare the workforce for the evolving job market. A seminal study by Autor, Levy, and Murnane (2003) in the United States highlighted the growing need for non-routine cognitive skills as a result of technological change. Their research, which analyzed data from 1960 to 1998, utilized a quantitative approach to examine the impact of computerization on job tasks. They found that jobs involving routine manual and cognitive tasks were increasingly automated, leading to a higher demand for analytical, problem-solving, and interpersonal skills. The study concluded that workers need to acquire advanced skills to remain competitive in an automated labor market. Frey and Osborne (2017) ^[7] conducted an influential study on the future of employment, assessing the susceptibility of jobs to computerization. Using a probabilistic model and data from the US labor market, they analyzed 702 detailed occupations. The study revealed that 47% of total US employment was at risk of being automated. They identified that jobs requiring creative and social intelligence were less likely to be automated, emphasizing the need for skills such as negotiation, persuasion, and originality. This study underscored the importance of fostering creativity and social skills alongside technical competencies in the workforce.

Across Africa, several studies have explored the emerging skill requirements resulting from technological advancements, providing insight into how countries are responding to the digital transformation in their labor markets. One key example is the research conducted in Kenya, a country that has positioned itself as a leader in digital transformation in the region. In a 2020 study by the World Bank, it was found that the demand for digital skills in Kenya, especially in the ICT sector, has surged with the rise of start-ups, ecommerce, and mobile applications. The study noted that while there is significant potential for growth, particularly in mobile technology and software development, there is a major skill gap in advanced digital fields like artificial intelligence, machine learning, and big data analytics. This gap presents a challenge for Kenya's ambitious goal of becoming a technological hub in Africa. In response to this, Kenya has launched initiatives such as coding schools, hackathons, and partnerships with private tech companies like Google and Microsoft to provide training in specialized skills (World Bank, 2020). However, the study also identified barriers such as access to high-speed internet in rural areas and limited exposure to advanced technologies among young people outside major urban centers. The authors emphasized that to meet future workforce needs, Kenya must continue to invest in digital literacy and infrastructure to ensure inclusive growth.

The Zambia Institute for Policy Analysis and Research (ZIPAR) investigated the readiness of Zambia's technical and vocational education and training (TVET) systems to address digital skills needs. Using mixed methods, including surveys and focus group discussions with students and instructors, the study revealed that most TVET curricula are outdated and do not reflect current technological demands. ZIPAR recommended aligning educational content with

industry needs, particularly in ICT and engineering fields (ZIPAR, 2020). An African regional study by Fox and Signé explored how technological innovations influence skill demands in various sectors, including agriculture and ICT. The research utilized data from surveys and interviews conducted across multiple African countries, including Zambia. Findings indicated that digital tools are underutilized in Zambian agriculture due to limited access and training. The study emphasized the need for comprehensive digital skill development to enable technology adoption in key sectors like agriculture and manufacturing (Fox & Signé, 2021).

2.3 Effectiveness of Current Policies and Interventions in Addressing Skill

Brynjolfsson and McAfee (2014) highlighted the global impact of technological advancements on the workforce, emphasizing the growing skill gaps. Conducted in the United States, this study used a mixed-methods approach, combining quantitative data analysis with qualitative interviews. The researchers found that while automation and digital technologies increased efficiency, they also rendered many traditional skills redundant. The study concluded that continuous learning and adaptive policies are essential for bridging these skill gaps. Globally, a study by the International Labour Organization (ILO) (2018) analyzed policies aimed at mitigating skill gaps due to technological changes. The study used a comparative policy analysis methodology, examining data from various countries. It found that countries with proactive, adaptive policies, such as Germany's dual education system, were more successful in addressing skill gaps. The ILO recommended policies that encourage lifelong learning and public-private partnerships in training programs. A study by the World Economic Forum (2018) provided a global analysis of effective policies and interventions for addressing skill gaps. Using a comparative policy analysis methodology, the study examined initiatives from countries such as Switzerland, Singapore, and Canada. The findings highlighted that successful policies often involved public-private partnerships, continuous education programs, and financial incentives for employee upskilling. The World Economic Forum recommended that countries adopt a holistic approach, integrating education, industry, and government efforts to effectively address skill gaps.

