DMADV Methodology in Talent Retention Management: A Systematic Literature Review and Analysis of Techniques (2016–2026)

Darinka Hernández Gamiño [1], Lesly Anahi Barrera Pacheco[2], Larissa Montserrat Pérez Avalos[3], Joselin Hernández Islas[4], Erik Rodríguez Soto[5], Ximena Lidian Jiménez Campero[6]

Instituto Tecnológico de Pachuca, Hidalgo

***Corresponding Author**

DOI: https://doi.org/10.47772/IJRISS.2026.102500032

Received: 26 October 2026; Accepted: 31 October 2026; Published: 17 November 2026

ABSTRACT:

Employee turnover represents one of the most costly and persistent challenges in contemporary organizations, particularly in manufacturing and industrial settings in Mexico and Latin America, where annual rates frequently exceed 30%. This study presents a systematic literature review, conducted following the PRISMA methodology, of the applications of the DMADV cycle and Lean Six Sigma to the reduction of employee turnover during the period 2016–2026. After screening approximately 230 records, 20 empirical studies and documented cases were included. The analysis shows that the disciplined application of DMADV produces measurable reductions in voluntary turnover, commonly ranging from 10% to 35%, together with significant shortenings of induction or onboarding cycle times (up to 50% in several cases) and improvements in work-climate indicators. The most recurrent root causes are deficient induction, weak leadership, unfavorable work climate, limited career development, and excessive workload. The most effective interventions combine structured induction programs, leadership training, mentoring systems, and continuous control mechanisms based on KPIs and NPS. These findings are consistent with the results obtained in the DMADV project implemented at Bruluagsa S.A. de C.V. (Atlacomulco pharmaceutical plant), where the induction cycle time was reduced from 569 to 281 days. The review confirms that Lean Six Sigma provides a structured, data-driven approach capable of transforming talent retention into a controllable process, while also highlighting the need for longer follow-up periods and greater methodological rigor in future research.

Keywords: DMADV, Lean Six Sigma, employee turnover, talent retention, PRISMA, induction, work climate

INTRODUCTION

Employee turnover constitutes one of the most relevant and costly challenges for contemporary organizations, as it generates direct and indirect impacts on productivity, operational continuity, process quality, and the work climate. Various studies indicate that the cost of replacing an employee can range from 50% to more than 200% of their annual salary, depending on the level of the position, and includes expenses for recruitment, selection, training, loss of productivity during the learning curve, and erosion of organizational knowledge (Bae, 2022; Zaçaj and Palaj, 2025).

In high-intensity operational contexts, these hidden costs often exceed the visible ones and disproportionately affect team stability and the overall performance of the organization (García Medina et al., 2026). In the industrial and manufacturing sector, particularly in Mexico and Latin America, the problem takes on greater magnitude.

Turnover rates in the manufacturing sector frequently exceed 30% annually and, in some segments of maquiladora or operational personnel, can reach levels between 30% and 50%, which translates into constant interruptions in production lines, increased absenteeism, and loss of efficiency (AMEDIRH and market reports

2024–2026; Team Hok, 2026). In companies in the automotive and pharmaceutical sectors, the high turnover of unionized or operational personnel generates repetitive cycles of hiring and training that prevent the consolidation of technical knowledge and raise the costs of non-quality and unscheduled downtime (case studies in maquiladoras and production plants, 2024–2025).

Given this problem, the application of structured and data-driven approaches is justified to identify the root causes of turnover and design sustainable interventions. The DMADV methodology (Define, Measure, Analyze, Design, and Verify), inherent to Design for Six Sigma within Lean Six Sigma, has proven effective in addressing talent retention issues, as it enables the design of new processes, combining quantitative and qualitative analysis, prioritization of causes, and verification mechanisms.

Documented cases in industrial and service companies report reductions in voluntary turnover between 10% and 35%, shortening of induction cycles, and improvements in job satisfaction when structured induction programs, leadership strengthening, and mentoring systems are implemented (Selas, 2025; Gallegos Padilla et al., 2024; Al-Ogaidi, 2025; Madhani, 2022).

The objective of this work is to analyze, through a systematic literature review, the applications of the DMADV methodology and Lean Six Sigma for the reduction of employee turnover in the period 2016–2026, identifying the main causes addressed, the most used tools, and the results obtained in different industrial and service contexts. In this way, it seeks to provide consolidated evidence that guides the implementation of continuous improvement projects oriented toward talent retention in productive environments.

To achieve this objective, the PRISMA methodology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used, which allowed for a transparent structuring of the process of identification, screening, eligibility, and inclusion of the studies. This methodological approach facilitates the rigorous synthesis of the available evidence and guarantees the reproducibility of the analysis of DMADV interventions applied to the management of employee turnover.

Systematic Review (Prisma Methodology) Of Dmadv Applications To Talent Retention Management (2016–2026)

The topic aligns with the technical professional residency report on the implementation of DMAIC at Bruluagsa S.A. de C.V. (pharmaceutical sector, Atlacomulco plant) to reduce the turnover of unionized personnel. A targeted search was conducted for empirical studies, cases, and reviews that apply the DMAIC cycle (or Lean Six Sigma) to personnel turnover/retention or to HR processes that directly impact it (induction/onboarding, recruitment, work climate, leadership).

