Proceedings of the Fourth Australian International Conference on Industrial Engineering and Operations Management, Melbourne, Australia, November 25-27, 2025

Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AU04.20250030
Published: November 25, 2025

Application of Business Process Management (BPM) and Lean Six Sigma (LSS) to Improve Productivity in Customer Service in the Insurtech sector: A Case Study

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Abstract

This project addresses the productivity problem in the requirement management process of a Latin American Insurtech in the digital services sector. Despite over a decade of experience and regional growth, the company showed substantial gaps versus industry benchmarks in response times, demand coverage, and client satisfaction. The support process lacked standardization, accurate time estimation, and data-driven planning, which became critical with rising demand during peak periods like month-end and billing closures. A diagnostic phase using 2024 operational records revealed an average resolution time of 24.92 days, service capacity covering only 44.96% of demand, and productivity at 0.0441 requirements/man-hour—well below expectations for a digital firm. Root causes included fragmented workflows, lack of real-time monitoring, and poor effort estimation. To solve these issues, a structured improvement model based on BPM and LSS was designed. The solution combined BPM process modeling, Arena simulation with Input Analyzer, and statistical validation in Minitab. A new model process integrated ISO/IEC 20000-1:2018, ISO/IEC 27001:2022, PMBOK domains, and stakeholder insights. Simulation over 118 replications showed a 45% productivity increase, resolution time drop from 299 to 207 hours, and 75-day capacity rising from 53 to 76.9 requirements. Beyond operational gains, the solution avoided extra hiring or infrastructure costs, supporting sustainability and reducing penalty risks of up to 50% on client premiums. This project confirms BPM and LSS as effective tools for small Insurtechs to achieve significant improvements through engineering analysis and without major investments.

Keywords
Business Process Management (BPM), Lean Six Sigma, Insurtech, Service Productivity, Simulation Modeling.

1. Introduction
In the context of rapid digitalization, Insurtech companies face growing pressure to optimize customer service processes while maintaining cost efficiency and compliance with strict service-level agreements (SLAs) that may impose penalties of up to 50% of monthly fees for delays. This challenge is greater in small and medium-sized enterprises (SMEs) in the insurance technology sector, which often operate with non-standardized workflows, limited resources, and minimal capacity planning. This research focuses on a Peruvian Insurtech whose core business is a SaaS platform for insurance operations, complemented by post-sale support and tailored development. However, major operational gaps were found: average requirement attention time is 24.92 days—well above the 15-day industry benchmark—and customer satisfaction lags by 14.6 percentage points, revealing significant productivity and responsiveness issues.

To address these deficiencies, this study designs and validates an improvement model based on BPM and Lean Six Sigma, tailored to a Latin American SME. Empirical and theoretical support include Sandner et al. (2020), who propose a Lean Six Sigma framework for insurance services, and Nurmadewi and Mahendrawathi (2019), who show that BPM adoption strengthens IT alignment. Park and Lee (2020) demonstrate that BPM models built on real data improve agility, while Kane (2022) and Pérez and Gómez (2020) emphasize variability control and quantitative validation, justifying the use of Arena and Minitab.

The proposed solution integrates BPM to redesign workflows and Lean Six Sigma to assess process variability, applying Input Analyzer to fit historical data and Minitab to compute Sigma levels. The TO-BE model was validated through Arena simulations with 118 replications against the AS-IS scenario. Results show a 35% reduction in average attention time, productivity gains above 45%, and improved process predictability. The study offers a replicable, data-driven framework for operational improvement in Insurtech SMEs, filling a gap in literature by combining BPM and LSS with quantitative validation in a complex digital service environment.

This research also contributes to academic discussion by integrating BPM and Lean Six Sigma into a unified, simulation-validated framework. While prior studies examined each separately, this hybrid approach adapts both to the operational reality of Latin American Insurtech SMEs. The model strengthens theoretical understanding of how BPM standardization and Lean Six Sigma's statistical control jointly enhance service productivity and offers a cost-effective framework for small technology-based firms seeking measurable improvements without major investments.

1.1 Objectives
This research project was developed with the purpose of addressing a concrete productivity issue in the customer service operations of a Peruvian Insurtech.

General Objective:
To design and implement a system based on BPM and Lean Six Sigma to improve the capacity and agility of the customer requirement handling process in an Insurtech.

Specific Objectives:
- To diagnose the current situation of the customer requirement handling process.
- To identify the root causes that explain the low productivity and deviation from the KPIs.
- To select the appropriate improvement tools, based on evidence from specialized literature.
- To redesign the process flow using BPM notation.
- To apply Lean Six Sigma to measure variability and process control levels, so that activities requiring reformulation towards the TO-BE model can be identified.
- To quantitatively evaluate the impact of the solution on key indicators such as productivity, average time to handle a requirement, number of requirements attended, and average queue time of a requirement before its development.

2. Literature Review

A systematic literature review was conducted to identify and analyze studies related to Business Process Management (BPM), Lean Six Sigma (LSS), and their application in the service and insurance technology sectors. Following the PRISMA methodology, this review ensured a rigorous selection process based on access, indexing in Q1 and Q2 journals, and direct relevance to the study's objectives. Keywords included combinations of "BPM," "Lean Six Sigma," "insurance," "services," and "technology," resulting in high-quality articles closely aligned with improving service productivity in an Insurtech SME.

