

# From Manual to Smart: Diagnosing Operational Inefficiencies in a Smart Parking Firm Transitioning to AI and Cloud Technologies

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**DOI Link:** <http://dx.doi.org/10.6007/IJARBS/v16-i6/28448>

**Published Date:** 19 June 2026

## Abstract

Rapid urbanization and surging vehicle ownership in Chinese cities have intensified pressure on conventional parking infrastructure, leading to chronic congestion, inefficiency, and environmental harm. While smart parking technologies, anchored in the Internet of Things (IoT), cloud computing, and artificial intelligence (AI), offer compelling solutions, the organizational and operational conditions required for successful adoption remain poorly understood. This paper presents the diagnostic phase of an action research study conducted at Shenzhen Ai Ke Technology, a company actively transitioning from traditional parking facility installation to AI- and cloud-enabled smart parking services. Through semi-structured interviews with ten members of top management, supplemented by fishbone diagram analysis, root cause analysis, and a prioritization matrix, the study identifies the principal barriers impeding this transition. Findings reveal that outdated infrastructure and continued reliance on manual processes constitute the most critical root causes of operational inefficiency, ranked ahead of secondary challenges, including high initial investment costs, workforce skill gaps, regulatory complexity, and limited market acceptance. Grounded in the Resource-Based View (RBV) and Change Management theory, the study proposes a sequenced intervention strategy in which cloud computing integration precedes AI deployment, establishing a reliable, centralized data foundation before higher-order intelligence functions are layered on. This sequencing not only reflects sound technical logic but also constitutes a manageable organizational change pathway for small and medium enterprises (SMEs). The study contributes an evidence-based diagnostic framework and a theoretically grounded roadmap for firms navigating the organizational challenges of smart parking transformation within China's rapidly evolving smart city ecosystem.

**Keywords:** Smart Parking, Digital Transformation, Action Research, Cloud Computing, Artificial Intelligence, Operational Efficiency, Smart Cities, China.

**Introduction**

Rapid urbanization has intensified pressure on existing transportation infrastructure, necessitating a transition to digitized, data-driven management frameworks to mitigate chronic traffic congestion and environmental degradation (Panda et al., 2024; Sharma et al., 2023). Nowhere is this more evident than in China, where unprecedented growth in private vehicle ownership has created a range of urban challenges. The number of registered vehicles in China is projected to reach 360 million by 2025, further exacerbating traffic congestion, limited parking availability, and rising environmental pollution. In major urban centers such as Shenzhen, these problems are compounded by high population density and ambitious smart city development agendas. Parking, in particular, has emerged as a critical urban pain point: studies indicate that up to 30 percent of urban congestion is attributable to drivers searching for parking, leading to wasted time, increased fuel consumption, and significant environmental costs (Rawat, 2023; Knights et al., 2024). The rising vehicle-to-infrastructure demand has rendered traditional manual parking management systems increasingly insufficient, causing significant fuel waste and localized emissions (Bagade et al., 2026; L et al., 2025).

Within this context, smart parking systems have been positioned as an essential building block of smart city transformation. These systems employ technologies such as the Internet of Things (IoT), cloud computing, and artificial intelligence (AI) to optimize the use of existing parking infrastructure (Amirah, 2024; Smart Parking System Using Artificial Intelligence and IoT, 2026). By enabling real-time monitoring of space occupancy, predictive analytics for demand forecasting, and seamless payment and reservation systems, smart parking offers a pathway to reducing congestion, improving air quality, and enhancing urban mobility. These technological frameworks leverage cloud-edge computing and machine learning algorithms to facilitate predictive space availability, thereby optimizing urban land use and improving overall traffic flow (Bangalore, 2025; Singh, 2025). Evidence from global implementations indicates that integrating cloud platforms and AI-driven analytics into parking management systems can yield improvements of 20 to 25 percent in parking space utilization alongside measurable reductions in congestion and greenhouse gas emissions. Furthermore, the integration of Mobility-as-a-Service platforms and shared mobility models complements these innovations by reducing dependence on private vehicles and promoting more efficient urban resource utilization (Syamala et al., 2023).

