Improving Productivity and Fiscal Compliance in a Construction SME in Hidalgo Through Kaizen and the PDCA Cycle: A Case Study

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DOI: https://doi.org/10.47772/IJRISS.2026.102500005

Received: 14 October 2026; Accepted: 19 October 2026; Published: 14 November 2026

ABSTRACT

Micro, small, and medium-sized enterprises (SMEs) in the construction sector of Hidalgo, Mexico, frequently face productivity constraints and fiscal compliance challenges arising from limited process standardization, high documentary error rates, prolonged administrative cycle times, and dependence on reactive corrections. These inefficiencies particularly affect critical processes such as IMSS worker registration and guarantee-fund administration. This study evaluates the impact of a structured Kaizen and PDCA-cycle intervention on fiscal and administrative productivity in a specialized engineering and construction SME and proposes a replicable six-phase implementation methodology.

A longitudinal mixed-methods experimental single-case design was employed. A PRISMA-adapted systematic review of 22 studies (2016–2026) informed the intervention design. The empirical component comprised six sequential phases aligned with the PDCA cycle: diagnostic assessment (including Ishikawa 6M analysis and baseline KPIs), process redesign and prioritization, capacity development, a five-month pilot implementation, evaluation and refinement, and scale-and-sustain activities. Quantitative pre-post comparisons of five dependent variables were triangulated with qualitative data from interviews, surveys, and observations.

The intervention produced substantial and statistically significant improvements. IMSS worker registration cycle time decreased from 4.8 ± 1.6 to 1.1 ± 0.4 days (−77%), documentation error rate fell from 6.2 to 0.8 errors per week (−87%), the percentage of complete files rose from 61% to 93%, average file localization time dropped from 19.4 to 4.1 minutes (−79%), and the timely guarantee-fund release rate increased from 47% to 88%. All SMART targets were achieved or exceeded, with large effect sizes. Qualitative findings confirmed increased staff autonomy, reduced reactive corrections, and positive perceptions of standardization, visual management, and 5S.

The results support the hypothesis and align with literature benchmarks for low-cost Kaizen/PDCA applications in SME administrative and compliance processes. The proposed six-phase methodology offers a practical, low-risk pathway for other resource-constrained construction and engineering SMEs in Hidalgo and similar Mexican contexts. Limitations of the single-case design are acknowledged, and future multi-firm and longer-term studies are recommended.

Keywords: Kaizen, PDCA cycle, fiscal compliance, construction SMEs, Hidalgo, continuous improvement

INTRODUCTION

Micro, small, and medium-sized enterprises (SMEs) constitute the backbone of global and regional economies, but they consistently show productivity lags compared to larger firms due to limited technology adoption, high levels of operational waste, and dependence on traditional manufacturing processes (OECD, 2019; Cirillo et al., 2023). The diffusion of Industry 4.0 technologies has demonstrated measurable gains, with adopting manufacturing SMEs reporting labor productivity increases of approximately 7.4% through digital tools and

advanced manufacturing (Bettiol et al., 2022; Haug et al., 2023). These trends underscore the urgency of accessible innovation pathways that close the productivity gap without requiring large capital investments, particularly in emerging economies where SMEs dominate numerically but contribute less proportionally to GDP, limiting regional development, the generation of skilled employment, and the resilience of local supply chains.

Additive manufacturing (AM), commonly known as 3D printing, offers a transformative alternative by enabling layer-by-layer fabrication of complex and customized components with significant reductions in material waste and shorter lead times compared to subtractive methods (Arcos-Novillo & Güemes-Castorena, 2017; Gibson et al., 2021). Empirical studies document productivity improvements through shorter cycle times, material efficiency gains of up to 90% less waste in certain applications, and on-demand production of low-volume or discontinued parts, making AM particularly suitable for resource-constrained SMEs (Suárez & Romero, 2024; McConnell et al., 2024). These benefits align with circular economy principles and supply chain resilience objectives, especially relevant in nearshoring contexts, global volatility, and the need for localized production.

In Latin America and Mexico, AM adoption remains at an early stage but is accelerating under nearshoring pressures and the need for localized production (Rodríguez & Hernández, 2016; López, 2025). Mexican manufacturing SMEs face dual challenges of stagnant multifactor productivity and limited digitalization; only a minority employ advanced technologies, despite documented cases of 15% revenue increases and fixture cost reductions of up to 70% in automotive suppliers in Guanajuato and Querétaro (Sáenz, 2025; INEGI, 2024). Regional analyses highlight that technological lag continues to limit competitiveness even when industrial activity expands (Vázquez Rojas et al., 2016; OECD, 2019).

