Redesign of the Cash Reconciliation Process in a Banking Institution through the Application of the SMED Methodology

Author: Admaris A. Borges Guzmán
Advisor: José A. Morales, Ph.D.
Master in Manufacturing Competitiveness
Graduate Project EXPO, February 2026

Abstract

This project presents the redesign of the cash reconciliation process in a banking institution through the application of the Single-Minute Exchange of Die (SMED) methodology adapted to a service environment. Traditionally, reconciliation activities were concentrated at the end of the workday, resulting in extended closing times, operational pressure, and delayed discrepancy detection. The redesigned process redistributed reconciliation tasks throughout the day using partial cash counts and continuous verification. A quantitative before-and-after analysis was conducted using time measurements, normality evaluation, and hypothesis testing. Results showed a 27.63% reduction in total reconciliation time, improved process stability, and statistically significant differences between the original and redesigned processes. The findings demonstrate that SMED can be effectively applied in banking operations to improve efficiency while strengthening internal control through preventive and continuous monitoring.

Introduction

- Cash reconciliation is a critical daily process in banking operations.
- Ensures accuracy between physical cash and system records.
- Traditionally performed at end-of-day, creating workload concentration.
- Lean methodologies offer opportunities to improve efficiency in service processes.
- This study applies SMED to redesign the reconciliation process in a banking environment.

Background

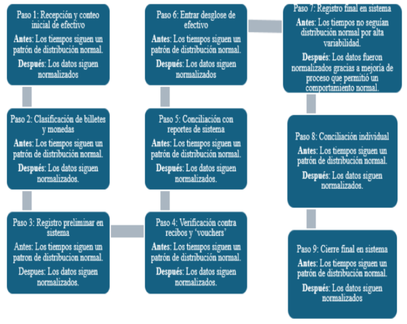
- SMED was developed to reduce changeover time in manufacturing processes.
- The methodology separates internal and external activities.
- In service environments, “changeover” can be interpreted as operational transitions.
- Lean service literature supports workload redistribution and continuous controls.
- Internal control frameworks emphasize early detection and monitoring of discrepancies.

Problem

- Reconciliation activities were concentrated at the end of the workday.
- Long closing times increased operational pressure on cashiers.
- Lack of task distribution limited efficiency and process stability.
- Need for a method that improves efficiency without weakening internal control.

Methodology

- Research design: Applied, quantitative, non-experimental before-and-after study conducted in a banking institution.
- Process analysis: Direct observation and documentation of the original cash reconciliation process, consisting of nine sequential steps primarily executed at end-of-day.
- Data collection:
  Execution time measured in seconds for each step and for total reconciliation time. Five observations collected under the original process and five under the redesigned process.
- Measurements taken under normal operating conditions to ensure representativeness.
- SMED application:
  Identification of internal activities (performed only at closing) and external activities (possible during operations).
- Conversion of selected internal activities into external ones through partial cash counts and continuous verification.
- Redistribution of workload throughout the workday to reduce end-of-day concentration.
- Process standardization: Updated operating procedures to ensure consistent execution of redesigned steps.
- Statistical analysis:
- Descriptive statistics (mean, standard deviation, coefficient of variation).
- Normality verified using probability plots.
- Hypothesis testing performed at $\alpha = 0.05$ to assess statistical significance of time reductions.



Average Execution Time per Step Before and After Redesign

Para el proceso antes del cambio

Estadistica Descriptiva para Proceso *Antes* del cambio

Variable	N	Mean	SE Mean	StDev	Coef-Var	Minimum	Q1	Median	Q3	Maximum	Range
Paso 1	5	166.4	10.9	24.4	14.7	127.0	142.5	181.0	183.0	184.0	57.0
Paso 2	5	158.0	15.1	33.7	21.3	126.0	131.5	139.0	194.0	202.0	76.0
Paso 3	5	603.0	30.9	69.1	11.5	491.0	544.5	606.0	660.0	663.0	172.0
Paso 4	5	343.4	23.9	66.8	7.1	838.0	891.0	950.0	992.5	1023.0	185.0
Paso 5	5	555.8	28.8	64.5	11.6	483.0	497.0	548.0	618.5	645.0	162.0
Paso 6	5	168.0	21.1	47.1	28.0	122.0	125.5	153.0	219.0	220.0	98.0
Paso 7	5	76.4	4.2	9.3	12.2	71.0	71.5	73.0	83.0	93.0	22.0
Paso 8	5	74.8	5.4	12.2	16.3	65.0	65.5	67.0	88.0	90.0	25.0
Paso 9	5	194.8	8.9	19.9	17.4	93.0	93.5	122.0	132.5	134.0	41.0

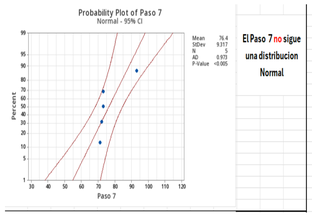
Para el proceso despues del cambio

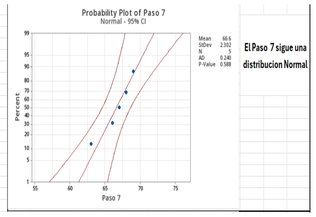
Estadistica Descriptiva para Proceso *Despues* del cambio

