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Addressing Production Constraints and Empowering Effective Knowledge Transfer Among Employees at XYZ Company: An Experience-Driven Framework

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ABSTRACT

This study explores the interplay between production constraints and tacit knowledge transfer in a Made-to-Order (MTO) manufacturing context. It examines how these systemic operational inefficiencies and informal knowledge practices influence Lean maturity through the lens of the operational architecture of Lean principles, Value Stream Mapping (VSM), and SECI (Socialization, Externalization, Combination, Internalization). Evidence from extensive Focus Group Discussions with operational production employees and supervisors revealed that, despite a technically skilled workforce, formal Lean implementation is severely hampered by critical systemic administrative shortfalls, inconsistent digital interoperability across departmental silos, and a historically ingrained operational culture. These constraints often compel personnel to use localized "diskarte" (intuitive, culturally embedded workarounds) and informal "shadow systems" to ensure continuity of workflow where what could be achieved through systemic mechanisms is effortfully done manually, which further exacerbates delays in overall organizational velocity. As a result, although tacit knowledge serves as a primary stabilizer through informal mentoring, tribal knowledge sharing, and sensory learning, the study appears to identify hot spots where the "knowledge standard paradox" is particularly ***critical****. Within this, heroics and brilliant ad hoc problem-solving save production times but, at best, hide deeper-level systemic structural failures from management. An Experience-Driven Framework is proposed to solve these vulnerabilities. It systematically integrates virtual supply chain modeling (VSM) with tactical tacit knowledge codification and strategic digital integration. Ultimately, it reveals why Lean maturity cannot be attained without institutionalizing operational resilience as a standardized, organizational system, rather than an erratic, person-dependent capability.*

Keywords: *Made-to-Order (MTO), Value Stream Mapping (VSM), SECI Model, Tacit Knowledge Transfer, Lean*

INTRODUCTION

Beneath the rumble of global industry, perfection is often imagined as a cold assembly of steel and computer programs, but in the industrial corridor in Bulacan, the reality is much more tangible. The dynamic landscape of manufacturing is not a set of neat dots on an Excel page. It is welding station heat, bending machine clatter, and the quiet anger that builds when a high-ticket item goes missing. Companies are embroiled in an unending battle against a limited workforce, protracted learning curves, and the loss of skills when experienced personnel exit the organization, a veteran exits stage left, taking decades of wisdom with them.

At XYZ Manufacturing Company, these challenges have historically created a cycle of putting out fires. Material and information flows are frequently disrupted by clerical errors or delayed parts provisioning.

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A gap exists between high-level administrative planning and the practical workarounds that frontline workers spontaneously develop on the shop floor. Existing literature often overlooks how frontline production personnel and design terminal operators navigate these systematic operational challenges to maintain continuity.

This study explores the lived experiences of frontline production workers, prioritizing the voices of those directly involved in execution. Through an experience-driven lens and insights gathered from focus group discussions, this research examines the practical realities of manufacturing operations and the 'diskarte', the intuitive, experience-based problem-solving that maintains production flow when formal systems fall short. The objective is to move beyond surface-level tools to develop a management model based on insider perspectives, transforming a reactive operating culture into a collaborative, standardized problem-solving environment.

Objective and Research Questions of the Study

The objective of this study is to bridge the gap between administrative planning and frontline execution through an experience-driven framework. Specifically, the research aims to evaluate the operational constraints and operational delays hindering Lean implementation, analyze how the workforce utilizes the SECI process and localized 'diskarte' to stabilize production during **systemic failures, and formulate a management** strategy to institutionalize these insider perspectives into a standardized organizational system. Ultimately, the study seeks to transform person-dependent "heroics" into sustainable, scalable operational excellence.

This study aimed to answer the following research questions:

I. What are the perspectives of production workers at XYZ Manufacturing Company regarding the operational constraints affecting lean implementation in terms of:
   a. Mapping Value Stream
   b. Establishing Flow
   c. Implementing Pull, and
   d. Pursuing Perfections?