Despite the technological promise, the practical implementation of smart parking systems remains fraught with challenges. Integrating advanced systems with legacy infrastructure often requires substantial capital investment. The absence of standardized technical protocols impedes interoperability across platforms, and user acceptance is frequently constrained by concerns related to data privacy, cybersecurity, and trust in automated technologies (Ke et al., 2020; Lin et al., 2017). Moreover, organizational factors, including workforce skill gaps and managerial readiness, play a decisive role in determining whether firms can successfully transition from traditional systems to digital platforms (Al-Haimi, B, et al. 2024). This suggests that the transformation toward smart parking is not solely a technological challenge but also a deeply organizational and strategic one.

This study focuses on Shenzhen Ai Ke Technology, a firm with registered capital of RMB 17 million that initially concentrated on the sale and installation of conventional parking

facilities. As Shenzhen has advanced its smart city agenda, the company has sought to reposition itself as a provider of digital, technology-driven smart parking solutions. However, the transition has exposed significant internal inefficiencies: despite a clear strategic vision, the company continues to rely heavily on manual processes and outdated infrastructure, which hinder both scalability and service effectiveness. These issues not only undermine operational efficiency but also limit the firm's capacity to capitalize on the opportunities presented by AI- and cloud-enabled smart parking ecosystems.

To better understand these organizational challenges, the diagnostic phase of this research employed an action research approach. Action research is particularly well-suited for practice-based inquiries seeking to both diagnose problems and implement solutions in collaboration with stakeholders. During this phase, semi-structured interviews were conducted with ten members of top management at Ai Ke Technology, encompassing sales, operations, digital management, and after-sales service functions. The interviews revealed several recurring operational issues: heavy reliance on manual processes, outdated and incompatible infrastructure, substantial financial burdens associated with infrastructure upgrades, limited technical expertise within the workforce, market hesitance regarding smart parking adoption, and uncertainty arising from evolving regulatory policies in Shenzhen.

Interview data were analyzed using a suite of diagnostic tools, including a fishbone (Ishikawa) diagram to categorize root causes, a root cause analysis table to evaluate their significance, and a prioritization matrix to rank issues based on impact and frequency. Findings consistently highlighted outdated infrastructure and manual processes as the most critical barriers directly generating operational inefficiencies. Other factors, cost, skill gaps, regulatory complexity, and market hesitance, were identified as secondary. These results confirm that unless reliance on outdated infrastructure and manual operations is systematically addressed, Ai Ke Technology will remain unable to achieve its strategic objectives.

Building on these diagnostic insights, the study proposes a sequenced intervention strategy in which cloud computing is introduced first, followed by AI integration. Cloud computing provides the necessary backbone for centralized, real-time data management and system interoperability, reducing dependence on fragmented manual reporting (Shankar et al., 2024; Kumari, 2025). Once this digital foundation is established, AI applications can be integrated to deliver predictive analytics, real-time monitoring, and intelligent decision-making such as demand forecasting and space optimization (Ficili et al., 2025). This sequencing is both practically logical, since AI depends on high-quality centralized data, and theoretically grounded. From a Resource-Based View (RBV) perspective, cloud and AI technologies represent strategic resources capable of delivering sustainable competitive advantage when effectively integrated. From a Change Management perspective, implementing cloud computing first constitutes a manageable organizational shift that reduces resistance and lays the groundwork for a smoother transition to AI-enabled automation.

The contributions of this study are twofold. At the practical level, it offers actionable, evidence-based insights for firms in the smart parking industry navigating the transition from traditional to digital systems, providing a sequenced roadmap adaptable to comparable organizational contexts. At the theoretical level, it extends existing research on smart parking

by integrating organizational and strategic perspectives, specifically RBV and Change Management theories, into a domain traditionally dominated by technology-centric analyses. This research thereby contributes to the broader discourse on digital transformation in smart cities, illuminating not only the technological requirements but also the organizational and strategic processes essential for successful implementation.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature on smart parking, digital transformation, and the theoretical frameworks underpinning this study. Section 3 describes the action research methodology and diagnostic tools employed during the first phase of the research. Section 4 presents the findings of the diagnostic phase, including the root cause analysis and prioritization of challenges. Section 5 discusses the implications of these findings for theory and practice, with particular attention to the sequencing of cloud and AI integration. Section 6 concludes with reflections on the study's contributions and outlines the next steps of the action research project.

