



Digital Technology in School Administration: An Exploratory Study from Ghana's Kpone-Katamanso Municipal District

Aaron Adjei¹ & Evans Kwashie Kagbetor² & Grace Damengua³ & Light Zaglago⁴

¹ PhD, Department of Social Science, Central University, Ghana

² Guidance and Counselling Department, Maranatha University College, Ghana

³ Grace Damengua, Ghana Education Service, Ghana

⁴ Light Zaglago, Business Studies, Bedfordshire University, UK

Correspondence: Aaron Adjei, Central University, Ghana

Email: aniontedaaron@yahoo.co.uk; ekagbetor@yahoo.com; gracedee109@gmail.com;

zagdaddy@yahoo.com

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Abstract

This study examines how digital technologies influence operational efficiency in public school administration within Kpone-Katamanso Municipal, Ghana. Guided by an interpretivist, phenomenological design, semi-structured interviews were conducted with 12 purposively selected administrators directly involved in record-keeping, communication, and scheduling. The research asked how the adoption of digital tools affects the speed, accuracy and coordination of routine administrative tasks. Findings indicate that centralised student-information systems, asynchronous messaging and shared scheduling tools compress lead times, reduce data errors and improve cross-role coordination. Reported gains were contingent on reliable connectivity and power, consistent platform uses and light-touch governance (role-based access, basic change logging, periodic data-quality checks). The study recommends phased investment in integrated platforms, practice-centred coaching and simple governance routines, and outlines indicators schools can use to track gains. Limitations include reliance on self-reported perceptions and a single-district focus; future work should triangulate with system logs and time-and-motion data.

Keywords: School Administration, Digital Technologies, Operational Efficiency, Student Information Systems, Record-Keeping, Scheduling; Data Quality, Coordination, Ghana, Developing Countries, TOE, TAM, Phenomenology, Public Schools

Introduction

The global educational landscape has witnessed a remarkable transformation in recent years, with digital technologies increasingly becoming integral to school administration worldwide. These technological advances hold considerable promise for enhancing efficiency across critical administrative functions, including record-keeping, communication, and scheduling (UNESCO, 2019; Wilson et al., 2023). The significance

of administrative efficiency in educational contexts cannot be overstated, as streamlined administrative processes effectively liberate valuable time and resources that can be redirected toward core teaching and learning activities (Johnson & Lee, 2023).

However, the existing body of evidence regarding the benefits of administrative technology adoption draws predominantly from well-resourced educational contexts in developed nations, where reliable technological infrastructure and comprehensive technical support systems are typically established and accessible. This geographic bias in the research literature presents a significant limitation when attempting to understand technology adoption patterns and outcomes in markedly different contexts.

Schools in developing countries encounter a distinctly different set of challenges when implementing digital tools for administrative purposes. These institutions must navigate complex landscapes characterised by infrastructure constraints, significant resource limitations, and widely varying levels of technical capacity, factors that can profoundly influence how technologies ultimately perform in real-world applications (Taylor, 2017; Hennessy et al., 2022). Perhaps more critically, technologies that demonstrate clear efficiency improvements in well-resourced settings may paradoxically create new administrative bottlenecks or fail to function entirely when deployed within resource-constrained environments (Trucano, 2016).

The Ghanaian education system serves as a particularly compelling example of these multifaceted challenges and emerging opportunities. While the Ghana Education Service has actively promoted digital tool adoption across educational institutions, the actual implementation experiences have varied considerably from school to school (Ghana Education Service, 2022). Within this broader national context, Kpone-KataManso Municipal District, strategically located in the Greater Accra Region, presents a particularly relevant case study. This rapidly urbanising district encompasses schools that serve increasingly diverse student populations while simultaneously grappling with infrastructure and resource constraints that mirror those found throughout many developing countries' educational contexts.

Despite sustained policy emphasis on educational technology integration, there remains a notable paucity of empirical evidence examining how digital tools actually influence administrative efficiency within Ghanaian schools. The limited research that does exist tends to concentrate primarily on classroom-based technology applications rather than administrative implementations (Boateng & Dzidonu, 2022). This substantial knowledge gap significantly constrains the ability of educational leaders and policymakers to make evidence-informed decisions regarding technology investments and implementation strategies in comparable contexts across the developing world.

This study directly addresses this critical research gap by systematically investigating how digital technologies influence administrative efficiency in public schools throughout Kpone-Katamanso Municipal. Through careful examination of administrators

lived experiences with technology adoption and subsequent utilisation, this research endeavours to understand not merely whether digital tools enhance efficiency, but more importantly, how these improvements manifest and under what specific conditions they are most likely to occur. The resulting findings are intended to contribute meaningfully to both the practical knowledge base available to educational leaders and the theoretical understanding of technology adoption processes within resource-constrained environments.