II. What specific ways are currently used to transfer tacit knowledge among production staff, and what key factors are identified as enablers and barriers in terms of:
   a. Socialization
   b. Externalization
   c. Combination and
   d. Internalization

III. What strategies derived from employee experience can be institutionalized to formulate the Experience-Driven Framework to strengthen Lean practices and knowledge transfer in the organization?

Significance of Study

The findings of this research offer valuable insights and structural benefits across multiple dimensions of the manufacturing sector, as detailed below:

Theory: This study contributes to the theoretical discourse on Lean Manufacturing by emphasizing the importance of employee-driven insights and contextual realities. Specifically, it uses the SECI model (Socialization, Externalization, Combination, and Internalization) to demonstrate how the fluid, often

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unrecorded expertise of the workforce can be transformed into standardized organizational assets, particularly in labor-intensive settings such as the Philippine manufacturing industry.

Practice: The findings help operations managers identify bottom-up solutions to recurring production constraints. By bridging Lean Manufacturing Theory with the SECI model, a practical roadmap for converting day-to-day worker intuition into a living strategy co-developed with worker input is created. Using SECI to institutionalize continuous improvement transforms knowledge into systemic flow, fostering an inclusive workplace culture that addresses operational realities.

Policy: The research highlights the value of participatory engagement and knowledge sharing as critical components of lean strategy. The findings inform internal corporate policy reforms to integrate frontline perspectives into strategic decision-making. By using the SECI model to formalize information, the organization can move away from rigid rules and create policies that better reflect the production lines.

Social Action: Socially, the study advocates worker empowerment through participatory methodologies. It positions employees as active co-creators of operational change rather than passive recipients of lean tools. This encourages a more democratic and inclusive approach to industrial development, fostering mutual respect and trust between management **and labor.**

Definition of Terms

To ensure clarity and consistent interpretation throughout this paper, the following key operational and conceptual terms are defined based on their application in this study.

- **Value Stream Mapping:** A diagnostic tool representing all material and information flows required to bring a product to the customer, used to identify various forms of waste, including repetitive manual drawings and incomplete kitting within the MTO process.
- **Establishing Flow:** Eliminating operational delays, such as manual data re-entry and administrative approval bottlenecks, to create uninterrupted, synchronized movement of work within the MTO configuration.
- **Implementing Pull:** A production strategy where work is initiated only when actual downstream demand arises, moving from top-down speculative planning to a market-signal-driven, real-time, capacity-based system.
- **Pursuing Perfection:** Striving for operational excellence by identifying and eliminating the root causes of waste, shifting away from reactive troubleshooting to standardized work and quality accuracy.
- **Socialization:** The transfer of tacit knowledge through direct conversation and shared experience, such as peer-to-peer mentorship, on-the-job demonstrations, and trust-based relationship building.
- **Externalization:** The process of converting tacit knowledge (experiential insights) into explicit knowledge. This involves documenting veteran skills into manuals, automation routines in SolidWorks, and expert guidelines to disseminate expertise across the company.
- **Combination:** The process of combining formal production standards with informal ‘diskate’ and lessons learned from errors captured during departmental meetings.
- **Internalization:** The process of embodying explicit knowledge into tacit mental models, often referred to as learning by doing.
- **Experience-Driven Lean Framework:** The primary conceptual output of this research, which connects technical Lean practices with the personal experience and intuitive know-how of

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employees. It provides a systematic foundation for production, infusing operational enhancements with the diskarte and pragmatic problem-solving of workers.

REVIEW OF RELATED LITERATURES

This section examines established academic literature and industry frameworks regarding production bottleneck management, knowledge retention methodologies, and the core principles of Lean manufacturing.

