The Influence of Technologies on Organizational Culture in Innovative SMEs

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Abstract. This study examines the impact of digital technologies on organizational culture in innovative telecommunications SMEs. A survey across three companies was conducted, analyzing key performance indicators through ANOVA, multiple regression, and SEM. Results reveal significant positive correlations between technology adoption and productivity, work quality, decision-making speed, and employee satisfaction. The strongest effects were observed in productivity and employee satisfaction. While technology enhances performance, it necessitates substantial cultural shifts for full potential realization. This research contributes to understanding digital transformation in SMEs, emphasizing the importance of aligning technological advancements with organizational culture. It provides insights for managers on strategic technology integration, balancing efficiency gains with cultural adaptations. The study's limitations include its cross-sectional nature, suggesting future longitudinal research to capture long-term dynamics of technology-driven cultural change in SMEs.

Keywords: Digital Technology, Organizational Culture, Small and Medium-sized Enterprises (SMEs), Telecommunications, Key Performance Indicators (KPIs), Strategic Adaptation.

1 Introduction

1.1 Background and Relevance of the Theme

This study examines the impact of digital technology adoption on organizational culture in SMEs, focusing on how digital tools transform business models and internal dynamics. SMEs are leveraging technologies like cloud computing, AI, and big data analytics to alter their operations and strategies.

Recent statistics underscore the growing importance of digital technology adoption in SMEs. According to a 2023 report by the European Commission, 69% of EU SMEs have reached at least a basic level of digital intensity, up from 60% in 2020 [1]. In the telecommunications sector, 76% of SMEs are prioritizing investments in cloud

computing, while 62% are focusing on data analytics and artificial intelligence [2]. The COVID-19 pandemic has accelerated this trend, with 70% of SMEs reporting increased digitalization efforts since 2020 [3].

However, challenges persist as only 17% of EU SMEs are highly digitalized, compared to 54% of large enterprises [1]. In the UK, while 61% of SMEs view digital technologies as crucial for their future growth, 39% cite lack of skills as a significant barrier to adoption [4].

Schein [5] argues that technology is a primary mechanism shaping organizational culture. Bharadwaj [6] propose that digital technologies fundamentally alter business strategies and processes. Li et al. [7] highlight that digital transformation in SMEs involves holistic cultural change.

SMEs face unique challenges in adopting digital technologies, including resource constraints [8], flatter structures making changes more disruptive [9], limited bargaining power, difficulty attracting digital talent [7], and managing data and cybersecurity [10].

The study's relevance is underscored by growing literature on digital transformation in SMEs. Ghobakhloo et al. [11] emphasize SMEs' unique challenges due to resource constraints. Matarazzo et al. [12] argue that successful transformation depends on aligning technological changes with organizational culture. This study contributes to understanding the micro-foundations of digital transformation at the organizational level [13].

1.2 Objectives of the Study

This research examines how digital technology transforms SMEs, focusing on its impact on corporate culture and competitive advantage. We investigate how digital tools affect SMEs' operations and strategic orientations, measuring KPIs like employee happiness, productivity, decision-making speed, and work quality. Using quantitative approaches, we aim to improve understanding of strategic and cultural changes caused by digital technology in SMEs.

While research has explored digital technologies' impact on organizational culture in large enterprises [14] [15] a significant gap remains in understanding these dynamics in SMEs. We address this by examining SMEs' unique challenges and opportunities in integrating digital technologies and adapting their cultures. We focus on the relationship between technology adoption and KPIs in SMEs, an underexplored area, particularly in the telecommunications sector.

This study addresses key literature gaps: 1) Limited empirical studies on SMEs in technology-intensive sectors like telecommunications, despite abundant research on large enterprises [16]. 2) Underexplored interplay between technology adoption and organizational culture in SMEs, especially regarding quantifiable KPI impacts. 3) Overlooked challenges SMEs face in balancing technological innovation with cultural adaptation [7]. By addressing these gaps, we provide a comprehensive understanding of how digital technologies influence operational efficiencies and cultural dynamics in SMEs, contributing industry-specific insights to the digital transformation discourse [17].

2 Literature Review

Technology adoption significantly shapes SMEs' structural and cultural dynamics. The Technological Imperative suggests technology necessitates organizational changes, while the Social Construction of Technology (SCOT) model posits those existing values mediate technology's impact.