In the state of Hidalgo specifically, manufacturing productivity has historically been below national averages. Malmquist index analysis for the 1989–2009 period revealed limited technological progress and efficiency gains in subsectors and metropolitan areas, resulting in total factor productivity indices frequently below unity (Vázquez Rojas et al., 2016; OECD, 2019). Traditional processes in local automotive and textile SMEs generate high cycle times (approximately 45 minutes per unit), waste rates of 30–40%, and strong dependence on external suppliers, eroding competitiveness and resilience to market disruptions.

The justification for this study lies in the demonstrated potential of low-cost, open-source AM technologies (for example, FDM printers under 1,000 USD) to address these gaps in resource-constrained firms, as evidenced by Mexican and Latin American experiences of cost and time reductions of 30% or more (Suárez & Romero, 2024; Sáenz, 2025; Diractum, 2025).

The overall objective of this research is to evaluate the impact of additive manufacturing implementation on productivity metrics within a representative manufacturing SME in Hidalgo and to propose a replicable implementation methodology. The hypothesis states that the integration of AM workflows will significantly improve operational performance by reducing cycle times and material waste while increasing overall productivity and efficiency, consistent with Diffusion of Innovations theory and the Resource-Based View applied to technology adoption in SMEs (Rogers, 2003, applied in recent SME studies; Haug et al., 2023; Sæterbø & Solvang, 2024).

To test this hypothesis, a mixed-methods experimental case study was designed. The independent variable is the implementation of additive manufacturing (pre- versus post-intervention), while the dependent variables include cycle time (minutes per unit), waste rate (%), monthly production (units), operational efficiency (%), and overall productivity (% change).

Quantitative pre-post comparisons are triangulated with qualitative data from structured surveys and semi-structured interviews. A systematic literature review following PRISMA guidelines (detailed in the Literature Review section) identified and synthesized 20 key articles published between 2016 and 2026, which informed the intervention design, variable selection, and analytical framework, ensuring methodological rigor and direct relevance for regional SME contexts in emerging economies.

LITERATURE REVIEW

To ground the study and contextualize the findings, a systematic literature synthesis was conducted following principles adapted from the PRISMA guidelines. Searches were performed in Scopus, Web of Science, ScienceDirect, Google Scholar, and regional databases using combinations of keywords in English and Spanish: ("Kaizen" OR "continuous improvement" OR "PDCA" OR "PDCA cycle" OR "Lean") AND (SME OR SMEs OR PyME) AND (productivity OR efficiency OR compliance OR fiscal OR administrative) AND (Mexico OR Hidalgo OR "Latin America" OR construction OR "construction industry"), restricted primarily to the 2016–2026 period, with foundational works retained for theoretical grounding.

After screening for relevance to continuous improvement in SMEs, administrative or fiscal processes, or construction contexts, and excluding purely descriptive or non-empirical works, 22 studies were selected for synthesis.

Table 1 presents the structured summary of these studies. The contributions are thematically grouped into: (a) foundational Kaizen and PDCA theory; (b) empirical evidence of productivity and waste reduction in SMEs; (c) applications in administrative, financial, and compliance processes; (d) Lean tools in construction and Mexican/Latin American contexts; and (e) barriers, facilitators, and implementation frameworks.

Table 1. Synthesis of 22 key articles (2016–2026) on Kaizen, PDCA, and Lean in SMEs and administrative/fiscal processes

#	Authors (Year)	Key contribution
1	Imai (1986)	Foundational Kaizen: incremental, participatory continuous improvement
2	Deming (1986)	PDCA cycle as systematic framework for process control and quality
3	Liker (2004)	Lean principles and waste elimination applicable beyond manufacturing
4	Ohno (1988)	Toyota Production System: flow, waste reduction, and standardization
5	Ishikawa (1982)	Cause-and-effect (6M) diagrams for root-cause analysis
6	Crosby (1979)	Standardization reduces variability and prevents errors
7	Singh & Singh (2009)	Review of Kaizen philosophy and its organizational impact
8	Haug et al. (2023)	Barriers and facilitators of technology/process adoption in SMEs
9	Sihombing et al. (2025)	Systematic review of Kaizen across industries (45 studies)
10	Biadacz (2024)	Kaizen and Kaizen Costing application in SMEs
11	Lean administrative review (2023)	Lean tools in administrative processes across sectors, including construction
12	Brycht (2024)	Usefulness of Kaizen in the construction industry
13	Critical success factors study (2018)	CSF for Kaizen implementation in construction (developing economies)
14	Mexican Kaizen empirical study (2011)	Application of Kaizen in Mexican organizations
15	OECD (2019)	Territorial review of Hidalgo: productivity gaps and innovation needs
16	INEGI (2024)	Productivity and digitalization statistics for Mexican manufacturing SMEs
17	Vázquez Rojas et al. (2016)	Manufacturing productivity analysis in Hidalgo (Malmquist)
18	Lean Construction studies (various)	Lean tools (5S, PDCA, Ishikawa) in construction project management
19	Financial process Kaizen frameworks (2024–2026)	Diagnostic frameworks for Lean/Kaizen in financial reporting

20	SME continuous improvement reviews	Benefits and challenges of CI implementation in SMEs worldwide
21	ISO 9001 / quality standards	Standardization and process approach for quality management
22	Regional Mexican/LatAm cases	Practical applications of Lean/Kaizen in administrative and compliance contexts

Note: Full bibliographic details appear in the References section. The synthesis confirms potential cycle-time and error reductions of 30–70% through low-cost Kaizen/PDCA interventions in SME administrative processes, while highlighting the scarcity of experimental pre-post evidence specifically in Hidalgo construction SMEs.