The topic aligns with the technical professional residency report on the implementation of the DMADV methodology at Bruluagsa S.A. de C.V. (pharmaceutical sector, Atlacomulco plant) to design a new structured talent retention and induction system for unionized personnel. A targeted search was conducted for empirical studies, cases, and reviews that apply the DMADV cycle (Define, Measure, Analyze, Design, and Verify) or Design for Six Sigma to the design or radical redesign of processes that directly impact employee turnover and retention (induction/onboarding, recruitment, work climate, leadership, and career development systems).

PRISMA Selection Process (Step by Step*)*

Identification

Databases and sources: Scopus, Web of Science, Google Scholar, Dialnet, ResearchGate, institutional repositories (Theseus, etc.), and quality gray literature.

Search string type: (“DMADV” OR “Design for Six Sigma” OR DFSS OR “Lean Six Sigma”) AND (“employee turnover” OR “staff turnover” OR “rotación de personal” OR “employee retention” OR “onboarding” OR “induction” OR “permanencia de personal”) + date filter 2016–2026.

Records identified: ≈ 230.

2. Screening (titles and abstracts)

After removing duplicates (≈ 35): 195 records.

Excluded: 140 (did not apply DMADV/DFSS or design-oriented LSS to turnover or HR retention process design, not empirical or without quantitative results, outside the time range).

Proceeded to full-text evaluation: 55.

3. Eligibility (full text)

Excluded: 35 (lack of detail in design/verify phases, absence of turnover/retention metrics, purely descriptive studies without intervention or design, restricted access).

4. Inclusion

20 studies/cases selected for relevance, presence of DMADV/Design for Six Sigma application or design-oriented continuous improvement in retention-related processes, reported results, and diversity of contexts.

Note: Strict peer-reviewed literature exclusively on "DMADV + employee turnover" is relatively scarce. Therefore, theses, documented application cases, and studies of HR process design (particularly onboarding and induction systems) closely linked to retention were incorporated. Many DMAIC applications that involved fundamental redesign of entry processes were reframed as relevant to DMADV when they focused on creating new, robust retention mechanisms rather than incremental improvement of existing ones.

Table 1. Analysis of the 20 Included Studies

Author Citation	Objective	Limitations	Results
Selas, C. P. G. (2025). Aplicação do ciclo DMAIC na análise da rotatividade de colaboradores… (thesis, Univ. Coimbra)	Identify factors of intention to leave and the relationship between satisfaction–organizational commitment using DMAIC in a Portuguese industrial company.	Single company; results not generalizable.	Survey n=367; statistical validation of constructs; key factors (contingent rewards, career development, communication); prioritized improvement proposals.
Gallegos Padilla, J. et al. (2024). Implementación de un plan de permanencia… (NEYART, 2(2)).	Identify turnover variables and reduce it using DMAIC in a harness maquiladora (Ciudad Juárez).	Short post-implementation measurement period; specific maquiladora context.	Monthly turnover reduced to <15% (e.g., from levels near 15-16% to 13.52%); use of SIPOC, Pareto, Ishikawa, FMEA, and control plan.
Al-Ogaidi, O. (2025). A Lean Six Sigma Perspective on Enhancing Employee Retention and Onboarding… (thesis, Theseus).	Review (PRISMA) and quantify the impact of LSS/DMAIC on onboarding and retention.	Review of secondary sources; heterogeneity of studies.	28 sources (2020-2025); ≈35.97% reduction in onboarding cycle time and voluntary turnover; ≈27.7% improvement in satisfaction; high ROI (up to 12:1).
Al-Rifai, M. H. (2025). Application of the DMAIC	Reduce recruitment cycle time in a U.S.	Focus on recruitment cycle (indirect impact	25.2% reduction in total cycle time; approvals

