

# Technological Adaptation as a Driver of Organizational Performance: Evidence from Waste Management Companies in Nairobi City County, Kenya

Miriam Wanjiku<sup>1</sup>, Simon Kipchumba<sup>2</sup>, Emily Cheposero Tumwet<sup>3</sup>

<sup>1, 2, 3</sup>Faculty of Commerce, School of Business and Economics, Kabarak University, Private Bag-20157 Kabarak, Kenya

**Abstract:** *The rapid growth of urban populations and the increasing generation of waste have intensified the demand for efficient and sustainable waste management services. In Nairobi City County, waste management companies face increasing operational pressures, creating a need for effective technological solutions to enhance service delivery and organizational performance. This study examined the effect of technological adaptation on the organizational performance of waste management companies in Nairobi City County, Kenya. The study used the Technology-Organization-Environment (TOE) framework, which explains organizational technology adoption in terms of technological, organizational, and environmental contexts. The study adopted a positivist research philosophy and a descriptive correlational research design. The study targeted employees and managers of waste management companies in Nairobi City County. The study issued 244 questionnaires, of which 195 were completed and returned, for a response rate of 79.9%. The study collected data using structured questionnaires and analyzed them using descriptive and inferential statistics. Descriptive analysis involved means and standard deviations, while inferential analysis employed Pearson correlation and simple linear regression. The descriptive findings indicated a moderately high level of technological adaptation, with a composite mean of 3.66 and a standard deviation of 1.22. The findings further established a strong positive relationship between technological adaptation and organizational performance, with a Pearson correlation coefficient of  $r = 0.700$  ( $p < 0.01$ ). Regression analysis revealed that technological adaptation explained 49.0% of the variation in organizational performance ( $R^2 = 0.490$ ). The analysis of variance further demonstrated that the regression model was statistically significant,  $F(1, 193) = 184.64$ ,  $p < 0.001$ . The regression coefficient results showed that technological adaptation had a positive and statistically significant effect on organizational performance ( $\beta = 0.700$ ,  $t = 13.588$ ,  $p < 0.001$ ). Consequently, the study rejected the null hypothesis that technological adaptation has no statistically significant effect on organizational performance. The study concludes that technological adaptation is an important driver of organizational performance among waste management companies in Nairobi City County. The study recommends that waste management companies increase investment in appropriate technologies, employee training, and digital integration, while policymakers should develop supportive frameworks and incentives to promote technological modernization in the waste management sector. The findings contribute empirical evidence on the importance of technological adaptation in improving efficiency, service delivery, and organizational performance in urban waste management.*

**Keywords:** Technological adaptation, organizational performance, waste management, technology adoption, digitalization

## 1. Introduction

Waste management has become an increasingly important concern globally due to rapid urbanization, population growth, rising consumption, and increasing volumes of solid waste. Effective waste management is essential not only for environmental protection but also for public health, economic productivity, and sustainable urban development. In this context, organizations involved in waste collection, transportation, recycling, and disposal increasingly need to improve operational efficiency and service delivery. Technological advances offer opportunities for these organizations to improve the efficiency, reliability, and sustainability of waste management operations through automation, digital information systems, route optimization, and other technology-enabled solutions [14]. Technological adaptation refers to organizations' ability to adopt, integrate, and use emerging technologies in their operations in response to changing environmental and operational demands. In organizational settings, technology adoption can enhance efficiency, innovation, resource utilization, and responsiveness. Recent evidence from Kenya demonstrates that technology adoption interventions can influence organizational performance by enabling organizations to respond to changes in their operating environments and

improve their competitiveness [3]. Similarly, research on digitalization indicates that integrating digital technologies into organizational operations can improve organizational performance by streamlining processes and supporting more effective decision-making [9]. The relevance of technological adaptation is particularly evident in the waste management sector, where organizations must coordinate complex activities involving waste collection, transportation, sorting, recycling, recovery, and disposal. Technologies such as GPS-enabled tracking, digital customer management systems, automated collection equipment, data management platforms, and route optimization systems can facilitate better coordination of these activities. Recent research in South Africa, for example, shows the growing use of digital technologies for waste diversion and performance assessment in smart-city environments [14]. Consequently, technological adaptation has increasingly become an important organizational capability for waste management firms seeking to improve service efficiency while responding to environmental and regulatory pressures.

In Kenya, the Sustainable Waste Management Act, 2022, reinforces the importance of effective and sustainable waste management by establishing a legal and institutional framework and providing for waste reduction, reuse,

recycling, recovery, and improved waste information management. The Act also provides for establishing a national waste information system to record, collect, manage, and analyze waste-related information, demonstrating the growing importance of information and technology in the sector [13]. Kenya's National Sustainable Waste Management Policy also emphasizes sustainable waste management, waste minimization, effective waste collection, and the transition towards a circular economy [11]. Despite these policy and technological developments, waste management remains a significant challenge in urban Kenya, particularly in Nairobi City County. The city's rapid expansion and rising demand for waste services put pressure on waste management companies to deliver reliable, cost-effective services. Organizational performance in this sector therefore depends on firms' ability to use available resources efficiently, improve service delivery, control operating costs, and respond to changing customer and regulatory requirements. Empirical evidence from Nairobi indicates that technology strategy is associated with organizational performance among waste management companies, although its effect has not always been statistically significant. [19], for instance, found that technology strategy had a positive but statistically insignificant influence on the performance of waste management companies in Nairobi County. This finding suggests that merely having a technology strategy may not necessarily translate into improved performance, creating a need to examine technological adaptation more specifically. The existing evidence therefore presents an important empirical gap. While previous studies have examined technology strategy and organizational performance among waste management companies in Nairobi, they have paid limited attention to technological adaptation as an organizational capability and its specific contribution to organizational performance. This distinction matters because adaptation goes beyond owning or planning for technology; it includes the organization's ability to integrate technological innovations into day-to-day operations and respond effectively to changing technological requirements. This study therefore examines technological adaptation as a driver of organizational performance among waste management companies in Nairobi City County, Kenya. By focusing on this relationship, the study contributes empirical evidence to the growing literature on technology-enabled organizational performance and provides insights that may help waste management firms and policymakers strengthen technology use for more efficient and sustainable waste management.

