JRSSEM 2026, Vol. 5, No. 12, July
E-ISSN: 2807 - 6311
P-ISSN: 2807 - 6494

Designing A Knowledge Management-Based Framework for Operator Skill Transfer in Fast-Moving Consumer Goods (FMCG) Manufacturing

Susilo Dwi Raharjo*, Muhammad Yorga Permana
Institut Teknologi Bandung, Indonesia
Email: susilodwiraharjo@gmail.com*

Keywords:
Knowledge Management; Tacit Knowledge; Operator Skill Transfer; SECI Model; Manufacturing Industry; Thematic Analysis.

Abstract

PT XYZ, a biscuit manufacturer located in Bekasi, West Java, faces a critical knowledge attrition risk as many senior operators in the wafer stick production area are expected to retire within the next five years. At the same time, the company experiences prolonged new-operator onboarding processes, extended changeover times, and higher defect rates. These symptoms indicate a deeper organizational challenge: critical knowledge required for optimal operator performance remains largely tacit and has not yet been systematically documented in a transferable format. This research developed a structured Knowledge Management (KM) framework to address this risk through systematic operator skill-transfer mechanisms, guided by three research questions concerning existing KM practices, the forms of critical knowledge required, and the development of an appropriate KM framework. A qualitative case study approach was employed using semi-structured interviews with ten internal informants representing four organizational levels and one external benchmark informant. The study was supported by Gemba Walk observations and reviews of Work Instruction documents. Thematic analysis was conducted using Braun and Clarke's approach combined with the Gioia data structure method, mapping 127 interview quotations to Milton and Lambe's five KM enablers: Strategy, Governance, People, Process, and Technology. The findings revealed that current KM practices remained informal, dependent on individual experience, and reactive, with the most significant challenge being the ineffective Externalization process within the SECI knowledge creation cycle. Troubleshooting capability emerged as the primary differentiating tacit competence and the largest documentation gap. This research proposed the KM House Framework for Operator Skill Transfer, positioning Strategy as the roof, Governance as the foundation, Process and People as the supporting pillars, Technology as the enabling layer, and the SECI cycle as the operational engine, supported by a 12-month implementation roadmap.

INTRODUCTION

. In today's global manufacturing landscape, organizations face dual pressures arising from unprecedented market volatility and an increasing human capital challenge. The fast-paced and consumer-driven nature of the Fast-Moving Consumer Goods (FMCG) sector requires high operational agility, compelling production facilities to rapidly adapt to new

products, packaging requirements, and demand fluctuations. At the same time, an aging workforce and high employee mobility have contributed to a talent gap in which decades of experience-based knowledge are at risk of being lost (Hilsen & Olsen, 2021; Maheshkar et al., 2027). The primary constraint between market demand and production capability is no longer determined solely by machine performance but also by workforce agility, defined as the ability to develop and deploy a multi-skilled, competent, and adaptable operator workforce.

This challenge is particularly significant within the Indonesian manufacturing context. In the third quarter of 2025, the manufacturing sector accounted for the largest share of national Gross Domestic Product (GDP), contributing 19.15% of GDP and 1.13 percentage points of the 5.04% GDP growth rate. Within the manufacturing sector, the food and beverage industry holds strategic importance because household consumption expenditure contributed 53.14% of Indonesia's GDP during the same period (Badan Pusat Statistik, 2025). This condition places the FMCG industry among the sectors most exposed to fluctuations in consumer behavior (Loxton et al., 2020; Thakur & Kiran, 2021). The highly competitive environment, characterized by market volatility, price sensitivity, and rapid innovation, creates a critical operational requirement: production agility, which depends heavily on the speed and effectiveness of operator skill transfer (Ahmed et al., 2019; Balzano & Bortoluzzi, 2024).

The case organization, PT XYZ, a biscuit manufacturer located in Bekasi, West Java, illustrates this challenge. Several senior operators in the wafer stick production area are expected to retire within five years, while new-operator onboarding remains slow, changeover times are extended, and defect rates among inexperienced operators are higher. These conditions indicate a deeper underlying issue: critical knowledge required for optimal operator performance remains largely tacit, embedded within the experience of senior operators, and has not yet been systematically documented in a transferable format. The traditional approach of informal on-the-job shadowing is time-consuming, costly, and inefficient, while also creating a single-point-of-failure risk when experienced operators leave the organization.