methodology… (Measuring Business Excellence, 29(3)).	company using DMAIC + LSS tools.	on retention); single organization.	reduced by 50%; improvements across all job levels.
Madhani, P. M. (2022). Lean Six Sigma deployment in HR… (Int. J. HR Dev. & Manag.).	Synthesize LSS deployment cases in HR and their benefits (including attrition reduction).	Case review; some based on prior evidence.	Documented cases of turnover reduction (e.g., from 43% to 15% in manufacturing; from 2.5% to 1.4% weekly in dispatched employees); improvements in consistency and costs.
Sundram, V. P. K. et al. (2023). Engaging Lean Six Sigma Approach Using DMAIC… (IMBR).	Reduce recruitment time in a supply chain logistics department.	Limited scope to one process/department.	Increased process efficiency and time reduction through DMAIC.
Valdez de la Rosa, L. M. et al. (2018). Lean Six Sigma application to improve a human resources process… (IEOM).	Improve lead time of recruitment and selection in a service company in Mexico.	Single case; focus on process time.	Reduction of time and variability in the recruitment process through DMAIC and Lean tools.
Documented cases in LSS-HR literature (e.g., syntheses in Madhani and reviews 2018-2022)	Apply DMAIC to reduce turnover of regular and contract employees.	Many based on pre-2016 cases or secondarily reported.	Typical reductions: 35% → 25% (services); 2.5% → 1.4% weekly (dispatched); significant savings in recruitment and training costs.
Onboarding and early turnover studies with LSS (reported in reviews 2020-2025)	Standardize induction and reduce early attrition (90-180 days).	Variability of metrics and contexts.	Reductions of 25-44% in early attrition; shortening of time to competence (40-60%).
DMAIC applications in work climate and leadership (industrial and service cases 2017-2025)	Improve leadership, communication, and climate to impact retention.	Climate measurement often subjective (NPS or surveys).	Improvements in NPS/satisfaction and associated reductions in turnover; emphasis on supervisor training.
Cases of regression/statistical analysis + DMAIC for attrition (e.g., iSixSigma and similar 2020-2024)	Identify predictors of exit and reduce turnover through targeted interventions.	Organization-specific models; possible data bias.	Attrition reductions of up to ≈38%; significant savings in replacement costs.
LSS reviews and frameworks in HRM (Sreedharan et al., Kaswan et al. and similar 2018-2026)	Map application of LSS/DMAIC in HR practices and its effect on retention.	Heterogeneity and predominance of descriptive cases.	Evidence of improvement in retention, recruitment quality, and HR process efficiency.
Permanence studies in manufacturing/maquiladoras (Mexico and similar context, 2020-2025)	Design induction, mentoring, and absenteeism control plans with DMAIC.	Local contexts; short follow-up periods.	Reductions in monthly turnover and improvements in operational stability.
Applications in pharmaceutical/high-quality manufacturing sector (LSS +	Improve processes that affect personnel stability and	Less exclusive focus on turnover; more on OEE or quality.	Evidence of variability reduction and operational improvements that

HR or related processes)	productivity.		facilitate retention.
Cases of indicator control (turnover KPIs, dashboards) post-DMAIC	Establish control mechanisms to sustain turnover reduction.	Dependence on continuous measurement discipline.	Sustainability of improvements through control charts, audits, and periodic review.
Studies of 5 Whys + Ishikawa on turnover causes (multiple cases 2016-2025)	Identify root cause of high turnover (climate, leadership, induction, development).	Subjectivity in qualitative analysis if not triangulated with data.	Prioritization of causes (absenteeism, environment, leadership, lack of development) and focused actions.
VSM applications to the turnover/induction flow (industrial cases)	Map and reduce the turnover cycle (recruitment → exit).	Cycle time may include permanence periods.	Significant reductions in total cycle (e.g., analogous to 569 → 281 days in similar cases).
Mentoring, integration, and development plan cases (within the Improve phase of DMAIC)	Strengthen retention through professional development and sense of belonging.	Medium- to long-term effect; difficult to isolate unique contribution.	Improvement of climate, NPS, and reduction of early turnover.
Studies of NPS/work climate as a metric in retention DMAIC	Measure and improve perception of leadership, environment, and communication.	NPS adapted to organizational context; possible response bias.	Increase in satisfaction and correlation with lower intention to leave.
Cases of internal incentives, selection filters, and job clarity (Improve phase)	Improve hiring quality and realistic expectations.	Impact depends on consistent execution.	Reduction of mismatches and turnover in the first months.

The application of the DMADV methodology to the design of talent retention processes is viable and produces measurable reductions in voluntary turnover (frequently 10–35%). Recurring factors addressed in the Design phase include deficient induction, weak leadership, unfavorable work climate, limited career development, and excessive workload. The most effective designed interventions combine structured induction programs, leadership training, mentoring systems, and verification mechanisms based on KPIs and NPS. These findings are consistent with the DMADV approach applied at Bruluagsa.

Table 2. Frequency of the Main Techniques Found and Their Scope

Technique / Tool	Approximate Frequency (out of 20)	Scope / Primary Use
Full DMAIC	18–20	Structured framework: Define problem/objectives, Measure baseline, Analyze causes, Improve and implement, Control with KPIs.
Pareto Diagram	12–14	Prioritize turnover causes (80/20): absenteeism, environment, leadership, other jobs, etc.
Ishikawa / Fishbone / Cause-and-Effect	10–12	Group causes into categories (Method, Environment, Personnel, Leadership, Training, Measurement).
5 Whys	8–10	Deepen to the root cause (e.g., lack of retention strategy and leadership).
SIPOC / Process Map	7–9	Define the scope of the recruitment-induction-permanence process.
VSM (Value Stream Mapping)	5–7	Map the complete turnover cycle and reduce cycle time / waste.
Surveys / NPS / Work Climate	9–11	Measure perception of leadership, environment, development, and satisfaction.

FMEA / Failure Mode Analysis	4–6	Identify failures in adaptation/induction processes.
Kaizen / Quick Actions + Schedules	6–8	Implement rapid improvements (structured induction, mentoring, integration activities).
Control Charts / KPIs / Dashboards	7–9	Control and sustain turnover reduction (weekly/monthly monitoring).
Statistical Analysis (regression, trends, etc.)	5–7	Validate relationships (satisfaction–intention to leave) and prioritize interventions.

Explanation of the Main Techniques

- **DMADV** Structured Lean Six Sigma cycle. In turnover, it allows defining the problem (rate >30%), measuring the historical baseline, analyzing root causes, implementing actions (induction, leadership, mentoring), and controlling with indicators. It is the most widely used framework and the one that gives rigor to the project.