### 1.2 Statement of the Problem

Effective waste management is essential for maintaining healthy, sustainable, and productive urban environments. However, rapid urban population growth and waste generation continue to put pressure on waste management systems. Nairobi City County generates approximately 3,200 tonnes of solid waste daily, showing the scale of waste that waste management companies must collect, transport, and dispose of effectively. National statistics further indicate that Nairobi generated approximately 1.19 million tonnes of municipal solid waste in 2023, of which about 1.03 million tonnes were collected, leaving a considerable proportion of waste uncollected. These challenges increase operational demands on waste management companies and underscore

the need for technological solutions that can improve efficiency, monitoring, route planning, resource utilization, and service delivery. Despite increasing emphasis on technology in waste management, organizational performance challenges remain evident. The Sustainable Waste Management Act, 2022 promotes sustainable waste management, including waste reduction, recycling, recovery, and improved waste information management, creating an environment in which technology can support more efficient waste management operations [13]. However, adopting technology does not automatically guarantee improved organizational performance because firms may differ in their ability to acquire, integrate, use, and continuously adapt to technological changes. Evidence from Nairobi also remains inconclusive. For instance, [19] found that technology strategy had a positive but statistically insignificant effect on the performance of waste management companies in Nairobi County. This finding suggests that technological strategies may not be sufficient to improve performance and raises the need to examine broader organizational capacity to adapt to technological change. The persistence of waste collection and service delivery challenges, despite increasing technological opportunities and regulatory emphasis on sustainable waste management, points to an important empirical gap. Existing studies have largely focused on technology adoption or technology strategy, with limited attention to technological adaptation as an organizational capability and its direct effect on organizational performance among waste management companies in Nairobi City County. It therefore remains unclear whether waste management companies' ability to adapt their processes, systems, and operations to changing technologies translates into improved organizational performance. This study therefore examined technological adaptation as a driver of organizational performance among waste management companies in Nairobi City County, Kenya, to provide empirical evidence to inform managerial decisions and strategies for technology-enabled improvement in the waste management sector.

### 1.3 Objective of the Study

To examine the effect of technological adaptation on the organizational performance of waste management companies in Nairobi City County

### 1.4 Research Hypothesis

**H<sub>0</sub>:** Technological adaptation has no statistically significant effect on the organizational performance of waste management companies in Nairobi City County.

### 1.5 Significance of the Study

The study on technological adaptation as a driver of organizational performance among waste management companies in Nairobi City County, Kenya, is significant to waste management companies, policymakers, regulators, management practitioners, and future researchers. The findings will provide waste management companies with empirical evidence on how technological adaptation influences organizational performance and may help managers identify appropriate technologies and improve their integration into waste collection, transportation, monitoring,

recycling, and disposal operations. This may improve operational efficiency, service quality, resource utilization, and competitiveness. The study will also be significant to policymakers and regulators, particularly the Nairobi City County Government, the relevant ministry, and other agencies responsible for environmental management, by providing evidence to inform policies and strategies that promote effective technological adaptation in the waste management sector. The findings may also support implementation of the Sustainable Waste Management Act, 2022, and broader efforts toward sustainable and efficient waste management. In addition, the study will benefit management practitioners by providing insights to guide decisions on technology acquisition, employee capacity development, digital systems, and integrating technology into organizational processes. Finally, the study will contribute to the existing body of knowledge on technological adaptation and organizational performance, particularly within the waste management sector in developing urban contexts. Future researchers may draw on the findings as a reference for further studies examining technological adaptation and organizational performance across different sectors, geographical areas, or organizational settings.

## 2. Literature Review

This section reviews theoretical and empirical literature on technological adaptation and organizational performance, focusing on waste management companies. It examines how technological adaptation can enhance efficiency and service delivery while identifying gaps in existing research. The review provides a basis for examining the effect of technological adaptation on organizational performance in waste management companies in Nairobi City County.

