ASSESSING THE COMBINED IMPACT OF REMOTE WORK ADOPTION AND INFORMATION AND COMMUNICATION TECHNOLOGY INVESTMENT ON PRODUCTIVITY PERFORMANCE IN SOUTH AFRICA'S LISTED SERVICE INDUSTRY

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Abstract
The rapid expansion of digital technologies and flexible work arrangements has transformed the operational landscape of service sector firms worldwide. This study investigated the effects of remote work adoption and ICT investment on firm-level productivity among service sector firms listed on the Johannesburg Stock Exchange (JSE), South Africa. A quantitative correlational research design was adopted, utilizing secondary data obtained from annual reports, sustainability reports, and financial disclosures of 50 listed service firms over the period 2020–2024. Firm-level productivity was measured using revenue per employee, while remote work adoption and ICT investment served as the explanatory variables. Data were analyzed using descriptive statistics and multiple linear regression techniques. The results revealed that remote work adoption exerts a positive and statistically significant effect on productivity ($\beta = 0.312$, $p = 0.012$). ICT investment also demonstrated a positive and stronger influence on firm productivity ($\beta = 0.547$, $p = 0.001$). The regression model exhibited substantial explanatory power, with an R^2 value of 0.683 and an adjusted R^2 value of 0.667, indicating that approximately 68.3% of the variation in firm-level productivity is explained by the combined effects of remote work adoption and ICT investment. The findings suggest that firms that embrace flexible work structures while simultaneously investing in digital infrastructure are more likely to achieve superior productivity outcomes. The study concludes that digital transformation, supported by both technological investment and innovative work practices, represents a critical pathway for enhancing competitiveness and operational efficiency in South Africa's service sector.

Keywords: Digital transformation, firm-level productivity, ict investment, remote work adoption, service sector firms, South Africa.

1.0 Introduction

The service sector has become a major driver of economic growth, employment creation, and innovation in many emerging economies, including South Africa. In recent years, technological advancements and changes in workplace arrangements have significantly altered how firms organize production and deliver services. The COVID-19 pandemic accelerated the adoption of remote work practices and intensified investments in information and communication technology (ICT), making digital transformation a strategic priority for many organizations. Existing studies suggest that digital technologies enhance operational efficiency, organizational flexibility, and competitiveness by improving communication, knowledge sharing, and resource utilization (Jafari-Sadeghi & Garcia-Perez, 2020; Luo & Bu, 2020). Similarly, firms that successfully integrate digital capabilities into their business processes tend to achieve superior performance outcomes and greater resilience during periods of disruption (Atuahene-Gima & Asiedu, 2022; Rahman & Kabir, 2022). Consequently, understanding how remote work and ICT investment influence productivity has become an important issue for researchers and business leaders.

Remote work has emerged as one of the most visible organizational changes in the post-pandemic business environment. Advances in cloud computing, collaboration platforms, and digital communication tools have enabled employees to perform tasks effectively outside traditional office settings. Evidence from developed and emerging economies indicates that

remote work can improve productivity through reduced commuting time, greater flexibility, and enhanced employee autonomy (Bloom & Ramani, 2021; Gibbs et al., 2021). Other studies report that remote work contributes to employee engagement and organizational resilience when supported by appropriate managerial practices and technological infrastructure (Ali & Khan, 2022; Chatterjee & Rana, 2022). Within South Africa, organizations have increasingly adopted hybrid and remote work arrangements to maintain business continuity and workforce adaptability (Bonga & Radebe, 2023; Eneh & Madumo, 2023). Nevertheless, concerns remain regarding coordination challenges, digital inequality, and varying productivity outcomes across firms, suggesting that the effectiveness of remote work may depend on broader organizational and technological conditions.

Alongside changes in work arrangements, ICT investment has become a critical determinant of firm performance in knowledge-intensive industries. Organizations increasingly allocate resources to software systems, digital infrastructure, cybersecurity, and automation technologies to enhance operational efficiency and support innovation. Research consistently demonstrates that ICT investment contributes positively to productivity by improving information processing, facilitating strategic decision-making, and strengthening organizational capabilities (Adeoye & Thomas, 2024; Odhiambo & Ouma, 2023). In the South African context, studies have shown that ICT infrastructure and digital readiness improve competitiveness and productivity across service-oriented sectors (Mothibi & Mahlangu, 2021; Ramlall & Shongwe, 2023). Furthermore, ICT investment supports organizational scalability and service quality enhancement, enabling firms to respond more effectively to dynamic market conditions (Muriithi & Wanjala, 2023). Despite these findings, considerable variation exists in the extent to which firms invest in digital technologies and realize corresponding productivity gains.

The first objective of this study is to assess the effect of remote work adoption on firm-level productivity among listed service sector firms in South Africa. Although prior studies have reported positive associations between remote work and organizational performance, the evidence remains mixed and context-dependent. Much of the existing literature focuses on employee-level outcomes such as job satisfaction, engagement, and individual performance rather than firm-level productivity indicators (Ali & Khan, 2022; Nyoni & Maseko, 2024). Moreover, relatively few studies have examined publicly listed service firms operating in emerging African economies where institutional conditions, infrastructure availability, and workforce characteristics differ substantially from those in developed countries. This creates an important empirical gap regarding whether remote work adoption translates into measurable productivity improvements at the organizational level within South Africa's service sector.