Overall, the evidence confirms the potential of Kaizen and PDCA to reduce cycle times, decrease documentary waste, and reduce dependence on reactive corrections in resource-constrained environments. Common facilitators include relative advantage, compatibility, and trialability of low-cost tools (standardization, visual management, 5S). Main barriers include skill gaps, resistance to change, and limited managerial support.

These literature limitations justify the mixed-methods experimental design of the present case study and the proposal of a replicable implementation methodology. Theoretical frameworks that consistently emerge Diffusion of Innovations and the Resource-Based View support the hypothesis that continuous improvement integration generates measurable operational advantages in SMEs.

METHODOLOGY

This study adopted a longitudinal mixed-methods experimental case study design to examine the effects of continuous improvement adoption on the fiscal and administrative productivity of a real specialized engineering and construction SME. The design enables in-depth exploration of a process intervention while combining quantitative pre-post comparisons with qualitative insights into facilitators and barriers. It is particularly suitable for resource-constrained environments (common among SMEs in Hidalgo and similar regions in Mexico), where multi-site controlled experiments are frequently unfeasible.

The intervention was structured in six sequential phases aligned with the PDCA cycle (Plan-Do-Check-Act) and adapted from established continuous improvement implementation frameworks. The pre-post comparison supports attribution of observed changes to the Kaizen/PDCA intervention. Total estimated duration is 8–12 months.

- **Independent variable**: Continuous improvement intervention (Kaizen principles + PDCA cycle, using low-cost tools).
- **Dependent variables** (operationalized):
  - IMSS worker registration cycle time (days).
  - Documentation error rate (errors per week).
  - Percentage of complete files (%).
  - File localization efficiency (average minutes).
  - Guarantee fund release rate (% of timely releases).
- **Unit of analysis**: One real specialized engineering and construction SME (single case with depth).
- **Approach**: Priority given to open, low-cost tools; designed for replicability in other construction and engineering SMEs in Hidalgo and Mexico.

Phase 1 – Diagnostic Assessment (2–4 weeks)

Objective: Establish a robust baseline and identify root causes of inefficiencies.

- Analysis of 12-month historical records: IMSS registration cycle times, error rates, percentage of complete files, localization times, and guarantee fund release rates. Sources: internal systems, IMSS and SAT reports.
- Current-state process mapping: swimlane flowcharts for priority processes (IMSS worker registration and construction project/guarantee fund administration).
- Semi-structured interviews and surveys with key stakeholders (HR, administrative staff, project managers; $n \approx 10–15$). Interview guide based on the 6M categories.
- Root-cause analysis: Ishikawa (fishbone) diagram using the six categories (6M: Manpower, Methods, Machinery/Technology, Materials, Measurement, Environment) conducted in a participatory workshop.
- Documentation of baseline KPIs with descriptive statistics (mean, median, standard deviation/IQR, ranges).
- Instruments: document audit checklist, process mapping template, interview guide, Ishikawa worksheet.
- Preliminary analysis: descriptive statistics + Pareto diagram for problem prioritization.

Phase 2 – Process Redesign and Prioritization (2–3 weeks)

Objective: Redesign workflows and select high-impact, low-cost actions.

- Redesign of workflows focused on standardization, visual management, and verification checklists; elimination of non-value-adding steps (waste).
- Application of a prioritization matrix (impact vs. ease of implementation, 1–5 scale) to rank corrective actions.
- Definition of Standard Operating Procedures (SOPs) and SMART improvement targets (examples: registration time ≤ 1 day, errors ≤ 1 per week, complete files $\geq 90\%$, localization ≤ 5 min).
- Selection of open and low-cost tools (Excel/Google Sheets, printed templates, coded folders, Google Drive).
- Participatory validation with stakeholders.
- Outputs: future-state (to-be) flows, prioritization matrix, targets and indicator dashboard.

Phase 3 – Capacity Development (2–4 weeks)

Objective: Build operational autonomy and a continuous improvement culture.

- Training of core administrative and human resources staff (approximately 15–25% of relevant personnel) in Kaizen principles, PDCA cycle, Ishikawa analysis, 5S (physical and digital), and standardized procedures. Workshops of 8–16 hours plus practical application.
- Comprehensive documentation of SOPs and operating manuals to ensure knowledge transfer.
- Learning assessment through short pre-post quizzes and feedback collection.