Analysis showed that 67.5% of the selected studies directly addressed BPM or Lean Six Sigma, underscoring a strong academic focus on process improvement for service efficiency. Additionally, 60% of the papers came from Q1 journals, reflecting the literature's overall quality.

Several insights from this review directly inform the present research on enhancing productivity and responsiveness in a Peruvian Insurtech's customer requirement handling process. Sandner,P et al. (2020) demonstrated how adapting Lean Six Sigma methodologies to insurance contexts leads to measurable gains in customer satisfaction and reduced operational waste, directly supporting the elimination of manual overload and non-value-adding tasks in this project. Schmiedel et al. (2020) emphasized that fostering a process-oriented organizational culture is critical for BPM success, reinforcing this study's approach of involving key stakeholders during redesign to embed standardized flows into company operations.

Furthermore, Sandner,K et al. (2020) developed a holistic Lean Six Sigma framework tailored for insurance services, demonstrating how combining Lean tools and the Six Sigma DMAIC cycle within a service context can effectively reduce variability and enhance process performance.

Similarly, Nurmadewi and Mahendrawathi (2019) explored how BPM capabilities linked with IT adoption strengthen operational effectiveness in small enterprises, mirroring the challenges faced by the studied Insurtech. By introducing BPM process mapping integrated with the existing digital platform, the project addresses the same gaps that these authors identified. Kane (2022) highlighted clear pathways for variability reduction and flow stabilization under LSS, which directly influenced the TO-BE design focused on shortening cycle times and improving predictability.

Lastly, Macias-Aguayo et al. (2022) discussed combining Industry 4.0 concepts with Lean Six Sigma to create scalable service solutions, validating this study's objective to implement a model that enhances responsiveness while supporting future growth without proportional cost increases.

Collectively, this literature provides a robust theoretical foundation for employing BPM and LSS to address the company's lack of standardized workflows, high process variability, and limited capacity to meet growing digital service demands, justifying their selection as primary improvement tools.

3. Methods

The methodology applied in this research followed a structured engineering approach oriented to diagnosing, redesigning, and validating the support request handling process of a Peruvian Insurtech company operating under a SaaS model. The project began with an in-depth diagnostic phase using tools such as process observation, time measurement, and internal data collection. The analysis was based on a finite population of 264 requirements registered during 2024, from which a representative sample of 157 requests was calculated using the standard formula for finite populations.

The study used a structured engineering approach to diagnose, redesign, and validate a Peruvian Insurtech's support process under a SaaS model. From 264 requests in 2024, a sample of 157 was calculated under the following parameters: a total population of 265 requirements, a Z value of 1.96 (95% confidence level), a standard deviation of 0.85 which is the historical process deviation based on the online platform records and an error of 0.13, equivalent to 5% of the reference value of 2.6 hours.

The AS-IS process, mapped in Bizagi and via interviews, revealed manual, variable steps without capacity planning. Lean Six Sigma tools were applied to redesign (TO-BE), eliminating tasks below Sigma 3 and keeping those above 4. Simulations in Arena, using real data and Input Analyzer distributions, showed a 45% productivity boost and average processing time cut from 299 to 207 hours, with no extra resources. Minitab confirmed statistical significance via t-tests. This aligns with Gijo and Scaria (2020), who validated Lean Six Sigma in services, proving its feasibility for digital firms with limited means.

Figure 1 summarizes the macro design of the proposed model solution, linking the main diagnosed issues (inputs) with the tools applied and the resulting improvements (outputs) under the TO-BE scenario.