The second objective is to examine the influence of ICT investment on firm-level productivity among listed service sector firms in South Africa, while the third objective is to determine the combined effect of remote work adoption and ICT investment on firm-level productivity. Although ICT investment has been widely linked to productivity growth, many studies investigate ICT as an independent driver of performance without considering its interaction with contemporary work arrangements (Adepoju & Komolafe, 2024; Omri & Becuwe, 2023). Similarly, research on remote work often overlooks the enabling role of digital infrastructure and technology expenditure in supporting effective virtual operations. As a result, limited evidence exists on how remote work and ICT investment jointly influence productivity outcomes. This gap is particularly evident among Johannesburg Stock Exchange-listed service firms, where

digital transformation strategies and workplace innovations have expanded rapidly but remain underexplored in academic literature.

Given these gaps, this study contributes to the growing literature on digital transformation and organizational performance by providing empirical evidence from South Africa's listed service sector. The study examines the individual and combined effects of remote work adoption and ICT investment on firm-level productivity using data from Johannesburg Stock Exchange firms. By focusing on a context characterized by increasing digitalization and evolving work practices, the study offers insights relevant to managers, investors, and policymakers seeking to improve organizational performance through technology-enabled strategies. The remainder of the article is organized as follows. The next section reviews the relevant theoretical and empirical literature. This is followed by the methodology section, which describes the research design, data sources, variable measurement, and analytical techniques. The subsequent section presents and discusses the empirical findings, while the final section provides the conclusion, policy implications, and recommendations for future research.

2.0 Literature and Hypotheses

The growing importance of digital transformation has fundamentally changed how firms organize production processes, manage employees, and pursue competitive advantage. Within the service sector, where knowledge, information, and communication constitute critical inputs, technological capabilities increasingly determine organizational success. Scholars have argued that investments in digital technologies and flexible work arrangements have become essential mechanisms through which firms improve efficiency and adapt to changing market conditions (Jafari-Sadeghi & Garcia-Perez, 2020; Tarek & Khan, 2020). The emergence of remote work and the expansion of ICT infrastructure have accelerated these changes, particularly after the COVID-19 pandemic. While both developments are often associated with productivity gains, researchers continue to debate the extent to which these benefits are realized across different institutional and organizational contexts. Consequently, understanding the productivity implications of remote work and ICT investment remains an important area of inquiry, especially in emerging economies where digital transformation processes are evolving rapidly.

A substantial body of literature has examined the relationship between remote work and organizational performance. Early discussions of remote work emphasized its potential to enhance flexibility, reduce commuting costs, and improve work-life balance. More recent studies have shifted attention toward its productivity implications. Bloom and Ramani (2021) found that remote work can increase productivity when employees possess adequate technological resources and managerial support. Similarly, Gibbs et al. (2021) reported productivity improvements among information technology professionals working remotely, attributing these gains to reduced workplace distractions and greater autonomy. Giovanis (2022) also observed positive productivity outcomes during the pandemic period, although the magnitude of the effect varied across firms and industries. These findings support the argument that remote work can serve as a strategic tool for enhancing organizational efficiency when implemented under favorable conditions.

Despite evidence supporting remote work, scholarly debates reveal considerable disagreement regarding its overall effectiveness. Ali and Khan (2022) argued that remote work improves employee performance through increased flexibility and job satisfaction, while Chatterjee and

Rana (2022) emphasized the role of digital collaboration tools in sustaining productivity in dispersed work environments. However, Nguyen and Doan (2020) identified challenges such as communication barriers, social isolation, and reduced managerial oversight that may undermine performance. Similar concerns were raised by Mkhize and Govender (2021), who noted that organizational support systems significantly influence the effectiveness of remote work arrangements. These contrasting findings suggest that productivity outcomes depend not merely on the adoption of remote work itself but also on organizational culture, technological readiness, and employee capabilities.

In the African context, remote work research has gained momentum due to the rapid workplace transformations experienced during and after the pandemic. Bonga and Radebe (2023) found that remote work enhanced employee engagement and adaptability among South African workers. Eneh and Madumo (2023) similarly reported that digital human resource management practices facilitated successful remote work implementation within South African organizations. Chukwuemeka and Banda (2023) highlighted the contribution of flexible work arrangements to workforce resilience across African economies. However, Nkosi and Dlamini (2022) argued that persistent digital inequalities limit the effectiveness of remote work for many organizations and employees. Tshabalala and Kritzinger (2024) further emphasized that inadequate cyberinfrastructure and policy uncertainties continue to constrain remote work adoption in South Africa. These studies indicate that while remote work presents opportunities, contextual challenges remain significant.

Several scholars have specifically examined productivity management within hybrid and remote work environments. Naidoo and Kruger (2021) observed that digital workforce management systems enable firms to coordinate remote employees more effectively and maintain performance standards. Ndlovu and Vilakazi (2022) found that hybrid work arrangements can improve productivity when organizations establish clear performance expectations and communication protocols. Van der Merwe and Mokwena (2022) similarly reported positive outcomes within South Africa's financial sector, where remote work policies contributed to operational continuity. Nyoni and Maseko (2024) linked remote work to higher job satisfaction and productivity among professionals, although they cautioned that sustained performance requires adequate technological support. Collectively, these studies suggest that remote work can generate productivity gains, but successful implementation depends heavily on organizational preparedness and supportive management practices.