2.1 Addressing Production Constraints in Manufacturing Companies: The Theory of Constraints (TOC) remains the foundation for pinpointing bottlenecks. Combining TOC with ECRS methods and Aggregate Production Planning (APP) addresses workforce instability and demand variability (Neisyafitri et al., 2023; Leong et al., 2025). Under Industry 4.0, Manufacturing Execution Systems (MES) address fragmented data and siloed operations (Goecks et al., 2020).

2.2 Factors Influencing Knowledge Transfer: Success depends on the recipient's absorptive capacity (Dubickis et al., 2024). To combat "knowledge drain", mentorship and digital platforms must preserve undocumented tacit expertise (KMWorld, 2025). Barriers include lack of trust, while supportive leadership acts as an enabler (Monika et al., 2022).

2.3 Frameworks for Improving Knowledge Transfer Effectiveness: Improving transfer draws from Lean and TOC methodologies, using VSM and Gemba walks (Neisyafitri et al., 2023). Frameworks using AHP assessments and design science research enable companies to strengthen weak areas and measure continuous improvement (Dubickis et al., 2024; Ferreira et al., 2024).

2.4 Understanding the Concept of Lean Manufacturing: Lean targets seven primary wastes, including underutilized human talent (Myszak, 2023). Integrating Lean principles with the SECI model enhances knowledge transfer during product development (Lindof et al., 2024).

2.5 Learning Complexities in Lean Manufacturing: Workers perceived behavioural control affects their intention to adopt innovative lean practices (Lai et al., 2022). Learning is a shared responsibility fostered through informal interactions (Dowson et al., 2024). Change agents are critical in managing resistance and facilitating mindset changes (Ismael et al., 2015).

2.6 Knowledge Sharing in Lean Manufacturing: Tacit knowledge is difficult to formalize because it involves personal insights (Nordin et al., 2019). Mechanisms like "sense-giving" and international teamwork help subsidiaries make sense of lean concepts (Boscari et al., 2015). Using EFAHP and A3 reports, lean tools strategically support knowledge codification (Tyagi et al., n.d.; Raudberget et al., 2018).

2.7 Lean Implementation and Operational Excellence: Waste elimination and long-term thinking are essential to achieving operational excellence (Klein et al., 2022). However, supply chain complexity acts as a "tax" that reduces the positive impact of lean practices (Rossetti et al., 2023; Komkowski et al., 2024).

2.8 Educational Approaches and Lean Training: Virtual reality (VR) allows students to practice lean concepts in a risk-free environment (Sayeg-Sánchez et al., 2024). Other approaches include Problem-Based Learning (PBL) and Learning from Demonstration (LfD) (Romao et al., 2024; Moreno et al., 2024). Generative Machine Learning (ML) holds potential to shift control from reactive to predictive (Lee & Ko, 2025).

2.9 Value Stream Mapping (VSM): VSM is a diagnostic tool used to visualize flows and spot non-value-added (NVA) activities, such as waiting time and over-processing (Setiawan, 2021). It identifies inefficiency gaps where a large proportion of activities are non-value-adding, aiming to reduce lead time and improve quality (Buyanjargal, 2025).

2.10 Establishing Flow: The establishment of flow within a manufacturing system focuses on the systematic removal of non-value-added time and friction. In a modern production environment, this

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involves eliminating administrative delays, manual IT data re-entry, and approval bottlenecks to create an uninterrupted, synchronized movement of materials and information within the complex MTO configuration (Buyanjargal, 2025; Setiawan, 2021).

2.11 Implementing Pull: Implementing pull shifts an organization away from speculative, volume-heavy production models. This strategy dictates that manufacturing work is initiated strictly when actual downstream demand arises, transforming operations from top-down presumptive planning into a market-signal-driven, real-time, capacity-based delivery system (Leong et al., 2025; Neisyafitri et al., 2023).

2.12 Pursuing Perfection: Striving for excellence by identifying and eliminating the root causes of waste. It represents a shift away from performing reactive "firefighting" and unsustainable shortcuts to one of standardized work and quality accuracy (Myszak, 2023).