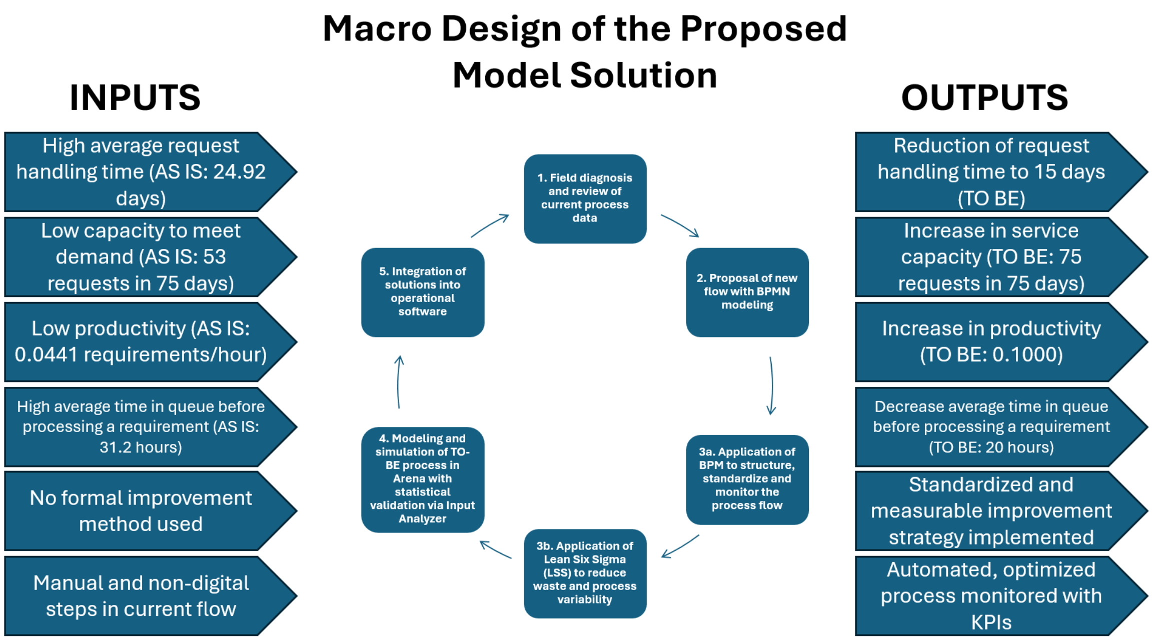


Figure 1. Macro Design of the Proposed Model Solution

The macro-level solution was structured to resolve the diagnosed inefficiencies in the support request process, focusing on four key indicators: request handling time, service capacity, productivity, and process standardization. The intervention was deployed through five sequential steps, beginning with a field diagnosis and process data review, followed by BPMN modeling to redesign the flow. Business Process Management (BPM) was applied to standardize and monitor activities (Nurmadewi & Mahendrawathi, 2019), while Lean Six Sigma (LSS) supported the reduction of waste and process variability through statistical analysis and the identification of low-Sigma tasks (Sandner et al., 2020). Simulation and validation in Arena, complemented by Input Analyzer and Minitab, confirmed significant performance improvements without requiring additional resources. This validates the applicability of structured engineering frameworks in technology-based service firms.

4. Data Collection

The data collection drew on 264 real service requests from the 2024 customer support records in the online platform. Filtering ensured consistency in attention time, arrivals, status, and processing. Descriptive stats showed an average attention time of 24.92 days, evidencing AS-IS delays. Productivity was just 0.0441 requests/man-hour, with only 53 requests closed per cycle, highlighting a major gap. Queue times averaged 31.2 hours, revealing assignment and prioritization lags. Field observations and interviews exposed bottlenecks, manual tasks, reassignments, and lack of planning. This informed the AS-IS Arena simulation and the TO-BE design. Input Analyzer confirmed exponential and triangular distributions, ensuring realistic modeling of task times.

For example, for the process of Understanding the Requirement, a distribution fitting analysis was conducted using Arena's Input Analyzer tool, based on a sample of 157 collected data points. The following hypotheses were established: the null hypothesis (H_0) stated that the times of this process follow a Uniform(1, 2) hours distribution, while the alternative hypothesis (H_1) posited that they do not fit such a distribution. Upon applying the goodness-of-fit tests (Chi-square and Kolmogorov-Smirnov), p-values of 0.75 and 0.15 were obtained respectively, both exceeding the significance threshold of 10%. This indicates that there is insufficient statistical evidence to reject the null hypothesis. Consequently, it is concluded that the data for the process of Understanding the Requirement can be appropriately represented by a Uniform distribution with limits between 1 and 2 hours.

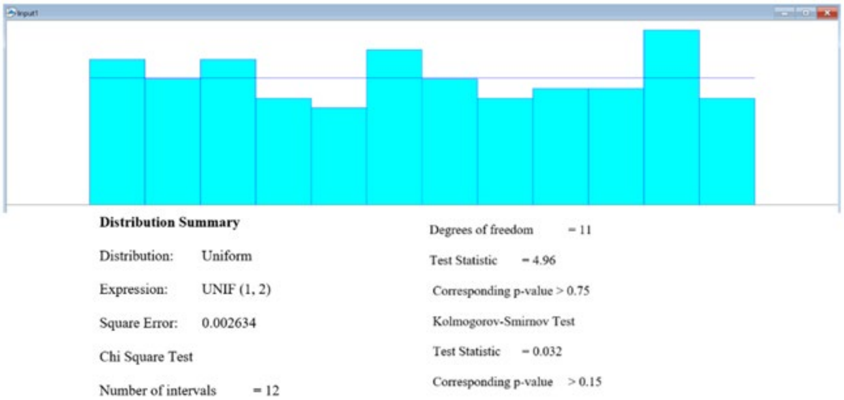


Figure 2. Input Analyzer for the process "Understanding the Requirement"

Additionally, the collected data underpinned the Six Sigma capability analysis (Figure 2), through which each process stage was assigned a Sigma level, providing a deeper understanding of operational variability and pinpointing the most critical subprocesses that needed redesign or elimination. This comprehensive approach to quantitative and qualitative data collection ensured a solid diagnostic foundation that later guided the process restructuring and validation of the proposed improvements.

5. Results and Discussion

The evaluation revealed major gaps in productivity and responsiveness. Initially, the process showed just 0.0441 requests/hour, an average attention time of 24.92 days, only 53 requests attended in 75 days, and 31.2 hours of queue time, exposing absent standardized workflows, poor tracking, and heavy manual work—signs of low process maturity and weak IT integration. This aligns with Schmiedel et al. (2020), who note that lacking a process-oriented culture hinders consistent workflows, harming performance. Similarly, Nurmadewi and Mahendrawathi (2019) emphasize that small firms often face misalignment between BPM and IT, limiting service effectiveness and flexibility. This Insurtech's scattered records and manual prioritization illustrated these risks. Thus, the project's data not only revealed inefficiencies but validated these authors' views, showing how limited maturity and IT integration lead to low productivity and slow responses. After implementing the BPM and Lean Six Sigma-based TO-BE model, results improved: productivity rose to 0.0641, average attention time dropped to 17.25 days, queue time fell to 23.7 hours, and attended requests increased 45.09%, confirming process redesign benefits.