Two complementary theoretical perspectives provide the foundation for addressing this problem. Competency-Based Human Resource Management identifies the knowledge, skills, and behaviors required for high-performing operators, while Knowledge Management provides a structured approach for capturing, sharing, and transferring such knowledge. A central concept in Knowledge Management is the SECI Model, which explains knowledge conversion through four processes: Socialization (tacit-to-tacit), Externalization (tacit-to-explicit), Combination (explicit-to-explicit), and Internalization (explicit-to-tacit). The five-enabler framework proposed by Milton and Lambe (2016), consisting of Strategy, Governance, People, Process, and Technology, provides a diagnostic perspective for assessing organizational Knowledge Management maturity. Meanwhile, the five skill groups proposed by Liker and Meier (2007) offer a framework for classifying operator competencies. The emerging Operator 4.0 paradigm further positions technology as an enabling foundation that supports human capability development rather than merely functioning as an additional tool (Kaasinen et al., 2020).

The novelty of this research lies in the integration of three theoretical perspectives into a coherent and empirically grounded framework for operator skill transfer. Unlike previous studies that examine competency development, Knowledge Management, and technology adoption as separate domains, this research synthesizes the SECI model, the five-enabler

framework, and operator skill-group taxonomy into a unified and actionable architecture. Furthermore, this research applies the Gioia methodology within an industrial Knowledge Management context, producing a rigorous qualitative analysis that contributes both theoretical insights and practical recommendations.

Although previous studies have explored Knowledge Management in manufacturing and production management contexts (Dombrowski et al., 2012; Kallio et al., 2016), as well as tacit knowledge capture in industrial environments (Johnson et al., 2019), limited research has integrated competency-based development, the SECI knowledge conversion cycle, and Knowledge Management enablers into a single actionable framework at the shop-floor operator level, particularly within the Indonesian FMCG industry. Therefore, this research aimed to design a structured Knowledge Management framework for operator skill transfer based on empirical diagnostic findings. The objectives of this research were to examine existing Knowledge Management practices related to operator skill transfer, identify critical knowledge requirements for achieving optimal operator performance, and develop a Knowledge Management framework representing the organization's desired future condition.

RESEARCH METHOD

This research employed a qualitative case study approach Creswell & Poth, (2018) to explore the knowledge-transfer process within an organizational context involving social interaction, work culture, and tacit knowledge. A qualitative approach was considered appropriate because Knowledge Management (KM) is closely associated with human and cultural factors, enabling a deeper understanding of the factors underlying ineffective knowledge transfer. PT XYZ was selected as the case organization because it represented a large-scale Indonesian FMCG manufacturer experiencing knowledge attrition challenges, while access to internal data and the production environment enabled an in-depth analysis for developing a context-specific framework.

Primary data were collected through semi-structured interviews (Adams, 2015), supported by an interview guide developed based on systematic guideline-development procedures and qualitative interviewing techniques (Rubin & Rubin, 2012). Participants were selected using purposive sampling to identify key informants directly involved in knowledge transfer activities within the biscuit production area. Ten internal informants were interviewed across four organizational levels: one Production Manager (PM), one HR Training Manager (TM), two Production Supervisors (SPV-1 and SPV-2), three Senior Operators/Mentors (MTR-1, MTR-2, and MTR-3), and three New Operators/Mentees (MTE-1, MTE-2, and MTE-3). In addition, one external HR Training Manager (EXT) from a comparable manufacturing organization was included as a benchmark informant. Field observations through Gemba Walks, based on the Genchi Genbutsu principle, were conducted to observe knowledge-transfer practices in the production environment. Secondary data were obtained from internal Work Instructions, training modules, and competency matrices.