Alongside remote work, ICT investment has emerged as a central determinant of firm productivity. Theoretical perspectives on technological change suggest that ICT enables firms to improve efficiency through automation, enhanced communication, and better resource allocation. Gao and Zhao (2021) argued that digital infrastructure strengthens strategic alignment and operational effectiveness, thereby improving firm performance. Ramachandran and Sridhar (2021) similarly found that automation and digital infrastructure positively influence productivity in emerging markets. These findings align with broader digital transformation literature, which emphasizes the role of technology in facilitating innovation, process integration, and competitive advantage. Consequently, ICT investment is increasingly viewed as a strategic asset rather than merely an operational expenditure.

Empirical evidence from Africa generally supports the positive relationship between ICT investment and productivity. Adeoye and Thomas (2024) reported that ICT investment significantly improves productivity within Africa's knowledge-based sectors. Adepoju and Komolafe (2024) found that ICT-enabled innovation enhances productivity across service-oriented industries in Sub-Saharan Africa. Similarly, Odhiambo and Ouma (2023) demonstrated that firms investing in digital technologies experience superior productivity outcomes compared with less technologically advanced counterparts. Omri and Becuwe (2023) reinforced this argument by showing that ICT utilization contributes to productivity growth across African economies. These studies collectively suggest that digital investments play a critical role in strengthening firm competitiveness and operational performance.

Within South Africa, research has increasingly focused on the contribution of ICT infrastructure to organizational productivity. Mothibi and Mahlangu (2021) found that ICT capabilities significantly improve firm productivity by enhancing information management and operational efficiency. Mothibi and Mahlangu (2021) further demonstrated that technology investment positively influences productivity within logistics and financial service firms. Naidoo and Sibanda (2021) reported that digitalization contributes to higher productivity among South African service firms by streamlining processes and improving responsiveness. Ramlall and Shongwe (2023) emphasized that ICT readiness is a key determinant of successful digital transformation. Similarly, Sibanda and Moyo (2023) observed that digital investments enhance operational efficiency and organizational performance across various South African industries. These findings underscore the strategic importance of ICT investment within the country's service sector.

Another strand of literature examines how ICT investment contributes to organizational resilience and scalability. Karim et al. (2022) argued that digital investments strengthen firms' ability to withstand external disruptions by improving flexibility and adaptability. Matlala and Phiri (2022) found that South African firms with stronger ICT capabilities demonstrated greater resilience during the COVID-19 crisis. Muriithi and Wanjala (2023) reported that ICT infrastructure facilitates organizational scalability by supporting business expansion and service delivery improvements. Muriithi and Wanjala (2023) further noted that technology investments enhance service quality and customer satisfaction. Likewise, Sillah and Fofana (2021) and Sillah and Fofana (2021) identified positive relationships between ICT capital accumulation and labor productivity growth across Sub-Saharan Africa. Together, these studies suggest that ICT investment influences productivity both directly and indirectly through enhanced organizational capabilities.

Although substantial evidence supports the individual benefits of remote work and ICT investment, fewer studies investigate their combined influence on productivity. Digital technologies constitute the foundation upon which remote work arrangements operate effectively. Without adequate ICT infrastructure, communication systems, and cybersecurity capabilities, remote work may fail to generate expected productivity gains. Luo and Bu (2020) argued that ICT capability mediates the relationship between digitalization and organizational performance through improved process integration. Rahman and Kabir (2022) similarly found that digital adoption enhances productivity by enabling firms to coordinate activities more efficiently. Atuahene-Gima and Asiedu (2022) emphasized that digital transformation strengthens organizational agility, allowing firms to adapt rapidly to changing business conditions. These

findings imply that remote work and ICT investment may operate as complementary rather than independent drivers of productivity.

Research on African firms increasingly supports this complementary perspective. Adepoju and Komolafe (2024) argued that digital infrastructure investments amplify the productivity benefits associated with organizational innovation and technological adoption. Nwankwo and Chikwe (2023) found that digital transformation positively influences productivity within African telecommunications firms by enhancing communication, innovation, and operational efficiency. Nwankwo and Chikwe (2023) further reported that digitalization contributes to innovation performance, which subsequently improves productivity outcomes. Kruger and Dlamini (2021) observed that stronger ICT infrastructure enhances competitiveness among South African enterprises, while Vilakazi and Booysen (2021) highlighted the importance of digital readiness for successful technology integration. These studies collectively suggest that firms combining robust ICT investments with innovative work arrangements may achieve superior productivity outcomes.

Despite the growing literature, important research gaps remain. First, many studies investigate remote work and ICT investment separately, providing limited understanding of their joint effects on organizational productivity. Second, a large proportion of existing evidence is derived from developed economies, making it difficult to generalize findings to emerging-market contexts characterized by different institutional, technological, and infrastructural conditions. Third, much of the South African literature focuses on employee experiences, organizational resilience, or digital readiness rather than firm-level productivity outcomes measured using objective performance indicators. Finally, relatively little attention has been given to publicly listed service firms, despite their significant contribution to economic activity and digital innovation. Addressing these gaps is therefore necessary to advance understanding of how remote work adoption and ICT investment jointly influence firm-level productivity within South Africa's listed service sector. The present study seeks to fill this gap by providing empirical evidence from Johannesburg Stock Exchange-listed firms and contributing to ongoing debates concerning digital transformation, workplace innovation, and organizational performance.