5.1 Proposed Improvements

The proposed solution consolidated and eliminated tasks with Sigma levels below 3, such as redundant technical validation steps and repeated manual prioritizations that introduced unnecessary delays and increased variability. This specific threshold was chosen because activities operating under 3 Sigma typically exhibit high variability and low predictability, making them unsuitable for processes that demand stable and repeatable outputs, especially in a digital services context. Conversely, processes that maintained Sigma levels above 4 were preserved due to their operational consistency and low variation, which aligned with the objective of sustaining reliable service delivery without additional supervision. This approach reflects the principles of Lean Six Sigma, which emphasize reducing process variation and eliminating non-value-added activities to achieve greater efficiency. As Gijo and Scaria (2020) explain, Lean Six Sigma is particularly effective in service operations because it systematically identifies wasteful steps and focuses on standardization, thereby improving both process capability and customer satisfaction. In this project, applying these criteria not only reduced the average attention time by approximately 7.67 days but also minimized resource saturation, enabling the company to handle higher demand without increasing staffing levels. By targeting low-Sigma activities for redesign or elimination, the solution ensured that the final TO-BE model was both statistically more robust and aligned with the company's digital operating environment.

Six Sigma equals the difference between the upper specification limit and the process mean, divided by the standard deviation.

The Upper Standard Limit (USL) was obtained from the company's internal procedures.
In traditional Six Sigma applications within manufacturing, a shift of +1.5 sigma is commonly added to the Z-value to account for long-term process drift observed in repetitive mechanical operations. However, this adjustment is not universally applicable, especially in service contexts where process variability is primarily caused by human factors, customer interactions, and less standardized workflows. As highlighted by Psychogios, Atanasovski, and Tsironis (2012), implementing Lean Six Sigma in service industries presents unique challenges due to the inherent complexity and unpredictability of service processes, which differ significantly from the structured environments of manufacturing. Therefore, assuming a standard 1.5 sigma shift in such cases may lead to inaccurate capability estimations and misguided performance assessments (Table 1 and Table 2).

Table 1. Sigma level classification of activities

Process	Mean	Std Dev	USL	Sigma Level
Request comparative priority	9.73	2.33	14.86	2.2
Sending priorities	14.88	2.51	20.55	2.26
Recording priority in online platform	11.88	1.56	15.50	2.32
Service Delivery prioritization committee	14.2	1.11	16.84	2.38
General prioritization committee	9.26	1.98	14.11	2.45
Meeting with client	40.00	5.54	57.73	3.20
Filling out requirement form	8.43	2.73	15.45	2.57
Approval of requirement sheet	12.86	2.14	18.49	2.63
Approval of requirement sheet	9.21	2.09	14.83	2.69
Uploading requirement sheet	9.2	2.56	16.24	2.75
Functional scope committee	11.44	2.08	17.30	2.82
Notification to client	14.06	1.59	18.63	2.87
Final requirement approval	10.77	2.76	18.89	2.94
Preliminary technical analysis	14.03	2.67	21.04	2.63
Arrival of requirements	12.84	1.64	20.73	4.81
Understanding the requirement	15.23	1.08	20.55	4.93
Recording requirement in online platform	14.89	1.77	23.79	5.03
Technical analysis committee	13.69	1.1	19.35	5.15
Development of the requirement	16.82	1.62	25.35	5.27
Technical review and validation	18.01	2.23	24.26	2.8
Client approval	12.34	1.41	20.07	5.48
Deploy to production	12.35	1.42	20.27	5.58
Functional tests	1.5	0.22	2.71	5.5
Delivery to client	45	2.47	58.83	5.6

The Sigma levels calculated for the AS-IS process show that most activities in the customer requirement handling flow operate below a Sigma level of 3, indicating high variability and low process capability. Tasks such as "Request comparative priority," "Sending priorities," and multiple approval steps had Sigma levels ranging from 2.2 to 2.9, confirming the lack of standardization and consistency. Only a few activities, like "Arrival of requirements," "Understanding the requirement," "Recording priority in online platform," and final stages like "Client approval" and "Delivery to client," exhibited Sigma levels above 4, reflecting stable, low-variability operations.

This analysis underscores why the improvement strategy focused on eliminating or consolidating low-Sigma activities while preserving high-Sigma ones. By targeting the weakest segments of the process, the redesigned TO-BE model effectively reduced operational waste, improved predictability, and increased throughput. These findings directly justify the Lean Six Sigma-driven approach of prioritizing process stability and customer-centered flows to achieve measurable gains in productivity and responsiveness without additional staffing.