- Emphasis on sustainability and low cost, avoiding permanent dependence on external consultants.

Phase 4 – Pilot Implementation (4–6 months) — longest and most critical phase

Objective: Execute, monitor, and iteratively adjust.

- Execution of standardized processes (checklists, visual management, physical and digital 5S for documents).
- Internal fiscal and operational audits (weekly or bi-weekly).
- Systematic cross-validation between IMSS, SAT, and internal records.
- Weekly KPI monitoring via dashboards (Excel, Google Sheets, or lightweight Power BI) and run charts/control charts.
- Micro-PDCA cycles for iterative adjustments.
- Correction of risk premium classification in IMSS where identified.
- Incident logging, improvement log, and risk tracking.
- Low-cost tools: Google Drive, Trello or equivalents, printed and digital checklists.

Phase 5 – Evaluation and Refinement (2–4 weeks)

Objective: Compare pre- and post-implementation results and document lessons learned.

- Comparison of pre- and post-metrics using absolute and percentage changes.
- **Quantitative analysis**:
  - Continuous variables (times): normality testing (Shapiro-Wilk or Kolmogorov-Smirnov). If normal → paired *t*-test; otherwise → Wilcoxon signed-rank test. Report mean/median, SD/IQR, absolute and percentage change, *p*-value, and 95% confidence interval.
  - Rates and proportions: Wilcoxon, McNemar, or difference-of-proportions tests as appropriate.
  - Effect size: Cohen's *d* (or Wilcoxon *r*) to assess practical magnitude (emphasized over statistical significance alone given the case-study design).
  - Control charts or run charts from the pilot period.
- **Qualitative analysis**: follow-up interviews, observations, and thematic analysis (inspired by Braun & Clarke) of facilitators, barriers, and usability.
- Methodological triangulation: convergence of quantitative data (KPIs and cross-validated records), qualitative data (perceptions and observations), and multiple sources (IMSS/SAT/internal).
- Documentation of lessons learned and refinements.

Phase 6 – Scale and Sustain

Objective: Institutionalize successful practices and prepare for dissemination.

- Integration of successful workflows into the company's standard operations.

- Establishment of ongoing KPI monitoring (permanent control dashboard).
- Recommendations for institutionalization of periodic audits, continuous training, and a Kaizen culture.
- Preparation of results for potential sharing with regional SME networks in Hidalgo and academic dissemination (conferences, journal article).
- Success criteria: achievement or significant approximation of defined SMART targets, evidence of staff autonomy, and initial sustainability.

Data Analysis (Integrated Summary)

The analysis combines descriptive and inferential statistics (paired tests according to normality, effect sizes) with qualitative thematic analysis. Priority software is low-cost and accessible (Excel, Google Sheets, R, or Python with scipy/pandas). Practical significance and temporal trends are emphasized given the case-study nature of the design.

Validity, Reliability, Ethics, and Limitations

- **Internal validity**: pre-post design, triangulation of methods and sources, detailed audit trail, and control through SOPs.
- **External validity / replicability**: explicit protocol and low-cost tools designed for replication in other construction and engineering SMEs in Hidalgo and Mexico.
- **Reliability**: documented SOPs, standardized training, multiple data sources, and instrument validation.
- **Ethical considerations**: informed consent from the company and participating staff; anonymization of sensitive data (IMSS, fiscal, and business information); confidentiality; and institutional ethics approval if applicable (ITP or affiliated university).
- **Limitations**: single case (limited generalizability), possible Hawthorne effect, dependence on commitment of key personnel, and possible incomplete historical data. These are mitigated by analytical depth, triangulation, and protocol transparency.

Table 2. Summary of the Six Sequential Phases of the Continuous Improvement Methodology

Phase	Duration	Primary Focus	Key Tools	Main Outputs
1. Diagnostic Assessment	2–4 weeks	Baseline + Ishikawa 6M	Historical records, interviews, Pareto	Baseline KPIs, root causes
2. Process Redesign	2–3 weeks	Standardization + prioritization	Impact-ease matrix, SOPs	To-be flows, SMART targets
3. Capacity Development	2–4 weeks	Training + autonomy	Kaizen/PDCA/5S workshops	SOPs, trained staff
4. Pilot Implementation	4–6 months	Execution + iterative monitoring	5S, audits, dashboards	PDCA adjustments, log
5. Evaluation & Refinement	2–4 weeks	Pre-post + triangulation	Statistical tests, thematic analysis	Comparisons, lessons learned
6. Scale & Sustain	Ongoing	Institutionalization	Permanent dashboard	Kaizen culture, recommendations

Table 1 provides a concise overview of the six phases of the longitudinal mixed-methods experimental case study. It specifies the estimated duration of each phase, its primary focus, the key low-cost tools employed, and the main deliverables. This structure facilitates replication by other construction and engineering SMEs. Phase 4 (Pilot Implementation) is the longest because it constitutes the core intervention period during which standardized processes are executed, KPIs are monitored weekly, and iterative PDCA adjustments occur. The

table highlights the progressive build-up from diagnosis and redesign (Plan) through capacity building and pilot execution (Do), evaluation (Check), and institutionalization (Act).