### 2.1 Theoretical Review

The Technology-Organization-Environment (TOE) framework, developed by [16], explains how organizations adopt, implement, and adapt to technological innovations by considering three contextual dimensions: technological, organizational, and environmental factors. The technological context concerns the availability, characteristics, compatibility, and suitability of technologies available to an organization. The organizational context includes organizational resources, management support, employee skills, and readiness to implement technological changes, while the environmental context includes regulatory requirements, competitive pressures, customer expectations, and other external stakeholders that may influence technological adaptation [16]. The framework is particularly relevant to the present study because technological adaptation among waste management companies depends not only on the availability of appropriate technologies but also on organizations' ability to acquire, integrate, and use them effectively. Waste management companies operate in an environment marked by increasing waste generation, regulatory requirements, and growing demand for efficient, sustainable service delivery. Consequently, organizational resources, technological compatibility, and external pressures may determine how successfully companies adapt to technological changes. Recent empirical studies continue to demonstrate the TOE framework's relevance in explaining

technology adoption and organizational outcomes. [5] found that technological, organizational, and environmental factors significantly influence technology adoption and that adoption can improve organizational outcomes. Similarly, [8], through a meta-analysis of 22 studies, found that TOE-related factors are key determinants of Industry 4.0 adoption and that technological adoption affects firm performance. Therefore, the TOE framework provides a suitable theoretical foundation for explaining how technological adaptation may influence organizational performance among waste management companies in Nairobi City County. The framework suggests that organizations with appropriate technologies, adequate resources, skilled employees, and supportive environmental conditions are better positioned to adapt to technological changes. Effective technological adaptation may consequently enhance operational efficiency, resource utilization, service delivery, and overall organizational performance.

### 2.2 Empirical Review

Technological adoption has increasingly become an important mechanism for improving organizational efficiency, service quality, resource utilization, and competitiveness. In the waste management sector, technology adoption involves integrating information and communication technologies, Internet of Things (IoT) devices, digital platforms, automated monitoring systems, artificial intelligence, and data analytics into waste collection, transportation, sorting, recycling, and disposal activities. [15], A systematic review of IoT-enabled smart waste management systems found that smart bins, sensors, data analytics, and route optimization technologies can improve waste collection efficiency and provide timely information for operational decision-making. These technologies enable organizations to monitor waste levels, optimize collection schedules, coordinate vehicles, and allocate resources based on actual waste-generation patterns. The findings demonstrate that technology adoption can improve organizational performance by reducing operational inefficiencies and strengthening decision-making. [17] further demonstrated technology's contribution to waste management performance through a smart municipal waste management system based on deep learning and IoT. The system incorporated technologies for waste monitoring, classification, and collection, demonstrating the potential of digital technologies to improve waste classification and coordinate collection activities. Similarly, [18] found that IoT-enabled accountability could improve source separation and household waste monitoring. Digital technologies facilitate waste tracking and improve information availability, thereby supporting effective waste separation and resource recovery. These findings indicate that technological adoption can improve organizational performance through better monitoring, information processing, waste classification, and utilization of operational resources.

Technology adoption has also been associated with improved waste collection and transportation. [6] examined an IoT-based route recommendation system for intelligent waste management and showed that IoT-derived information can support more effective waste collection and routing decisions. Similarly, [2] found that improved routing approaches could

improve solid waste collection efficiency by reducing unnecessary travel and increasing vehicle utilization. These findings are particularly relevant to private waste management companies because transportation is a major operating cost. Efficient route planning can reduce fuel consumption, vehicle operating costs, collection time, and unnecessary trips while improving service delivery reliability. Thus, the adoption of technology can enhance organizational performance by enabling companies to utilize vehicles, labour, and financial resources more efficiently. In Africa, technological adoption has become increasingly important because waste management organizations operate in an environment characterized by rapid urbanization, increasing waste generation, inadequate infrastructure, financial constraints, and limited operational capacity. [1] established that digital control systems and mobile applications could strengthen municipal waste management by improving monitoring, communication, information sharing, and coordination among stakeholders. However, technological adoption comes with challenges. [10], examining Industry 4.0 technologies in solid waste management in Cape Town, identified financial constraints, inadequate technological skills, organizational challenges, institutional limitations, and technological unpreparedness as major implementation barriers. These findings demonstrate that technology investment alone does not guarantee improved organizational performance. Organizations need adequate financial resources, employee skills, infrastructure, management support, and institutional capacity to integrate technology effectively into their operations.

The human-resource dimension of technological adoption is equally important because waste management remains highly labor-intensive. Digital human-resource management can support recruitment, employee records, training, communication, performance appraisal, and employee monitoring. [21] found that HRM digitalization could influence firm performance, particularly where digital HR systems are sufficiently developed and integrated with broader organizational processes. Digital HR platforms can improve access to employee information, facilitate communication, strengthen performance monitoring, and support more timely human-resource decisions. [4] similarly established that sustainable electronic HRM systems can contribute to firm performance through HR practices that enhance employee capabilities and motivation. For waste management companies, these benefits are important because employee productivity, skills, motivation, and responsiveness directly influence waste collection, sorting, customer service, equipment utilization, and service reliability. Within Kenya, technological adoption is particularly relevant because urban waste management systems face increasing operational demands. [7], in examining solid waste management policies and practices in Nairobi and Mombasa, established that Kenya's urban waste management system involves multiple public and private actors and faces institutional and operational constraints. The study identified challenges associated with capacity, staffing, equipment, and coordination. These challenges provide a basis for examining technological adoption as a means of strengthening monitoring, information sharing, resource allocation, and coordination among waste management actors.