## **Literature Review**

### *Smart Parking and Urban Mobility Challenges*

The rapid surge in urban population and vehicle ownership has overwhelmed conventional infrastructure, resulting in persistent search-time delays, increased carbon footprints, and severe traffic congestion (Rawat, 2023; Knights et al., 2024). These urban mobility challenges are exacerbated by the slow pace of traditional planning frameworks, which fail to keep pace with the exponential rise in vehicle density (Abdul-Rahaim et al., 2024). In dense urban centers such as Shenzhen, insufficient parking contributes significantly to congestion, with research indicating that up to one-third of urban traffic is generated by drivers circulating in search of available spaces. Conventional parking systems, often reliant on manual processes and fragmented infrastructure, lack the agility and efficiency needed to address these demands.

In response, advanced management systems utilizing IoT-based sensor networks and predictive analytics have emerged as critical interventions to optimize space allocation and minimize the environmental impact of circling vehicles (Baikani et al., 2025; Cahyadi et al., 2023). Smart parking systems leverage digital technologies, including IoT, cloud computing, and AI, to enable real-time monitoring of parking availability, demand forecasting, and automated payment systems. These AI-driven models move beyond simple monitoring by employing predictive analytics to forecast demand, significantly reducing the time drivers spend searching for available spaces and improving overall traffic flow efficiency (Kumar et al., 2026; Sundaramoorthy et al., 2023). Additionally, the implementation of residential parking-sharing networks leverages geofencing and real-time slot booking to transform underutilized private spaces into accessible urban assets (Hariharasudhan et al., 2025). Global evidence demonstrates that such systems can improve parking utilization rates, reduce congestion, and enhance user satisfaction, outcomes that align with the broader sustainability objectives of smart cities.

### *Barriers to Smart Parking Adoption*

Despite the technical advantages of IoT-integrated frameworks, widespread adoption is often hampered by high upfront capital expenditures on sensing infrastructure and a lack of standardization across municipal digital platforms (Dawale et al., 2025). Moreover, concerns

regarding data privacy, cybersecurity risks inherent in interconnected urban devices, and the complex integration of legacy infrastructure with modern cyber-physical systems often discourage stakeholders from full-scale deployment (Ke et al., 2020). Beyond these fiscal and technical hurdles, municipal authorities must navigate the intricate, transdisciplinary nature of smart city ecosystems, where fragmented policy-making often delays the evaluation of viable cross-jurisdictional solutions (Lin et al., 2017). The lack of interoperability between proprietary software and existing public infrastructure further limits the scalability of these solutions, creating functional silos that impede comprehensive urban data sharing (Elkhalidi et al., 2024; G., 2025).

At the organizational level, many firms struggle with workforce skill gaps, as employees may lack the technical expertise required to manage digital platforms or maintain AI-enabled systems. Externally, cities like Shenzhen are actively updating smart-city and urban-planning policies, but frequent changes create ambiguity for firms seeking long-term strategic alignment. Similarly, consumer trust and awareness of smart parking remain limited, leading to hesitancy in adoption despite demonstrable benefits. These barriers collectively illustrate that digital transformation in parking is not solely a technological shift but also a socio-technical and organizational challenge.

#### *Cloud Computing in Digital Transformation*

Cloud computing provides the foundational architecture necessary to aggregate and process the massive datasets generated by urban IoT sensors, serving as a centralized hub for executing complex artificial intelligence operations (Shankar et al., 2024). Cloud environments utilize fog and edge computing models to perform localized data processing, effectively mitigating latency issues caused by the physical distance between peripheral devices and centralized servers (Kumari, 2025). This paradigm facilitates remote monitoring and system control, enabling operators to organize and analyze parking status data from any geographical location (Sanghvi, 2024). By enabling a shared cloud platform, these systems allow multiple parking service providers to advertise and allocate vacant lots, effectively transforming individual properties into a unified urban inventory (Atif et al., 2016).