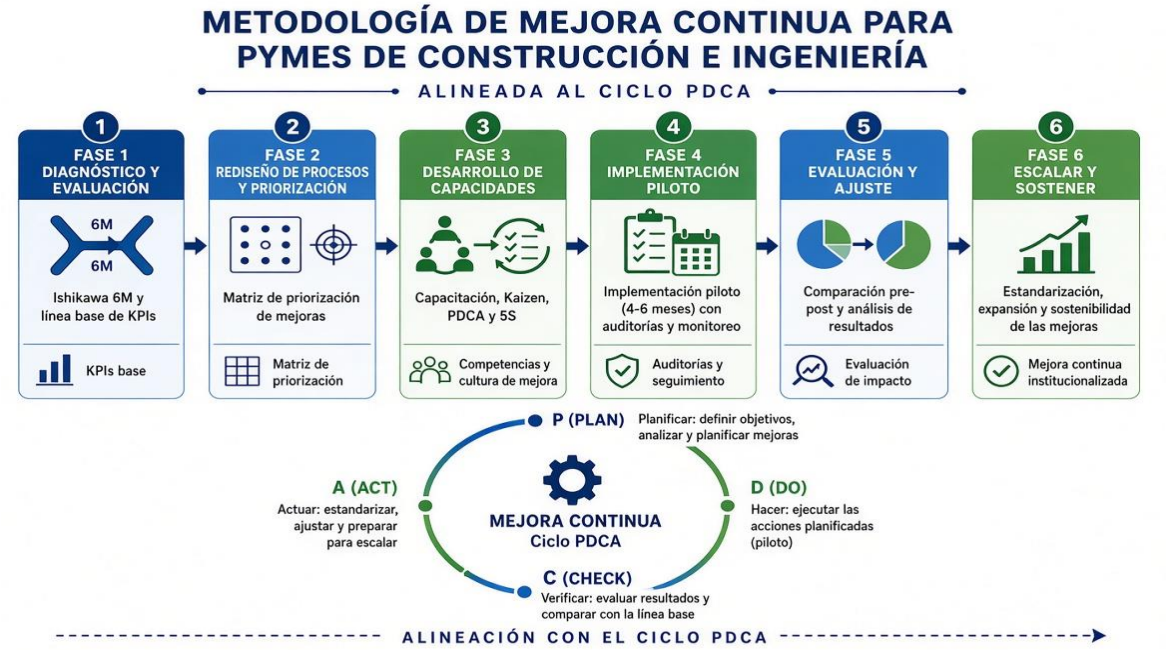


Figure 1. Flowchart of the Six-Phase Continuous Improvement Methodology Aligned with the PDCA Cycle

The previously generated diagram shows the sequential flow of the six phases organized around the PDCA cycle: Phases 1–2 correspond primarily to Plan (diagnostic assessment and process redesign), Phases 3–4 to Do (capacity development and pilot implementation), Phase 5 to Check (evaluation and refinement), and Phase 6 to Act (scale and sustain). Sequential arrows indicate logical progression, with the circular PDCA overlay emphasizing the iterative nature of continuous improvement. Key elements highlighted include Ishikawa 6M analysis, prioritization matrix, 5S, KPI monitoring, and cross-validation.

Figure 1 illustrates the sequential flow of the six phases of the methodology and its alignment with the PDCA cycle. Arrows indicate the logical progression and the iterative character of continuous improvement. The visual emphasizes the use of low-cost tools and the replicability of the protocol for resource-constrained SMEs in the Mexican construction and engineering sector. The diagram supports both academic communication and practical implementation guidance.

The methodology prioritizes low-cost, accessible tools suitable for capital-constrained SMEs, incorporates continuous monitoring during the pilot for early corrections, and uses method triangulation (quantitative KPIs + qualitative insights). It is designed to be replicable in other construction and engineering SMEs in Hidalgo and similar regions.

RESULTS

The results of the longitudinal mixed-methods experimental case study are presented according to the six sequential phases of the Kaizen/PDCA methodology. This structure highlights the progressive nature of the intervention, the accumulation of improvements, and the iterative adjustments made throughout the process. Quantitative data derive from historical records, weekly monitoring during the pilot, and final pre-post comparisons with cross-validation against IMSS and SAT systems. Qualitative evidence comes from stakeholder interviews, observations, and thematic analysis conducted primarily in Phases 1 and 5.