Data analysis was conducted using Braun and Clarke's six-phase thematic analysis approach, combined with the structured coding method of Gioia, Corley, and Hamilton (2023), which organized the findings into first-order concepts, second-order themes, and aggregate dimensions. The analysis process followed an interactive cycle of data condensation, data display, and conclusion drawing (Miles et al., 2014). Coding was performed manually using

color coding of interview transcripts due to the manageable volume of qualitative data. Data validity was ensured through source triangulation by comparing perspectives from operators, supervisors, and management, as well as technical triangulation by comparing interview findings with field observations and document reviews.

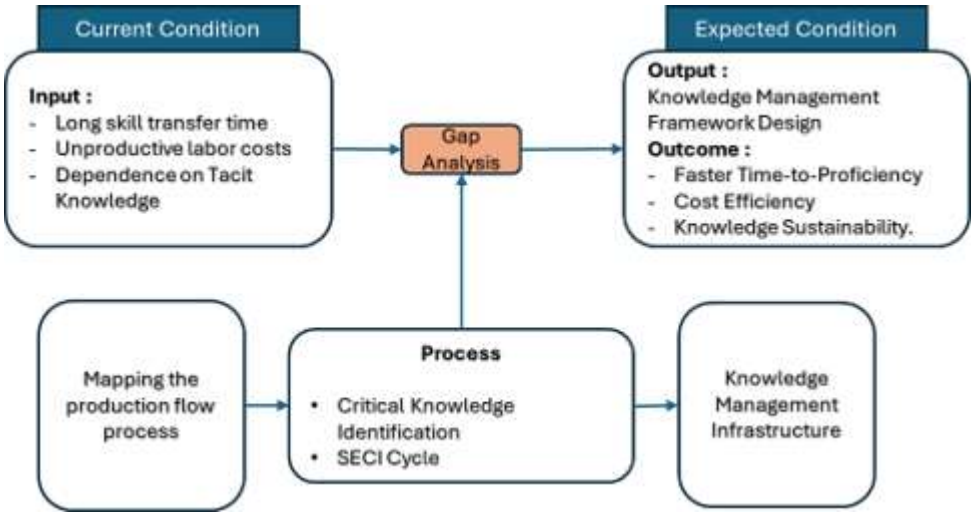

Figure. 1: Research activity flow

RESULTS AND DISCUSSION

Thematic analysis applied the six-phase approach of Braun and Clarke, (2006) ombined with the hierarchical coding structure of Gioia et al. (2013), producing a three-level data structure of first-order informant concepts, second-order researcher themes, and aggregate dimensions mapped to the five enablers of Milton and Lambe (2016). Across the three research questions, the analysis of 127 quotes produced 27 themes. The results are presented below in three movements that correspond to the current condition, the critical knowledge architecture, and the aspired framework, followed by the proposed business solution and its implementation plan.

Current State of Knowledge Management Practice. The thematic analysis of 48 quotes yielded 11 themes organized into the five aggregate dimensions, summarized in Table 1. The Strategy dimension reveals the absence of a formal top-down KM policy, acknowledged consistently across HR, management, and supervisors who describe training as ad hoc, not recorded, and not measured. When strategy is absent, KM activity becomes reactive and dependent on daily operational pressure, treating knowledge as a by-product of production rather than as an input to production capability. The known retirement wave in the wafer stick area has not yet been translated into a documented organizational priority, confirming the need for a written KM Charter as the first intervention.

Table 1. Data Structure of Thematic Analysis Results for Current KM Practice (RQ1)

Aggregate Dimension	Second-Order Theme	Quotes
KM Strategy	Formalization of top-down KM policy	5
KM Strategy	Critical knowledge prioritization & forward planning	3
Governance	Structured policy & rules of the game	4
Governance	Resource allocation for mentoring	3
People	Knowledge dependency	4
People	Inconsistent mentor capability & sharing culture	5
People	Mentee psychological readiness	4
Process	Unstandardized On-the-Job Training	4
Process	Tacit knowledge on troubleshooting documentation	5
Technology	Digital infrastructure	4
Technology	Learning format documentation	7
Total		**48**

In the Governance dimension, the absence of a structured mentor-selection policy is confirmed across four role levels; the Production Manager admits that prior mentor appointments were based on guesswork rather than documented criteria, while SPV-1 proposes that field supervisors be involved in candidate selection. Governance is the mechanism that transforms an ad hoc activity into a repeatable organizational capability, and when it is absent, mentoring outcomes become a function of individual personality rather than the organizational system. In the People dimension, the analysis surfaces high dependency on senior operators, inconsistent mentor capability and sharing culture, and the mentee's psychological readiness, the last of which informants consistently describe as a mental block that precedes any technical learning.