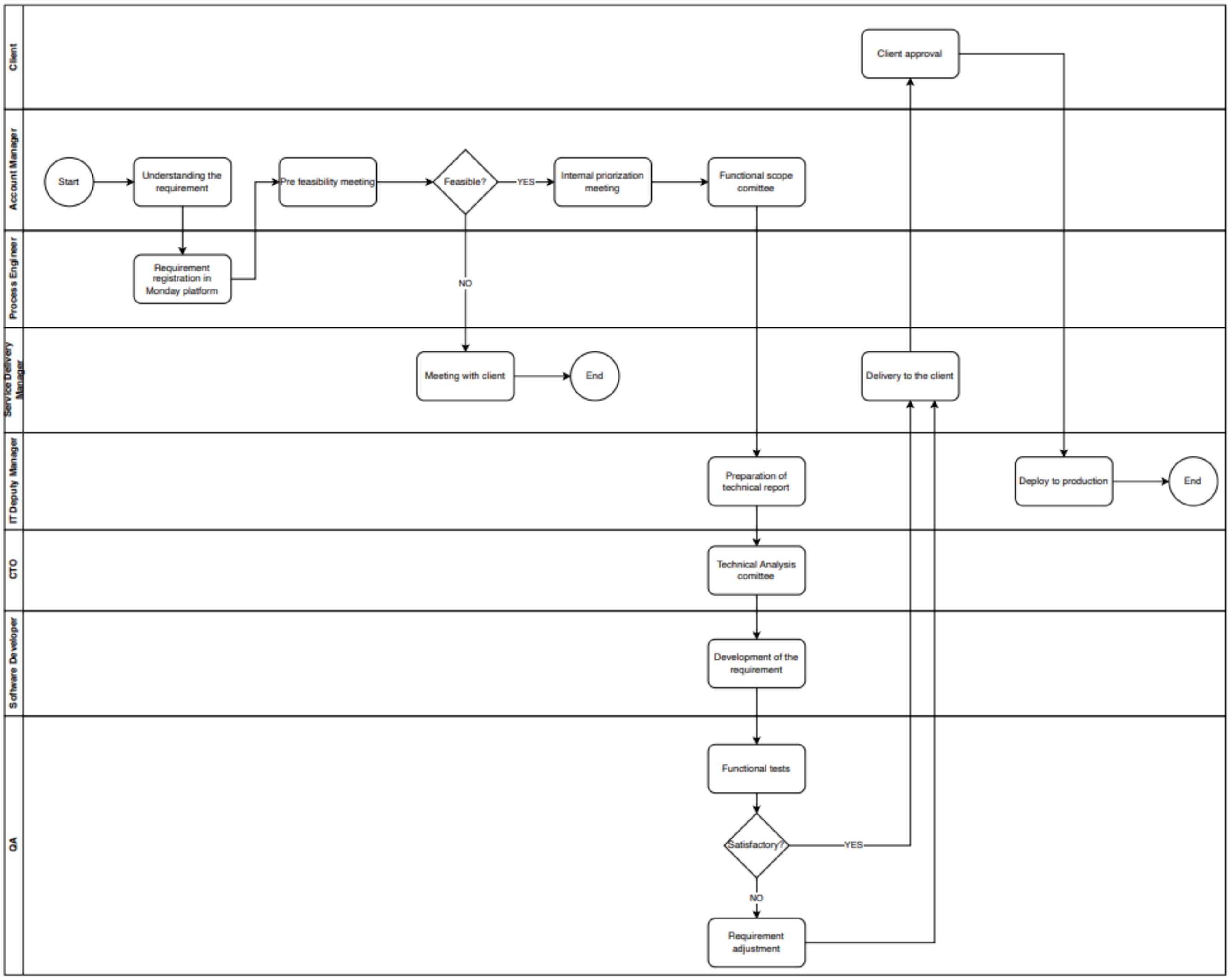


Figure 3. Proposed Model flow in Bizagi using BPM

The redesign of the customer requirement handling process was performed through BPM (Figure 3), using BPM diagrams to identify inefficiencies and restructure flows. The old model displayed a highly fragmented process with multiple manual validations and committee meetings, which contributed to excessive average attention times and bottlenecks. From an industrial engineering perspective, these issues reflected a lack of standardization, unnecessary handoffs, and limited capacity planning.

Applying Lean Six Sigma principles, the improvement strategy classified each activity based on its Sigma level. Activities with Sigma levels below 3 were identified as high-variability and low-control tasks, which included redundant prioritization requests, repeated technical validations, and several approval committees that did not add direct value to the customer. These were either eliminated or adjusted in regard to time lapse. On the other hand, activities with Sigma levels above 4 were retained, such as the technical analysis committee, the registration in the online platform, and the development and production release stages, due to their operational stability and predictability.

Through BPM, the proposed model flow was redesigned to simplify decision routes, reduce manual interventions, and strengthen traceability by consolidating inputs into the online platform. This also incorporated earlier technical filters and a pre-feasibility meeting to identify critical requirements upfront. The redesign thus aligned with Lean Six Sigma objectives by minimizing process variability, reducing unnecessary queues, and directly enhancing throughput, all while ensuring compliance with international standards like ISO/IEC 20000-1 for continuous improvement. This structured reconfiguration demonstrates how industrial engineering tools can transform a high-complexity digital service flow into a streamlined, customer-focused operation.

Recent studies highlight the importance of balancing operational control with adaptability in digital environments. Helbin and Van Looy (2021) argue that Business Process Management must evolve toward organizational ambidexterity — the capability to simultaneously exploit current efficiencies and explore new digital innovations. This principle directly supports the dual-focus strategy implemented in this project, which aimed to reduce variability while enabling scalability through structured yet flexible workflows.