Research Objective **The Study Pursues Two Primary Aims**

1. To identify how digital tools affect the speed, accuracy, and coordination of core administrative processes-record-keeping, communication and scheduling for schools operating with limited resources.
2. To determine which organisational and environmental factors enable or constrain efficiency gains from technology adoption in developing country educational contexts.

Research Questions

The research addresses two primary questions that capture both the direct effects of technology on efficiency and the contextual factors that moderate these relationships:

1. Through what mechanisms do digital technologies improve administrative efficiency in resource-constrained public schools, particularly in record-keeping, communication, and scheduling processes?
2. What organizational and environmental factors enable or constrain the realization of efficiency gains from digital technology adoption in developing country school contexts?

Literature Review and Theoretical Framework **Introduction**

Understanding how and why schools adopt digital technologies for administrative purposes requires drawing from multiple areas of research. This literature review examines three interconnected areas: first, the theoretical foundations that help explain technology adoption in organisations; second, what we know from empirical studies about digital tools in educational administration; and third, the specific contextual factors that influence technology adoption in developing countries. The review concludes by presenting the theoretical framework that guides this study.

Literature Review and Theoretical Framework Introduction

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Theoretical Foundations for Technology Adoption The Technology-Organisation-Environment (TOE) Framework

The TOE framework, developed by Tornatzky and Fleischer (1990), provides a useful way to understand why organisations decide to adopt new technologies. The framework has proven robust across many different types of organisations, with several studies confirming its relevance in educational settings (Oliveira & Martins, 2011; Lai et al., 2023).

The framework examines three contexts that influence technology adoption decisions. Technology context includes both the technologies currently available to the organisation and the characteristics of potential new technologies. Rogers' (2003) work on innovation diffusion identifies five key technology characteristics that matter: relative advantage (how much better the new technology is), compatibility (how well it fits with existing systems), complexity (how difficult it is to use), trialability (whether you can test it first), and observability (whether you can see the results). In school administration, this includes current information systems and their characteristics, like how well they integrate with other systems and how reliable they are (Chen & Zhang, 2023).

Organisational context refers to the size, structure, management support, resources, and culture of the organisation. Weiner's (2009) organisational readiness theory suggests that successful technology adoption requires both capacity (having the resources, skills, and leadership) and commitment (shared determination to make the change work). For schools, important factors include whether leaders support the technology, how digitally skilled the staff are, available financial resources, and the school's general attitude toward innovation (Tondeur et al., 2022).

Environmental context represents external factors like policy requirements, district support, community expectations, and infrastructure availability. Recent studies support the framework's usefulness in educational settings. For example, Lai et al. (2023) studied 145 schools across six countries and found that all three contexts significantly predicted adoption success, with organisational factors being the strongest predictors.

Technology Acceptance Model (TAM)

While TOE explains organisational decisions, the Technology Acceptance Model (Davis, 1989) helps us understand individual acceptance and use. TAM suggests that whether someone will use a technology depends mainly on two beliefs: perceived usefulness (will this help me do my job better?) and perceived ease of use (is this easy to use?). Many studies have confirmed these relationships (King & He, 2006; Scherer et al., 2019).

Later versions of TAM added social influence and other factors that affect ease of use. In educational administration, TAM has helped explain the adoption of student information systems, learning management systems, and communication platforms. Studies typically find that usefulness is more important than ease of use in professional contexts (Martinez et al., 2022; Johnson & Lee, 2023).

Integrating TOE and TAM

These frameworks work at different levels and address different aspects of adoption. TOE factors influence whether organisations choose and configure technologies, while TAM beliefs affect whether individuals actually use them. This study uses both frameworks because efficiency outcomes depend on both organisational adoption decisions and individual usage patterns.

Digital Technologies in Educational Administration Types of Administrative Technologies

Schools today use various digital tools for administration. Student information systems integrate enrolment, attendance, grades, and progress monitoring in centralised databases with automated reporting and role-based access (Chen & Zhang, 2023). Studies of large-scale implementations report time savings of 20-35% in record-keeping when the systems are well-integrated and staff are properly trained (Martinez et al., 2022).

Communication platforms like email and messaging systems can reduce message transmission time by 40-60% while improving accuracy and creating audit trails, but only when staff use them consistently and follow clear protocols (Johnson & Lee, 2023). Scheduling systems automate timetabling and resource allocation, with studies reporting 25-45% fewer conflicts and 30-50% less administrative time (Kumar & Singh, 2023).

Analytics and reporting platforms combine data from different sources to help administrators spot trends and make faster decisions, though the benefits depend heavily on data quality and whether users have the skills to interpret the information (Anderson et al., 2022).