The most consequential findings lie in the Process and Technology dimensions. The Process dimension exposes unstandardized on-the-job training and, critically, the absence of troubleshooting documentation. This is the empirical signature of a broken Externalization mode in the SECI cycle: senior operators actively transfer tacit knowledge through direct interaction, so Socialization is functioning, but that knowledge is never converted into an explicit form that can be stored independently of the senior's physical presence. The Technology dimension confirms the lack of digital infrastructure and reliance on vulnerable paper-based learning formats. Taken together, the five enablers show structural gaps that compound one another: the absence of strategy leaves governance instruments unbuilt, which leaves people without defined roles, which yields unstandardized processes unsupported by digital infrastructure.

Critical Knowledge Identification. The analysis of 33 quotes produced six themes organized into the tacit and explicit dimensions, summarized in Table 2. The distribution is numerically balanced, 17 quotes (52 percent) describe tacit knowledge and 16 (48 percent) describe explicit knowledge, but the analytical depth reveals that the tacit dimension carries the differentiating competence. The three tacit themes are Safety and Quality Awareness as the foundational layer, Troubleshooting as the differentiator of competence, and Change Over as the variant-specific skill. As one mentee observes, basic operation is something many can do,

but complex troubleshooting is what makes the difference. Troubleshooting therefore represents both the primary competence differentiator and the largest documentation gap, the precise point at which the broken Externalization mode is most damaging.

Table 2. Data Structure of Thematic Analysis Results for Critical Knowledge (RQ2)

Aggregate Dimension	Second-Order Theme	Quotes
Tacit Knowledge	Basic Knowledge: Safety & Quality awareness	8
Tacit Knowledge	Troubleshooting	6
Tacit Knowledge	Change Over	3
Explicit Knowledge	Basic Operation	7
Explicit Knowledge	5R Implementation	3
Explicit Knowledge	Production Flow Process	6
Total		**33**

The three explicit themes, Basic Operation, 5R Implementation, and Production Flow Process, map to the fundamental and core job skill groups of Liker and Meier, (2007) and represent the layer where the Combination mode of the SECI cycle operates. The mentees provide a useful temporal benchmark: roughly two months in tandem with a senior suffices for basic operational mastery, while more than a year is needed for full competence including tacit troubleshooting, reflecting the fundamental distinction between explicit knowledge transferable through structured instruction and tacit knowledge requiring extended contextual exposure. A clear competence hierarchy emerges and is unanimously endorsed across role levels: Basic Knowledge, Basic Operation, Troubleshooting, and Change Over, in which the foundational layers must be mastered before the differentiating layers can be effectively learned.

Expected Knowledge Management Framework. The analysis of 46 quotes produced ten themes representing the desired condition across the same five enablers. The gap analysis between the current and aspired conditions confirms that the transformation required is not a single-point intervention but a system-wide redesign addressing all five enablers in an integrated manner. The aspirations converge across all role levels on a consistent vision: a top-down formal KM policy, structured governance with mentor selection and KPI integration, structured capability development through Training for Trainer and mentee induction, a sequenced learning curriculum with multi-option tacit documentation, and a digital KM platform with video and visual content. This convergence indicates high organizational readiness for transformation; what remains is the formal decision to convert distributed aspiration into coordinated action.