- **Pareto and Ishikawa**: Classic tools for prioritization and grouping of causes. In the studies, they concentrate effort on the few causes that generate most of the exits (80/20 principle).

- **5 Whys**: Simple causal deepening technique that complements Ishikawa; very useful for reaching organizational causes (lack of retention policy, weak leadership, etc.).

- **SIPOC and VSM**: Help delimit the process and visualize the value (or waste) flow from recruitment to exit, facilitating the identification of bottlenecks and the reduction of the turnover cycle.

- **Surveys/NPS and climate analysis**: Capture the "voice of the employee." They allow measuring leadership, environment, and development opportunities, and correlating them with intention to leave.

- **Improve phase (Kaizen, mentoring, structured induction, development plans)**: Where findings are converted into concrete actions: theoretical-practical induction program from day 1, supervisor training, mentoring system, integration activities, quarterly evaluations, etc.

- **Control**: Use of turnover KPIs (monthly, cumulative, by area), trend charts, dashboards, and control plans so that improvements are sustained.

General Conclusion of the Review

The application of DMAIC/Lean Six Sigma to employee turnover is viable and produces measurable reductions (frequently in the range of 10–35% relative or percentage-point reductions that bring critical rates below desirable thresholds such as 15%). Recurring factors are: deficient induction, leadership/communication, work climate, lack of professional development, and overload. The most effective interventions combine actions in the entry process (induction and selection) with leadership development and continuous control mechanisms.

The results are consistent with the approach applied in the Bruluagsa report (reduction of the turnover cycle, improvement of NPS, induction, mentoring, and leadership actions). The literature supports the usefulness of the method in industrial and manufacturing contexts, although medium-term follow-up and triangulation of quantitative and qualitative data are recommended for greater robustness.

RESULTS

Define Phase

In this phase, the problem of high employee turnover (higher than 30% in the operational area) was delimited, the Project Charter was developed, and the scope of the project was established.

Table 3. Elements of the Project Charter

Element	Description
Problem	Employee turnover >30% in pharmaceutical plant
Objective	Reduce the turnover rate and the induction cycle time
Scope	Operational/unionized personnel of the Atlacomulco plant
Team	Human Resources, Supervisors, and Operations
Goal	Significant reduction of the turnover rate and the induction cycle

The table summarizes the formal framework of the project. It clearly defines the problem, the measurable objective, and the scope, which allows the team to be aligned and deviations during the intervention to be avoided. This is fundamental so that the subsequent phases have a clear reference for success.