However, the transition to cloud-centric models necessitates the adoption of robust, open-standard frameworks to ensure secure data exchange and interoperability between disparate service providers (Hashem et al., 2016). The Smart City Operational Platform Ecology model addresses these complexities by integrating machine learning and cognitive correlates to ensure a balanced ecosystem capable of sustainable operations across heterogeneous cloud environments (Abbas et al., 2023). Beyond technical infrastructure, these platforms must overcome organizational fragmentation, wherein diverse urban entities independently develop solutions without a unified framework for data integration (Recupero et al., 2016). Decentralized edge architectures help to alleviate bandwidth saturation and latency, which remain significant obstacles when scaling real-time IoT networks in densely populated urban centers (Gill et al., 2019; Τρίγκας & Δρίτσας, 2025). Critically, cloud computing serves as a prerequisite for effective AI deployment, since AI applications require high-quality, centralized, and real-time data streams to function effectively.

### *Artificial Intelligence and Smart Operations*

By shifting from passive monitoring to predictive intelligence, AI-enabled systems allow for proactive resource management through real-time decision-making and predictive analytics (Ficili et al., 2025). Advanced machine learning models interpret vast, heterogeneous datasets to forecast traffic congestion and proactively identify operational inefficiencies, facilitating dynamic adjustments to infrastructure management. These algorithms further optimize urban mobility by analyzing flow patterns to suggest real-time modifications that significantly reduce vehicular congestion (Folorunsho et al., 2024; Jagatheesaperumal et al., 2024). AI applications in smart parking include predictive analytics for demand forecasting, optimization algorithms for space allocation, and dynamic pricing strategies. By automating error-prone manual tasks, AI reduces operational inefficiencies while improving decision-making speed and accuracy.

In the context of urban mobility, AI also contributes to scalability by enabling adaptive learning systems that can expand to new sites with minimal human intervention. Furthermore, AI enhances user experiences through personalized services, such as real-time availability updates and optimized navigation. The integration of Federated Learning and Explainable AI is emerging as a pivotal approach to enhance model transparency while simultaneously safeguarding citizen data privacy during the training of decentralized urban intelligence (S et al., 2026). Moreover, sophisticated algorithmic frameworks enable organizations to optimize resource allocation by predicting demand patterns across diverse operational environments (Venigandla et al., 2024; Alahakoon et al., 2020). Critically, however, effective AI deployment remains contingent upon reliable and integrated data infrastructure, underscoring the foundational importance of cloud computing.

### **Theoretical Perspectives**

#### *Resource-Based View*

The Resource-Based View (RBV) provides a strategic lens for understanding how digital technologies can deliver sustained competitive advantage. According to RBV, organizations gain an advantage not simply by adopting new technologies but by integrating them into unique, valuable, rare, inimitable, and non-substitutable (VRIN) organizational capabilities. In this study, cloud computing and AI are conceptualized as strategic resources. When deployed effectively, they enhance operational efficiency and scalability, thereby positioning Shenzhen Ai Ke Technology to compete more effectively in the smart city ecosystem. Conversely, the diagnostic findings reveal that the absence of such resources, specifically modern digital infrastructure and advanced technological capabilities, has created a competitive disadvantage that inhibits the firm's strategic repositioning.

#### *Change Management Theory*

Technological transformation requires more than technical solutions: it demands careful management of organizational change. Change Management theory emphasizes the processes by which employees and stakeholders are prepared, trained, and supported during transitions. Applying this lens, the sequencing of cloud-first, followed by AI integration, reflects a pragmatic, risk-minimizing change strategy. Cloud computing represents a relatively manageable organizational shift that reduces employee resistance and builds familiarity with digital systems, thereby laying the groundwork for the more radical transition to AI-enabled automation. The persistence of manual practices at Ai Ke Technology, despite recognition of

their inefficiency, reflects the organizational inertia that Change Management theory identifies as a major barrier to transformation.

#### *Complementary Lenses: Lean Management and Diffusion of Innovation*

While not central to this study, insights from Lean Management and the Diffusion of Innovation (DOI) framework offer complementary perspectives that enrich the analysis. Lean Management underscores the importance of reducing waste and streamlining processes, objectives that directly align with the operational efficiency goals of AI and cloud adoption. DOI highlights how the adoption of innovations depends on perceptions of relative advantage, complexity, and compatibility with existing systems and practices, factors directly relevant to consumer acceptance of smart parking technologies and to employee resistance within the firm. Together, these perspectives help contextualize the broader ecosystem in which Ai Ke Technology operates.