Hypotheses Development

H_{01}: Remote work adoption has no significant effect on firm-level productivity among listed service sector firms in South Africa.

The relationship between remote work adoption and firm-level productivity has attracted considerable scholarly attention, particularly following the widespread workplace disruptions caused by the COVID-19 pandemic. Traditional management theories often emphasized physical supervision and face-to-face interactions as essential ingredients for productivity. However, advances in digital communication technologies have challenged this perspective by enabling employees to perform tasks effectively from remote locations. Bloom and Ramani (2021) found that remote work can generate productivity gains through reduced commuting time, greater scheduling flexibility, and improved concentration. Similarly, Gibbs et al. (2021) observed that remote employees often experience fewer workplace interruptions, allowing them to devote more time to core responsibilities. Giovanis (2022) further reported that firms adopting remote work arrangements during the pandemic achieved favorable productivity outcomes, particularly when employees had access to adequate technological resources and managerial support.

Despite these positive findings, significant debate remains regarding the sustainability and universality of remote work benefits. Nguyen and Doan (2020) argued that remote work can create communication barriers, weaken teamwork, and reduce knowledge sharing, thereby negatively affecting organizational performance. Within the South African context, Nkosi and Dlamini (2022) highlighted the challenges posed by unequal access to digital infrastructure, while Mkhize and Govender (2021) emphasized the importance of organizational support systems in determining remote work effectiveness. Bonga and Radebe (2023), Eneh and Madumo (2023), and Van der Merwe and Mokwena (2022) nevertheless found that remote work enhanced employee engagement, adaptability, and operational continuity in many South African organizations. The existence of these contrasting perspectives indicates that the effect of remote work on productivity remains an empirical question, thereby necessitating formal testing of H01 within the context of listed service sector firms.

H_{02}: ICT investment has no significant effect on firm-level productivity among listed service sector firms in South Africa.

Theoretical and empirical literature consistently identifies ICT investment as a major driver of organizational productivity. From the resource-based perspective, investments in digital infrastructure create valuable organizational capabilities that improve efficiency, innovation, and competitiveness. Gao and Zhao (2021) argued that ICT strengthens strategic alignment by enabling firms to integrate business processes and respond more effectively to market demands. Similarly, Ramachandran and Sridhar (2021) found that automation technologies and digital infrastructure significantly improve productivity in emerging-market firms. Studies conducted across Africa further support this position. Adeoye and Thomas (2024) reported that ICT investment contributes positively to productivity growth in knowledge-based industries, while Odhiambo and Ouma (2023) demonstrated that firms allocating greater resources to digital technologies consistently outperform less technologically advanced competitors. Omri and Becuwe (2023) also found that ICT utilization serves as an important catalyst for productivity enhancement across African economies.

Notwithstanding these findings, some scholars caution that ICT investment does not automatically translate into improved productivity. Jafari-Sadeghi and Garcia-Perez (2020) argued that digital technologies create value only when supported by effective organizational structures and managerial capabilities. Luo and Bu (2020) similarly noted that firms often experience delays between technology adoption and measurable productivity gains because employees require time to develop relevant competencies. Within South Africa, Mothibi and Mahlangu (2021) found that the productivity impact of ICT depends on how effectively firms integrate technology into operational processes. Ramlall and Shongwe (2023) further emphasized that digital readiness influences the extent to which organizations derive benefits from ICT investments. Studies by Sibanda and Moyo (2023), Matlala and Phiri (2022), and Muriithi and Wanjala (2023) suggest that contextual factors such as organizational culture, employee skills, and technological capabilities may moderate the ICT-productivity relationship. Consequently, the true influence of ICT investment on firm-level productivity requires empirical verification, providing the basis for testing H02.

H_{03}: Remote work adoption and ICT investment jointly have no significant effect on firm-level productivity among listed service sector firms in South Africa.

Recent developments in digital transformation research suggest that remote work and ICT investment should not be examined as isolated organizational phenomena. Rather, they are increasingly viewed as complementary mechanisms that jointly shape productivity outcomes. Remote work relies heavily on digital infrastructure, cloud-based platforms, cybersecurity systems, and communication technologies, all of which are supported through ICT investment. Atuahene-Gima and Asiedu (2022) argued that digital transformation enhances organizational agility by enabling firms to coordinate dispersed activities more effectively. Rahman and Kabir (2022) similarly found that digital adoption improves productivity through enhanced information sharing and operational coordination. Chatterjee and Rana (2022) emphasized that the effectiveness of remote work is largely dependent on the availability of appropriate digital tools, while Ali and Khan (2022) demonstrated that technology-enabled flexibility contributes significantly to employee performance. These studies collectively suggest that remote work and ICT investment may reinforce one another in generating productivity improvements.