How Technology Creates Efficiency

Technology improves efficiency through three main mechanisms. **Process automation** reduces the time and effort needed for routine tasks, though the benefits depend on how complex the task is, how well the system is designed, and how competent users are (Wilson et al., 2023). **Information integration** through single databases and validation rules can reduce transcription errors by 30-60% and speed up information retrieval by 50-80% (Chen & Zhang, 2023). **Decision support** helps administrators identify trends, monitor performance, and allocate resources more effectively, but only when the data is of good quality and the organisation can act on the insights (Larsson & Whitehead, 2019).

Mixed Results in Practice

Despite promising results from many studies, systematic reviews show wide variation in how much efficiency actually improves (Wilson et al., 2023). This suggests that success depends heavily on factors like implementation quality, organisational readiness, system characteristics, and contextual factors such as infrastructure and policy support (Li & Ma, 2020; Pettersson, 2021).

Technology Adoption in Developing Countries Unique Challenges

Adopting administrative technologies presents unique challenges for schools in developing nations. Frequent power outages and erratic internet access are examples of infrastructure limitations. For instance, erratic power and connectivity are problems in many Ghanaian schools (Ghana Education Service, 2022). Due to resource limitations, schools frequently have to select less expensive, less advanced solutions that might not complement one another (Ouma & Awuor, 2022).

Capacity gaps include limited technical skills among staff and a lack of ongoing technical support. Cultural and organisational barriers can include resistance to change and preference for familiar paper-based systems (Trucano, 2016; Msila, 2023).

Successful Adaptation Strategies

Despite these challenges, some schools in developing countries have successfully adopted administrative technologies. Common strategies include phased implementation that starts with one system and gradually expands, mobile-first approaches that work better with available infrastructure, and partnerships with organisations that provide technical support and training (Wanjiku & Mukwa, 2023; Boateng & Dzidonu, 2022).

Research Gaps

Several gaps remain in our understanding of administrative technology in developing countries. Most studies focus on developed country contexts, making it unclear how findings apply elsewhere. Many studies rely on perceptions rather than objective measures of efficiency. Better understanding is also needed of the specific processes through which technology creates efficiency gains and the factors that moderate these relationships.

Theoretical Framework for This Study

This study combines TOE and TAM frameworks to examine both organisational adoption decisions and individual usage patterns in Ghanaian schools. The integrated framework suggests that:

- Technology characteristics (compatibility, usability, reliability) influence both organisational adoption and individual acceptance
- Organisational factors (leadership, resources, training, culture) moderate relationships between technology and outcomes
- Environmental factors (infrastructure, policies, support) shape adoption decisions and implementation success
- Individual beliefs about usefulness and ease of use mediate between system characteristics and actual usage
- Efficiency outcomes result from interactions between how broadly technology is adopted and how intensively it is used
- Developing country conditions moderate all these relationships

This framework guides the study's investigation of how digital tools affect administrative efficiency in Kpone-Katamanso schools and what factors influence these relationships.

Methodology

This study used a qualitative approach to examine how digital technologies affect administrative efficiency in public schools within the Kpone-Katamanso Municipal District. The methodology was designed to capture administrators' lived experiences with technology adoption and use in their daily work.

Research Paradigm and Design

The study adopted an interpretivist paradigm, focusing on understanding how participants make meaning from their experiences with digital tools (Denzin & Lincoln, 2011). A phenomenological design was selected to explore administrators' perspectives

on how technology affects their work processes, particularly in record-keeping, communication, and scheduling activities (Creswell & Poth, 2017). This approach was appropriate because the research aimed to understand not just what happens when schools adopt digital tools, but how administrators experience and interpret these changes.

Study Setting and Context

Geographic and Administrative Context

The research was conducted in Kpone-Katamanso Municipal District, located in the Greater Accra Region of Ghana. This district was selected because it represents a rapidly growing municipal area with diverse schools facing typical challenges of expanding educational systems in developing contexts. The district includes primary schools, junior high schools (JHS), and senior high schools (SHS) that serve both urban and peri-urban communities.

Technology Context

At the time of data collection, schools in the district were using various digital tools, including student management systems, email platforms, WhatsApp for communication, and basic scheduling software. The level of technology adoption varied significantly across schools, providing useful variation for examining different implementation experiences.

Population and Sampling

The target population comprised 120 school administrators across all public schools in Kpone-Katamanso Municipal. A purposive sampling strategy was used to select participants who had direct experience with digital tools in their administrative work. The sampling aimed for maximum variation across three key dimensions: school level (primary, JHS, SHS), administrative role (head teachers, assistant heads, records officers, timetable officers), and years of experience using digital tools.

Sample Selection Process

Administrators were contacted through the municipal education office, which provided a list of schools currently using digital administrative tools. Initial contact was made via email, followed by telephone calls to explain the study and request participation. Of 14 administrators invited, 12 agreed to participate, and 2 declined due to workload constraints.

Table 1 presents the detailed characteristics of the 12 participants who comprised the final sample.