Digital technologies improve communication and collaboration, fostering dynamic and innovative cultures. They enhance operational efficiency, employee autonomy, and job satisfaction. However, new technology can disrupt routines and face resistance, requiring effective change management.

The Technological Imperative model [18] suggests digital technology adoption leads to organizational changes. We hypothesize that integrating cloud computing, AI, and big data analytics will positively impact productivity and decision-making speed in telecommunications SMEs.

The SCOT framework [19] emphasizes social context in shaping technological impact [20] [21]. We hypothesize that technology's effect on employee satisfaction and work quality may vary based on pre-existing cultural attributes.

Orlikowski's [22] dynamic interaction model suggests a reciprocal relationship between technology and organizational structures. We hypothesize that digital technologies' influence on organizational culture will be shaped by employee interpretation and engagement.

The Resource-Based View [20] helps understand how digital technologies confer competitive advantages. We hypothesize that SMEs effectively integrating digital technologies will demonstrate superior performance across KPIs.

The Theory of Reasoned Action [21] informs individual-level technology adoption. We posit that employees' attitudes towards digital technologies will significantly influence integration effectiveness and performance impact.

These frameworks provide a nuanced understanding of the interplay between digital technology adoption, organizational culture, and performance in telecommunications SMEs.

3 Methodology

3.1 Survey Technique

Our research employed a survey methodology to quantify the impact of digital technologies on organizational culture in telecommunications SMEs. This approach facilitates the collection of standardized data amenable to statistical analysis and generalization [23], crucial for our cross-sectional study of multiple SMEs.

The survey method offers cost-effective and time-efficient data collection [24], anonymity for candid feedback [25], and precise operationalization of key constructs [26] [27]. Our survey instrument assessed four key performance indicators (KPIs): productivity, quality of work, decision-making speed, and employee satisfaction,

chosen based on their prominence in organizational performance literature [28] [29] and relevance to technology adoption in SMEs [8].

The questionnaire structure (Table 1) demonstrates our comprehensive approach, with each KPI evaluated through ten questions using a 5-point Likert scale. This design enhances measurement reliability and validity [9], providing a nuanced picture of each construct.

Table 1. Questionnaire Structure and Sample Items.

KPI	Sample Items	Evaluation	Reference
Productivity	How often do you manage to complete your tasks within the time limit?	Assess the ability to handle multiple tasks simultaneously.	Adapted from Torkzadeh and Doll (1999)
Quality of Work	How often do your projects pass quality control on the first attempt?	Rate the overall quality of work against industry standards.	Adapted from Torkzadeh and Doll (1999)
Decision-Making Speed	How quickly can you make important decisions?	Rate how quickly someone can evaluate complex alternatives.	Inspired by Eisenhardt (1989)
Employee Satisfaction	How satisfied are you with your work-life balance?	Rate the level of satisfaction with the recognition received at work.	Adapted from Spector (1985)

Our survey design followed principles of comprehensiveness and relevance [25], incorporating both established scales and context-specific adaptations. This approach addresses significant research gaps, particularly concerning the unique challenges faced by SMEs in technology-intensive sectors.

To ensure robustness, we subjected the instrument to expert review and pilot testing. These steps were crucial in refining the questionnaire, ensuring its relevance to telecommunications SMEs, and validating its effectiveness in capturing the intended constructs.

This comprehensive approach enables us to address the significant research gaps identified in the literature, providing a solid foundation for exploring the unique challenges faced by SMEs in technology-intensive sectors, particularly in terms of how digital technology adoption influences and is influenced by organizational culture.

3.2 Dataset Description

The dataset comprises responses from 127 employees across three technology-focused SMEs in telecommunications and technical support. Table 2 summarizes key demographic and organizational characteristics, illustrating the diversity of our respondent pool.

Table 2. Demographic and Organizational Characteristics of the Sample.