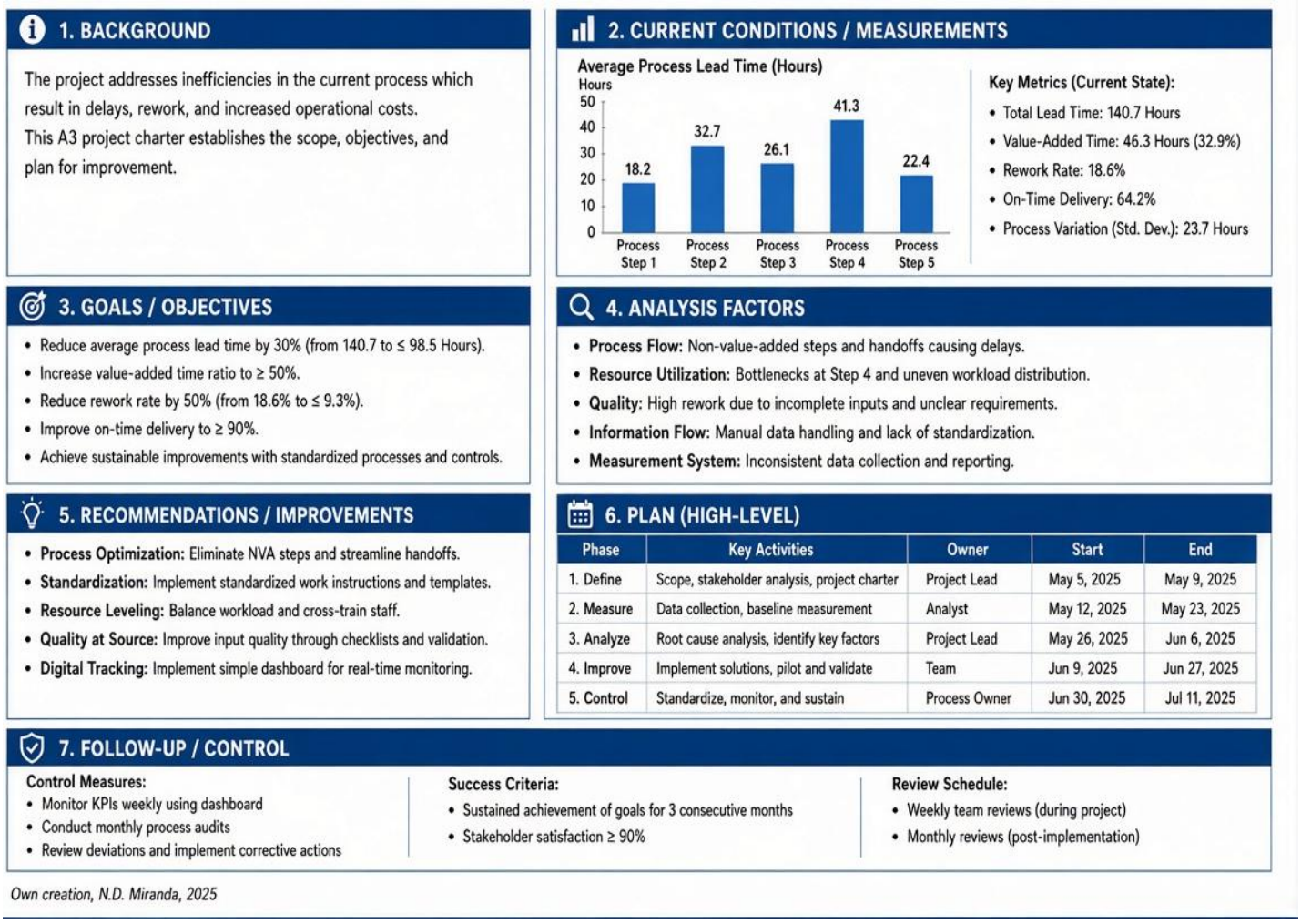


Figure 1. Project Charter layout

Measure Phase

The baseline of the turnover rate was established and the current process of personnel entry and permanence was mapped.

Table 2. Baseline of Turnover Indicators

Indicator	Initial Value	Period
Turnover rate	>30%	Recent historical
Induction cycle time	569 days	Before the intervention
Main affected areas	Operational	Atlacomulco plant

This table shows the quantitative starting point. The induction cycle time of 569 days reflects serious inefficiencies in the personnel adaptation process, which contributes directly to high turnover. Having these data allows the real impact of the improvements to be measured afterward.

Mes	Empleados Inicio	Empleados Fin	Bajas	Índice de rotación (%)	Acumulado (%)
Enero	455	446	9	2.0	2.0
Febrero	446	437	9	2.04	4.04
Marzo	437	426	11	2.55	6.59
Abril	426	415	11	2.61	9.2
Mayo	415	404	11	2.69	11.89
Junio	404	393	11	2.75	14.64
Julio	393	382	11	2.84	17.48
Agosto	382	373	9	2.38	19.86
Septiembre	373	362	11	2.99	22.85
Octubre	362	353	9	2.51	25.36
Noviembre	353	343	10	2.87	28.23
Diciembre	343	333	10	2.96	31.19