Emerging evidence also demonstrates the application of technology in Nairobi's waste management sector. [20] developed and tested an IoT-based smart waste segregation system for residential estates in Nairobi. The system used sensors to support automated waste classification and demonstrated the potential of IoT technologies to improve waste segregation and reduce contamination. Such technologies can improve recycling processes and resource recovery by enabling organizations to identify and separate different waste categories more effectively. However, private waste management companies in Nairobi continue to face resource-related challenges. [12] found that private waste management companies faced difficulties due to inadequate capital to acquire and maintain equipment and weaknesses in waste collection and disposal practices. These challenges suggest that the performance benefits of technology adoption depend on companies' capacity to acquire, maintain, and effectively use technological systems. Overall, empirical evidence demonstrates that technology adoption can improve organizational performance in waste management through several mechanisms, including improved waste monitoring, automated classification, optimized collection routes, efficient resource allocation, enhanced employee management, and better coordination among stakeholders. Nevertheless, the literature also shows that realizing these benefits depends on organizational readiness, financial capacity, employee competencies, management support, and institutional conditions. Existing international studies have largely focused on the technical capabilities of smart bins, IoT systems, routing technologies, and digital platforms, while African studies have emphasized implementation barriers and institutional challenges. In Kenya, studies have examined general waste management challenges and emerging technological applications, particularly in Nairobi, but have given limited empirical attention to the extent to which technology adoption influences the overall organizational performance of private waste management companies. This study therefore addresses this gap by examining the effect of technology adoption on the organizational performance of waste management companies in Nairobi City County, Kenya.

### 2.3 Conceptual Framework

The conceptual framework illustrates the expected relationship between technological adaptation and organizational performance among waste management companies in Nairobi City County. It provides a structured representation of how technological adaptation, as the independent variable, is expected to influence organizational performance, the dependent variable. The framework therefore guides the study in examining whether changes in technological adaptation are associated with improvements in organizational performance.

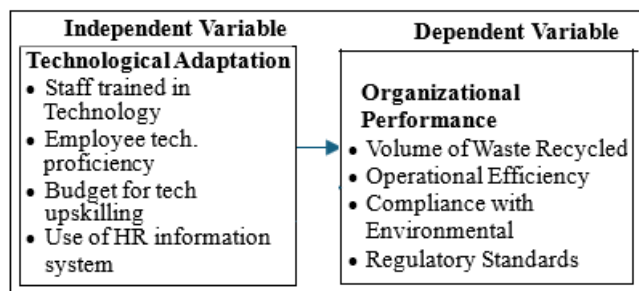


Figure 1: Conceptual Framework

### 3. Methodology

The study adopted a positivist research philosophy because it sought to objectively examine the effect of technological adaptation on organizational performance using measurable and quantifiable data. The study employed a descriptive and correlational research design to describe the characteristics of the study variables and establish the relationship between technological adaptation and organizational performance. The study targeted employees and managers of registered waste management companies operating in Nairobi City County. The study used a structured questionnaire to collect primary data, with items measured on a five-point Likert scale. A pilot study was conducted among respondents not included in the final sample to assess the instrument's reliability and clarity. Expert review enhanced validity, while reliability was assessed using Cronbach's alpha; a coefficient of 0.70 or above was considered acceptable. Data collected were coded and analysed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequencies, percentages, means, and standard deviations, summarized the data. Inferential analysis involved Pearson correlation and simple linear regression to determine the relationship and effect of technological adaptation on organizational performance. The regression model was specified as:

$$Y = \beta_0 + \beta_1 X_1 + \epsilon$$

Where: Y represents organizational performance,  $X_1$  represents technological adaptation,  $\beta_0$  is the regression constant,  $\beta_1$  is the regression coefficient, and  $\epsilon$  represents the error term. We tested statistical significance at the 5% level ( $p < 0.05$ ). We rejected the null hypothesis when the p-value was less than 0.05. The study observed ethical considerations, including informed consent, voluntary participation, confidentiality, anonymity, and secure handling of research data.

### 4. Findings

This section presents the study's findings on the effect of technological adaptation on organizational performance among waste management companies in Nairobi City County, Kenya. The findings are presented in line with the study objective and hypothesis. Descriptive and inferential statistics summarize the responses and establish the relationship between technological adaptation and organizational performance.

#### 4.1 Response Rate

A total of 244 questionnaires were issued to respondents from waste management companies in Nairobi County. Of these, 195 questionnaires were completed and returned, representing a response rate of 79.9%. The response rate of the study is presented in Table 1

Table 1: Response Rate

| Response Category           | Frequency | Percentage (%) |
|-----------------------------|-----------|----------------|
| Questionnaires Issued       | 244       | 100            |
| Questionnaires Returned     | 195       | 79.9           |
| Questionnaires Not Returned | 49        | 20.1           |
| Total                       | 244       | 100            |

This response rate was considered adequate for statistical analysis and meets the acceptable threshold for survey research. The relatively high response rate enhances the reliability of the findings and reduces the risk of non-response bias, thereby strengthening the validity of the study conclusions.

#### 4.2 Descriptive Statistics

This section presents the descriptive statistics for technological adaptation and organizational performance. The analysis uses means and standard deviations to summarize respondents' perceptions and show the extent to which waste management companies in Nairobi City County practice technological adaptation. The findings provide an overview of the study variables before inferential analysis.