Characteristic	Category	Frequency	Percentage
Age	*20-30*	28	22.05%
	31-40	39	30.71%
	41-50	35	27.56%
	51-60	22	17.32%
	61+	3	2.36%
Organizational Role	*Technical*	48	37.80%
	Managerial	35	27.56%
	Customer Support	29	22.83%
	Administration	15	11.81%
Years of Experience	*0-5*	31	24.41%
	6-10	42	33.07%
	11-15	29	22.83%
	16+	25	19.69%
Educational Background	*High School*	18	14.17%
	Bachelor's Degree	73	57.48%
	Master's Degree	32	25.20%
	Doctoral Degree	4	3.15%

This study employed 40 items to measure four key performance indicators (KPIs): Productivity, Quality of Work, Decision-Making Speed, and Employee Satisfaction. Each KPI comprised 10 items adapted from established scales: Torkzadeh and Doll [30] [31]for Productivity and Quality of Work, Eisenhardt [32] for Decision-Making Speed [33], and Spector's Job Satisfaction Survey [34] for Employee Satisfaction.

The items were tailored to reflect the unique characteristics of telecommunications SMEs and the impact of digital technologies. All items utilized a 5-point Likert scale, with some reverse-coded to mitigate response bias. To ensure cross-cultural equivalence, items were presented in both English and Italian, employing a rigorous translation and back-translation process.

The adaptation process involved expert review by three senior managers in the sector and pilot testing with 15 employees from a non-participant SME, ensuring clarity and relevance. This approach combined established measures with context-specific adaptations, grounding our items in established theory whilst ensuring relevance to our research context [33].

To assess the internal consistency reliability of our KPI measures, we calculated Cronbach's alpha for each scale. The results demonstrated excellent reliability: Productivity ($\alpha = 0.923$), Quality of Work ($\alpha = 0.919$), Decision-Making Speed ($\alpha = 0.914$), and Employee Satisfaction ($\alpha = 0.923$). These high alpha values indicate strong

internal consistency, suggesting that the items effectively measure their respective constructs in a coherent manner.

3.3 Methodological Approaches Used

We employed the CRISP-DM (Cross-Industry Standard Process for Data Mining) methodology for systematic data analysis across three SMEs, focusing on culture-related KPIs. This methodology was chosen for its structured approach to data mining projects, aligning well with our research objectives. The CRISP-DM process involves six phases: Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, and Deployment. In our study, we particularly emphasized the Data Understanding and Modeling phases.

Using Anaconda and Jupyter Notebook, we conducted both descriptive and inferential statistical analyses. Descriptive statistics, including measures of central tendency and dispersion, were used to examine data distributions and provide an overview of our sample characteristics. To address inter-organizational differences and test our hypotheses, we employed inferential statistics such as ANOVA for comparing means across groups, and multiple regression analysis to explore relationships between variables.

To ensure robustness of our findings, we also conducted non-parametric tests where appropriate, such as Kruskal-Wallis tests for non-normally distributed data. All statistical tests were performed with a significance level of $\alpha = 0.05$.

While our cross-sectional design precludes definitive causal inferences, the advanced statistical techniques employed in this study allow us to explore potential causal relationships within the limitations of our methodology. The Structural Equation Modeling (SEM) approach enables us to test hypothesized causal structures and examine direct and indirect effects among variables. However, we acknowledge that true causality can only be established through longitudinal or experimental designs. Our SEM results should therefore be interpreted as providing strong evidence of associations and potential causal pathways, rather than conclusive proof of causality. The multiple regression and factor analyze further support our understanding of the complex interrelationships between variables, offering insights into potential causal mechanisms. These methods, while not establishing causality, provide a robust foundation for future longitudinal studies to confirm the causal relationships suggested by our findings.

This comprehensive approach enabled us to assess technology's impact on organizational dynamics thoroughly, aligning with our study objectives and providing statistically rigorous answers to our research questions.

4 Results

4.1 Descriptive Data Analysis

The initial descriptive statistical analysis reveals insightful distributions across various KPIs (Table 3). Employee ages range from 23 to 63 years, indicating a diverse workforce. Productivity and quality of work scores exhibit broad ranges, highlighting performance variability.

Table 3. Initial Descriptive Statistical Analysis of the Dataset.