Bessen (2015) examined the impact of technological advancements on workforce skills across various industries globally. Conducted in multiple countries including the United States and Germany, the study utilized a longitudinal research design, analyzing employment data over a 20-year period. Bessen found that while technological innovations increased productivity, they also created significant skill gaps, especially in industries heavily reliant on manual labor. The study concluded that continuous skill development and adaptive learning programs are crucial for mitigating these gaps and ensuring workforce readiness. Another global perspective comes from a meta-analysis by Arntz, Gregory, and Zierahn (2016), which reviewed existing literature on the potential displacement of jobs due to automation. This study synthesized findings from over 30 studies worldwide and concluded that while automation posed a threat to certain job categories, it also created opportunities for new skill sets. The researchers emphasized the need for dynamic training programs and adaptive policy

frameworks that evolve with technological advancements. Mwansa and Phiri (2020) focused on Zambian Breweries specifically, examining the effectiveness of current policies and interventions in addressing skill gaps. The researchers used a mixed-methods approach, combining surveys of 150 employees with interviews of 15 managers. The findings highlighted that while some training programs were in place, they were often generic and not tailored to the specific technological advancements in the brewing industry. The study concluded that more targeted and regularly updated training programs, along with supportive policies, are essential for bridging the skill gaps effectively. Mwansa and Phiri's study on Zambian Breweries also evaluated the current policies and interventions aimed at addressing skill gaps. The research indicated that while some initiatives were effective, there was a need for more comprehensive and continuous training programs tailored to the specific technological needs of the brewing industry. The study recommended that Zambian Breweries, in collaboration with the government, develop more targeted training programs and update existing policies to better address the evolving skill requirements. A focused study by Kalinda and Simuchimba (2021) on Zambian Breweries examined the effectiveness of existing policies in addressing skill gaps. Using a mixed-methods approach, the researchers conducted surveys with 200 employees and interviews with 20 managers. The study found that while Zambian Breweries had implemented some training programs, these were often generic and did not cater specifically to the technological advancements within the brewing industry. Kalinda and Simuchimba concluded that more targeted training programs, developed in collaboration with technological experts, are necessary to effectively bridge the skill gaps.

2.4 The Impact of Technological Change on Wage Structures and Employment

Acemoglu and Restrepo (2018) analyzed the impact of automation on wage structures in developed countries, including the United States and Germany. Utilizing a quantitative research design, they examined employment and wage data from 1990 to 2015. Their findings revealed that automation led to wage polarization, where high-skilled workers saw wage increases while low-skilled workers experienced wage stagnation or decline. Acemoglu and Restrepo concluded that policy interventions are necessary to address the widening wage gap caused by technological advancements. A comprehensive study by Autor, Dorn, and Hanson (2015) examined the effects of technological advancements on wage structures in the United States. Using a longitudinal research design, the authors analyzed data from the Current Population Survey and various industry reports from 1980 to 2010. Their findings indicated that technological advancements, particularly computerization and automation, led to wage polarization. High-skilled workers saw significant wage increases, while middle-skilled workers experienced wage stagnation or decline. The study concluded that the wage gap could be mitigated by policies promoting education and retraining for middle-skilled workers to adapt to technological changes. A global study by Frey and Osborne (2017)^[7] assessed the risk of job automation across various industries in OECD countries. Using a quantitative approach, they analyzed employment data and the potential for automation of

different job categories. Their findings indicated that technological advancements posed a significant threat to employment stability, particularly for routine-based jobs. Frey and Osborne recommended that governments and industries collaborate to develop strategies that enhance job security and provide support for displaced workers. Autor and Dorn (2013) conducted a significant study on the effects of automation on employment stability in the United States. Using data from the Decennial Census and the American Community Survey, the researchers analyzed the impact of computerization on employment from 1980 to 2005. The study found that automation displaced routine-based jobs, leading to job instability for many workers. However, it also created new opportunities in nonroutine cognitive and manual jobs. The authors concluded that policy interventions, such as retraining programs and social safety nets, are crucial for maintaining employment stability.

3. Research Methodology

3.1 Research Design

A case study design was particularly suitable for investigating complex phenomena within specific contexts, making it an appropriate choice for examining the effects of technological change on the labour market in Zambia's manufacturing sector, as evidenced by numerous studies (Smith, 2014).

3.2 Target Population

The target population for this study comprised employees from Zambian Breweries' main plant, located at Plot 6438 Mungwi Road in Lusaka's Heavy Industrial Area.

3.3 Sampling Design

This study employed a quantitative approach due to its ability to provide a comprehensive and objective analysis of the effects of technological advancements on the labor market at Zambian Breweries.

3.4 Sample Size Determination

The sample size for this study consists of 50 respondent.

3.5 Data Collection Methods

Structured questionnaires provided a standardized format for collecting quantitative data, enabling the comparison of responses across different participants. This approach minimized interviewer bias and ensured that all respondents were asked the same questions in the same manner, ensuring the validity of the research findings.