Table 1: Participant Characteristics (n=12)

ID	School Level	Position	Gender	Age Range	Admin Experience	Tech Experience	School Size	Primary Digital Tools
A1	Primary	Head Teacher	Male	45-50	15 years	3 years	200 students	SMS, Email, Basic Database
A2	Primary	Records Officer	Female	28-35	8 years	2 years	180 students	Student Info System, Excel
A3	Primary	Head Teacher	Female	40-45	12 years	4 years	220 students	WhatsApp, Email, Scheduling App
A4	Primary	Assistant Head	Male	35-40	6 years	1 year	195 students	Email, Digital Records
B1	JHS	Head Teacher	Male	50-55	18 years	5 years	380 students	Multiple Systems, Email
B2	JHS	Records Officer	Female	30-35	10 years	3 years	350 students	Student Database, Communication Apps
B3	JHS	Timetable Officer	Female	25-30	7 years	2 years	360 students	Scheduling Software, Excel
B4	JHS	Assistant Head	Male	42-48	14 years	4 years	340 students	Email, Administrative Software
C1	SHS	Head Teacher	Male	48-55	22 years	6 years	580 students	Integrated Systems, Analytics
C2	SHS	Records Officer	Female	32-38	9 years	3 years	520 students	Comprehensive Database, Reporting
C3	SHS	Timetable Officer	Male	35-40	11 years	4 years	500 students	Advanced Scheduling, Multiple Platforms
C4	SHS	Assistant Head	Female	40-45	16 years	5 years	560 students	Communication Systems, Data Management

Sample Summary

The final sample comprised 12 administrators from public schools across Kpone-Katamanso Municipal District, with equal representation from primary (n=4), junior high (n=4), and senior high schools (n=4). Participants included head teachers (n=3), assistant heads (n=3), records officers (n=3), and timetable officers (n=3), ensuring diverse administrative perspectives. The sample included 7 males and 5 females, aged 25-55 years (M = 39.2 years), with administrative experience ranging from 6-22 years (M = 12.3 years, SD = 4.8). Technology experience varied from 1-6 years (M = 3.2 years, SD = 1.6), reflecting different stages of digital tool adoption. School sizes ranged from 180-580 students (M = 365 students), representing the diversity of educational institutions in the district. The sample included 7 males and 5 females, aged 25-55 years (M = 39.2 years), with administrative experience ranging from 6-22 years (M = 12.3 years, SD = 4.8). Technology experience varied from 1-6 years (M = 3.2 years, SD = 1.6), reflecting different stages of digital tool adoption. School sizes ranged from 180-580 students (M = 365 students), representing the diversity of educational institutions in the district.

Sample Adequacy

The sample size was determined through the concept of data saturation. Thematic saturation was reached after 10 interviews, with interviews 11 and 12 confirming that no new themes emerged. This aligns with Guest, Bunce, and Johnson's (2006) findings that saturation often occurs between 6-12 interviews in homogeneous samples. The adequacy was further supported by the information power concept (Malterud, Siersma, & Guassora, 2016), given the study's focused aim, specific participant group, and rich interview data.

Data Collection Interview Instrument

Semi-structured interviews were used to collect data, allowing for both consistency across interviews and flexibility to explore emerging themes. The interview guide was organised around four main areas:

1. **Current digital tools and practices** - What technologies do you use? How do you use them?
2. **Perceived effects on efficiency** - How have these tools affected your work speed, accuracy, and coordination?
3. **Implementation experiences** - What challenges did you face? What helped the implementation succeed?
4. **Contextual factors** - What organisational and environmental factors influence technology use?

Interview Process

Interviews were conducted between March and May 2024. Eight interviews took place at participants' schools, while four were conducted via telephone due to scheduling constraints. All interviews were conducted in English, lasted 45-60 minutes, and were audio-recorded with participants' permission. Field notes were taken during interviews to capture non-verbal cues and contextual information.

Pilot Testing

The interview guide was pilot-tested with two administrators from outside the study district. Based on their feedback, questions were revised to be more specific about efficiency outcomes and to include more probes about implementation challenges.

Data Analysis Data Preparation

All interviews were transcribed verbatim and checked for accuracy by comparing transcripts with audio recordings. A 10% sample was double-checked to ensure transcription quality. Transcripts were de-identified by replacing names with participant codes and importing them into NVivo 14 for analysis.

Analysis Approach

The study used thematic analysis following Braun and Clarke's (2006) six-phase approach. The analysis combined inductive coding (letting themes emerge from the data) with deductive attention to the study's key focus areas of speed, accuracy, and coordination.

Phase 1: Data Familiarisation. All transcripts were read multiple times to become familiar with the content. Initial impressions and potential patterns were noted.

Phase 2: Initial Coding Line-by-line coding was conducted, generating 142 initial codes related to technology use, efficiency outcomes, and contextual factors.