Moreover, Antony, Gupta, and Sunder (2019) emphasize that implementing Lean Six Sigma in digital service environments requires addressing both process variability and technological adaptability. Their findings support the structured redesign carried out in this study, which aligned process simplification with digital traceability to improve performance while ensuring integration with the company's SaaS platform.

5.2 Numerical Results

The comparison of the AS-IS and Results scenarios shows substantial progress in all KPIs: productivity rose by 42.44%, requirements attended increased to 77, average attention time dropped by 30%, and the queue time decreased by 24%. These changes are not only substantially significant but crucial for operational management, evidencing a process redesign that boosts capacity without raising resources.

Table 2. Summary of KPIs

KPI	AS-IS	TO-BE	Results	Unit
Productivity	0.0441	0.1000	0.0641	requirements/man-hour
Requirements attended in 75 days	53	75	77	requests
Average time in queue before processing a requirement	31.2	20	23.7	hours
Average attention time of a requirement	24.92	15	17.25	days

From a process engineering view, this is due to eliminating low Sigma, high-variability tasks, cutting operational waste. Jiménez et al. (2021) indicate Lean Six Sigma identifies non-value activities, replacing them with stable, customer-focused flows, as achieved here through committee consolidation and technical validation standardization. This aligns with ISO/IEC 20000-1:2018 clause 10.2 on continuous improvement, using data to iteratively adjust and refine the system.

Park and Lee (2020) note BPM models based on real data and simulation enhance agility in tech firms, seen here with added pre-feasibility meetings and early technical filters. Kane (2022) outlines Lean Six Sigma improvement paths like reducing variability and stabilizing flows, applied in this TO-BE model. Pérez and Gómez (2020) stress that improvements need quantitative validation; this was ensured through Minitab and Input Analyzer, reinforcing data-driven decisions. Sandner,P et al. (2020) present a Lean Six Sigma approach tailored for insurance, underlining structured improvement to boost efficiency and customer satisfaction, mirrored in this Insurtech's redesigned process. In summary, the BPM and Lean Six Sigma-based TO-BE redesign is more than a substantial upgrade—it's an empirically proven structural transformation. It eases bottlenecks, optimizes resource use, upholds SLAs, and fosters a faster, more predictable, customer-centric operation, showcasing the power of hybrid improvement methods in complex Insurtech environments.

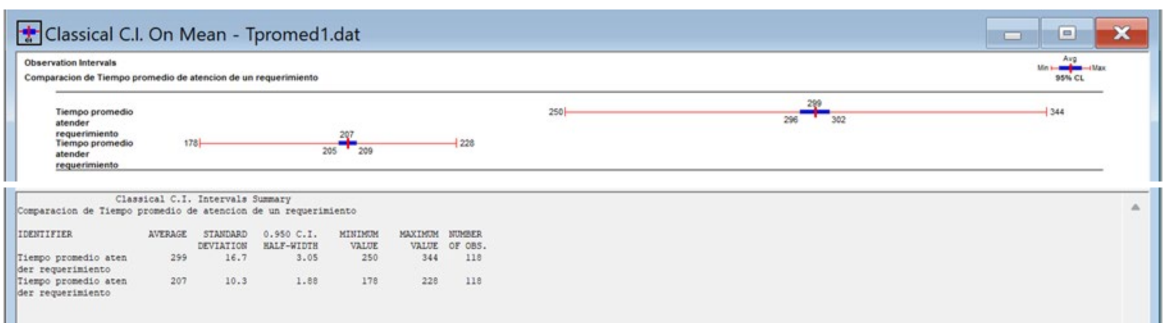
In comparison with previous research that applies BPM or Lean Six Sigma independently, this study demonstrates that combining both under a simulation-based validation cycle achieves stronger and more sustainable performance improvements under constrained resources. Unlike large-scale insurance or manufacturing contexts analyzed by Sandner et al. (2020) and Gijo and Scaria (2020), the proposed model adapts these methodologies to SMEs in emerging markets, where digitalization and data availability are limited. This comparative insight reinforces the theoretical contribution of aligning BPM's process governance with Lean Six Sigma's quantitative rigor, extending their joint applicability to knowledge-intensive digital services.

5.3 Graphical Results

Graphical outputs from Arena and Output Analyzer illustrated the improvement trends. Confidence intervals for productivity and the number of requests attended in the TO-BE model did not overlap with the AS-IS model, signifying meaningful differences. Meanwhile, for average queue time before processing a requirement, the paired means test showed a significant reduction despite initial overlap of intervals. This visualization corroborates the findings by Dumas et al. (2018), who emphasize that business process simulation not only validates proposed improvements before their real implementation but also enables the quantitative comparison of alternative scenarios to anticipate operational impacts. In this context, their work directly relates to the results obtained in this project, since the Arena simulations made it possible to empirically test the redesigned process against the existing one, ensuring that decisions were based on data rather than assumptions. Thus, the use of simulation as recommended by Dumas et al. was key to demonstrating that the process changes in the TO-BE model would effectively reduce variability and improve performance metrics such as productivity and queue time.

In the case of the average attention time of a requirement, Arena initially provided output values in hours. To interpret these results in alignment with how the company tracks its internal metrics (based on effective working days), these values were divided by 12, considering that the simulation and actual operations were modeled over a 12-hour workday. This time frame accurately mirrors the operational window in which customer requests arrive at the company, thereby validating the decision to simulate demand within this period. As a result, the average attention time was transformed from 299 hours in the AS-IS model to approximately 24.92 days, and from 207 hours in the TO-BE model to about 17.25 days, evidencing a substantial reduction in processing time.