##### 4.2.1 Descriptive Statistics in Technological Adoption

Respondents were asked to indicate their level of agreement with statements on technological adoption using a five-point Likert scale (1 = Not at All (NA), 2 = Small Extent (SE), 3 = Moderate Extent (ME), 4 = Large Extent (LE), and 5 = Very Large Extent (VLE)). The results are presented in Table 2

Table 2: Descriptive Statistics in Technological Adoption (N = 195)

| Statement                             | VLE<br>F (%) | LE<br>F (%) | ME<br>F (%) | SE<br>F (%) | NA<br>F (%) | Mean        | SD          |
|---------------------------------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Training on emerging technologies     | 46 (23.6%)   | 75 (38.5%)  | 33 (16.9%)  | 25 (12.8%)  | 16 (8.2%)   | 3.56        | 1.21        |
| Employees equipped with tech skills   | 50 (25.6%)   | 72 (36.9%)  | 35 (17.9%)  | 21 (10.8%)  | 17 (8.7%)   | 3.6         | 1.23        |
| Tech training improves productivity   | 73 (37.4%)   | 55 (28.2%)  | 29 (14.9%)  | 23 (11.8%)  | 15 (7.7%)   | 3.73        | 1.22        |
| Use of HR information systems         | 49 (25.1%)   | 71 (36.4%)  | 26 (13.3%)  | 27 (13.8%)  | 22 (11.3%)  | 3.5         | 1.31        |
| HRIS streamlines HR processes         | 74 (37.9%)   | 58 (29.7%)  | 31 (15.9%)  | 22 (11.3%)  | 10 (5.1%)   | 3.83        | 1.15        |
| HRIS enhances decision-making         | 75 (38.5%)   | 56 (28.7%)  | 28 (14.4%)  | 24 (12.3%)  | 12 (6.2%)   | 3.8         | 1.21        |
| Tech proficiency among employees      | 53 (27.2%)   | 69 (35.4%)  | 33 (16.9%)  | 25 (12.8%)  | 15 (7.7%)   | 3.61        | 1.22        |
| Adaptation to new systems             | 52 (26.7%)   | 70 (35.9%)  | 32 (16.4%)  | 23 (11.8%)  | 18 (9.2%)   | 3.59        | 1.24        |
| Tech proficiency improves performance | 70 (35.9%)   | 55 (28.2%)  | 30 (15.4%)  | 21 (10.8%)  | 19 (9.7%)   | 3.7         | 1.28        |
| <b>Overall Composite</b>              | —            | —           | —           | —           | —           | <b>3.66</b> | <b>1.22</b> |

The findings indicate that technological adoption is moderately strong in waste management companies in Nairobi County, as most responses fall within the positive categories of Large Extent (LE) and Very Large Extent (VLE). On whether the organization provides training on emerging technologies, 121 respondents (62.1%) indicated a great extent, while 41 respondents (21.0%) indicated a low extent, resulting in a mean of 3.56 (SD = 1.21), suggesting that technology training is fairly established. Similarly, 122 respondents (62.5%) agreed that employees are equipped with technological skills, with a mean of 3.60 (SD = 1.23), indicating a generally competent workforce in terms of ICT skills. On whether technology training improves productivity, 128 respondents (65.6%) agreed to a great extent, yielding a mean of 3.73 (SD = 1.22), confirming that training is perceived to enhance productivity. Regarding the use of HR information systems, 120 respondents (61.5%) indicated a great extent while 49 respondents (25.1%) indicated a lower extent, resulting in a mean of 3.50 (SD = 1.31), suggesting moderate but growing adoption of HRIS tools. Further, respondents strongly agreed that HRIS streamlines HR processes, with 132 respondents (67.6%) indicating a high extent and a mean of 3.83 (SD = 1.15), the highest in this section, showing that HRIS significantly improves efficiency. Similarly, 131 respondents (67.2%) agreed that HRIS enhances decision-making, with a mean of 3.80 (SD = 1.21), indicating strong perceived value of digital HR systems in decision support. On employee technological proficiency, 122 respondents (62.6%) indicated a high extent, with a mean of 3.61 (SD = 1.22), while adaptation to new systems recorded 122 respondents (62.6%) at a high extent and a mean of 3.59 (SD = 1.24), showing moderate adaptability to technological change. Lastly, 125 respondents (64.1%) agreed that technological proficiency improves performance outcomes, with a mean of 3.70 (SD = 1.28), confirming the importance of ICT skills in organizational performance. These findings align with [19], who found that respondents in waste management companies in Nairobi County generally agreed that technology strategy influenced organizational performance. Their study reported a positive relationship between technology strategy and performance, although the effect was statistically insignificant. Similarly, the relatively high composite mean of 3.66 indicates that respondents generally recognized technology's contribution to organizational processes and performance. This finding also aligns with [9], who reported that digitizing organizational operations enhanced efficiency and performance. However, the relatively lower rating for HRIS usage suggests that while organizations recognize technology's value, the extent of actual digital integration may still be limited. This aligns with [19], who observed that technological strategies do not automatically translate into significant performance improvements unless they are effectively integrated into organizational operations.

### 4.3 Correlation Analysis

Pearson correlation analysis was conducted to determine the direction and strength of the relationship between technological adaptation and organizational performance among waste management companies in Nairobi City County. The analysis used the composite scores for the two

variables, with statistical significance assessed at the 1% level.