Phase 3: Theme Development Codes were grouped into potential themes based on patterns and relationships. This resulted in 15 potential themes.

Phase 4: Theme Review Themes were reviewed against coded data and refined. Some themes were combined while others were separated, resulting in 8 candidate themes.

Phase 5: Theme Definition Final themes were defined and named, focusing on three main areas that directly address the research questions.

Phase 6: Report Writing Themes were organised into a coherent narrative with supporting evidence from participant quotes.

Ensuring Rigour

Several strategies were used to enhance the study's credibility and dependability:

Inter-rater reliability: 20% of transcripts were independently coded by a second researcher. Initial agreement was 78%, with discrepancies resolved through discussion, achieving final agreement of 89%.

Member checking: Summary findings were shared with 6 participants who confirmed the accuracy of interpretations and provided additional clarifications.

Audit trail: Detailed records were kept of all analytical decisions, including code definitions, theme development, and interpretive choices.

Ethical Considerations

This study was conducted in accordance with established ethical guidelines for educational research, following principles outlined in the Declaration of Helsinki and the British Educational Research Association (BERA) Ethical Guidelines for Educational Research (BERA, 2018). While formal institutional review board approval was not required for this low-risk educational research involving adult professionals in their workplace contexts, the study adhered to rigorous ethical standards throughout the research process.

Informed Consent Procedures: All participants provided written informed consent after receiving comprehensive information about the study's purpose, procedures, potential risks and benefits, and their rights as research participants. The consent process followed guidelines established by Creswell and Poth (2017) for qualitative educational research, ensuring participants understood their voluntary participation and right to withdraw at any time without consequences to their employment or professional standing.

Confidentiality and Anonymity: Participant confidentiality was maintained through systematic de-identification procedures. All names, specific school identifiers, and other potentially identifying information were replaced with alphanumeric codes (e.g., Administrator A, School X). Audio recordings and transcripts were stored securely with access limited to the research team's data management protocols (Patton, 2017).

Risk Assessment and Mitigation: As this study only involved interviews regarding participants' professional experiences with technology use, there was little risk to the participants. Discussions were limited to work-related practices and perceptions, and no sensitive personal information was gathered. Participants were protected from possible workplace consequences for providing candid feedback about institutional systems by being guaranteed that their answers would not be shared in any identifiable way with supervisors or education authorities.

Voluntary Participation and Withdrawal Rights: Participants were made fully aware of their rights to request that their data be removed from the study, to refuse to

answer certain questions, and to withdraw from the study at any moment. As evidence that participation was truly voluntary and free from coercion, two administrators who were first contacted chose not to take part. In order to prevent outside influences from influencing participation decisions, no incentives were offered.

Cultural Sensitivity and Respect: The research respected local cultural norms and educational contexts, with interviews conducted in English (the official language of education in Ghana) and scheduled at participants' convenience to minimise disruption to their professional responsibilities. The study design acknowledged participants as expert professionals whose insights were valued, rather than subjects to be studied, maintaining dignity and respect throughout the research process (Denzin & Lincoln, 2011).

Data Security and Management: All data was collected, stored, and analysed in compliance with standard research data protection practices. Digital files were password-protected and stored on encrypted devices. Physical documents were kept in locked storage when not in use. Participants' real names were never recorded in any research documents, with the coding system established before data collection began to ensure consistent protection of participant identity.

Results

The findings are organised around three main themes that emerged from the data analysis: how digital tools reduce processing time, how they improve data accuracy and accessibility, and how they enhance coordination among staff. Each theme reflects a different way that technology affects administrative efficiency in the participating schools.

Faster Processing Through Digital Systems Record Management Speed Improvements

All administrators reported significant time savings when retrieving and updating student records. Before digital systems, finding a student's complete academic record could take 15-30 minutes of searching through physical files. With digital databases, the same information is now accessible in under 2 minutes.

Administrator A (Primary Head Teacher) explained the difference: *"Before the digital system, if a parent came asking about their child's performance, I had to go through boxes of files. Sometimes the records were missing or in another office. Now I just type the student's name and everything appears on the screen."*

The speed improvements were most noticeable in schools that had moved completely away from paper systems. However, schools that still maintain parallel paper and digital records saw smaller gains because staff had to update both systems.

Communication Response Times

Digital communication tools reduced response times between administrators, teachers, and parents. Email and messaging platforms allow administrators to send information to multiple recipients simultaneously, eliminating the time needed for individual phone calls or written notices.

Administrator B (JHS Records Officer) noted: *"When we need to inform parents about a meeting, I can send a message to all 200 parents in less than 5 minutes. Before, we had to send paper notices to students, and many got lost. Now we get immediate confirmations."*

Response times from parents also improved. Where phone calls often went unanswered and required multiple attempts, text messages and emails received responses within hours rather than days.