3.6 Data Analysis

Quantitative data analysis was conducted using SPSS version 22.0, a widely recognized statistical software package. SPSS was chosen for its userfriendly interface, which simplifies the generation of tables and graphs. The collected data was coded, organized, and presented in descriptive tables, including frequency distributions and percentage tables.

3.7 Triangulation

To ensure the robustness of research results, triangulation was employed. Quantitative data collection, through structured surveys, was used to gather numerical data on the

effects of technological change on employment, skill requirements, policies, and wages. Additionally, longitudinal data collection over several years was conducted to track trends and changes in these areas (Johnson *et al.*, 2023). By integrating data from diverse sources and time periods, this study provided a comprehensive and nuanced understanding of the effects of technological advancements on the labor market at Zambian Breweries. The triangulated approach contributed to both academic knowledge and practical policy recommendations, addressing gaps in the existing literature.

3.8 Limitations of the Study

This study encountered several limitations. Access and cooperation from employees at Zambian Breweries were challenging, as some respondents were hesitant to disclose sensitive information or were unavailable due to work commitments. Language barriers and cultural nuances also posed communication challenges between the researcher and respondents.

3.9 Ethical Considerations

Strict ethical standards were maintained throughout the study. All information obtained from respondents was kept confidential and used solely for research purposes. A letter of introduction from the researcher's institution was provided to facilitate the study. Participation in the study was voluntary, and respondents were asked to provide informed consent before contributing. The study observed privacy and confidentiality principles regarding all information provided by participants, ensuring the ethical integrity of the research process.

4. Results/Findings

4.1 presentation of results on background characteristics of results

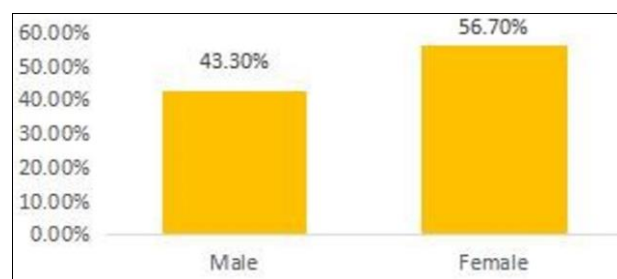


Fig 1: Gender of respondents

In our 21st century era, gender distribution within organizations or programs receives particular attention. Thus, the author of this study deemed it necessary to integrate this distribution into the analysis. According to the collected data, 56.7% of the respondents were women and 43.3% were men. Consequently, it is expected that the conclusions of this study will more significantly reflect the female perspective than the male.

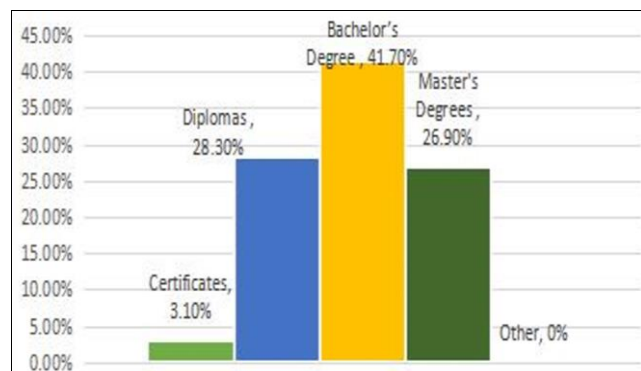


Fig 2: Education background of respondents

As illustrated in Fig 2, 3.1% of the participants in the research held certificates as their highest level of education. Those with diplomas represented 28.3% in distribution, while those with a bachelor's degree represented 47.1%. Another 26.9% had master's Degrees. This suggested a workforce with a solid academic foundation, potentially well-equipped to adapt to and leverage technological advancements.

4.2 The Extent to Which Technological Advancements have Led to Job Displacement at Zambian Breweries

Table 1: Job Roles Most Affected by Displacement

Response	Percentage	Frequency
Production Workers	61.8	62
Supervisors	20.6	21
Technicians	10.3	10
Administrative Staff	10.3	10

Table 1 shows that production workers were the most vulnerable: The overwhelming majority (61.8%) of displaced roles were in production, highlighting the significant impact of automation and technological advancements on labor-intensive positions. This was a critical area for intervention, where companies focused on providing reskilling opportunities to help production workers transition into new roles.