#### *Research Gap*

Although the literature extensively discusses the technological potential of smart parking, empirical work on how firms in emerging smart-city contexts navigate organizational and operational barriers to digital transformation remains limited. Most studies adopt a technology-centric perspective, overlooking the sequencing and integration challenges firms face when transitioning from legacy systems. Furthermore, few studies apply action research to diagnose organizational inefficiencies and collaboratively design interventions at the firm level. This study addresses these gaps by conducting a root-cause analysis of operational inefficiencies at Shenzhen Ai Ke Technology, proposing a theoretically grounded, sequenced intervention strategy of cloud-first followed by AI integration, and anchoring the analysis in RBV and Change Management theories. In doing so, it also addresses the practical gap noted in the literature: the lack of evidence-based frameworks to guide companies at the implementation stage as they move from traditional parking systems to integrated AI- and cloud-enabled models in ways that are both operationally feasible and strategically aligned with smart city goals.

### **Methodology**

#### *Research Design: Action Research Approach*

This study adopts an action research design, which is particularly appropriate for organizational contexts undergoing active transformation. Action research is both participatory and iterative, enabling researchers and practitioners to collaboratively diagnose problems, design interventions, implement changes, and evaluate outcomes. The choice of action research is justified on three grounds.

First, Shenzhen Ai Ke Technology is currently in transition, and the participatory nature of action research provides a structured mechanism for co-creating solutions with management rather than imposing externally derived prescriptions. Second, action research places problem diagnosis at the foundation of intervention design, directly aligning with this study's objective of identifying and addressing root causes of operational inefficiency. Third, the cyclical structure of action research is well-suited to the six-month project timeline, in which two intervention cycles, cloud integration and AI integration, will be designed, implemented, and evaluated sequentially. The present paper focuses exclusively on the diagnostic phase,

which establishes the root causes of inefficiency and creates the empirical foundation for subsequent interventions.

### *Data Collection*

Data collection was conducted through semi-structured interviews with ten members of top management at Shenzhen Ai Ke Technology, comprising one sales manager, two sales staff, one parking lot operation manager, two parking lot operation staff, one digital operation manager, two online parking lot duty personnel, and one after-sales customer service manager. This purposive sampling strategy ensured that perspectives from across the organization's core operational functions were represented.

The interviews explored current operational practices, technological capabilities, organizational readiness, and perceived challenges in transitioning to smart parking solutions. The semi-structured format allowed flexibility to probe specific issues while maintaining consistency across respondents. The interview protocol covered five domains: (1) existing operational processes and reliance on manual practices; (2) current infrastructure and its compatibility with digital platforms; (3) workforce skills and training needs; (4) financial and regulatory barriers to digital adoption; and (5) perceptions of market readiness for smart parking solutions. All interviews were audio-recorded, transcribed verbatim, and analyzed thematically to identify recurring issues and systemic bottlenecks.

### *Diagnostic Tools and Analysis*

To complement and structure the qualitative interview data, three diagnostic tools were applied systematically to identify and prioritize the challenges facing the company.

The Fishbone Diagram (Ishikawa Analysis), presented as Figure 1, visualized the causal relationships underlying operational inefficiencies, categorizing root causes into thematic dimensions including processes, technology, people, and external environment. The Root Cause Analysis Table (Table 1) summarized each potential root cause alongside a structured assessment of whether it constituted a fundamental rather than symptomatic cause of inefficiency. The Prioritization Matrix (Table 2) ranked challenges according to their frequency of mention during interviews and their perceived impact on operational efficiency.

Triangulation across these three analytical instruments, qualitative interview narratives, visual causal mapping, and structured prioritization, strengthened the reliability and validity of findings by ensuring that insights were consistently supported across multiple methods.

### *Validity and Reliability*

Several measures were taken to enhance the trustworthiness of findings. Methodological triangulation was achieved by combining interview data with visual diagnostic tools and structured analysis frameworks. Member checking was conducted by sharing preliminary findings with management to confirm accuracy and interpretive fidelity. The use of an established interview protocol ensured consistency in data collection across respondents. Given the action research design, the study prioritizes practical validity: findings are not only analytically rigorous but are directly actionable in the organizational decision-making context they are intended to inform.

### *Ethical Considerations*

Ethical protocols were observed throughout the research process to ensure transparency, fairness, and confidentiality. Participation was entirely voluntary, informed consent was obtained from all participants, and no identifiable information about individual respondents is reported in this paper. The collaboration with Shenzhen Ai Ke Technology was conducted under a mutual understanding that findings would be used to improve organizational practices while simultaneously contributing to academic knowledge on digital transformation in smart parking contexts.