METHODOLOGY

This section delineates the qualitative research parameters, ethical frameworks, participant selection criteria, and data analysis methods utilized to gather floor-level insights at XYZ Manufacturing Company.

3.1 Research Design: This study employs a phenomenological method as its qualitative research design; described as the study of what it is like to have a particular experience. Instead of a robotic catalogue of machines, this design sees the production floor as a "lifeworld" constructed by lived human experience. It unearths the essential nature of working in a made-to-order environment, capturing how front-line workers navigate the tension between overtly prescribed, top-down standards and the immediate reality of firefighting. The research is informed by Interpretative Phenomenological Analysis (IPA), seeking to understand participants' sense-making and to uncover the "hidden genius" of the workforce.

3.2 Ethical Considerations: The study was conducted following the guidelines and principles of the Philippine Health Ethics Research Board. Prior to data collection, a letter of request was sent to the target participants. Confidentiality and anonymity of the participants will be guaranteed to avoid any resentment or fear when sharing experiences that might question the protocol's implementation. The records of responses shall be kept for a maximum of (2) months to allow the researcher to review details for accuracy. The researcher adhered to the principles of transparency, legitimate purpose, and privacy (PHREB 2017).

3.3 Research Locale: XYZ Manufacturing Company is in Sta. Maria Industrial Park, Barangay Bulac, Sta. Maria Bulacan. Established in 1988, it specializes in producing battery-making machines, molds, and stainless-steel products. XYZ aims to be a leader in engineering and technology, providing custom-made tools and equipment focused on quality, cost efficiency, and on-time delivery. The company serves as a vital hub for manufacturing stainless-steel products for industrial and commercial use.

3.4 Population and Sampling: A total of 18 participants (divided into 2 groups) were invited from key operational areas including Fabrication, Assembly, Technical, Cutting, Engineering, and PPIC. Selection was based on a purposeful, criterion-based sampling strategy. Participants must have had more than two years of tenure to guarantee institutional memory. The selection emphasized "boundary spanners"—people who coordinate across multiple functions—and those directly involved in the engineering change notice (ECN) process or in on-the-job training (OJT).

3.5 Instrumentation: The study employed focus group discussions as the primary data collection method. To guide these discussions, the researcher developed a set of self-constructed, open-ended questions designed to encourage participants to share detailed, nuanced accounts of their experiences. These questions were provided to participants in advance to allow time to reflect. All responses were audio-recorded using a reliable recording device to ensure accuracy and completeness for later transcription. The **18 participants** were divided into two sessions: the first group consisted of **9 production staff** members from each section, while the **second group** comprised team leaders and

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supervisors. This structured categorization ensured analytical clarity and alignment with the research objectives, allowing the qualitative insights from both groups to be systematically grouped according to the specific subject matter of each Research Question (RQ1 and RQ2).

3.6 Data Gathering Procedure: The discussions were implemented through facilitated and semi-structured inquiry, functioning as a shared space to reflect,'**Ba' (shared space)** where collective interaction can reveal the "hidden genius" of the workforce. Participants were mixed into clusters of welders, programmers, and operators to improve data flow and minimize a reactive bias. Sessions were framed around "how can we improve our process together" to create an open environment regarding firefighting and "band-aid" solutions. The researcher probed the rationale for the so-called "diskarte," or intuitive workarounds, and how workers transfer "tricks of the trade" that are not written in any manual.

3.7 Data Analysis: The data analysis used a reflexive thematic approach to integrate qualitative focus group transcripts and observational field notes. Using Braun and Clarke (2006), the analysis started from systematically coding focus group "verbatim," grouping quotes describing "firefighting" as well as "diskarte" into themes such as Operational Friction. This was supplemented by Gemba walks acting as a 'visual audit' of the shop floor. The analysis revealed the workforce's "hidden genius" as a systematized response to systemic deficiencies by triangulating what the researcher heard with what was observed on the production floor.