4.3 The Emerging Skill Requirements Resulting from Technological Changes in the Manufacturing Sector at Zambian Breweries

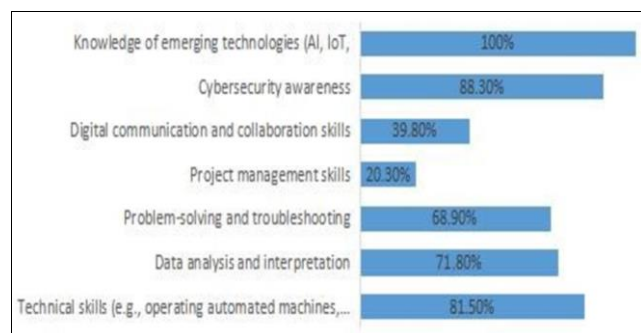


Fig 3: New skills required due to the technological changes at Zambian Breweries

The findings in Fig 3 reveal that Zambian Breweries employees identified knowledge of emerging technologies,

such as artificial intelligence (AI) and the Internet of Things (IoT), as the most critical skill (100%) to keep up with technological advancements in the manufacturing sector. Cybersecurity awareness ranked second (88.30%), reflecting the need to safeguard digital infrastructure in an increasingly connected environment. Technical skills, including operating automated machines and programming (81.50%), were also highly emphasized, underscoring the shift toward automation in manufacturing processes. Data analysis and interpretation (71.80%) and problem-solving skills (68.90%) further highlight the necessity of equipping employees to handle complex challenges and optimize operations. Meanwhile, digital communication and project management skills were identified as less critical but still important (39.80% and 20.30%, respectively), indicating a secondary focus on collaboration and workflow organization. Similarly, Liu *et al.* (2019) found that manufacturing firms worldwide are prioritizing skills such as cybersecurity and advanced technical knowledge to address the demands of Industry 4.0 and ensure competitive advantage in technology-driven markets.

4.4 The Effectiveness of Current Policies and Interventions in Addressing the Skill Gaps Created by Technological Advancements at Zambian Breweries

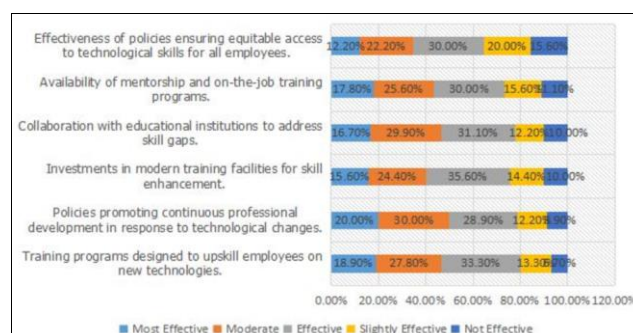


Fig 4: Effectiveness of current policies at Zambian Breweries

The results in Fig 4 suggest that while Zambian Breweries has implemented policies and interventions to address skill gaps, their effectiveness remains moderate. Respondents moderately agreed (mean = 3.85) that current training programs prepare employees for technological advancements, but many emphasized the need for improvement (mean = 4.15) in targeted and proactive interventions to bridge existing gaps. Budget and resource constraints were highlighted as significant limitations (mean = 4.02), indicating that financial and infrastructural challenges impede the full implementation of policies. Although management support (mean = 3.87) and the presence of relevant policies (mean = 3.80) were acknowledged, the findings underscore the need for Zambian Breweries to increase its commitment to closing skill gaps, particularly through enhanced resource allocation and specialized training initiative.

4.5 The Impact of Technological Change on Wage Structures and Employment Stability at Zambian Breweries

Table 2: A Chi square test on the Extent of Job Displacement Due to Technological Advancements

Category	Observed (O)	Expected (E)	
High Job Displacement	40	50	2.00
Moderate Displacement	30	25	1.00
Low Job Displacement	33	28	0.89
Chi-Square Statistic (χ^2)	3.89	Degrees of Freedom (df)	2
Critical Value (0.05)	5.99		

The findings in Table 2 suggested that technological advancements were associated with job displacement at Zambian Breweries.

H0: Technological advancements job displacement at Zambian Breweries are not associated

H1: Technological advancements job displacement at Zambian Breweries are not associated

a) Summary of Findings

The Chi-square test statistic calculated from the observed and expected frequencies was 3.89, with 2 degrees of freedom. The critical value at the 0.05 significance level is 5.99. The observed values reflect varying levels of job displacement, with high displacement recorded at 40, moderate at 30, and low at 33, compared to their expected frequencies of 50, 25, and 28, respectively.

b) Decision

Using the decision rule, since the calculated Chisquare statistic (3.89) is less than the critical value (5.99), we fail to reject the null hypothesis (H_0).

c) Conclusion

The findings suggest that there is no statistically significant association between technological advancements and job displacement at Zambian Breweries at the 0.05 significance level. While job displacement due to technological advancements is observed, the results indicate that the variations between observed and expected frequencies are not significant enough to confirm a strong impact of technological change on employment patterns at Zambian Breweries.