**Table 3:** Correlation between Technological Adaptation and Organizational Performance

| Variables                  | Technological Adaptation | Organizational Performance |
|----------------------------|--------------------------|----------------------------|
| Technological Adaptation   | 1                        |                            |
| Organizational Performance | 0.7                      | 1                          |
| Sig. (2-tailed)            | 0                        |                            |
| N                          | 195                      | 195                        |

Table 3 shows a positive relationship between technological adaptation and organizational performance ( $r = 0.700$ ,  $p < 0.01$ ). This implies that higher levels of technological adaptation are associated with higher levels of organizational performance among waste management companies in Nairobi City County. The relationship is statistically significant at the 1% level, indicating that the observed association is unlikely to have occurred by chance. This finding suggests that organizations that effectively adapt and integrate technology into their operations are more likely to improve efficiency, service delivery, and overall performance. The finding is consistent with [19], who reported a positive relationship between technology strategy and the performance of waste management companies in Nairobi County. It also supports [9], which found that digitizing organizational operations was associated with improved organizational performance. The strong correlation observed in the present study therefore provides further evidence that technological adaptation is an important factor associated with organizational performance in the waste management sector.

### 4.4 Model Summary

A simple linear regression analysis was conducted to determine the extent to which technological adaptation predicts organizational performance among waste management companies in Nairobi City County. The model summary presents the correlation coefficient (R), coefficient of determination ( $R^2$ ), adjusted  $R^2$ , and standard error of the estimate.

**Table 4:** Model Summary

| Model | R     | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------|----------|-------------------|----------------------------|
| 1     | 0.700 | 0.490    | 0.487             | 0.714                      |

The results in Table 4 indicate that the correlation coefficient ( $R = 0.700$ ) confirms a strong positive relationship between technological adaptation and organizational performance. The coefficient of determination ( $R^2 = 0.490$ ) indicates that technological adaptation explains 49.0% of the variation in organizational performance among waste management companies in Nairobi City County. The remaining 51.0% is explained by other factors not included in the model. The adjusted  $R^2$  of 0.487 indicates that the model retains approximately 48.7% explanatory power after adjusting for the number of predictors. Overall, the results suggest that technological adaptation substantially explains organizational performance.

#### 4.5 Analysis of Variance (ANOVA)

An analysis of variance (ANOVA) was conducted to determine whether the regression model statistically explains the relationship between technological adaptation and organizational performance. The analysis assesses whether the variation in organizational performance explained by technological adaptation is statistically significant.

**Table 5: ANOVA**

| Model      | Sum of Squares | df  | Mean Square | F      | Sig.  |
|------------|----------------|-----|-------------|--------|-------|
| Regression | 94.10          | 1   | 94.10       | 184.64 | 0.000 |
| Residual   | 98.39          | 193 | 0.51        |        |       |
| Total      | 192.49         | 194 |             |        |       |

The ANOVA results indicate that the regression model was statistically significant, with  $F(1, 193) = 184.64$ ,  $p < 0.001$ . This implies that technological adaptation significantly explains variation in organizational performance among waste management companies in Nairobi City County. Because the significance value is below the 0.05 threshold, the regression model is statistically significant and suitable for explaining the relationship between the study variables. The findings therefore provide further evidence that technological adaptation is an important predictor of organizational performance.

#### 4.6 Regression Coefficients

Regression coefficient analysis was conducted to determine the extent to which technological adaptation predicts organizational performance among waste management companies in Nairobi City County. The analysis presents the unstandardized and standardized coefficients, standard errors, t-values, and significance levels.

**Table 6: Regression Coefficients**

| Model                    | Unstandardized Coefficients B | Std. Error | Standardized Coefficients Beta | t      | Sig.  |
|--------------------------|-------------------------------|------------|--------------------------------|--------|-------|
| Constant                 | 1.200                         | 0.185      | —                              | 6.486  | 0.000 |
| Technological Adaptation | 0.700                         | 0.052      | 0.700                          | 13.588 | 0.000 |

Table 6 shows that technological adaptation had a positive and statistically significant effect on organizational performance, with a standardized beta coefficient of  $\beta = 0.700$  and  $p < 0.001$ . The positive coefficient indicates that increases in technological adaptation are associated with increases in organizational performance. Specifically, the unstandardized coefficient of  $B = 0.700$  implies that a one-unit increase in technological adaptation is associated with a 0.700-unit increase in organizational performance, holding other factors constant. The t-value of 13.588 and p-value of 0.000 demonstrate that the effect is statistically significant at the 5% level. The regression equation is therefore:

$$\text{Organizational Performance} = 1.200 + 0.700(\text{Technological Adaptation}) + \epsilon$$

Based on the findings, the null hypothesis stating that technological adaptation has no statistically significant effect on organizational performance is rejected. The results therefore provide evidence that technological adaptation is a

significant positive predictor of organizational performance among waste management companies in Nairobi City County.

#### 4.7 Hypothesis Test Results

The study tested the null hypothesis to determine whether technological adaptation had a statistically significant effect on organizational performance among waste management companies in Nairobi City County. The decision to reject or fail to reject the null hypothesis was based on a 5% significance level ( $\alpha = 0.05$ ).

**Table 7: Hypothesis Testing Results**

| Hypothesis                                                                                                        | $\beta$ | t-value | p-value | Decision               |
|-------------------------------------------------------------------------------------------------------------------|---------|---------|---------|------------------------|
| H <sub>01</sub> : Technological adaptation has no statistically significant effect on organizational performance. | 0.700   | 13.588  | 0.000   | Reject H <sub>01</sub> |

Table 7 shows H<sub>1</sub>: Technological adaptation has a positive and statistically significant effect on organizational performance, with  $\beta = 0.700$ ,  $t = 13.588$ , and  $p < 0.001$ . The positive beta coefficient indicates that improvements in technological adaptation are associated with corresponding improvements in organizational performance. The relatively high t-value further provides strong evidence of the relationship's significance. Since the p-value of 0.000 is below the established significance level of 0.05, the null hypothesis (H<sub>01</sub>) is rejected. The study therefore concludes that technological adaptation significantly influences organizational performance among waste management companies in Nairobi City County. This finding suggests that organizations that effectively integrate and adapt to technological changes are more likely to enhance operational efficiency, service delivery, resource utilization, and overall performance. The result is also consistent with the correlation finding ( $r = 0.700$ ,  $p < 0.01$ ) and the regression model, which showed that technological adaptation explained 49.0% of the variation in organizational performance.