The Proposed KM House Framework. Building on the gap analysis, this research proposes the KM House Framework for Operator Skill Transfer, illustrated in Fig. 2. The house metaphor carries a systemic meaning: a house cannot stand without all its components, and the failure of any one compromises the integrity of the whole, mirroring the cascading interdependence observed in the diagnosis. The framework integrates three theoretical pillars: the five enablers as the structural components, the SECI Model as the engine, and the five skill

groups as the content classification. Strategy is positioned as the roof that provides directional intent through a director-level KM Charter, a five-year regeneration roadmap, and a helicopter view of critical knowledge. Governance is the foundation that bears the structural load through documented mentor-selection criteria, integration of mentoring into supervisor and senior-operator KPIs, protected mentoring time, a recognition system, and a level-based competency assessment.

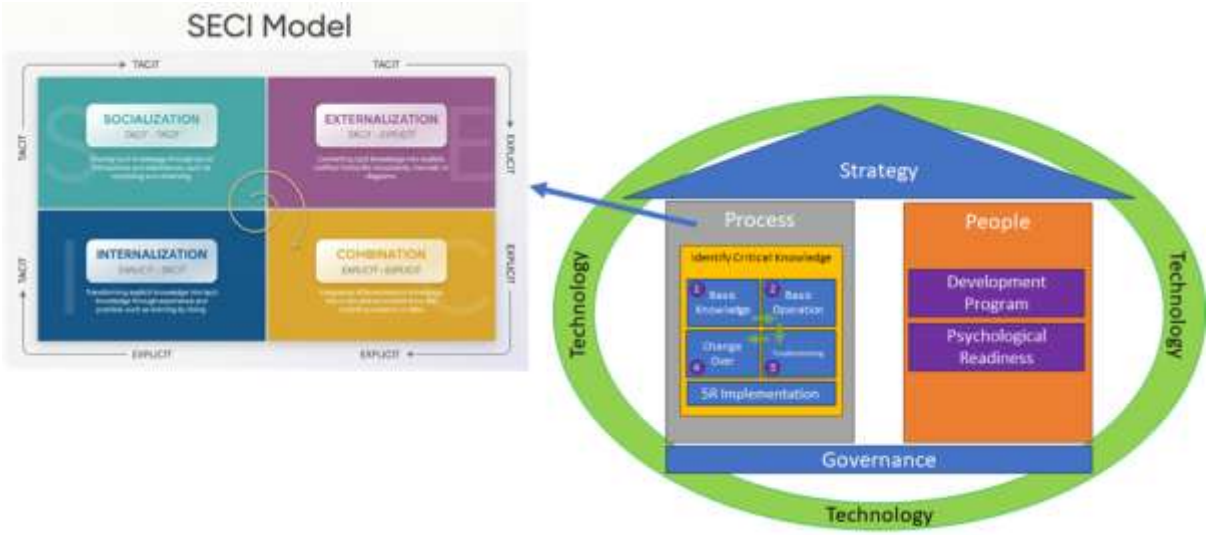

Figure. 2: The KM House Framework for Operator Skill Transfer

Process and People form the two pillars that hold the house up. The Process pillar organizes critical knowledge into a four-level curriculum sequence, Basic Knowledge, Basic Operation, Troubleshooting, and Change Over, resting on a cross-cutting foundation of 5R Implementation, with each level mapped to a skill group and a primary SECI mode (Table 3). The People pillar contains a Development Program that builds mentors' capability to articulate tacit knowledge through Training for Trainer, and a Psychological Readiness Preparation that addresses the mentee's affective readiness; the former strengthens the Externalization side of the SECI cycle while the latter strengthens the Internalization side. Technology is positioned not as a co-equal enabler but as an enveloping layer that connects and amplifies all components, reflecting the Operator 4.0 reality, and is designed around visual-first, mobile-accessible, and field-language principles.