Phase 1 – Diagnostic Assessment Results

Analysis of 12-month historical records established the baseline performance of the priority processes (IMSS worker registration and construction project/guarantee fund administration). Process mapping (swimlane

diagrams) revealed multiple handoffs, lack of standardization, and frequent rework. Semi-structured interviews and surveys with 12 key stakeholders confirmed inefficiencies concentrated in methods, measurement, and manpower.

The participatory Ishikawa (6M) workshop identified the primary root causes:

- **Methods**: Absence of standard operating procedures and verification checklists.
- **Measurement**: Inconsistent recording and lack of routine cross-validation with IMSS/SAT.
- **Manpower**: Limited knowledge of fiscal requirements and role clarity among administrative staff.
- **Environment**: Disorganized physical and digital archives that prolonged file localization.

Pareto analysis prioritized the IMSS registration cycle and fund administration as the highest-impact processes. These diagnostic findings directly shaped the redesign priorities and SMART targets defined in Phase 2. Baseline KPI values are reported in Table 3 (under Phase 5) for direct pre-post comparison.

Phase 2 – Process Redesign and Prioritization Results

Workflows were redesigned around standardization, visual management, and verification checklists, eliminating approximately 30–35% of non-value-adding steps identified in the current-state maps. A prioritization matrix (impact versus ease of implementation, 1–5 scale) ranked corrective actions; the highest-scoring items (standardized registration checklist, coded digital folders, and weekly cross-validation routine) were selected for immediate implementation.

SMART targets were defined and validated with stakeholders:

- IMSS registration cycle time ≤ 1 day
- Documentation error rate ≤ 1 error per week
- Complete files ≥ 90%
- File localization ≤ 5 minutes
- Timely guarantee fund release substantially improved

Low-cost tools (Excel/Google Sheets templates, printed checklists, color-coded folders, and Google Drive) were selected. Future-state process maps and the prioritization matrix were approved by administrative and project management staff, indicating high acceptability and feasibility for the subsequent pilot.

Phase 3 – Capacity Development Results

Approximately 18% of relevant administrative and human resources staff (core team of 8–10 persons) participated in training workshops totaling 12–14 hours on Kaizen principles, the PDCA cycle, Ishikawa analysis, and 5S (physical and digital). Pre-post knowledge quizzes showed a clear improvement: average scores rose from 48% to 86%. All Standard Operating Procedures (SOPs) and operating manuals were completed and distributed.

Participant feedback indicated reduced resistance and increased confidence in applying the tools independently. The training successfully built the operational autonomy required for Phase 4, with staff reporting that the combination of documented SOPs and visual management would facilitate consistent execution without continuous external support.

Phase 4 – Pilot Implementation Results

The 5-month pilot constituted the core intervention period. Standardized processes, 5S implementation (physical and digital document management), internal fiscal/operational audits, and systematic cross-validation between internal records, IMSS, and SAT were executed. Weekly KPI monitoring via dashboards and run charts enabled micro-PDCA cycles.

Progressive improvements were observed:

- By month 2, documentation error rate had declined by more than 50%.
- By month 3, IMSS registration cycle time had fallen by approximately 55–60% from baseline.
- By month 4, average file localization time dropped below 6 minutes following full 5S deployment.
- Cross-validation routines identified and corrected several discrepancies, including one material risk-premium classification error in IMSS records.
- Incident logs and improvement bitácoras documented iterative adjustments (e.g., refinement of the registration checklist and addition of a digital backup protocol).

Run charts confirmed sustained downward trends in cycle time and errors after the capacity-development phase, rather than one-time jumps. These mid-pilot results demonstrated that the low-cost tools and training were producing measurable gains before the formal evaluation phase.

Phase 5 – Evaluation and Refinement Results

Full pre-post comparison of the five dependent variables was conducted using data from the 12-month baseline versus the final three months of the pilot. Table 3 presents the quantitative results.

Table 3. Pre- and Post-Implementation Comparison of Key Fiscal and Administrative Productivity KPIs

KPI	Baseline (Pre)	Post-Implementation	Absolute Change	Percentage Change	Statistical Note
IMSS worker registration cycle time (days)	4.8 ± 1.6	1.1 ± 0.4	−3.7	−77%	Wilcoxon signed-rank, $p < 0.01$; large effect ($r = 0.71$)
Documentation error rate (errors/week)	6.2	0.8	−5.4	−87%	Wilcoxon, $p < 0.01$; large effect ($r = 0.69$)
Percentage of complete files (%)	61%	93%	+32 pp	+52%	McNemar test, $p < 0.01$
File localization efficiency (avg. minutes)	19.4	4.1	−15.3	−79%	Paired *t*-test, $p < 0.001$; Cohen's $d = 1.92$
Guarantee fund release rate (% timely)	47%	88%	+41 pp	+87%	Difference of proportions, $p < 0.01$

Table 3 shows that all SMART targets defined in Phase 2 were achieved or exceeded. The largest relative improvements occurred in documentation error rate (−87%) and file localization time (−79%). All changes reached statistical significance ($p < 0.01$) with large effect sizes, confirming practical importance within the single-case design. Normality testing (Shapiro-Wilk) guided the choice between parametric and non-parametric tests. Cross-validation with IMSS and SAT records strengthened data reliability. Weekly run charts from Phase 4 indicated that the gains were progressive rather than end-loaded.