#### 5.1 Summary of Findings

The study examined the effect of technological adaptation on the organizational performance of waste management companies in Nairobi City County. The study issued 244 questionnaires, of which 195 were completed and returned, for a response rate of 79.9%. The descriptive findings indicated a moderately high level of technological adaptation, with a composite mean of 3.66 and a standard deviation of 1.22. This suggests that respondents generally agreed that technological adaptation was practiced within their organizations and contributed to improvements in organizational processes and performance. However, the relatively lower rating associated with HRIS usage suggested that some aspects of digital integration remained limited. The inferential findings established a strong positive relationship between technological adaptation and organizational performance, with a Pearson correlation coefficient of  $r = 0.700$ ,  $p < 0.01$ . The regression analysis further demonstrated that technological adaptation significantly predicted organizational performance. The model produced an  $R^2$  of

0.490, indicating that technological adaptation explained 49.0% of the variation in organizational performance, while the remaining 51.0% was attributable to other factors outside the model. The ANOVA results confirmed that the regression model was statistically significant,  $F(1, 193) = 184.64$ ,  $p < 0.001$ . The hypothesis testing results showed a positive and statistically significant effect of technological adaptation on organizational performance ( $\beta = 0.700$ ,  $t = 13.588$ ,  $p < 0.001$ ). Because the p-value was below the 0.05 significance level, the study rejected the null hypothesis that technological adaptation has no statistically significant effect on organizational performance. The study therefore established that technological adaptation is an important predictor of organizational performance among waste management companies in Nairobi City County.

## 5.2 Conclusion

The study concludes that technological adaptation significantly and positively influences organizational performance among waste management companies in Nairobi City County. The findings show that organizations that effectively integrate and adapt to technological changes are more likely to improve operational efficiency, service delivery, resource utilization, and overall performance. The strong correlation and significant regression results provide empirical evidence that technology is not merely a supportive organizational function but an important strategic capability for waste management companies. However, the moderate level of technological adaptation and the regression model's 49.0% explanatory power indicate that organizations still have considerable opportunity to strengthen technological integration while addressing other factors that influence performance.

## 5.3 Recommendations

### 5.3.1 Recommendations for Policy

Nairobi City County Government and relevant regulatory agencies should strengthen policies that encourage technological modernization within the waste management sector. This may include developing clear technology adoption standards, providing incentives for companies investing in environmentally sustainable technologies, and promoting digital systems for waste tracking, reporting, and monitoring. The County Government should also strengthen partnerships with technology providers and waste management companies to improve access to affordable, appropriate technologies. Such policies would support more efficient waste collection, transportation, recycling, and disposal while contributing to sustainable urban waste management.

### 5.3.2 Recommendations for Practice

Waste management companies should prioritize continuous technological adaptation and integration across their operations. Managers should invest in appropriate digital systems, automated waste-handling technologies, GPS and route-optimization systems, digital customer management, and human resource information systems. Companies should also provide regular training and capacity-building programs to ensure employees have the skills needed to use new technologies effectively. Management should also evaluate

the performance outcomes of technology investments to ensure technology is fully integrated into organizational processes rather than adopted without effective use. These practices can enhance operational efficiency, employee productivity, service quality, and overall organizational performance.

## References

- [1] Adeniran, A. A., Shakantu, W., & Ayesu-Koranteng, E. (2022). A proposed digital control system using a mobile application for municipal solid waste management in South Africa. *Waste Technology*, 10(1), 30–42. <https://doi.org/10.14710/10.1.30-42>
- [2] Akhtar, M., Hannan, M. A., Begum, R. A., Basri, H., & Scavino, E. (2017). Backtracking search algorithm in CVRP models for efficient solid waste collection and route optimization. *Waste Management*, 61, 117–128. <https://doi.org/10.1016/j.wasman.2017.01.022>
- [3] Asser, J. H., Waiganjo, E., & Njeru, A. (2022). Influence of technology adoption interventions on performance of selected commercial state corporations in Kenya. *Multidisciplinary Journal of Technical University of Mombasa*, 2(1). <https://doi.org/10.48039/mjtm.v2i1.49>
- [4] Bag, S., Dhamija, P., Pretorius, J. H. C., Chowdhury, A. H., & Giannakis, M. (2022). Sustainable electronic human resource management systems and firm performance: An empirical study. *International Journal of Manpower*, 43(1), 32–51. <https://doi.org/10.1108/IJM-02-2021-0099> University of Johannesburg
- [5] Chittipaka, V., Kumar, S., Sivarajah, U., Bowden, J. L.-H., & Baral, M. M. (2023). Blockchain technology for supply chains operating in emerging markets: An empirical examination of technology-organization-environment framework. *Annals of Operations Research*, 327, 465–492. <https://doi.org/10.1007/s10479-022-04801-5>
- [6] Ghahramani, M., Zeng, M., Molter, A., & Pilla, F. (2022). IoT-based route recommendation for an intelligent waste management system. *IEEE Internet of Things Journal*, 9(14), 11883–11892. <https://doi.org/10.1109/JIOT.2021.3132126> Birmingham City University
- [7] Haregu, T. N., Ziraba, A. K., Aboderin, I. A. G., Amugsi, D., Muindi, K., & Mberu, B. U. (2017). An assessment of the evolution of Kenya's solid waste management policies and their implementation in Nairobi and Mombasa: Analysis of policies and practices. *Environment and Urbanization*, 29(2), 515–532. <https://doi.org/10.1177/0956247817700294> Sage Journals
- [8] Jeyaraj, A., & Raj, A. (2023). Antecedents and consequents of Industry 4.0 adoption using technology, organization and environment (TOE) framework: A meta-analysis. *Annals of Operations Research*, 322, 101–124. <https://doi.org/10.1007/s10479-022-04942-7>
- [9] Kosi, B. W., Rintari, N., & Mutea, F. (2025). Effect of digitizing operations on organizational performance of Marsabit County Government, Kenya. *Journal of Strategic Management*, 5(3), 1–15. <https://doi.org/10.70619/vol5iss3pp1-15>