RESULTS AND DISCUSSION

This section presents empirical data gathered from focus group discussions and field observations, beginning with core qualitative themes and their operational implications before validating the findings against the academic literature.

4.1 Production Constraints, from "Firefighting" Push to Systemic Friction (RQ1): The Focus Group Discussion (FGD) reveals that the value stream is consistently throttled **by** administrative bottleneck and operational delays that favor manual data overload over technical execution (Myszak, 2023). This systemic friction is exacerbated by the absence of a reliable digital handshake, leaving the team strategically paralysed by siloed tacit knowledge and fragmented documentation (Rossetti et al., 2023; Goecks et al., 2020). Efforts to establish flow are impeded by Human Factor Variability and localized tactics (diskarte), resulting in a "digital shadow" where units remain in administrative limbo (Nordin, 2019; Fortes et al., 2023). Consequently, the pull system has devolved into a firefighting "push" model forced to rely on human endurance rather than stable process design (Leong et al., 2025; Neisyafitri et al., 2023). Ultimately, the organization is caught in a "Recovery Trap" where individual heroics mask deep architectural flaws (Pivato et al., 2024; Lindof et al., 2024).

4.2 Knowledge Transfer, The SECI Model and Expert Intuition (RQ2): Data indicate that tacit knowledge transfer is the human-face of a precarious institutional memory. Socialization occurs through informal peer-to-peer learning and "diskarte", producing a "single point of failure" as critical knowledge bottlenecks in individuals (KMWorld, 2025; Dowson et al., 2024). Externalization remains disjointed, with SOPs acting as reactive "sticking plasters" due to bad media integration and continued reliance on live demonstrations (Kauffman et al., 2024; Sun & Hsiao, 2020). This gap means that Combination occurs through slow, manual syncing to cross the "invisible walls" between departmental silos (Edwards et al., 2022; Rossetti et al., 2023). Consequently, Internalization relies on "expert intuition" and informal systems, such as personal photo galleries, in which workers apply acquired skills (Nordin et al., 2019; Myszak, 2023).

4.3 Integrated Strategic Resolution, Institutionalizing Employee Strategies via Experience-Driven Lean Framework (RQ3): To address the operational gaps identified in RQ1 and RQ2, the strategies developed from employee floor experiences have been institutionalized into a formal

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Experience-Driven Lean Framework. This resolution uses Value Stream Mapping (VSM) as the overarching strategic tool to identify process waste, while the DMAIC (Define, Measure, Analyze, Improve, Control) problem-solving methodology provides the structured discipline needed to systematically reduce process variation and eliminate operational bottlenecks.

The table below maps the qualitative findings from the focus groups directly to the actionable strategies and tactical floor implementation plans of the framework,

Table 1: Value Stream Mapping

Value Stream Mapping VSM Findings/Concern	Process Metric (Hypothetical Issue)	Strategic Resolution (Experiene Driven Framework)	Rationale for Resolution	Required Resources & Management Support
Excessive Waiting (Inventory/Delay)	The "Data Validation" step and the "Final Approval" step has a NVA Time of 72 hours in the existing system. This wait only leads to team frustration and missed deadlines."	Implement a Pull System (Kanban/Heijunka). Enforce a WIP limit for the "Final Approval" queue. Adapt a basic visual control (Kanban board) to govern the flow of work and so prevent an upstream team "pushing" work before downstream capacity is ready.	Lean Flow Principle. Quite simply, by capping WIP, we focus attention on the bottleneck which in turn cuts overburden (Muri) and ensures that we deal with a concern around delay immediately. This serves to stabilize the rate of flow and make it predictable.	Resources: Kanban tool (Digital – Jira board, Trello), time for team members to be trained. Help from Leadership: Senior Manager support and enforce new WIP Limit; Final Approval manager commitment to provide the right number of folks for the bottleneck.
Redundant Processing (Over-Processing)	VSM demonstrates that three quality checks are conducted on the same input good data by separate functions, and thus there is a 75% rework of reviewing data.	The standardization and consolidation of QC with DMAIC. Re-configure so that 2 "like" checks are not necessary and place imposed control gates in the one highest activity point (e.g. at data entry).	Six Sigma Read More: Six Sigma Extreme Focus on the reduction of Variations. We eliminate duplicated steps, streamline workflow and address directly team concerns about rework and the overhead of repetitive administrative actions by centralizing control. The solution is verified by reaching a FTY threshold after implementation.	Resources: Process Analyst 10 days to complete DMAIC analysis; document ation file for new SOP. Management Help: Cross functional Directors (from the 3 work groups) need to sign another single consolidated QC process deck and take out duplicate steps from job descriptions.