Below is the scenario comparison performed using Output Analyzer from Arena to statistically determine whether there was an improvement or not for each KPI.



IDENTIFIER	AVERAGE	STANDARD DEVIATION	0.950 C.I. HALF-WIDTH	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBS.
Tiempo promedio aten der requerimiento	299	16.7	3.05	250	344	118
Tiempo promedio aten der requerimiento	207	10.3	1.88	178	228	118

Figure 4. Comparison of scenarios for average attention time of a requirement

For the indicator of the number of requirements attended, the simulation results directly showed how the redesigned TO-BE model increased capacity, processing an average of 76.9 requests compared to the 53 requests (Figure 4) handled by the AS-IS process under identical conditions. This outcome reflects the improved ability of the process to absorb demand without additional resources.

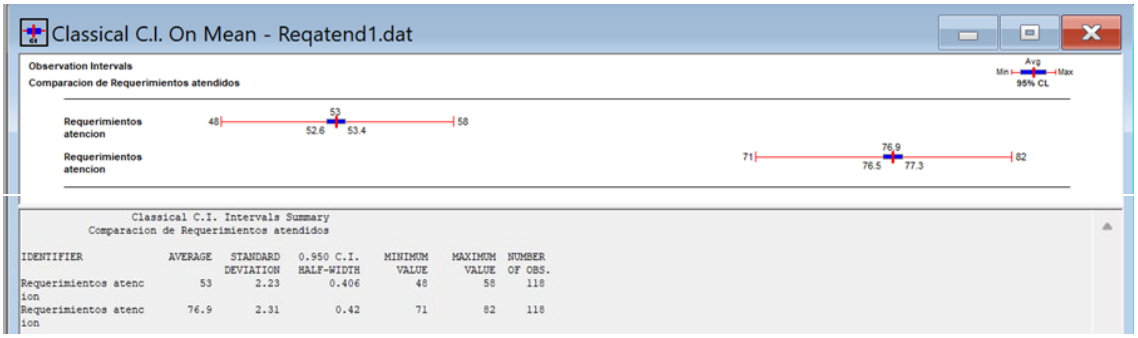


Figure 5. Comparison of scenarios for the number of requirements attended in 75 days

The statistical comparison shows a clear improvement in productivity, with the average increasing from 0.0441 to 0.0641. The 95% confidence intervals do not overlap, indicating a notable difference (Figure 5). This suggests that the implemented changes positively impacted performance.

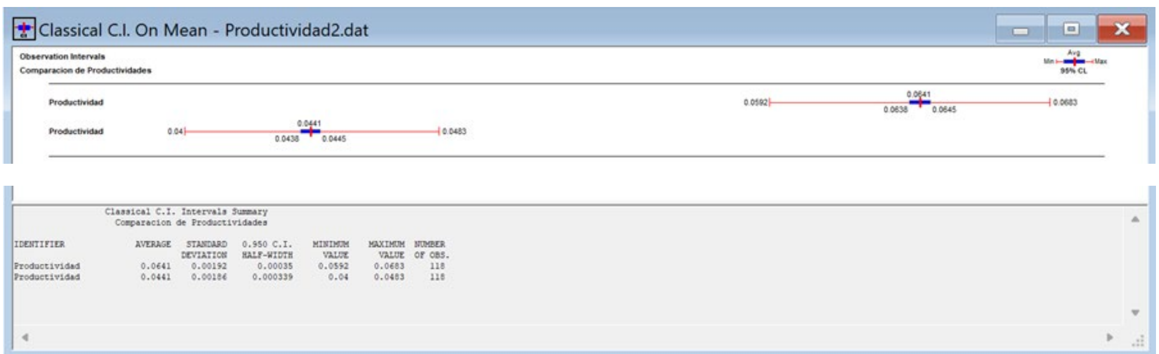


Figure 6. Comparison of scenarios for productivity

For the indicator of average queue time before processing a requirement, an initial scenario comparison using Output Analyzer revealed overlapping confidence intervals (Figure 6), which suggested the possibility of no significant difference. However, to further validate this outcome, a paired means test was applied, which confirmed the existence of a substantially significant difference ($p < 0.05$), with an average reduction of 7.55 hours in queue time. This two-step analysis demonstrated that although initial graphical outputs suggested a partial overlap, the rigorous statistical test provided conclusive evidence that the TO-BE process effectively reduced waiting times before processing, enhancing the overall customer experience and operational flow.

The scenario comparison was carried out through simulations performed in Arena over a period of 75 days, which corresponds to the defined simulation time used to model the operational behavior of the process. This horizon was selected because it effectively represents the typical monthly and extended operational cycles of the company, allowing for a realistic evaluation of how the system handles accumulated requests and workload over a sustained period.

5.4 Validation

Validation was performed through extensive simulation in Arena using 118 replications, ensuring a maximum error of 0.05 for the confidence intervals, consistent with accepted statistical rigor.