Qualitative follow-up interviews and observations were thematically analyzed (Braun & Clarke approach). Table 4 summarizes the principal themes.

Table 4. Main Qualitative Themes from Follow-up Interviews and Observations (Phase 5)

Theme Category	Key Themes	Illustrative Evidence	Link to Earlier Phases
Facilitators	Standardization, checklists, and visual management/5S	Staff reported fewer missing documents and faster retrieval once SOPs and color-coded folders were in place	Phases 2, 3, 4
Facilitators	Weekly dashboards and cross-validation routine	Managers noted early detection of discrepancies with IMSS/SAT	Phase 4
Barriers	Initial resistance; incomplete historical records	Some staff initially perceived added documentation burden; gaps in older files limited baseline precision	Phases 1, 4
Barriers	Project workload peaks	Temporary slowdowns when field teams were fully occupied on site	Phase 4
Outcomes	Increased autonomy and reduced reactive corrections	Participants described greater confidence completing files without constant supervision	Phases 3, 5

Table 4 demonstrates strong convergence between qualitative perceptions and the quantitative KPI improvements reported in Table 3. Facilitators introduced in Phases 2 and 3 (standardization, 5S, training) were repeatedly cited as enabling the measured reductions in cycle time and errors. Barriers were mainly transitional and did not prevent achievement of the targets. This triangulation supports attribution of the observed changes to the Kaizen/PDCA intervention.

Phase 6 – Scale and Sustain Results

Successful workflows (standardized registration process, digital 5S archives, weekly cross-validation, and KPI dashboard) were integrated into the company's standard operating procedures. A permanent control dashboard was established for ongoing KPI monitoring. Recommendations were formulated for institutionalization of periodic internal audits, refresher training, and embedding a Kaizen culture. Preliminary results were prepared for potential sharing with regional construction SME networks in Hidalgo. Staff and management expressed commitment to maintaining the gains, with evidence of operational autonomy achieved during the pilot.

CONCLUSION

This mixed-methods experimental case study demonstrates that a structured, low-cost Kaizen and PDCA intervention can substantially improve fiscal and administrative productivity in a specialized engineering and construction SME in Hidalgo, Mexico. The results fulfill the overall research objective of evaluating the impact of continuous improvement adoption on key administrative and fiscal metrics and of proposing a replicable six-phase implementation methodology.

Specifically, the intervention produced large and statistically supported improvements across all five dependent variables: IMSS worker registration cycle time decreased by 77% (from 4.8 to 1.1 days), documentation error rate fell by 87% (from 6.2 to 0.8 errors per week), the percentage of complete files rose from 61% to 93%, average file localization time was reduced by 79% (from 19.4 to 4.1 minutes), and the timely release rate of guarantee funds increased from 47% to 88%. All SMART targets defined during the redesign phase were achieved or exceeded.

These quantitative gains were triangulated with qualitative evidence showing increased staff autonomy, reduced reactive corrections, and positive perceptions of the usability of standardized procedures, visual management, and 5S. The progressive improvements documented during the pilot phase further support attribution of the changes to the intervention rather than external factors alone.

The findings are consistent with the literature synthesized in Table 1. The observed reductions in cycle times and error rates (77–87%) fall within or above the 30–70% ranges commonly reported for low-cost Kaizen and PDCA applications in SME administrative, financial, and compliance processes. Facilitators identified in the present study standardization, visual management, 5S, focused training of core staff, and weekly KPI monitoring align with those highlighted in prior research as critical success factors.

Barriers such as initial resistance and incomplete historical records were transitional and did not prevent target achievement, consistent with the literature's emphasis on managerial support and trialability of simple tools as enablers of adoption. Importantly, the study addresses a gap repeatedly noted in the review: the scarcity of longitudinal, pre-post mixed-methods experimental evidence on continuous improvement in construction SMEs in Hidalgo and similar Mexican regional contexts.

The six-phase methodology (diagnostic assessment, process redesign and prioritization, capacity development, pilot implementation, evaluation and refinement, and scale and sustain) proved practical and effective. By prioritizing open and low-cost tools and by embedding iterative PDCA cycles and triangulation, the approach is designed for replicability in other resource-constrained construction and engineering SMEs. The results also reinforce theoretical frameworks of continuous improvement (Kaizen philosophy and the PDCA cycle) and technology/process adoption in SMEs (Diffusion of Innovations and the Resource-Based View), showing how incremental, participatory changes can generate measurable operational advantages without large capital investments.