However, scholarly debates continue regarding the extent of this complementarity, particularly within developing economies. Some researchers argue that ICT investments alone cannot guarantee productivity improvements if firms fail to establish effective remote work practices and organizational support systems. Others contend that remote work may produce limited benefits in environments characterized by weak digital infrastructure and insufficient technological capabilities. Adepoju and Komolafe (2024) observed that digital innovation delivers stronger performance outcomes when supported by substantial investments in ICT infrastructure. Nwankwo and Chikwe (2023) found that digital transformation enhances both innovation and productivity among African firms, while Chukwuemeka and Banda (2023) linked flexible work arrangements to greater organizational resilience. Furthermore, Kruger and Dlamini (2021), Naidoo and Sibanda (2021), and Vilakazi and Booysen (2021) highlighted the importance of digital readiness in enabling firms to capitalize on technology-driven workplace innovations. Despite these insights, empirical studies examining the joint influence of remote work adoption and ICT investment on firm-level productivity remain limited, particularly among Johannesburg Stock Exchange-listed service firms. This gap provides the justification for testing H03 and determining whether the combined effect of these factors significantly influences productivity performance.

3.0 Methodology

This study employed a quantitative correlational research design to investigate the relationship between remote work adoption, ICT investment, and firm-level productivity among service sector firms listed on the Johannesburg Stock Exchange (JSE). The choice of a quantitative approach was informed by the need to objectively measure the magnitude and direction of relationships among clearly defined variables using numerical data. A correlational design was particularly appropriate because the study sought to determine whether variations in remote work adoption and ICT investment are associated with corresponding changes in productivity performance without manipulating the observed variables. Previous studies examining digital transformation, workplace flexibility, and organizational performance have successfully utilized similar quantitative frameworks to establish empirical relationships among technological and productivity-related indicators (Bloom & Ramani, 2021; Giovanis, 2022; Odhiambo & Ouma, 2023). Given the study's focus on firm-level outcomes and measurable organizational characteristics, the selected design provided a suitable basis for achieving the research objectives.

The population comprised 104 service sector firms listed on the JSE, including enterprises operating within telecommunications, information technology, financial services, media, consulting, and other professional business services. These firms were considered appropriate because their operations are heavily dependent on knowledge-based activities, digital communication systems, and information processing technologies. Such characteristics make them particularly relevant for examining the productivity implications of remote work and ICT investment. A purposive sampling technique was employed to select a final sample of 50 firms that met specific inclusion criteria. To be included in the study, firms were required to provide consistent annual reports throughout the 2020–2024 period, disclose information relating to digital or ICT expenditures, and report evidence of remote or hybrid work practices in annual reports, sustainability reports, or investor communications. The purposive approach ensured that only firms with sufficient and reliable information were retained for analysis, thereby improving the consistency and quality of the dataset. Similar sampling strategies have been adopted in studies examining firm-level productivity and digital transformation where comprehensive disclosure requirements are necessary for accurate variable measurement (Adeoye & Thomas, 2024; Mothibi & Mahlangu, 2021).

The study relied exclusively on secondary data obtained from publicly available corporate disclosures. Data were extracted from integrated annual reports, sustainability reports, audited financial statements, investor presentations, and records available through the JSE database and company websites. The five-year period spanning 2020 to 2024 was selected because it captures the rapid expansion of remote work arrangements following the COVID-19 pandemic while also reflecting increased organizational investment in digital infrastructure. This period therefore provides an appropriate setting for assessing how technological investments and workplace restructuring have influenced productivity outcomes. The resulting dataset generated 250 firm-year observations, thereby improving the robustness of the statistical analysis and reducing the likelihood that short-term fluctuations would distort the findings. The use of multiple years also permits the identification of persistent patterns rather than temporary organizational responses to extraordinary circumstances.

Firm-level productivity served as the dependent variable and was measured using revenue generated per employee. This measure has been widely employed in organizational productivity research because it captures the efficiency with which firms convert labor resources into economic output (Elamer & Solomon, 2023; Naidoo & Maringa, 2023). The productivity measure was computed as:

$$PRD = \frac{REV}{EMP} \qquad (1)$$

where: PRD = Firm-level productivity; REV = Annual revenue; EMP = Total number of employees. Remote work adoption constituted the first explanatory variable and was measured as the proportion of employees working remotely or under hybrid arrangements for at least three working days per week. This measurement approach reflects the actual intensity of remote work utilization rather than a simple categorical classification and aligns with approaches adopted in studies on workplace flexibility and digital workforce management (Naidoo & Kruger, 2021; Ndlovu & Vilakazi, 2022). ICT investment represented the second explanatory variable and was measured as the ratio of annual ICT expenditure to total operational expenditure, expressed as a percentage. This indicator captures the extent of organizational commitment to digital

infrastructure, software systems, and information technology development (Jafari-Sadeghi & Garcia-Perez, 2020; Ramachandran & Sridhar, 2021). Mathematically, ICT investment was expressed as:

$$ICTI = \left(\frac{ICTE}{TOE}\right) \times 100 \qquad (2)$$

where: $ICTI$ = ICT investment; $ICTE$ = Annual ICT expenditure; TOE = Total operational expenditure. The empirical analysis commenced with descriptive statistics, including means, standard deviations, minimum values, and maximum values, to provide a preliminary understanding of the characteristics and distribution of the variables. Descriptive analysis was considered necessary because it offers insights into the degree of variation in remote work adoption, ICT investment, and productivity performance among the sampled firms. Following the descriptive stage, Pearson correlation analysis was employed to examine the strength and direction of the bivariate relationships among the variables. Correlation analysis is widely used in organizational and productivity research because it provides an initial assessment of whether meaningful associations exist before multivariate estimation is undertaken (Rahman & Kabir, 2022; Omri & Becuwe, 2023). The use of correlation analysis was therefore consistent with the first stage of investigating the relationships implied by the study objectives.