Statistic	Age	Productivity	Quality of Work	Decision Making Speed	Employee Satisfaction
Mean	41.75	29.65	29.82	31.04	30.78
Std	10.39	9.17	9.25	7.89	8.27
Min	23.00	10.00	10.00	10.00	10.00
25%	33.00	22.50	23.00	26.00	25.50
50%	41.00	29.00	30.00	30.00	30.00
75%	49.00	37.00	36.50	36.00	36.00
Max	63.00	50.00	50.00	50.00	50.00
Mode	32.00	20.00	28.00	28.00	30.00

"Decision Making Speed" and "Employee Satisfaction" approximate normal distributions, while "Productivity" and "Quality of Work" show more uniform distributions, suggesting varied influencing factors.

Figure 1 visualizes inter-company variability and central tendencies of KPIs. Productivity and Employee Satisfaction show less variability between quartiles, while Quality of Work and Productivity exhibit wider ranges. Outliers, particularly in Decision Making Speed, warrant further investigation.

This analysis underscores the diverse impacts of technological integration on organizational culture within SMEs. The varied age distribution allows examination of technology adoption across different generational cohorts. The variability in KPI scores aligns with our aim to understand how digital tools affect SMEs' operations and strategic orientations.

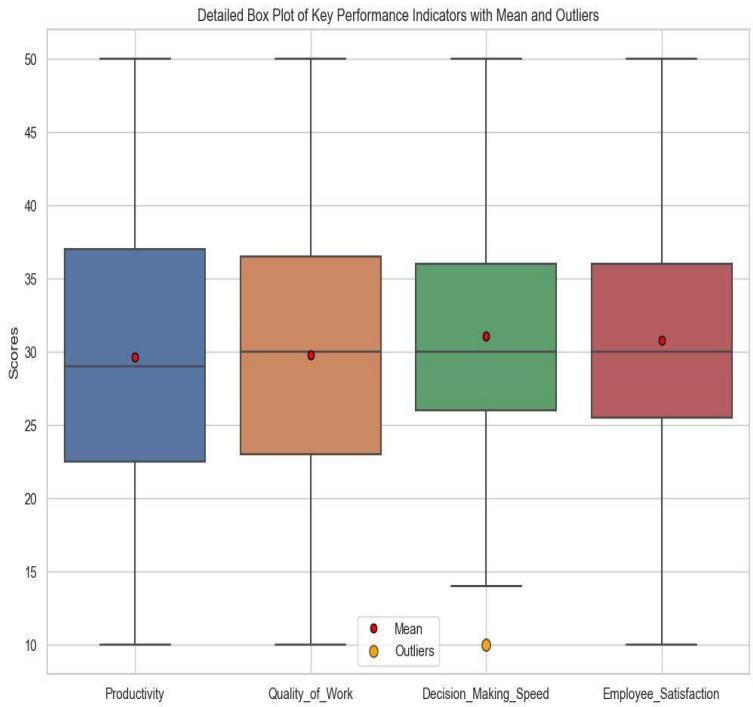

Fig. 1. Detailed Box Plot of Key Performance Indicators with Mean and Outliers.

These preliminary findings set the stage for our inferential analyses, testing our hypotheses regarding the relationship between technology adoption and organizational culture in telecommunications SMEs.

4.2 Correlations and Implications

The correlation analysis shows minimal age impact on KPIs like productivity, work quality, decision-making speed, and employee happiness, suggesting uniform technology adoption across age groups in SMEs. Productivity positively correlates with work quality, indicating technology enhances both efficiency and efficacy. Decision-making speed variably associates with productivity but not work quality, suggesting faster decisions may boost productivity without necessarily improving output quality. Employee satisfaction's independence from other KPIs implies it's influenced by factors beyond productivity or decision-making speed.