## **Findings**

### *Overview of Emerging Themes*

The diagnostic phase of this action research identified several critical inefficiencies constraining Shenzhen Ai Ke Technology's transition toward AI- and cloud-enabled smart parking solutions. Thematic analysis of semi-structured interviews with top management, corroborated by fishbone diagram analysis and root cause analysis, consistently revealed that manual processes and outdated infrastructure constitute the central organizational obstacles. These root causes generate cascading operational challenges that limit scalability, reduce efficiency, and undermine the firm's ability to meet the demands of Shenzhen's rapidly expanding smart city initiatives.

### *Manual Processes and Outdated Infrastructure as Primary Barriers*

All interview participants emphasized that the company's operations remain heavily dependent on manual reporting, error-prone data entry, and fragmented system management. These practices significantly slow decision-making, increase the risk of errors in allocation and monitoring, and limit real-time visibility across multiple operational sites. Moreover, the existing infrastructure is not compatible with IoT platforms or AI-driven applications, rendering technical integration both complex and financially burdensome.

These findings were visually confirmed in the fishbone diagram (Figure 1), where manual processes and outdated infrastructure emerged as the most critical causal factors leading to operational inefficiency. The root cause analysis table (Table 1) further confirmed that these two factors represent the fundamental bottlenecks to digital transformation, while other identified issues remain secondary in scope and urgency.

Table 1

*Root Cause Analysis of Operational Inefficiencies at Shenzhen Ai Ke Technology*

Possible Root Cause	Discussion	Root Cause?
Outdated Infrastructure & Technologies	Existing systems lack compatibility with IoT and AI platforms, impeding scalability and digital integration.	Yes
Manual Processes	High error rates and operational inefficiencies arising from human-dependent operations that hinder automation.	Yes
High Initial Costs	Substantial financial investment required for smart infrastructure upgrades, limiting scalability and adoption.	Yes
Market Hesitance	Low consumer acceptance due to limited awareness of smart parking benefits, negatively affecting adoption rates.	Yes
Regulatory Complexity	Frequently evolving urban policies create uncertainty and challenge long-term strategic planning.	Yes
Skill Gaps in Workforce	Limited technical expertise in smart parking technologies among existing staff slows adoption.	Yes
Competitive Pressure	External pressure to deploy smart solutions rapidly may compromise implementation quality.	No

*Source: Author*

*Secondary Challenges*

Beyond the primary root causes, the diagnostic analysis also revealed several secondary barriers that, while significant in their own right, are not as central to the company's current operational crisis:

**High Financial Burden:** The capital cost of transitioning to smart infrastructure and cloud-based systems is substantial, creating short-term financial strain and limiting the pace of modernization.

**Workforce Skill Gaps:** Staff lack the technical expertise required to manage AI-based solutions and cloud platforms, slowing adoption timelines and reducing system reliability during implementation.

**Regulatory Complexity:** Shenzhen's dynamic smart city policies create uncertainty in planning long-term technology investments, particularly in relation to compliance and interoperability standards.

**Market Hesitance:** Consumer acceptance of smart parking systems remains limited, requiring concerted awareness campaigns and trust-building efforts before user adoption can be expected at scale.

These secondary challenges were identified in the prioritization matrix (Table 2) and ranked consistently lower than manual processes and outdated infrastructure in terms of both impact severity and frequency of mention across interviews.

*Prioritization of Issues*

Table 2 presents a ranked assessment of identified challenges, combining frequency of mention in interviews with the perceived relative impact on operational efficiency. The findings confirm that manual processes and outdated infrastructure are the most pressing concerns, ranked first and classified as critical. High financial costs and workforce skill gaps were ranked second and third respectively, reflecting their substantial but secondary influence. Regulatory complexity and market hesitance were mentioned less frequently and were assessed to have lower immediate operational impact, though they remain relevant for long-term strategic planning and scalability.