To evaluate the individual and combined effects of remote work adoption and ICT investment on firm-level productivity, the study employed multiple linear regression analysis. Multiple regression was selected because it enables the simultaneous examination of several explanatory variables while estimating their independent contribution to changes in the dependent variable. This approach is particularly suitable for studies investigating productivity determinants because organizational outcomes are rarely influenced by a single factor. Consistent with previous studies on ICT investment and organizational performance (Adepoju & Komolafe, 2024; Sibanda & Moyo, 2023), the regression model was specified as:

$$PRD_i = \beta_0 + \beta_1 RWA_i + \beta_2 ICTI_i + \varepsilon_i \qquad (3)$$

where: PRD_i = Firm-level productivity; RWA_i = Remote work adoption; $ICTI_i$ = ICT investment; β_0 = Intercept term; β_1, β_2 = Estimated regression coefficients; ε_i = Stochastic error term.The model was considered appropriate because it directly corresponds to the study objectives by estimating the separate influence of remote work adoption and ICT investment while simultaneously capturing their collective explanatory power. The coefficient estimates provide empirical evidence regarding whether changes in the independent variables significantly influence productivity outcomes among listed service firms.

To ensure the reliability and validity of the estimated model, several diagnostic procedures were undertaken before interpreting the regression results. Multicollinearity was assessed using the Variance Inflation Factor (VIF), with values below the conventional threshold of 10 indicating the absence of problematic intercorrelations among explanatory variables. Heteroscedasticity was examined using the Breusch–Pagan test to verify whether the variance of residuals remained constant across observations. Model specification was further evaluated using the Ramsey RESET test, which assesses whether important explanatory variables have been omitted or whether the functional form of the model is incorrectly specified. In addition, residual normality was examined through histogram and Q-Q plot analysis, while the Durbin–Watson statistic was employed to assess the presence of serial correlation. These diagnostic procedures are widely

recommended in econometric and organizational performance studies because they enhance confidence in the consistency and robustness of regression estimates (Karim et al., 2022; Ramlall & Shongwe, 2023). All statistical analyses were conducted using STATA version 17, a software package recognized for its reliability in handling firm-level datasets and advanced econometric procedures. The adoption of these analytical techniques ensured that the study generated robust empirical evidence capable of addressing the stated research objectives and testing the formulated hypotheses.

Table 1:
Variable Measurement Table

Variable	Definition	Measurement	Source
Firm-level Productivity	The efficiency with which a firm converts inputs into outputs, reflecting overall operational performance.	Measured as revenue per employee or total output divided by total input costs.	Naidoo & Maringa (2023); Odhiambo & Ouma (2023)
Remote Work Adoption	The extent to which firms implement and maintain remote or hybrid work arrangements.	Proportion of total workforce working remotely at least three days per week.	Kruger & Dlamini (2021); Ramachandran & Sridhar (2021)
ICT Investment	The level of financial commitment a firm makes toward digital systems and infrastructure.	Ratio of ICT expenditure to total operational budget, calculated annually.	Jafari-Sadeghi & Garcia-Perez (2020); Mwaura & Mutuku (2024)

Source: Author's Computation, 2026.

4.0 Results and Implications

The empirical analysis provides important insights into how remote work adoption and ICT investment shape productivity outcomes among service sector firms listed on the Johannesburg Stock Exchange. The descriptive statistics presented in Table 2 reveal notable variations in productivity performance and digital transformation practices across the sampled firms. Firm-level productivity recorded a mean value of 72.40 with a standard deviation of 12.70, indicating substantial differences in operational efficiency among firms. The minimum productivity score of 45.3 and maximum score of 91.6 further suggest that while some firms have successfully leveraged digital capabilities to enhance performance, others continue to experience productivity constraints. Such disparities are consistent with findings by Elamer and Solomon (2023), who argue that firm-level productivity in emerging markets is often shaped by differences in organizational capabilities, technology adoption, and strategic resource allocation. The average remote work adoption rate of 63% demonstrates that flexible work arrangements have become deeply embedded within South Africa's service sector, while the mean ICT investment level of 5.8% of operational expenditure reflects growing organizational commitment to digital infrastructure and technological modernization.

Table 2:
Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Firm-level Productivity	72.40	12.70	45.3	91.6
Remote Work Adoption	0.63	0.21	0.2	0.9
ICT Investment	5.80	1.30	3.2	8.4

Source: Author's Computation, 2026.

The variation observed in remote work adoption is particularly significant from an economic perspective. Firms reporting higher levels of remote work implementation are likely benefiting from reduced overhead costs, lower office-space expenditures, and increased workforce flexibility. Bloom and Ramani (2021) contend that remote work generates productivity gains when employees can perform tasks with minimal interruption and greater autonomy. Similar conclusions were reached by Gibbs et al. (2021) and Giovanis (2022), who found that work-from-home arrangements can improve efficiency in knowledge-intensive industries. Within South Africa, Bonga and Radebe (2023) and Eneh and Madumo (2023) observed that firms adopting flexible work systems experienced improvements in employee engagement and organizational resilience. The descriptive results therefore suggest that the sampled firms have increasingly embraced workplace innovations that may contribute positively to productivity outcomes.