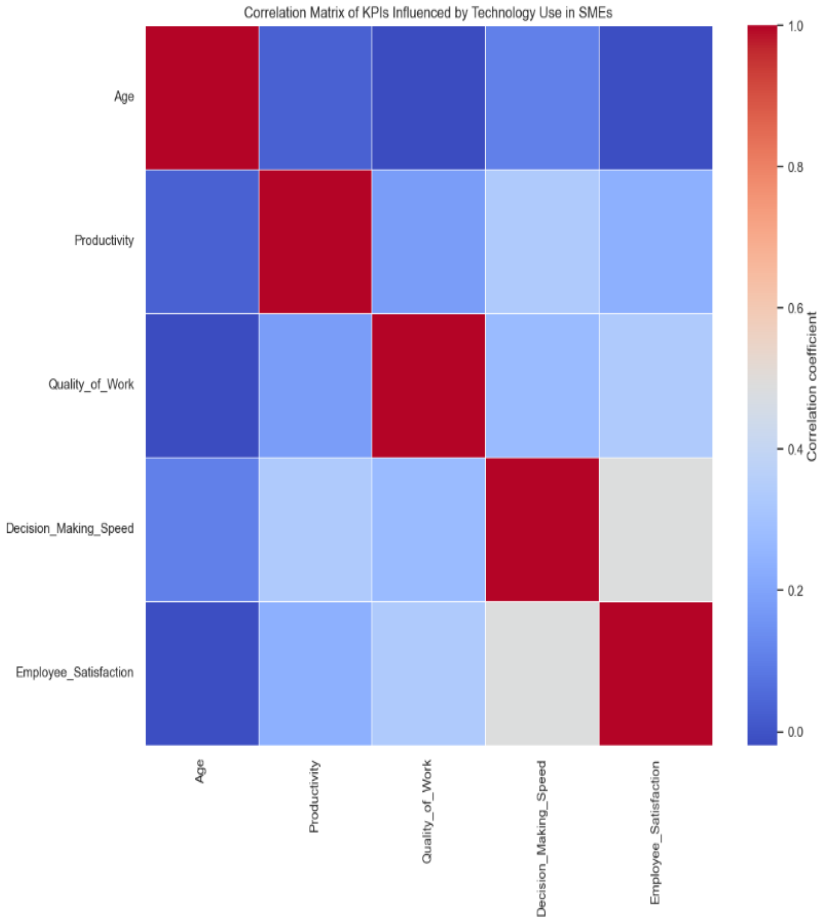

Fig. 2. Data Visualization of the Correlation Analysis Results.

These findings imply that, while technology integration has no negative impact on important aspects of corporate culture, the complexities of its benefits necessitate a strategic approach that aligns technology with human resource practices and organizational goals. This research highlights the need of considering a variety of aspects when evaluating the impact of technology on SMEs.

4.3 Inferential Statistical Analysis

To elucidate relationships between variables and test our hypotheses, we employed advanced inferential statistical techniques. These analyses provide a nuanced understanding of the interplay between employee characteristics, digital technology adoption, and performance metrics in SMEs within the telecommunications sector.

Multiple linear regression analysis examining the predictive power of age, education level, and company affiliation on key performance indicators (KPIs) yielded

disappointing results. None of the independent variables significantly predicted the KPIs ($p < 0.05$), with low R-squared values indicating minimal explanatory power.

Factor analysis of the KPIs identified four latent factors: (1) A general performance factor (negative loadings across all KPIs) (2) A productivity-quality trade-off (3) An efficiency-contentment dimension (4) An organizational agility aspect

These factors suggest complex underlying dimensions influencing KPI performance.

ANOVA and t-test results for education levels revealed no significant differences in KPIs between graduated and non-graduated individuals. However, possession of a scientific degree showed significant differences in quality of work ($F = 4.333$, $p = 0.039$; $t = -2.082$, $p = 0.039$) and a trend towards significance in decision-making speed ($F = 3.340$, $p = 0.070$; $t = -1.828$, $p = 0.070$).

Structural Equation Modeling (SEM) analysis was employed to provide comprehensive insights into the complex relationships between technology adoption, organizational culture, and KPIs. This statistical technique allows for the simultaneous examination of multiple interdependent relationships, making it particularly suitable for our multifaceted research model.

The SEM approach offers several advantages: testing theoretical models with multiple dependent variables, accounting for measurement error, and including latent variables. This is particularly relevant when examining abstract concepts such as organizational culture.

The SEM analysis was conducted using R Studio. We first assessed the measurement model to ensure construct validity, followed by the evaluation of the structural model to test our hypotheses.

The results of this comprehensive analysis are summarized in Table 4, which presents the standardized path coefficients, their significance levels, and the model fit indices.

Table 4. Summarized SEM Analysis Results.