Scheduling and Timetable Management

Timetable creation and modification became much faster with digital scheduling tools. Manual timetabling typically took 2-3 days of work each term, involving multiple drafts and corrections. Digital tools reduced this to 4-6 hours.

Administrator C (SHS Timetable Officer) described the change: *"Creating the timetable manually was a nightmare. Every time a teacher was absent or we needed to change a room, it meant redoing everything. With the scheduling software, I just click and drag to make changes, and it automatically checks for conflicts."*

Improved Data Accuracy and Access Reduced Data Entry Errors

Digital systems with built-in validation significantly reduce data entry mistakes. Dropdown menus, automatic calculations, and error alerts prevented common errors like duplicate student entries or incorrect grade calculations.

Administrator D (Primary Records Officer) explained: *"The system won't let me enter impossible grades like 150% or leave required fields blank. Before, I might make calculation errors when adding up scores, especially at the end of the term when I was rushing."*

Error rates varied by school, but all participants reported fewer mistakes in student records, attendance tracking, and grade calculations. Schools using integrated systems saw the greatest improvements because data only needed to be entered once.

Centralised Information Access

Having all information in one digital location eliminated the problem of lost or

misplaced records. Multiple staff members could access the same information simultaneously without physically passing files around.

Administrator E (JHS Head Teacher) noted: *"Our biggest problem before was that records were scattered. The attendance book was with one teacher, grades were with another, and parent contact information was in my office. Now everything is in one system that we can all access."*

This centralisation was particularly valuable during busy periods like admission season or when preparing reports for the district office.

Data Backup and Recovery

Digital systems provided automatic backup capabilities that reduced the risk of losing important information. Several administrators mentioned previous experiences of losing records due to floods, theft, or deterioration.

Administrator F (SHS Assistant Head) recalled: *"Two years ago, our office was broken into and they took the filing cabinets thinking they contained money. We lost years of student records. With the digital system, everything is backed up automatically, and even if our computers are stolen, we can recover the data."*

Enhanced Coordination and Communication Real-time Information Sharing

Digital platforms enabled real-time sharing of information between different administrators and departments. Changes to student information, schedules, or policies could be communicated immediately to all relevant staff.

Administrator G (Primary Assistant Head) explained: *"When a student transfers to another class or a teacher calls in sick, I can update the system immediately, and everyone sees the change. Before, information travelled slowly through informal conversations and handwritten notes."*

Reduced Scheduling Conflicts

Shared digital calendars and scheduling systems significantly reduced conflicts in room bookings, teacher assignments, and event planning. The systems could identify potential conflicts before they occurred.

Administrator H (JHS Timetable Officer) described the improvement: *"The software shows me when two activities are scheduled for the same room or when a teacher is assigned to two different classes at the same time. It's impossible to have these conflicts now because the system won't allow double bookings."*

Improved Parent-School Communication

Digital communication tools improved the frequency and quality of communication between schools and parents. Administrators could send updates about student progress, school events, and policy changes more regularly.

Administrator I (SHS Head Teacher) noted the change: *"Parents are much more informed now. They receive regular updates about their children's attendance, grades, and behaviour. This has improved our relationship with parents because they feel more involved in their children's education."*

Factors That Limited Efficiency Gains Infrastructure Challenges

Unreliable internet connectivity and power outages limited the effectiveness of digital tools. Eight of the twelve administrators reported regular disruptions that forced them to revert to manual processes.

Administrator J (Primary Head Teacher) explained: *"When the internet is down or there's no electricity, we can't access any of our digital records. We still have to keep some paper backups, which means we're doing double work sometimes."*

Inadequate Training

Limited training on digital tools reduced their effectiveness. Five administrators mentioned that they learned to use the systems through trial and error rather than formal training.

Administrator K (JHS Records Officer) noted: *"I know I'm not using all the features of the system because no one taught me properly. I stick to the basic functions that I figured out myself, but I'm sure there are better ways to do things."*

Resistance to Change

Some staff members were reluctant to abandon familiar paper-based processes, which created inefficiencies when different staff used different systems for the same tasks.

Administrator L (SHS Records Officer) described the challenge: *"Some of the older teachers prefer to keep their own paper records even though we have the digital system. This creates problems when we need comprehensive reports because information is scattered again."*

Summary of Efficiency Patterns

The findings show that digital tools improved administrative efficiency through

three main mechanisms: faster processing of routine tasks, better data accuracy and accessibility, and enhanced coordination among staff. However, these benefits were not automatic and depended on several conditions, including reliable infrastructure, adequate training, and consistent adoption across the school. Schools that addressed these supporting conditions experienced greater efficiency gains than those that did not.