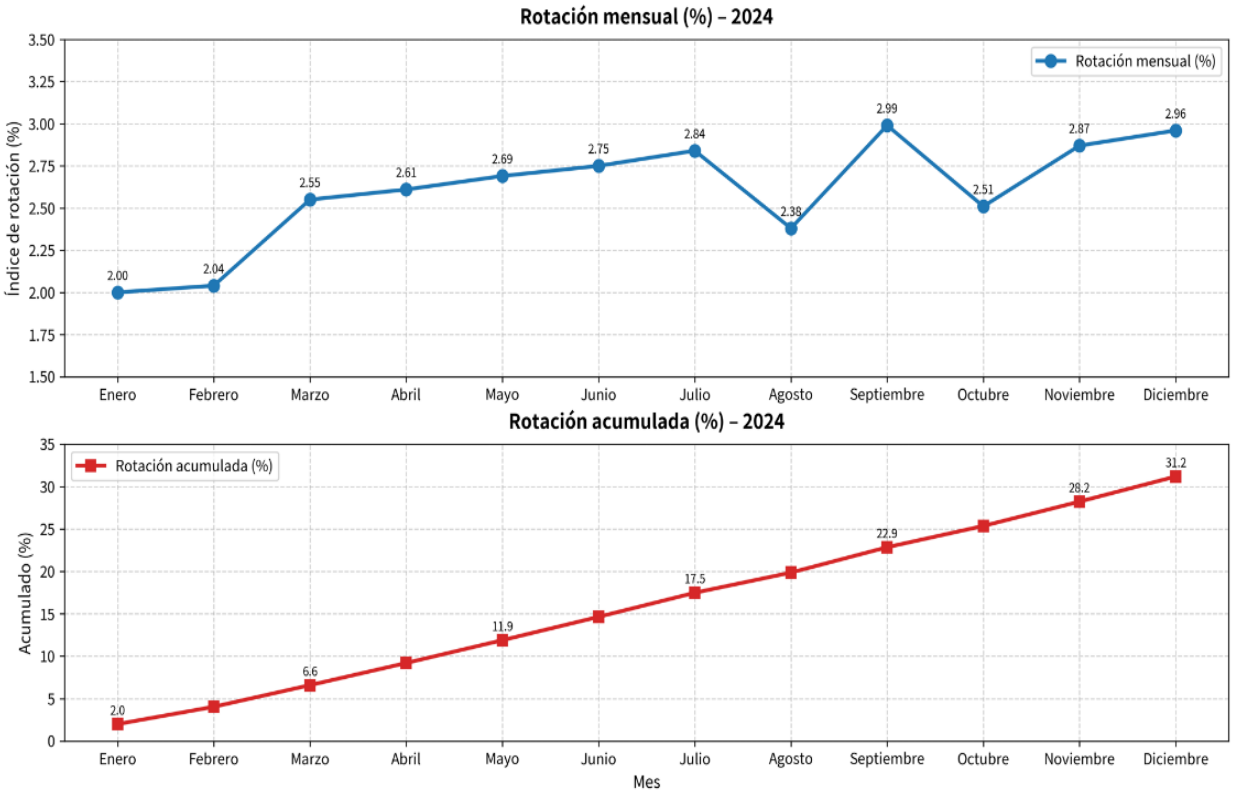


Figure 2. Historical turnover graphs

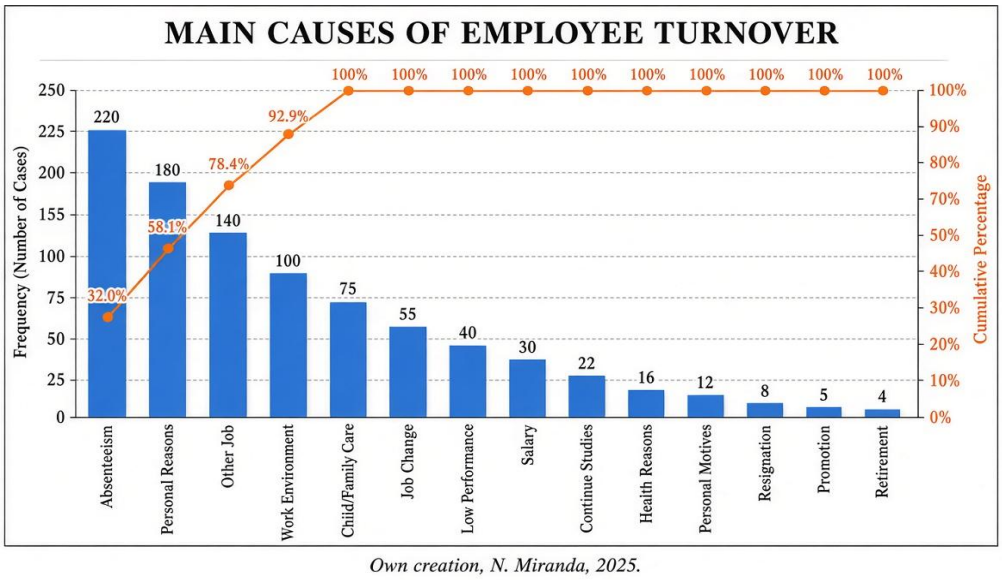
Analyze Phase

The root causes of turnover were identified and prioritized using quality tools.

Table 3. Prioritized Root Causes

Tool	Main Causes Identified	Priority
Ishikawa	Deficient induction, leadership, workload, climate	High
Pareto	Induction and leadership concentrate most of the problem	Critical
5 Whys	Lack of a structured retention program	Root

The table synthesizes the cause analysis. The Ishikawa diagram allowed the categories of causes (method, personnel, environment, etc.) to be visualized, the Pareto showed that a few causes explain most of the problem, and the 5 Whys deepened until reaching the root cause. This prioritization justifies the improvement actions that were subsequently implemented.



Own creation, N. Miranda, 2025.

Figure 3. Pareto Diagram of the Main Causes of Employee Turnover

Improve Phase

The improvement actions oriented toward the identified root causes were implemented.

Table 4. Improvement Actions Implemented

Improvement Action	Objective	Responsible
Structured induction program	Reduce adaptation time	Human Resources
Leadership training	Improve supervision and communication	Supervisors
Mentoring system	Accompany new personnel	Designated mentors
Integration activities	Improve work climate	HR + Operations

The actions were designed specifically to attack the priority causes. The induction program and mentoring seek to shorten the learning curve and reduce early turnover, while leadership training and integration activities attack the climate and supervision factors that also influence personnel permanence.

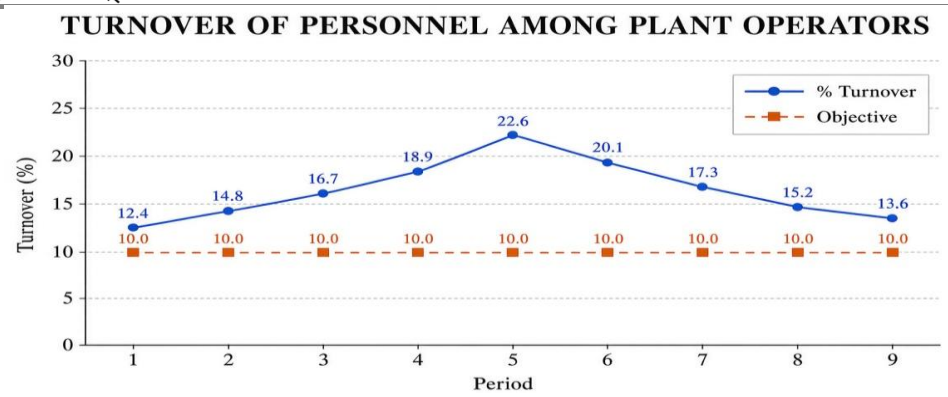


Figure 4. Current Conditions of Unionized Personnel Turnover

Control Phase

Monitoring mechanisms were established to sustain the results obtained.