KPI	Model	R^2	F-Statistic	P-value	Coefficients	Relev.
Productivity	TA + OC	0.402	41.69	1.42e-14	TA 0.429 | OC 0.390	Yes
Quality of Work	TA + OC	0.393	40.21	2.20e-14	TA 0.417 | OC 0.378	Yes
Decision Making Speed	TA + OC	0.379	37.80	3.57e-14	TA 0.403 | OC 0.365	Yes
Employee Satisfaction	TA + OC	0.418	44.60	1.07e-15	TA 0.437 | OC 0.401	Yes
Organizational Culture	TA	0.002	0.2654	0.607	TA 0.037	No

Legend: *TA = Technology Adoption, OC = Organizational Culture*

These findings underscore the need for integrated strategies combining technological advancements with cultural development to drive organizational success. By strengthening organizational culture, organizations can create an environment

conducive to effective adoption and utilization of new technologies, thereby maximizing their overall impact on key performance indicators.

5 Discussion

5.1 Interpretation of Results

This study examined the relationship between technology integration and organizational culture in SMEs, focusing on key performance indicators (KPIs). The findings align with both the Technological Imperative paradigm and the Social Construction of Technology (SCOT) hypothesis, demonstrating a bidirectional interaction between technology and corporate culture.

These results partially support the Technological Imperative model (Markus and Robey, 1988), showing positive impacts of technology on productivity and decision-making speed. However, the lack of significant demographic-KPI relationships challenges its deterministic view. The SCOT framework (Bijker et al., 1987) is supported by varied technology impacts on employee satisfaction and work quality, indicating the mediating role of existing cultural and social structures.

Orlikowski's [22] dynamic interaction model is reinforced by our findings, demonstrating a complex interplay between technology adoption and organizational culture. The absence of a direct significant relationship between technology adoption and organizational culture, coupled with significant impacts on various KPIs, suggests a reciprocal and nuanced interaction.

The Resource-Based View [20] is partially supported, as we observed some performance improvements associated with technology integration. However, modest effect sizes suggest that technology alone may not confer substantial competitive advantages.

These findings underscore the need for aligning technological solutions with organizational goals and management strategies that promote technology acceptance and cultural adaptation. Our research highlights the multifaceted implications of technology in workplace environments and emphasizes the importance of understanding both technological tools and organizational contexts for fostering innovation and adaptability in the digital era.

5.2 Comparison with Existing Literature

This study focuses on key performance indicators (KPIs) such as productivity, decision-making speed, job quality, and employee happiness. Our findings align with [35] [36] [37], supporting increased productivity in SMEs due to technology adoption. However, we found a complex relationship between technology deployment and employee happiness, challenging predictions [38] [39] and aligning with [40], which highlights the importance of organizational context and perception in technological deployments.

While [39] noted that many US SMEs use analytics tools primarily for marketing and sales purposes, our findings indicate variable benefits across different business

functions, particularly for strategic decisions. Our research extends these findings by showing that the impact of analytics on decision-making is not uniform across all areas of business operations.

These empirical findings support Orlikowski's [22] dynamic interaction model, emphasizing the need for contextual and deliberate technology integration in SMEs.

Limitations of our study include its cross-sectional design, focus on telecommunications SMEs, and reliance on self-reported measures. Future research should consider longitudinal designs, cross-sector studies, and triangulation of data sources. Additionally, exploring specific mechanisms of technology's effects, the role of leadership in technology-driven cultural change, and the impact of specific digital technologies (e.g., AI, blockchain, IoT) would further enrich our understanding of the technology-organizational culture relationship in SMEs.

6 Conclusions

6.1 Major Findings

This study illuminates the unique challenges faced by SMEs in the telecommunications sector when adopting digital technologies. These challenges, including resource constraints, limited technological capabilities, and the need for judicious investments, significantly influence technology adoption and its impact on organizational culture.

The findings both confirm and challenge the distinctions between SMEs and large enterprises outlined in the introduction. While SMEs benefit from greater flexibility in implementing new technologies, the impact of limited specialized expertise was more pronounced than anticipated, emphasizing the critical need for targeted skill development.

The study reveals a complex interplay between technology and culture in telecommunications SMEs. Digital technology adoption influences both operational efficiency and organizational culture, particularly affecting decision-making, employee satisfaction, and productivity. The sector's rapid technological progress amplifies this dynamic, necessitating an adaptive and innovative organizational culture.