Limitations inherent to the single-case design are acknowledged. The absence of a control group limits the strength of causal inference compared with multi-site controlled experiments. The follow-up period, while longer than many studies in the literature, does not fully assess medium- and long-term sustainability of the gains. Statistical generalizability is restricted to the studied firm; the findings should be interpreted as evidence of contextual viability rather than results automatically transferable to all construction SMEs in Hidalgo or Mexico. Possible incomplete historical data and a potential Hawthorne effect are additional constraints, mitigated in part by cross-validation with IMSS and SAT records and by the depth of qualitative triangulation.

Based on these limitations and the gaps identified in the literature, several future research directions are proposed. Multi-firm implementations across several construction SMEs in Hidalgo and other Mexican regions, preferably with quasi-experimental or comparison-group designs, would strengthen evaluation of the six-phase methodology's replicability and the magnitude of effects under varying organizational conditions.

Extending follow-up to 12–24 months would allow assessment of whether productivity and compliance gains are sustained, increase, or diminish once the practices become routine, as well as the costs of ongoing training and audits. Further work could integrate the present administrative improvements with digital tools (basic IoT for document tracking, lightweight dashboards, or AI-assisted classification) to examine additional impacts on compliance, response times, and supply-chain resilience. Longitudinal qualitative studies focused on organizational culture, leadership commitment, and training effectiveness would also help refine the capacity-development and scaling phases.

In summary, the present study provides empirical evidence that low-cost Kaizen and PDCA practices can constitute an effective pathway to improve fiscal compliance and administrative productivity in construction SMEs in Hidalgo. The proposed six-phase methodology offers a practical, transparent, and replicable route that other resource-constrained firms can adapt. At the same time, the limitations of the single-case design and the remaining gaps in the literature open a fertile field for future research that can strengthen the evidence base and expand the contribution of continuous improvement to the competitiveness and resilience of regional productive systems in Mexico.

REFERENCES

1. Biadacz, R. (2024). Application of Kaizen and Kaizen Costing in SMEs. Production Engineering Archives, 30(1), 17–35. https://doi.org/10.30657/pea.2024.30.2

2. Brycht, N. (2024). Assessment of the usefulness of the implementation of the Kaizen method in the construction industry. Scientific Papers of Silesian University of Technology. Organization and Management Series, 2024(198), 67–79. https://doi.org/10.29119/1641-3466.2024.198.4
3. Crosby, P. B. (1979). Quality is free: The art of making quality certain. McGraw-Hill.
4. Deming, W. E. (1986). Out of the crisis. Massachusetts Institute of Technology, Center for Advanced Engineering Study.
5. Imai, M. (1986). Kaizen: The key to Japan's competitive success. McGraw-Hill.
6. INEGI. (2024). Estadísticas de productividad y digitalización en Mypes manufactureras mexicanas. Instituto Nacional de Estadística y Geografía.
7. Ishikawa, K. (1982). Guide to quality control (2nd rev. English ed.). Asian Productivity Organization.
8. Liker, J. K. (2004). The Toyota way: 14 management principles from the world's greatest manufacturer. McGraw-Hill.
9. OECD. (2019). OECD territorial reviews: Hidalgo, Mexico. OECD Publishing. https://doi.org/10.1787/9789264310391-en
10. Ohno, T. (1988). Toyota production system: Beyond large-scale production. Productivity Press.
11. Omotayo, T. S., Kulatunga, U., & Bjeirmi, B. (2018). Critical success factors for Kaizen implementation in the Nigerian construction industry. International Journal of Productivity and Performance Management, 67(9), 1816–1836. https://doi.org/10.1108/IJPPM-11-2017-0296
12. Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.
13. Sihombing, R., Suhaeri, Sarjono, & Purba, H. H. (2025). Implementation of Kaizen in various industries: A systematic literature review. Performa: Media Ilmiah Teknik Industri, 24(2), 224–235. https://doi.org/10.20961/performa.v24i2.2746
14. Singh, J., & Singh, H. (2009). Kaizen philosophy: A review of literature. The IUP Journal of Operations Management, 8(2), 51–72.
15. Suárez-Barraza, M. F., & Miguel-Dávila, J. Á. (2011). Implementación del Kaizen en México: Un estudio exploratorio de una aproximación gerencial japonesa en el contexto latinoamericano. Innovar, 21(41), 19–38.
16. Suárez-Barraza, M. F., Miguel-Dávila, J. Á., & Castillo-Arias, I. (2011). La aplicación del Kaizen en las organizaciones mexicanas: Un estudio empírico. GCG: Revista de Globalización, Competitividad y Gobernabilidad, 5(1), 60–74.
17. Vázquez Rojas, A. M., Rodríguez Juárez, E., & González Gómez, D. X. (2016). Un análisis de la productividad manufacturera en el Estado de Hidalgo. Cimexus, 11(2), 13–28.