Table 2

*Prioritization Matrix: Challenges Based on Interview Findings*

Challenge	Impact on Efficiency	Frequency in Interviews	Overall Priority
Manual Processes & Outdated Infrastructure	High error rates, scalability issues, and operational delays	Mentioned by all respondents	<b>1 , Critical</b>
High Initial Costs	Limits technology upgrades and modernization	Mentioned by majority	<b>2 , High</b>
Workforce Skill Gaps	Slows adoption and system maintenance	Mentioned by majority	<b>3 , High</b>
Regulatory Complexity	Creates uncertainty for long-term planning	Mentioned occasionally	<b>4 , Moderate</b>
Market Hesitance	Slows user adoption of smart services	Mentioned occasionally	<b>5 , Moderate</b>
Competitive Pressure	Impacts speed-to-market	Mentioned rarely	<b>Low</b>

Source: Author

This prioritization provides strong empirical justification for the initial focus of the action research on interventions targeting process automation and digital infrastructure modernization. Management consensus, verified during member checking, confirmed that addressing these primary issues through cloud computing followed by AI integration is expected to generate the most immediate and measurable improvements in operational performance.

*Synthesis of Diagnostic Phase*

In summary, the diagnostic phase demonstrates that Shenzhen Ai Ke Technology's operational challenges are not primarily attributable to external factors such as market hesitance or regulatory complexity, but rather to internal operational bottlenecks embedded in outdated systems and manual processes. Unless these core inefficiencies are systematically addressed, the company will remain constrained in its ability to leverage smart technologies and align with Shenzhen's broader smart city agenda. The findings thereby establish a firm empirical foundation for the forthcoming intervention cycles of this action research, wherein cloud integration will first be deployed to centralize and digitize

operations, followed by AI applications to enhance automation, predictive analytics, and scalability.

## **Discussion**

### *Linking Findings to Theoretical Frameworks*

The diagnostic findings confirm that Shenzhen Ai Ke Technology's operational inefficiencies stem primarily from manual processes and outdated infrastructure, which restrict the firm's capacity to leverage digital technologies strategically. This aligns strongly with the Resource-Based View (RBV), which holds that sustainable competitive advantage depends on the acquisition, deployment, and protection of VRIN resources. At Ai Ke Technology, the absence of such resources, specifically modern digital infrastructure and advanced technological capabilities, has created a competitive disadvantage. Without the strategic integration of cloud computing and AI, the company remains constrained by operational inefficiencies that undermine its position within Shenzhen's rapidly evolving smart city ecosystem.

The findings are equally consistent with Change Management theory, which identifies organizational inertia as a major barrier to transformation. The persistence of manual practices, despite clear recognition of their inefficiency among management, reflects the cultural and structural resistance to change that Change Management theory predicts. Transitioning to AI- and cloud-based operations will therefore require not only technological investment but also structured change management processes to overcome skill gaps, foster employee acceptance, and align operations with the firm's strategic digital transformation objectives.

### *Practical Implications of the Findings*

The prioritization of root causes provides actionable guidance for intervention design. By establishing manual processes and outdated infrastructure as the central bottlenecks, the diagnostic findings justify a specific sequencing of interventions:

Cloud computing first: This provides the foundational digital infrastructure necessary to centralize data, eliminate paper-based reporting, and enable real-time operational visibility. It also delivers early scalability benefits, preparing the company for multi-site management.

AI integration second: Once a reliable data foundation is established through cloud integration, AI applications can be layered to automate processes, enhance predictive analytics, and optimize resource utilization across sites.

This sequencing ensures that AI applications are not deployed upon fragmented or unreliable data systems, thereby substantially reducing implementation risk and maximizing the potential for measurable efficiency gains. The sequencing logic is supported by the literature, which consistently shows that AI performance is contingent on the quality and reliability of underlying data infrastructure (Ke et al., 2020; Ficili et al., 2025).

### *Contribution to the Smart Parking Industry*

The findings highlight an important lesson for the broader smart parking and smart city sectors: technological transformation is not solely dependent on external enablers such as regulatory support or consumer acceptance, but primarily on internal organizational readiness. Firms must first address process inefficiencies and infrastructural weaknesses before advanced technologies like AI can deliver measurable value. This reinforces the importance of aligning technological adoption with the firm's existing resource base, a principle central to RBV, and challenges the prevailing technology-centric bias in smart parking research. The study also demonstrates the value of action research as a methodology for uncovering these organizational realities in ways that purely technical studies cannot.