Theoretically, our results align with [41] [42] [43], affirming technology's significant impact on organizational culture and behavior. They also support the Resource-Based View [20], suggesting that technological resources enhance organizational efficiency and competitive advantage.

Our findings validate the Change Management approach [41] [35], indicating the need for a structured method when introducing new technologies to minimize transitional challenges. While short-term disruptions may occur, long-term gains in productivity and decision-making capabilities are achievable through effective technology integration.

This research provides practical insights on leveraging technology to foster a dynamic corporate culture that enhances productivity and employee satisfaction in SMEs. Future studies should further explore the specific effects of technology across various SME sectors.

6.2 Practical and Theoretical Implications

Theoretically, our findings support [42] view of technology as a crucial influencer of organizational behavior and culture in SMEs [44]. The complex relationship between technology adoption and improved productivity, decision-making speed, and work quality aligns with the Resource-Based View [20], while also highlighting the nuanced nature of these benefits.

This research supports Orlikowski's [41] [22] dynamic interaction model, demonstrating the reciprocal relationship between technology and organizational culture. This challenges simplistic interpretations of technology's impact and emphasizes the need for context-specific technological solutions in SMEs [45].

Practically, our study suggests SME managers should consider integrating flexible work technologies, while being mindful of potential challenges. The varied impacts on employee satisfaction and work quality underscore the importance of aligning technological implementations with organizational goals and existing cultural structures.

Our findings support the Change Management theory (Kotter, 1996), advocating for a structured approach in implementing new technologies to mitigate transitional challenges. While short-term disruptions may occur, long-term benefits in productivity and decision-making capabilities are achievable through effective integration [46].

For organizational theorists, our research provides empirical evidence supporting theories that posit technology as a critical, yet complex, agent of organizational change. For practitioners, particularly SME managers in the telecommunications sector, our findings offer actionable insights on leveraging technology to cultivate a more dynamic and responsive organizational culture, enhancing both operational efficiency and employee satisfaction [47].

These insights not only validate and extend existing theories but also suggest areas for future research, particularly in exploring the differential impacts of specific technologies across various SME sectors and the mechanisms through which these effects occur. Such studies could further delineate the contexts in which technology integration is most beneficial, guiding both theoretical exploration and practical implementation in the rapidly evolving landscape of SMEs.

6.3 Limitations of the Study and Future Perspectives

While this study provides valuable insights, it's important to acknowledge its limitations and outline directions for future research.

Our cross-sectional methodology limits our capacity to examine long-term effects or draw causal conclusions. Future research should employ longitudinal designs to capture the dynamic interplay between technology integration and cultural shifts over time, providing a deeper understanding of causal relationships.

Our focus on telecommunications SMEs in a specific region may limit generalizability. Further studies should extend this research to diverse sectors and geographical contexts, enabling cross-industry comparisons and identification of sector-specific versus universal patterns in technology-driven cultural change [44] [45].

Reliance on self-reported measures may introduce common method bias. Future research could triangulate data sources, incorporating objective performance metrics and qualitative insights from in-depth interviews or case studies.

While we examined the impact of technology adoption on various KPIs, we did not delve deeply into the specific mechanisms through which these effects occur. Future research could explore these mediating processes, perhaps employing structural equation modeling to unpack the complex relationships between technology adoption, organizational culture, and performance outcomes [47].

Additionally, future studies could:

- Examine the role of leadership in facilitating technology-driven cultural change [46]
- Investigate the impact of specific types of digital technologies (e.g., AI, blockchain, IoT) on organizational culture
- Explore how the COVID-19 pandemic has accelerated digital transformation and cultural shifts in SMEs
- Investigate the role of organizational learning capacities in mediating the relationship between technology adoption and cultural transformation

By addressing these limitations and exploring these new directions, future research can build on our findings to further enrich our understanding of the intricate relationship between technology and organizational culture in the rapidly evolving landscape of SMEs.

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Disclosure of Interests. The authors declare that they have professional interests in the SME and telecommunications sectors, and professional connections to the companies that provided data for this study. However, to protect individual privacy and comply with GDPR, we do not disclose specific company names or individual identities. These associations did not inappropriately influence the design, conduct, or reporting of this research. The authors have taken all necessary precautions to ensure the anonymity of the data and to prevent any potential conflicts of interest from affecting the integrity of this study.

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