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Unnecessary Motion (Inefficient Layout)	The ANP physical process map demonstrates that the analysts are required to work on three different, non-integrated and independent pieces of software in order that they can perform one customer transaction. This significantly increase cycle time.	At the elbow level, the optimization for 'Spaghetti Diagram' and digital integration should be performed. 3-Build API layer or unified dashboard to bring those three systems together into one UI for the analysts.	Lean Layout and Systems Thinking. This settles out the wasted digital motion and toggle switching, further reducing cognitive load and time to perform. It involves a transition from functional silo to nice, customer-centric process flow – and as such directly drives day to day team efficiency	Resources: In-house IT Development Team (1 FTE x 5 weeks); UX/UI designer for dashboard design; budget for API licensing or build out. Management Support: CIO/IT Director sponsored initiative to lead this project; cross-functional governance committee established for phased rollout and leveraging of user feedback.

Table 2: Tacit Knowledge Mapping

Tacit Knowledge Mapping

Tacit Knowledge Concern/Issue	Contextual Insight (Hypothetical Issue)	Strategic Resolution (Experiene Driven Framework)	Rationale for Resolution	Required Resources & Management Support
Critical Skill Dependency (Knowledge Hoarding)	Their joint experience suggests that there are only two people with the undocumented debug steps necessary to fix an ongoing high-impact system error (the "Guru Dependence" risk).	Standardize Knowledge through JI and Jidoka. Why not train across-job titles with the JI training methodology – taking the "Guru's" solution and separating it into common denominator steps that could be taught to others? Work this checklist (as a Jidoka, Autonomation) into the process as a control-a documented way to halt production when the problem is seen so he's guided through his own fix.	OpEx on Human Capital. This has significantly mitigated the risk of critical knowledge leaving the organization by making tacit knowledge explicit, standardized knowledge (Standard Work). Jidoka means that quality is automatically built into the process- it doesn't depend on human vigilance.	Resources: Training/R&D Specialist to support work on JI documentation; time to be able (4 hours/week for 3 weeks) allocated to the Gurus for working on the documentation. Management Help: Invoke the manager mandate to use the new Jidoka checklist; make sure performance management will include a sign-off that Knowledge Transfer was achieved over time during the Guru review cycle.