4.6 Discussion of Results

The first objective of this study sought to analyze the extent to which technological advancements have led to job displacement at Zambian Breweries. Production workers were the most affected by displacement, with 61.8% of displaced roles falling within this category, reflecting the significant impact of automation on labour-intensive jobs.

The second objective of this study sought to assess the emerging skill requirements resulting from technological changes in the manufacturing sector at Zambian Breweries. The study revealed several critical findings regarding the emerging skill requirements resulting from technological changes in the manufacturing sector at Zambian Breweries. The employees identified knowledge of emerging

technologies, such as artificial intelligence (AI) and the Internet of Things (IoT), as the most important skill to keep pace with technological advancements in the manufacturing sector, with 100% of respondents agreeing. Cybersecurity awareness followed closely at 88.3%, reflecting the need to safeguard digital infrastructures. Technical skills, including machine operation and programming, were also emphasized by 81.5% of employees, highlighting the shift towards automation in manufacturing processes.

Furthermore, the study on the effectiveness of current policies and interventions in addressing the skill gaps created by technological advancements at Zambian Breweries revealed moderate success, but also highlighted significant areas for improvement. The findings indicated that 33.3% of respondents found training programs for upskilling employees on new technologies effective, with 27.8% rating them as moderate; however, 20% found these initiatives either slightly or not effective, pointing to inconsistencies in their implementation and accessibility.

4.7 Conclusion

In conclusion, the study on the effects of technological change on the labour market in the manufacturing sector, with a focus on Zambian Breweries, revealed that technological advancements have significantly impacted job roles, skill requirements, and workforce policies. Automation has led to substantial job displacement, particularly among production workers, while supervisors and administrative staff experienced moderate displacement due to organizational restructuring and technology integration. Technicians remained relatively secure, emphasizing the importance of specialized skills. Despite job displacement, the company's retraining and upskilling initiatives provided a pathway for affected employees to transition into less vulnerable or higher-skilled roles. The shift in skill demands highlighted the critical need for expertise in emerging technologies, technical operations, cybersecurity, and analytical problem-solving, underscoring the growing importance of continuous professional development to adapt to technological changes.

5. Acknowledgment

First and foremost, I would like to thank the Almighty God for granting me the strength, knowledge, and perseverance to undertake this study and complete it satisfactorily. My heartfelt thanks go to my supervisor, Dr Peter Silwimba for his valuable guidance, encouragement, and constructive feedback throughout the research process.

6. References

1. Acemoglu D, Restrepo P. Robots and Jobs: Evidence from US Labor Markets. *Journal of Political Economy*. 2020; 128(6):2188-2244.
2. Banerjee A, Galiani S, Levinsohn J, McLaren Z. Why has unemployment risen in the new South Africa? *Economics of Transition*, 2008.
3. Bessen JE. AI and Jobs: The role of demand. NBER Working Paper No. 24235. National Bureau of Economic Research, 2019.
4. Central Statistical Office. Labour Force Survey Report 2020. Lusaka: Government of Zambia, 2021.
5. Chiwala J. The Impact of Technological Change on Employment and Wages in Zambia. *Journal of African Economies*. 2019; 28(4):499-515.

6. CSO (Central Statistical Office). 2015 Living Conditions Monitoring Survey Report. Lusaka: Central Statistical Office, 2015.
7. Frey CB, Osborne MA. The future of employment: How susceptible are jobs to computerization? *Technological Forecasting and Social Change*. 2017; 114:254-280.
8. International Labour Organization (ILO). The future of work: Guidelines for a humancentred agenda. ILO Report, 2020.
9. Kagermann H, Wahlster W, Helbig J. Recommendations for Implementing the Strategic Initiative INDUSTRIE 4.0: Securing the Future of German Manufacturing Industry, 2013.
10. Kalinda B, Kangwa J. Skills Mismatch in Zambia's Manufacturing Sector, 2020.
11. Mokyr J. The Second Industrial Revolution, 1870-1914. *Storia dell'economia Mondiale*, 1998.
12. Mwiinga C. Technological Adoption in Zambia's Brewing Industry: A Case Study of Zambian Breweries. *Zambia Business Journal*. 2020; 12(1):45-61.
13. World Bank. The Future of Work in Africa: Harnessing the Potential of Digital Technologies for All. Washington, DC: World Bank, 2019.