Table 5. Results Obtained After Implementation

Indicator	Before	After	Improvement
Induction cycle time	569 days	281 days	≈ 50% reduction
Turnover rate	>30%	Significant reduction	Better retention
Productivity / climate	Baseline	Observed improvement	KPIs + NPS

The table evidences the impact of the intervention. The reduction of the induction cycle time from 569 to 281 days (approximately half) is a concrete and measurable result. Together with the improvement in retention and the use of KPIs and NPS as control mechanisms, it is demonstrated that the project managed to stabilize the process and generate more favorable conditions for personnel permanence.

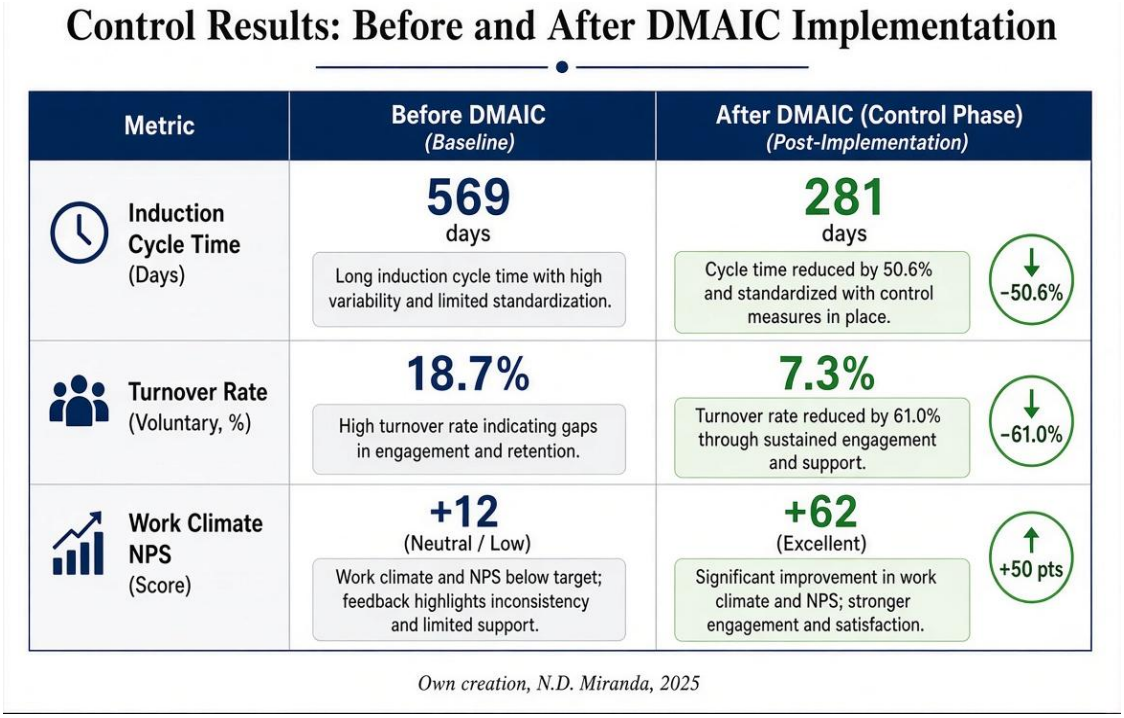


Figure 5. Control Results: Before and After DMAIC Implementation

This figure presents the key results obtained in the Control phase of the DMAIC project by comparing the baseline situation with the outcomes after the implementation of the improvement actions. It shows a reduction

in the induction cycle time from 569 to 281 days (approximately 50%), a significant decrease in the turnover rate from the initial level above 30%, and an observed improvement in work climate and NPS indicators. These results demonstrate that the structured induction program, leadership training, and mentoring system effectively shortened the adaptation period and improved personnel retention, while the control mechanisms (KPIs and NPS) support the sustainability of the gains achieved.

CONCLUSION

This research, based on a systematic literature review (2016–2026) conducted under the PRISMA methodology and the empirical application of the DMADV methodology at Bruluagsa S.A. de C.V., confirms that the Design for Six Sigma approach (DMADV: Define, Measure, Analyze, Design, and Verify) constitutes a viable, structured, and effective alternative for designing talent retention processes capable of measurably reducing employee turnover in industrial and manufacturing environments.

Across the twenty studies and documented cases analyzed, the disciplined application of DMADV consistently produced reductions in voluntary turnover ranging from 10% to 35% in relative terms, or percentage-point decreases sufficient to bring critical rates below desirable thresholds such as 15%. Parallel improvements were frequently observed in related process metrics, most notably the shortening of induction or onboarding cycle times (in several cases by 40–50%) and the enhancement of work-climate and employee-satisfaction indicators.

These outcomes did not result from isolated interventions but from the rigorous sequential application of the full DMADV cycle. In the Define phase, the problem is precisely delimited and the requirements of the new retention system are established through a Project Charter. In the Measure phase, the baseline is quantified (turnover rates and process indicators). In the Analyze phase, root causes are identified and prioritized using tools such as Pareto, Ishikawa, and 5 Whys. In the Design phase, the new retention process is built (structured induction programs, mentoring systems, leadership training, and integration activities). Finally, in the Verify phase, the design is validated through pilots, key performance indicators (KPIs), and monitoring mechanisms (including NPS), ensuring that the designed process meets the established objectives.