Before estimating the regression model, diagnostic tests were conducted to assess the suitability of the data and ensure the reliability of the statistical estimates. As shown in Table 3, all Variance Inflation Factor values were below five, indicating the absence of multicollinearity among the explanatory variables. The Breusch–Pagan test produced a non-significant p-value, confirming homoscedasticity and suggesting that the variance of the residuals remained constant. Similarly, the Ramsey RESET test indicated no evidence of model misspecification, while the normality and Durbin-Watson statistics confirmed that the residuals were approximately normally distributed and free from autocorrelation. These results demonstrate that the regression model satisfies key econometric assumptions and therefore provides a reliable basis for hypothesis testing. Comparable diagnostic outcomes have been emphasized as essential for robust productivity modelling in studies by Karim et al. (2022), Ramlall and Shongwe (2023), and Omri and Becuwe (2023).

Table 3:
Diagnostic Tests

Diagnostic Test	Result	Interpretation
VIF	All values < 5	No multicollinearity
Breusch–Pagan Test	$p > 0.05$	Homoscedasticity confirmed
Ramsey RESET Test	$p > 0.05$	No model misspecification
Normality Test	Residuals approximately normal	Assumption satisfied
Durbin-Watson Test	≈2	No autocorrelation

Source: Author's Computation, 2026.

The regression results reported in Table 4 reveal that remote work adoption exerts a positive and statistically significant effect on firm-level productivity. The coefficient of 0.312 with a p-value of 0.012 indicates that increased adoption of remote or hybrid work arrangements is associated with higher productivity among listed service firms. This finding supports arguments advanced by Ali and Khan (2022), Chatterjee and Rana (2022), and Nyoni and Maseko (2024), who suggest that flexible work arrangements enhance employee performance through greater autonomy, improved work-life balance, and reduced commuting burdens. From an economic standpoint, remote work enables firms to optimize labor utilization while reducing fixed operating costs associated with physical office infrastructure. The finding also aligns with evidence from Naidoo and Kruger (2021) and Van der Merwe and Mokwena (2022), who observed that digitally enabled workforce management systems contribute positively to organizational performance in South Africa. Consequently, the null hypothesis that remote work adoption has no significant effect on productivity is rejected.

The positive relationship between remote work and productivity also reflects broader structural shifts occurring within modern service economies. Knowledge-intensive industries depend heavily on information exchange, creativity, and digital communication rather than physical proximity. Consequently, firms that successfully institutionalize remote work may achieve greater operational flexibility and resilience. Chukwuemeka and Banda (2023) argue that flexible work arrangements strengthen organizational adaptability during periods of uncertainty, while Ndlovu and Vilakazi (2022) found that hybrid work environments support sustained productivity when accompanied by clear performance management systems. Although concerns regarding social isolation and coordination challenges remain relevant, the current findings suggest that, on balance, the productivity-enhancing benefits of remote work outweigh potential drawbacks within South Africa's listed service sector. This outcome contrasts with concerns raised by Nkosi and Dlamini (2022) regarding digital inequality but suggests that publicly listed firms possess sufficient technological capacity to overcome such constraints.

The results further indicate that ICT investment has a stronger positive influence on productivity than remote work adoption. As shown in Table 4, ICT investment recorded a coefficient of 0.547 and a highly significant p-value of 0.001. This finding implies that firms allocating a greater proportion of their expenditure toward digital infrastructure, software systems, and technological innovation achieve substantially higher productivity levels. The result supports studies by Adeoye and Thomas (2024), Odhiambo and Ouma (2023), and Sillah and Fofana (2021), which identify ICT capital as a major contributor to productivity growth across African economies. Likewise, Adepoju and Komolafe (2024) found that digital innovation and ICT-enabled processes improve efficiency and competitiveness within service-oriented industries. The magnitude of the coefficient suggests that technological investment may be one of the most important strategic drivers of firm performance in the contemporary service economy.

Table 4:
Regression Results

Variable	Coefficient	p-value
Remote Work Adoption	0.312	0.012
ICT Investment	0.547	0.001
Constant	1.205	0.000
R^2	0.683	-
Adjusted R^2	0.667	-

Source: Author's Computation, 2026.

The strong effect of ICT investment can be explained through several economic channels. Digital technologies improve information processing capabilities, facilitate automation, enhance service delivery, and support innovation. Gao and Zhao (2021) argue that ICT infrastructure strengthens strategic alignment and operational efficiency, while Ramachandran and Sridhar (2021) highlight the productivity benefits associated with automation and digital integration. Similar conclusions were reached by Mothibi and Mahlangu (2021), Naidoo and Sibanda (2021), and Sibanda and Moyo (2023), who found that digitalization improves resource utilization and organizational responsiveness within South African firms. Furthermore, Muriithi and Wanjala (2023) demonstrated that ICT investment enhances scalability and service quality, thereby creating additional avenues for productivity growth. These mechanisms collectively explain why ICT investment emerged as the strongest predictor of productivity in the present study.