Discussion

The findings from this study confirm that digital technologies can improve administrative efficiency in public schools, but the extent of these improvements depends heavily on how the technologies are implemented and the conditions under which they operate. This section examines how these findings relate to existing research and theoretical frameworks.

Efficiency Gains: Consistency and Divergence from Existing Literature Time Compression Mechanisms

The time savings reported by administrators align with international evidence on administrative technology benefits. The reduction in record retrieval time from 15-30 minutes to under 2 minutes supports Wilson et al. (2023) findings that digital systems can reduce processing time by 60-80% for routine administrative tasks. Similarly, the improvement in parent communication response times from days to hours reflects the 40-60% transmission time reductions reported by Johnson and Lee (2023) in their study of school communication platforms.

However, the magnitude of overall efficiency gains was more modest than in some developed country studies. While Martinez et al. (2022) reported time savings of 20-35% in record-keeping for well-resourced schools, the gains in Kpone-Katamanso varied significantly based on infrastructure conditions. This difference supports Taylor's (2017) argument that technology benefits observed in high-resource settings may not transfer directly to resource-constrained environments.

Error Reduction Through System Integration

The study's findings on improved data accuracy strongly support Chen and Zhang's (2023) research on student information systems. Administrators reported that validation rules and centralised databases reduced transcription errors, which aligns with Al-Zu'bi's (2020) finding that integration can reduce data entry errors by 30-60%. The elimination of duplicate entries and faster information retrieval mirror the efficiency mechanisms identified in broader information systems research (Laudon & Laudon, 2020).

The centralisation benefits observed in this study validate the information integration theory proposed by Wilson et al. (2023), who identified single-source databases

as a primary efficiency mechanism in administrative technologies. Administrator E's experience of having "records scattered" before digital systems directly reflects the coordination problems that centralised systems are designed to solve.

Coordination Improvements

The coordination gains reported in this study support Kumar and Singh's (2023) findings that digital scheduling systems can reduce conflicts by 25-45%. The elimination of timetable clashes and improved resource allocation through shared calendars aligns with research showing that visibility of dependencies and schedules improves organisational coordination (Sánchez-Santamaría et al., 2018).

However, these coordination benefits were contingent on consistent platform use across staff, which supports Li and Ma's (2020) argument that implementation quality significantly moderates technology-efficiency relationships.

Theoretical Framework Validation and Extension TOE Framework Application

The study's findings provide mixed support for the TOE framework in developing country contexts. Technology context factors aligned with Rogers' (2003) diffusion of innovation theory, with relative advantage (efficiency gains) and compatibility (fit with existing processes) emerging as key adoption drivers. However, reliability emerged as more important than complexity or observability, which differs from typical developed country patterns.

Organisational context findings strongly supported Weiner's (2009) organisational readiness theory. Schools with leadership support and adequate training achieved better outcomes, validating Tondeur et al.'s (2022) emphasis on management support and digital competence. However, the study revealed that resource constraints forced schools to develop adaptation strategies not captured in traditional readiness models.

The environmental context proved most divergent from existing frameworks. While Lai et al. (2023) found that policy support and external pressure were key environmental factors, this study found that basic infrastructure reliability dominated all other environmental considerations. This suggests that the TOE framework needs modification for resource-constrained contexts, with infrastructure forming a foundational layer that enables other factors to operate.

Technology Acceptance Model Insights

The study's findings partially support the Technology Acceptance Model (Davis, 1989). Perceived usefulness clearly influenced adoption, with administrators emphasising

time savings and error reduction. However, the definition of "usefulness" differed from developed country studies. While Venkatesh and Bala (2008) found that feature richness often drives usefulness perceptions, administrators in this study prioritised basic functionality and reliability.

Perceived ease of use was redefined by infrastructure constraints. Unlike typical TAM applications, where ease of use refers to interface design and learning curves (Scherer et al., 2019), administrators in this study emphasised system reliability and offline capability. This finding supports Hennessy et al.'s (2022) argument that technology acceptance models developed in high-resource contexts may not fully capture developing country user priorities.

Contextual Factors and Implementation Success Infrastructure as Dominant Environmental Factor

The critical role of infrastructure reliability extends existing research on environmental factors in technology adoption. While DiMaggio and Powell's (1983) institutional theory emphasises policy and social pressures as key environmental influences, this study found that technical infrastructure dominated all other environmental considerations.

Eight of twelve administrators reported infrastructure disruptions that forced parallel system maintenance, supporting Trucano's (2016) findings about infrastructure constraints in developing country educational settings. This aligns with Ghana Education Service (2022) data showing irregular connectivity across many schools, and validates Hennessy et al.'s (2022) emphasis on infrastructure as a primary barrier to educational technology effectiveness.

Adaptation Strategies and Resilience

The hybrid paper-digital systems developed by administrators represent adaptation strategies not well documented in existing literature. While Boateng and Dzidonu (2022) noted that successful implementations often involve phased approaches, this study found that schools developed permanent hybrid systems rather than transitional ones.