### *Short-Term Measurable Outcomes*

Given the six-month action research timeframe, the study prioritizes operational efficiency as the primary measurable short-term outcome. Improvements in error reduction, transaction speed, and reporting reliability provide tangible, observable indicators of progress. While scalability and strategic competitiveness remain longer-term objectives, the diagnostic findings suggest that enhancing operational efficiency creates the enabling conditions for these broader outcomes. Operational efficiency is therefore positioned as both a standalone performance target and a necessary precursor to digital scalability at Ai Ke Technology.

### *Broader Implications for Change Management in SMEs*

This study offers broader insights into the challenges of digital transformation for small- and medium-sized enterprises operating in high-growth, technology-intensive industries. Unlike large corporations with established digital infrastructure, SMEs such as Ai Ke Technology face compounded barriers of limited financial resources, workforce skill gaps, and cultural inertia. The findings underscore that digital transformation in SMEs must be staged, iterative, and supported by targeted training and change management strategies. Without these organizational enablers, even significant technological investments in AI and cloud platforms risk failing to deliver sustainable operational value.

## **Conclusion**

### *Summary of Findings*

This action research study investigated the root causes of operational inefficiencies at Shenzhen Ai Ke Technology as the company transitions from conventional parking installations to AI- and cloud-enabled smart parking systems. Findings from management interviews, root cause analysis, and a prioritization matrix consistently confirmed that manual processes and outdated infrastructure are the most significant barriers to operational efficiency and digital scalability. Secondary challenges, including high initial costs, workforce skill gaps, market hesitance, and regulatory complexity, further compound these inefficiencies but remain contingent on first addressing the core bottlenecks.

The study underscores the critical importance of a sequenced approach to technological integration: beginning with cloud computing to establish a reliable centralized data foundation, followed by AI applications to automate processes and enhance predictive capabilities. This pathway mitigates risks associated with fragmented data environments and aligns with the Resource-Based View, which emphasizes the strategic importance of building

and effectively leveraging organizational resources. The findings also reinforce Change Management theory by highlighting the necessity of addressing organizational inertia, building workforce capability, and cultivating cultural readiness to achieve sustainable digital transformation. Operational efficiency emerges from this analysis as both a primary short-term outcome and an indispensable enabler of long-term scalability and competitiveness.

### **Theoretical Contributions**

This study contributes to the literature on digital transformation and smart city innovation in three substantive ways. First, it extends RBV to the context of SME digital transformation in an emerging technology sector, demonstrating how firms must restructure their operational resource base before higher-order technologies like AI can generate competitive advantage. Second, it conceptualizes operational efficiency not merely as an outcome of digital transformation but as a necessary antecedent to scalability and competitiveness, offering a staged perspective on transformation trajectories. Third, it demonstrates the value of diagnostic action research as a methodology for uncovering organizational inefficiencies in technology adoption contexts, a methodological contribution that complements the predominantly positivist, technology-centric literature on smart parking.

### *Practical Recommendations*

For practitioners navigating similar transformations, the findings offer several actionable recommendations. Sequencing matters: cloud computing should precede AI integration to avoid the compounding inefficiencies associated with deploying AI on fragmented or unreliable data systems. Operational efficiency must be prioritized first: reducing errors, improving reporting reliability, and lowering manual workload create the organizational foundation for broader scalability and service quality improvements. Workforce readiness is non-negotiable: investments in infrastructure must be complemented by targeted training and structured change management strategies to build internal capacity and overcome cultural resistance. Finally, policy alignment can accelerate adoption: policymakers in Shenzhen and other smart city contexts can facilitate SME transformation by streamlining regulations and offering financial incentives that reduce the burden of digital infrastructure investment.

### **Limitations and Future Research Directions**

This study is limited by its six-month diagnostic timeframe, which restricts the observation of longer-term outcomes such as market adoption, customer experience improvements, and sustained competitive performance. The study is also limited to a single firm in a specific urban context, which constrains the generalizability of findings. Future research could extend the timeframe to evaluate post-intervention outcomes, compare the transformation experiences of multiple smart parking firms across different regulatory and market contexts, or examine the role of government partnerships in accelerating SME adoption of AI and cloud technologies. Empirical measurement of post-intervention efficiency gains will also provide important validation of the proposed cloud-first, AI-second sequencing model advanced in this study.

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