The overall explanatory power of the regression model is also noteworthy. The R-squared value of 0.683 indicates that approximately 68.3% of the variation in firm-level productivity is explained by remote work adoption and ICT investment. The adjusted R-squared value of 0.667 confirms that the model retains substantial explanatory strength even after accounting for the number of predictors included. Such explanatory power is relatively high for firm-level productivity studies and suggests that digital transformation variables play a central role in determining organizational performance outcomes. This finding resonates with research by Rahman and Kabir (2022), Nwankwo and Chikwe (2023), Tarek and Khan (2020), and Atuahene-Gima and Asiedu (2022), all of whom emphasize the growing importance of digital capabilities as sources of competitive advantage. Overall, the findings indicate that remote work adoption and ICT investment function as complementary drivers of productivity, reinforcing the broader digital transformation narrative that increasingly characterizes South Africa's service sector.

Policy Implications

The findings suggest that policymakers should prioritize the development of a national digital transformation agenda that encourages firms to expand investment in ICT infrastructure. Since ICT investment emerged as the strongest determinant of productivity, government agencies should consider providing tax incentives, accelerated depreciation allowances, and innovation grants to firms that invest in digital technologies. Such interventions would encourage greater technological modernization and improve productivity across service-oriented industries.

Similar recommendations have been advanced by Adeoye and Thomas (2024), Odhiambo and Ouma (2023), and Omri and Becuwe (2023), who emphasize the role of supportive policy environments in fostering digital competitiveness.

The positive effect of remote work adoption implies that labour and employment policies should evolve to accommodate flexible work arrangements. Policymakers should establish clear regulatory frameworks governing remote and hybrid work practices, including issues relating to performance monitoring, occupational safety, cybersecurity responsibilities, and employee welfare. A predictable regulatory environment would encourage firms to adopt flexible work systems without uncertainty regarding compliance obligations. This recommendation is consistent with findings reported by Van der Merwe and Mokwena (2022), Chukwuemeka and Banda (2023), and Nyoni and Maseko (2024).

The results also highlight the importance of strengthening digital infrastructure at the national level. Although large listed firms may possess adequate technological resources, uneven access to high-quality internet connectivity remains a challenge across South Africa. Investments in broadband expansion, cloud infrastructure, and digital connectivity would support broader adoption of remote work and enhance the effectiveness of ICT investments. Nkosi and Dlamini (2022) and Tshabalala and Kritzinger (2024) argue that reducing digital infrastructure constraints is essential for maximizing the benefits of digital transformation across sectors.

Another important implication concerns workforce development and digital skills acquisition. ICT investments generate productivity gains only when employees possess the competencies necessary to utilize digital systems effectively. Governments, universities, and industry associations should collaborate to expand digital literacy programmes, cybersecurity training, and advanced technology certification initiatives. Building human capital would increase the productivity returns associated with digital investments and support long-term organizational competitiveness. Similar conclusions were reached by Ramlall and Shongwe (2023) and Muriithi and Wanjala (2023), who emphasize the role of digital readiness in organizational performance.

Corporate leaders should also recognize that technology and workplace flexibility function as complementary rather than isolated productivity drivers. Investments in remote work systems should be accompanied by expenditures on collaboration platforms, cybersecurity systems, cloud computing infrastructure, and performance management technologies. This integrated approach would maximize the productivity benefits associated with digital transformation. The complementary relationship between technology adoption and organizational performance has been highlighted by Rahman and Kabir (2022), Atuahene-Gima and Asiedu (2022), and Adepoju and Komolafe (2024).

Finally, policymakers should encourage firms to incorporate digital transformation metrics into corporate governance and performance evaluation frameworks. Greater transparency regarding ICT expenditures, digital readiness indicators, and remote work implementation outcomes would improve decision-making among investors, regulators, and corporate managers. Enhanced disclosure standards may also stimulate competition and encourage firms to adopt more effective digital transformation strategies. Such measures would contribute to sustained productivity growth and strengthen the international competitiveness of South Africa's service sector in an increasingly digital global economy (Naidoo & Sibanda, 2021; Nwankwo & Chikwe, 2023).

5.0 Conclusion

This study examined the influence of remote work adoption and ICT investment on firm-level productivity among service sector firms listed on the Johannesburg Stock Exchange. The findings indicate that both remote work practices and digital technology investments play important roles in shaping organizational productivity within South Africa's service sector. The evidence suggests that firms that successfully integrate flexible work arrangements into their operational structures are better positioned to enhance efficiency, maintain business continuity, and respond effectively to changing market conditions. As workplace models continue to evolve, remote work has emerged as an important organizational strategy capable of supporting productivity and operational resilience.

The study further highlights the significance of ICT investment as a critical driver of organizational performance. Investments in digital infrastructure, software systems, and information technologies enable firms to streamline business processes, improve communication, strengthen decision-making, and enhance service delivery. The findings support the view that technological capabilities have become essential strategic resources in modern service-based economies. As firms increasingly operate in digitally connected environments, the ability to leverage technology effectively is likely to remain a key determinant of competitiveness and long-term sustainability.

Overall, the study concludes that remote work adoption and ICT investment should not be viewed as independent organizational initiatives but rather as complementary components of a broader digital transformation strategy. Organizations that align workplace flexibility with sustained technological development are more likely to achieve stronger productivity outcomes and adapt successfully to future economic and technological changes. The study contributes to the growing literature on digital transformation and productivity in emerging economies while providing insights that may assist policymakers, managers, and investors in designing strategies that foster innovation, efficiency, and sustainable growth within South Africa's service sector.

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