Table 3. Critical Knowledge Curriculum Sequence in the Process Pillar

Seq.	Curriculum Level	Knowledge Type	Skill Group	Primary SECI Mode
1	Basic Knowledge (Safety & Quality)	Tacit (foundational)	Fundamental Skills	Socialization
2	Basic Operation	Explicit (codifiable)	Fundamental Skills	Combination & Internalization
3	Troubleshooting	Tacit (feeling-based)	Problem-Solving Skills	Externalization
4	Change Over	Tacit (variant-specific)	Job-Specific Skills	Externalization & Socialization
–	5R Implementation (cross-cutting)	Explicit (rule-based)	Fundamental Skills	Combination

pillar (Table 4). The diagnostic finding indicates that the cycle is open at the Externalization node: the tacit knowledge of the senior never converts into a storable explicit form. The framework therefore treats the closure of this gap as the central priority, with the Process pillar, the People pillar, and the Technology layer working together to enable the conversion. Once Externalization is closed, the downstream Combination and Internalization modes can run at organizational scale, producing the self-sustaining knowledge spiral the framework is designed to deliver.

Table 4. SECI Engine Operation within the KM House Framework

SECI Mode	Direction	Operational Mechanism	Supporting Component(s)
Socialization	Tacit → Tacit	Direct interaction through shadowing, joint problem solving, and shared experience at the gemba.	People (Psychological Readiness); Governance (protected time)
Externalization	Tacit → Explicit	Articulation of tacit knowledge via video recording, decision-tree documentation, OPL, and structured debriefs.	People (TfT); Process (curriculum); Technology (visual platform)
Combination	Explicit → Explicit	Integration and dissemination of codified knowledge through the digital platform and cross-line sharing.	Technology (platform); Process (templates)
Internalization	Explicit → Tacit	Re-conversion into operator tacit knowledge through hands-on practice, simulation, and guided application.	People (Readiness); Governance (assessment); Technology (blended learning)

Implementation Plan. The framework is translated into a 12-month roadmap structured into four phases. Phase 1 (Months 1–3), Assessment and Planning, installs the roof and designs the foundation by formalizing the KM Charter and the regeneration roadmap. Phase 2 (Months 3–6), Preparation and Design, raises the pillars and wraps the technology layer by running the Training for Trainer program, designing the four-level curriculum, and developing a Minimum Viable Product of the digital platform. Phase 3 (Months 6–9), Trials and Pilots, validates the integrated house in the wafer stick area as the priority pilot location. Phase 4 (Months 9–12), Roll-out and Embedding, scales and institutionalizes the framework with a quarterly content-update cycle. Key implementation risks, production-target pressure crowding out mentoring, senior reluctance to share, and low technology adoption, are mitigated respectively through KPI integration, the recognition and career-path system, and the visual-first mobile design.

These findings extend prior manufacturing KM research Dombrowski et al., (2012); Johnson et al., (2019) by demonstrating that, at the operator level, the binding constraint is not the absence of knowledge-sharing activity but the absence of an Externalization mechanism that converts active tacit transfer into a durable explicit asset. The contribution is threefold. Theoretically, the research synthesizes three complementary literatures into one coherent framework that addresses the cascading interdependencies among organizational dimensions. Practically, it delivers an actionable framework and phased plan that the case organization can adopt directly. Methodologically, it demonstrates the application of the Gioia methodology in

an industrial KM context. The interpretation remains bounded by the single-case design, so the framework is offered as an analytically generalizable architecture rather than a statistically generalizable claim.

CONCLUSION

This research examined Knowledge Management practices for operator skill transfer at PT XYZ and found that the current system remained informal, dependent on individual experience, and reactive, with structural gaps across all five Knowledge Management enablers that reinforced one another and ultimately resulted in an ineffective Externalization process within the SECI cycle. The critical knowledge required for optimal operator performance followed a four-level hierarchy, with troubleshooting capability—largely tacit and insufficiently documented—identified as the primary differentiating competence and the largest knowledge gap. The consistent aspirations expressed by informants indicated the need for a comprehensive system redesign rather than isolated improvements. In response, this study proposed the KM House Framework for Operator Skill Transfer, which positioned Strategy as the roof, Governance as the foundation, Process and People as the supporting pillars, Technology as the enabling layer, and the SECI cycle as the operational engine. The framework prioritized strengthening the Externalization process because improving this stage would facilitate subsequent Combination and Internalization processes at the organizational level.