Variable	N	Mean	SE Mean	StDev	Coef-Var	Minimum	Q1	Median	Q3	Maximum	Range
Paso 1	5	111.0	6.1	13.6	12.2	93.0	100.0	109.0	123.0	133.0	34.0
Paso 2	5	128.8	6.2	13.9	10.8	109.0	115.0	133.0	140.5	142.0	34.0
Paso 3	5	359.4	6.7	14.9	4.1	337.0	344.5	366.0	371.0	374.0	37.0
Paso 4	5	527.0	41.1	92.0	17.5	371.0	450.0	561.0	587.0	611.0	240.0
Paso 5	5	476.2	16.7	37.4	7.9	419.0	443.0	476.0	509.5	513.0	94.0
Paso 6	5	186.2	6.7	15.1	8.1	171.0	172.0	188.0	193.5	208.0	37.0
Paso 7	5	66.6	1.0	2.3	3.5	63.0	64.5	67.0	68.5	69.0	6.0
Paso 8	5	73.2	2.5	5.6	7.7	66.0	68.5	72.0	78.5	81.0	15.0
Paso 9	5	141.8	14.1	31.4	22.2	117.0	117.5	123.0	175.5	194.0	77.0

Results and Discussion

- The redesigned process reduced average total reconciliation time from 47.7 minutes to 34.5 minutes, representing a 27.63% reduction.
- Standard deviation decreased, indicating improved process stability and consistency.
- Normal probability plots confirmed that both the original and redesigned processes followed an approximately normal distribution, validating the use of parametric statistical tests.
- Hypothesis testing showed statistically significant reductions in the total reconciliation time and in several of the longest process steps. The most time-consuming steps prior to redesign experienced the greatest improvements, consistent with SMED principles targeting high-impact activities.
- Shorter-duration steps showed minimal variation, indicating that efficiency gains did not negatively affect stable activities.
- From an internal control perspective, the redesigned process shifted the operation from a corrective control model to a preventive and continuous verification model, enabling earlier discrepancy detection.





Total Reconciliation Time Before and After Redesign

Means Hypothesis	TOTAL		Variance Hypothesis
Ho: μ antes	EQUALS TO	μ después	Ho: σ a EQUALS TO σ b
Select one: 1 = YES	MORE THAN	LESS THAN	NOT EQUAL: 1
H1: μ a	MORE THAN	μ b	H1: σ a MORE THAN σ b

Paso	Antes	Después
Dia 1	2837	2011
Dia 2	2977	2101
Dia 3	2752	2156
Dia 4	2877	2079
Dia 5	2860	2004
N	5	5
Min	2860.6	2070.2
Std Dev	80.9	63.8

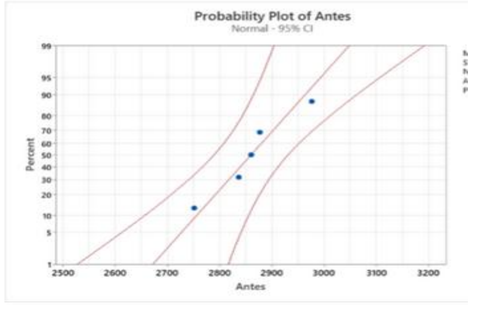
Mean Hypothesis Test Results		
Std. Dev.	80.9	63.8
X Bar	2860.6	2070.20
N	5	5
T exp	17.16	
V	8.0	
P-value	0.0000	
Alpha	0.05	

Min Antes es mayor que Min Despues

Variance Hypothesis Test Results		
	A	B
Sigma	80.9	63.8
V	4	4
F exp	1.61	
P-value	0.328	
Alpha	0.05	

There is not enough evidence to reject Ho, Both Variances are equal

Means Hypothesis	TOTAL	Variance Hypothesis



Conclusions

- The application of SMED significantly improved the efficiency of the cash reconciliation process in a banking environment.
- A 27.63% reduction in total reconciliation time was achieved and confirmed as statistically significant.
- Process variability decreased, indicating a more predictable and stable operation.
- Redesigning the process through workload redistribution reduced end-of-day stress and reliance on last-minute corrective actions.
- Continuous verification throughout the day strengthened internal control by enabling earlier detection of discrepancies.
- The study demonstrates that process efficiency and internal control are complementary, not conflicting objectives.
- Findings confirm that SMED can be successfully adapted beyond manufacturing into financial and service operations.
- The project positions SMED as a strategic framework for operational restructuring in banking institutions.

Future Work

- Apply SMED to other banking closing and settlement processes.
- Increase sample size for extended statistical validation.
- Evaluate long-term impact on error rates and operational risk.
- Explore digital tools to further automate reconciliation activities.

Acknowledgements

The author would like to thank the Polytechnic University of Puerto Rico, José A. Morales, Ph.D., and the participating banking institution for their guidance, support, and collaboration throughout this project..

References

{1} S. Shingo, A Revolution in Manufacturing: The SMED System. Portland, OR, USA: Productivity Press, 1985.

[2] M. L. George, Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services. New York, NY, USA: McGraw-Hill, 2003.

[3] Z. Radnor and P. Walley, “Learning to walk before we try to run: Adapting lean for the public sector,” Public Money & Management, vol. 28, no. 1, pp. 13–20, 2008.