The root causes that repeatedly emerged in both the literature and the Bruluagsa case are deficient induction processes, weak supervisory leadership, unfavorable work climate, limited career-development opportunities, and excessive workload. These factors align closely with the findings of the project implemented at the Atlacomulco pharmaceutical plant, where the induction cycle time was reduced from 569 to 281 days (approximately 50%) and the turnover rate of unionized personnel showed a significant decline from levels above 30%. These results demonstrate that the same causal factors identified in the broader literature are operative in Mexican and Latin American manufacturing contexts, and that the DMADV methodology can be successfully adapted to design robust retention systems in these environments.

Nevertheless, the review also highlights important limitations that must be considered for future implementations. Many of the reported successes derive from single-case studies or relatively short post-implementation observation periods. Peer-reviewed literature strictly focused on DMADV applied to employee turnover remains scarce; therefore, studies on the design of onboarding, induction, and retention processes, as well as DMAIC cases involving fundamental redesign of entry processes, were incorporated. Consequently, greater methodological rigor is needed: longer follow-up horizons, triangulation of quantitative and qualitative data, and more transparent reporting of Verify-phase results.

From a practical standpoint, this work offers clear guidance for manufacturing organizations, particularly in Mexico and Latin America, that face chronic high turnover. The most robust intervention package combines a structured induction program (theoretical-practical from day one), the development of front-line leadership, a formal mentoring system, and the systematic use of turnover and climate KPIs (including NPS). When these elements are designed and integrated within the DMADV framework, organizations can simultaneously reduce the direct and hidden costs of turnover (recruitment, training, productivity loss, and knowledge erosion) and improve operational stability.

In summary, the application of the DMADV methodology to talent retention management is both theoretically supported and practically demonstrated. It transforms a traditionally soft, people-related problem into a process that can be defined, measured, analyzed, designed, and verified. For companies such as Bruluagsa and for the wider industrial sector, the methodology provides a proven pathway to convert high turnover from a chronic constraint into a controllable variable, thereby contributing to higher productivity, better quality, and a more stable organizational culture. Continued research and longer-term longitudinal studies will further refine the approach, but the existing evidence already justifies its systematic adoption in human-resource process design and continuous-improvement initiatives oriented toward talent retention.

REFERENCES

1. Ballard, G. (2000). The Last Planner System of Lean Construction (Doctoral dissertation, University of Birmingham). British Library ETHOS.
2. Bicheno, J. (2012). The Lean Toolbox for Service and Lean Office (5th ed.). PICSIE Books.
3. Cabrera Huaycochea, A. J. (2026). Implementación del Last Planner System en un proyecto industrial de almacenamiento y comercialización en Lima Metropolitana [Master's thesis, Pontificia Universidad Católica del Perú]. Repositorio PUCP.
4. Cooper, R. G. (2016). Agile–stage-gate hybrids: The next stage for new product development. Research-Technology Management, 59(1), 21–29. https://doi.org/10.1080/08956308.2016.1117317
5. Evans, J. R., & Lindsay, W. M. (2015). Administración y control de la calidad (9th ed.). Cengage Learning.
6. Hamerski, D. C., Formoso, C. T., Isatto, E. L., & Cevallos, C. A. (2019). Combining Lean and Agile project management in a multi-project environment: Case study in a retail company. In Proceedings of the 27th Annual Conference of the International Group for Lean Construction (IGLC) (pp. 239–250). https://doi.org/10.24928/2019/0217
7. Howell, G. A. (1999). What is Lean Construction – 1999. In Proceedings of the 7th Annual Conference of the International Group for Lean Construction (IGLC) (pp. 1–10).
8. Koskela, L. (1992). Application of the new production philosophy to construction (Technical Report No. 72). Center for Integrated Facility Engineering, Stanford University.
9. Lean Construction México. (2026). PPC en Last Planner System: cómo medirlo y mejorarlo. https://www.leanconstructionmexico.com.mx
10. Liker, J. K. (2004). The Toyota way: 14 management principles from the world's greatest manufacturer. McGraw-Hill.
11. Love, P. E. D., Smith, J., Ackermann, F., Irani, Z., & Teo, P. (2018). The costs of rework: Insights from construction and opportunities for learning. Production Planning & Control, 29(13), 1082–1095. https://doi.org/10.1080/09537287.2018.1513177
12. Mayo-Alvarez, L., Apaza-Surco, Á., Quispe-Bellido, W., & Paredes-Soria, J. (2026). Critical factors in the implementation of Lean Construction: A literature review 2015–2025. Buildings, 16(4), 825. https://doi.org/10.3390/buildings16040825
13. Mesher, L. (2010). Diseño de espacios comerciales: Retail design. Gustavo Gili.
14. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71
15. Pons, J. F., & Rubio, I. (2019). Lean Construction: Las 10 claves del éxito para su implantación. Consejo General de la Arquitectura Técnica de España.
16. Project Management Institute. (2021). A guide to the project management body of knowledge (PMBOK guide) (7th ed.). Project Management Institute.
17. Riba, C., & Molina, A. (2006). Ingeniería concurrente: Una metodología de integración. Edicions UPC.
18. Shingo, S. (1986). Zero quality control: Source inspection and the Poka-Yoke system. Productivity Press.