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Low Morale & Bureaucracy (Cultural Friction)	It has been feed back to the teams that they have ideas for process change and improvement, but it all goes into a 'black hole' and nothing happens, consequently we now have staff who are cynical about OpEx as an initiative.	Create a Visible and Dedicated System for Continuous Improvement. Develop and use structured A3 Problem-Solving when addressing team identified problems. Above all, create a Gemba Walk calendar for leadership to walk the A3 boards and give real-time documented feedback (yes/no/why)	People Respect and Hoshin Kanri. This solves the problem of bureaucracy by making improvement cycle visible and responsible. It respects the team's intellectual contribution on two levels, relying on their tacit knowledge as its first tier of process detection.	Resources: Easy-to-see tangible/digital 'Improvement Board' (KAIZEN/A 3); allocated 30 minutes a week for review of suggestions. Management Help: Commit time at the director/VP level for weekly scheduled Gemba Walks to the improvement board; give a small, discretionary budget (e.g., $500 per month) that can be immediately spent based on simple high impact fixes identified by team.
Ambiguity in Unwritten Rules (Decision Making)	New employees are regularly misled by conflicting messages of different supervisors, only to be set straight by the informal "unwritten rules" understood by long-timers.	Create a RACI Matrix and Standard Prioritization Procedure. Develop a RACI matrix for high-stakes decisions You may also want to author an explicit template delineating what might be included in the relevant RACI categories: Responsible, Accountable, Consulted, Informed. Document existing unofficial prioritization logic as an SOP for the team.	OpEx Governance. This captures the critical yet informal tacit knowledge in explicit, codified governance. This reduces operational ambiguity, by having the same decision every time: This is very important for process stability and reducing team friction.	Resources: RACI definition session leader (4–hour meeting); A central repository accessible to all where the final RACI document and protocol will reside. Management Help: Require sign off from Senior leadership (all applicable Department Heads) on the RACI to establish accountability; consensus to use this documented process as the only source of truth when priority disputes arise.

Conclusion

The individual technical expertise at XYZ Manufacturing is mature, but the organization is constrained by structural and administrative inefficiencies and information delays that stifle Lean maturity. The Value Stream Map shows that the flow is constantly choked by administrative red tape, leaving operators in a reactive state searching for missing parts and information. This business-process gap and systemic drag result in a "digital shadow" and a firefighting "push" model, where human endurance is relied on rather than process. The organization remains trapped in the "Recovery Trap" with operational delay and information delay hindering true value creation

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The SECI Model focus group discussion (FGD) data indicate that knowledge transfer operates under an ineffective standard that acts as a temporary workaround for the absence of standard records. Critical technical mastery is locked in informal documentation, creating a single point of failure and triggering operational barriers or departmental silos. Internalization has deteriorated to an over-reliance on undocumented worker experience and an informal information network where private “diskarte” hides deep architectural defects.

The Fully Integrated Strategic Resolution requires moving from unpredictable to stabilized predictable workflow. By embedding tacit knowledge in explicit Job Instructions and using a RACI matrix, the organization can eliminate "Guru Dependence" and ambiguity of roles. This transition from reactive firefighting to supportive Gemba Walks and an open Kaizen system will turn production pressures into a continuous group learning competitive advantage.

Recommendations

To transform XYZ manufacturing company from a reactive to a proactive Lean system, the research presents a systematic roadmap based on the Socio-Technical Process Optimization (STPO) model. By combining lean management practices such as Value Stream Mapping with organizational health measures, this framework integrates data-driven and human dynamics into a formula that reduces not only technical but also human waste, restoring balance between operational efficiency and the people side of performance.

Immediate execution is enabled by a phased rollout with low-risk Pilot Improvement Cells for rapid prototyping of Standard Work, role-based training on SOPs and RACI matrices to eliminate operational errors, and Visual Management Boards for real-time metric tracking, incorporating employee feedback.

This sustainability-by-design paradigm is emphasized through legally and financially binding policy, governance structures that include zero-waste sign-offs (no pile-it-high and wide post-sales refunds), decentralized continuous improvement budgets that would be digital or analog, Tacit Knowledge Harvesting Policy for retiring veterans, dual-competency certifications to enable agile resource sharing across organizations, and digital change controls in PLM/Digital Twin systems.

The Visible Improvement Loop (VIL) is the engine for cultural change and active ownership: it requires 30-minute executive Gemba Walks every week, allows employees to serve as temporary Process Owners for specific problem areas, and eliminates organizational silos through cross-functional reviews.

Lastly, the roadmap indicates future research looking to scale these efforts —how to best utilize new-hire mentorship; how AI and Manufacturing Execution Systems (MES) can convert operators' sensory cues into predictive maintenance alerts; and a cost-benefit evaluation of introducing Heijunka (Production Leveling) for customer demand management against the mental costs borne by operators.

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AI Declaration Statement:

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