- [10] Mabiletsa, V., & Ramdass, K. (2025). Barriers to implementing Industry 4.0 technologies in solid waste management: Case of the City of Cape Town Metropolitan Municipality. *Journal of Environmental Protection*, 16, 979–997. <https://doi.org/10.4236/jep.2025.1610052>
- [11] Ministry of Environment and Forestry. (2021). *National sustainable waste management policy*. Government of Kenya.
- [12] Ngunju, P. W. (2018). *Municipal solid waste management: Contribution and challenges of private solid waste management companies in Nairobi County, Kenya* [Master's dissertation, University of Nairobi]. University of Nairobi Repository.
- [13] Republic of Kenya. (2022). *Sustainable Waste Management Act, 2022 (Cap. 387C)*. Government Printer.
- [14] Siwawa, V. S. (2025). Assessing waste management performance in smart cities through the 'Zero Waste Index': Case of African Waste Reclaimers Organisation, Johannesburg, South Africa. *Frontiers in Sustainable Cities*, 7. <https://doi.org/10.3389/frsc.2025.1449868>
- [15] Sosunova, I., & Porras, J. (2022). IoT-enabled smart waste management systems for smart cities: A systematic review. *IEEE Access*, 10, 73326–73363. <https://doi.org/10.1109/ACCESS.2022.3188308> Aalto University's research portal
- [16] Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington Books. *Financial Management*, 7(2), 53–68.
- [17] Wang, B., Farooque, M., Zhong, R. Y., Zhang, A., & Liu, Y. (2021). Internet of Things (IoT)-enabled accountability in source separation of household waste for a circular economy in China. *Journal of Cleaner Production*, 300, 126773. <https://doi.org/10.1016/j.jclepro.2021.126773> ScienceDirect
- [18] Wang, C., Qin, J., Qu, C., Ran, X., Liu, C., & Chen, B. (2021). A smart municipal waste management system based on deep-learning and Internet of Things. *Waste Management*, 135, 20–29. <https://doi.org/10.1016/j.wasman.2021.08.028> ScienceDirect
- [19] Wanjia, R., & Kamau, S. (2024). Influence of technology strategy on the performance of waste management companies in Nairobi County, Kenya. *International Journal of Management Studies and Social Science Research*, 6(4), 233–239. <https://doi.org/10.56293/ijmsssr.2024.5123>
- [20] Wasai, R. T., & Yohannis, M. A. (2025). Internet of Things-based smart waste segregation system for sustainable waste management in Nairobi's residential estates. *Journal of Information and Technology*, 5(10), 68–96. <https://doi.org/10.70619/vol5iss10pp68-96>
- [21] Zhou, Y., Liu, G., Chang, X., & Wang, L. (2021). The impact of HRM digitalization on firm performance: Investigating three-way interactions. *Asia Pacific Journal of Human Resources*, 59(1), 20–43. <https://doi.org/10.1111/1744-7941.12258>

## Author Profile

**Miriam Wanjiku** is a strategic and results-driven credit professional with over 12 years of experience in credit risk management, compliance, and financial services. She has developed extensive expertise in assessing credit risk, developing financial proposals, and monitoring SME funding processes to support sound and informed financing decisions. Throughout her career, Miriam has demonstrated a strong ability to enhance organizational performance while ensuring adherence to regulatory requirements and established risk-management frameworks. Her professional expertise encompasses credit assessment, risk mitigation, regulatory compliance, SME financing, financial proposal development, and monitoring of funding processes. Miriam is particularly passionate about developing practical and sustainable solutions that minimize financial risks while improving organizational systems and operational efficiency. She brings a problem-solving orientation to her work, with a strong focus on continuous improvement, process optimization, and sustainable business growth. Her ability to identify emerging challenges and translate them into practical solutions enables organizations to strengthen resilience, improve efficiency, and remain responsive to changing financial and regulatory environments. With a combination of extensive industry experience, strategic thinking, analytical capability, and a strong commitment to professional excellence, Miriam brings valuable expertise to financial institutions and organizations seeking to strengthen credit governance, manage financial risks, improve SME financing processes, and achieve sustainable organizational performance.