To determine the required number of replications, a statistical approach was applied based on the confidence interval for the mean. This method involves calculating the sample size needed to ensure that the half-width of the confidence interval does not exceed the maximum allowable error (0.05). The calculation considers the t-Student distribution value with n–1 degrees of freedom (2.2622, corresponding to 10 initial replications), the standard deviation obtained from the output analyzer, and the desired precision level. The resulting value was then rounded up to the nearest integer to define the final number of replications.

This procedure was repeated for the KPIs measured in the model, and the highest number of replications was ultimately selected.

Minitab was employed to analyze capability indices and to conduct t-tests that confirmed the reduction in both average attention time and process variability. Additionally, the validation was supported by engineering standards, particularly through the PMBOK guidelines on performance and stakeholder management, which ensured that the redesigned model not only met operational metrics but also aligned with the expectations of key internal and external stakeholders through several meetings.

Moreover, the process was aligned with ISO/IEC 20000-1:2018, specifically clauses 6.1 on planning actions to address risks and opportunities, 8.1 on operational control of service processes, and 10.2 on continual improvement. These clauses provided a framework to systematically identify operational risks, implement the redesigned flows under controlled parameters, and establish mechanisms to progressively refine the model based on empirical evidence. Likewise, ISO/IEC 27001:2022 clause 8.1 was incorporated to ensure process traceability and secure handling of information throughout the redesigned service cycle, directly supporting compliance in a digital services environment. This structured alignment with international standards was critical to validate that the proposed model did not simply optimize isolated KPIs but embedded improvement within a robust, auditable, and risk-controlled system, as also highlighted by Liu et al. (2023) for service-driven organizations.

Finally, to reinforce the realism of the study, the actual model was carefully built using real historical data from the company's operational records. The close similarity observed between the real KPIs and those obtained in Arena for the actual scenario confirmed that the simulation reliably replicated the existing process. Subsequently, based on this model, the proposed model was built in Arena, maintaining the same logic and main modules, as shown below in Figure 7.

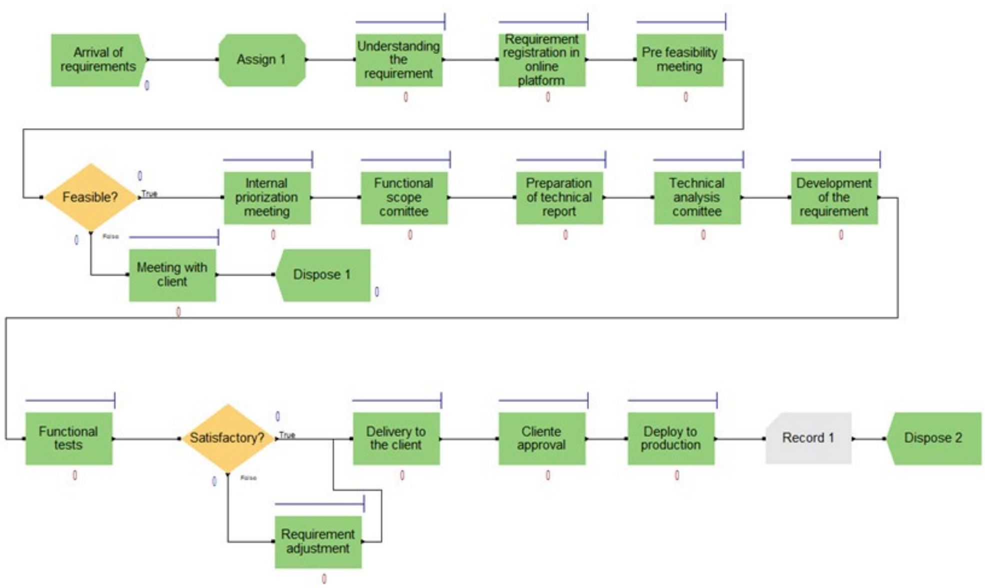


Figure 7. Proposed model in Arena

6. Conclusions

- The implementation of the BPM and Lean Six Sigma-based system allowed the company to substantially increase its process capacity, evidenced by a rise from 53 to 76.9 requests handled per cycle, which represents almost a 45% improvement. This confirms that the approach was effective for tackling the productivity limitations initially diagnosed.
- The detailed analysis of the current process through BPM models and the use of real operational data revealed that excessive manual tasks and the absence of standardization were the main factors behind low productivity. By restructuring these activities, the solution directly attacked the identified root causes.

- The systematic selection and application of improvement tools, supported by specialized literature such as Dumas et al. (2018) and Sandner,P et al. (2020), ensured that the redesign was not arbitrary but rather grounded in proven methodologies for service process optimization.
- The redesign of the process flow using BPM facilitated the visualization of inefficiencies and the strategic elimination or consolidation of tasks with Sigma levels below 3. This decision was quantitatively validated with capability indices and Six Sigma analysis performed in Minitab, supporting the methodological rigor of the TO-BE model.
- Applying Lean Six Sigma not only allowed measurement of process variability but also established notable significant improvements, such as reducing the average total processing time from 299 to 207 hours, which represents a cut of approximately 92 hours per requirement (7.67 days). This was confirmed through Arena simulations and paired means tests.
- The quantitative evaluation demonstrated that the solution positively impacted key performance indicators, notably increasing productivity by more than 42% and reducing average attention time from 24.92 to 17.25 days. Additionally, the average queue time before a requirement was processed showed a significant decrease, reflecting better workload distribution.

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