The framework was operationalized through a 12-month implementation roadmap. For the case organization, the immediate priorities were to establish a director-level KM Charter focused on the wafer stick production area, integrate mentoring activities into supervisor and senior operator performance indicators, and develop a tablet-based digital platform as a Minimum Viable Product (MVP). These initiatives aimed to convert critical knowledge held by experienced operators approaching retirement into sustainable organizational knowledge assets before such knowledge was lost. Future research should examine the transferability of the proposed framework across other production lines and industrial sectors, as well as evaluate its impact on onboarding time, changeover duration, and defect rates following implementation.

REFERENCE

Ahmed, W., Najmi, A., Mustafa, Y., & Khan, A. (2019). Developing model to analyze factors affecting firms' agility and competitive capability: a case of a volatile market. *Journal of Modelling in Management*, *14*(2), 476–491.

Adams, W. C. (2015). Conducting semi-structured interviews. In K. E. Newcomer, H. P. Hatry, & J. S. Wholey (Eds.), *Handbook of practical program evaluation* (4th ed., pp. 492–505). Jossey-Bass.

Badan Pusat Statistik. (2025). *Pertumbuhan ekonomi Indonesia triwulan III-2025* (Berita Resmi Statistik No. 102/11/Th. XXVIII). Badan Pusat Statistik. https://www.bps.go.id

Balzano, M., & Bortoluzzi, G. (2024). Strategic agility in dynamic business environments. *International Series in Advanced Management Studies*, *10*, 973–978.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Dombrowski, U., Mielke, T., & Engel, C. (2012). Knowledge management in lean production

systems. *Procedia CIRP, 3*, 436–441. https://doi.org/10.1016/j.procir.2012.07.076

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods, 16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Hilsen, A. I., & Olsen, D. S. (2021). *The importance and value of older employees: Wise workers in the workplace*. Springer.

Johnson, T. L., Fletcher, S. R., Baker, W., & Charles, R. L. (2019). How and why we need to capture tacit knowledge in manufacturing: Case studies of visual inspection. *Applied Ergonomics, 74*, 1–9. https://doi.org/10.1016/j.apergo.2018.07.010

Kaasinen, E., Schmalfuß, F., Özturk, C., Aromaa, S., Boubekeur, M., Heilala, J., Heikkilä, P., Kuula, T., Liinasuo, M., Mach, S., Mehta, R., Petäjä, E., & Walter, T. (2020). Empowering and engaging industrial workers with Operator 4.0 solutions. *Computers & Industrial Engineering, 139*, Article 105678. https://doi.org/10.1016/j.cie.2019.01.052

Loxton, M., Truskett, R., Scarf, B., Sindone, L., Baldry, G., & Zhao, Y. (2020). Consumer behaviour during crises: Preliminary research on how coronavirus has manifested consumer panic buying, herd mentality, changing discretionary spending and the role of the media in influencing behaviour. *Journal of Risk and Financial Management*, *13*(8), 166.

Kallio, H., Pietilä, A.-M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954–2965. https://doi.org/10.1111/jan.13031

Maheshkar, C., Nandan, D., Nandedkar, T., & Mehta, Y. (2027). The Aging Workforce: Employment Risks and Opportunities in the AI Era. In *Sustainable Industrial Transformation in the AI Era* (pp. 199–228). IGI Global Scientific Publishing.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Milton, N., & Lambe, P. (2016). *The knowledge manager's handbook: A step-by-step guide to embedding effective knowledge management in your organization*. Kogan Page.

Muniz, J., Batista, E. D., Jr., & Loureiro, G. (2010). Knowledge-based integrated production management model. *Journal of Knowledge Management, 14*(6), 858–871. https://doi.org/10.1108/13673271011084934

Rhem, A. J. (2016). *Knowledge management in practice*. CRC Press.

Rubin, H. J., & Rubin, I. S. (2012). *Qualitative interviewing: The art of hearing data* (3rd ed.). SAGE Publications. https://doi.org/10.4135/9781452275727

Thakur, V., & Kiran, P. (2021). Impact of the covid-19 pandemic outbreak on panic buying behavior in the FMCG sector. *Ushus Journal of Business Management*, *20*(2), 71–90.