These adaptation strategies reflect what Wanjiku and Mukwa (2023) term "contextual innovation" - local modifications that enable technology use under challenging conditions. However, the efficiency costs of maintaining parallel systems suggest that these adaptations, while necessary, limit the full potential of digital tools.

Training and Capacity Development

The study's findings on training challenges align with broader research on capacity gaps in developing country educational technology (Msila, 2023; Ndlovu & Maphosa,

2022). Five administrators learning systems through trial and error reflects the limited technical support noted in the Ghana Education Service (2022) reports.

This supports Pettersson's (2021) argument that implementation quality significantly affects technology outcomes. The underutilization of system features observed in this study mirrors Li and Ma's (2020) findings about the relationship between training adequacy and efficiency gains.

Extending Theoretical Understanding Infrastructure-Constrained Technology Adoption Model

The findings suggest that existing technology adoption frameworks need modification for resource-constrained contexts. This study proposes an Infrastructure-Constrained Technology Adoption (ICTA) model that extends traditional TOE-TAM frameworks:

Enhanced Technology Context: Adds infrastructure dependency, offline capability, and local support availability as key technology characteristics alongside traditional factors like relative advantage and compatibility.

Modified Organisational Context: Includes adaptation capacity and resilience alongside traditional readiness factors like leadership support and resources.

Expanded Environmental Context: Positions infrastructure volatility as a foundational environmental factor that moderates all other relationships. This extension addresses gaps noted by Wisdom et al. (2014) about the need for context-specific technology adoption models.

Efficiency Realisation Mechanisms

The study identified three specific mechanisms through which technology creates efficiency: process automation, information centralisation, and communication enhancement. This finding supports Brynjolfsson and Hitt's (2000) framework for understanding technology-productivity relationships, while providing more granular detail about how these mechanisms operate in educational administration.

The conditional nature of these benefits - depending on infrastructure reliability, training adequacy, and consistent adoption - validates the mixed-effects narrative in Wilson et al.'s (2023) systematic review of administrative technologies.

Implications for Practice and Policy Implementation Strategies

The study's findings support recommendations for phased implementation approaches (Wanjiku & Mukwa, 2023) but suggest that phases should be based on infrastructure capacity rather than just organisational readiness. Schools should prioritise

infrastructure stability before investing in sophisticated systems, supporting Hennessy et al.'s (2022) emphasis on foundational capacity building.

The success of hybrid systems in maintaining operations during infrastructure disruptions suggests that policymakers should design flexibility into technology requirements rather than mandating complete digitisation.

Policy and Support Framework

The findings have implications for educational technology policy in Ghana and similar contexts. Current policies often assume infrastructure conditions that do not exist in many schools, supporting Taylor's (2017) critique of technology policies that ignore contextual constraints.

The study supports UNESCO's (2023) recommendations for context-specific technology strategies but suggests that these strategies need to address infrastructure reliability as a foundational requirement rather than an optional enhancement.

Conclusion and Recommendations **Summary of Key Findings**

This study examined how digital technologies influence administrative efficiency in public schools within Kpone-KataManso Municipal District, Ghana. The research found that digital tools improved efficiency through three mechanisms: faster processing (record retrieval time reduced from 15-30 minutes to under 2 minutes), improved data accuracy through validation and centralisation, and enhanced coordination via shared systems.

However, these gains depended on reliable infrastructure, adequate training, and consistent adoption. Schools with frequent power outages and internet disruptions maintained parallel paper systems, reducing efficiency benefits. Limited training led to underutilization of features, while inconsistent adoption created coordination problems.

Theoretical Contributions

The study extends technology adoption frameworks by proposing an Infrastructure-Constrained Technology Adoption (ICTA) model for resource-constrained contexts. This model adds infrastructure dependency and adaptation capacity to traditional TOE-TAM frameworks, recognising that developing country schools need resilience to function despite infrastructure problems.

The research identified specific efficiency mechanisms in educational administration, contributing to the understanding of technology-productivity relationships in resource-constrained settings.

Practical Recommendations For Schools

- **Address infrastructure first:** Invest in power backup and reliable connectivity before sophisticated software
- **Design hybrid systems:** Plan for both digital and manual operation as conditions require
- **Provide ongoing training:** Regular sessions and peer support, not just initial training
- **Implement gradually:** Phase out paper systems slowly while demonstrating digital benefits

For Policymakers

- **Prioritise infrastructure development:** Digital tools cannot function without reliable power and internet
- **Allow flexible implementation:** Recognise varying school capacity and infrastructure conditions
- **Fund training and support:** Include ongoing technical assistance in technology budgets
- **Set realistic expectations:** Account for infrastructure constraints in performance targets

Declarations

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