



HAL
open science

Balancing Confidence and Caution: Artificial Intelligence's Integration in Lean Profession

Florian Magnani, Maricela Arellano, Laurent Joblot, Fernando Naranjo, Alexandre Guillard, Mario Passalacqua

► **To cite this version:**

Florian Magnani, Maricela Arellano, Laurent Joblot, Fernando Naranjo, Alexandre Guillard, et al.. Balancing Confidence and Caution: Artificial Intelligence's Integration in Lean Profession. EUROMA 2025, Jun 2025, Milan, Italy. <hal-05222872>

HAL Id: hal-05222872

<https://hal.science/hal-05222872v1>

Submitted on 16 Sep 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Balancing Confidence and Caution: Artificial Intelligence's Integration in Lean Profession

*Florian Magnani (florian.magnani@univ-lyon3.fr)
Université Jean Moulin Lyon 3, iaelyon school of management, UR Magellan*

*Maricela C. Arellano
HEC Montréal, Logistics and Operations Management department*

*Laurent Joblot
Arts et Métiers Institute of Technology, LISPEN department*

*Fernando Naranjo
Niagara University, Holzschuh College of Business Administration*

*Alexandre Guillard
ESSEC Business School*

*Mario Passalacqua
Université du Québec à Montréal, Psychology department*

Abstract:

With artificial intelligence (AI) transforming operations management, lean professionals—ranging from in-house practitioners to external consultants—face both opportunities and tensions. This study explores how AI influences their practices and roles by applying a Delphi-Régnier method with experts from industry, academia, and consulting. It examines organizational, technological, informational, and people challenges. We aim to offer preliminary insights into the challenges faced by lean professionals, including how they navigate between executional tasks and strategic advisory roles. It also investigates how AI complements human expertise within hybrid decision-making systems. The study will propose practical guidelines for aligning AI integration with lean principles.

Keywords: Artificial Intelligence, Lean, Delphi-Régnier study

Topic(s): 15. Lean and Agile Operations

Introduction

Artificial Intelligence (AI) is reshaping operations management, from traditional operations to knowledge-intensive professional services, by offloading low-value tasks and generating insights that enhance high-value advisory work (Mithas *et al.*, 2022; Spring *et al.*, 2022). As AI increasingly assumes cognitive tasks like decision-making, researchers have yet to fully grasp the interplay between AI and human factors, and its repercussions for established professions (Meissner and Keding, 2021). Lean professionals—ranging from in-house practitioners to external consultants—, with its strong commitment to both process improvement and people-centric approaches, exemplifies a tension that becomes even more pronounced in the face of AI (Khan *et al.*, 2024).

AI holds great promise for lean practices by not only enabling real-time process improvement and boost of lean tools (Chiarini and Kumar, 2025), but also supporting greater employees' interaction and knowledge sharing (Tortorella *et al.*, 2024). However, trust issues further complicate the picture; experienced employees who shoulder broader responsibilities often show skepticism toward AI, considering potential deceleration in productivity gains (Wang *et al.*, 2024) and highlighting the inherent challenges of transitioning from human-only to hybrid decision-making systems (Feuerriegel *et al.*, 2022).

Lean, with its emphasis on field observation, methodical experimentation, pragmatic skills development, and critical reasoning, calls for a measured, need-driven transformation while creating opportunities for collaboration between AI and lean consultants (Alavi and Westerman, 2023). Chiarini and Kumar (2025) highlight the key role that lean leaders play as learning facilitators for the integration of digitalization and lean. Yet, while lean professionals have traditionally guided improvement initiatives and shared expertise, lean culture also empowers every employee to act as a local expert—making it increasingly challenging to balance decentralized knowledge with centralized oversight in digitalized contexts. For instance, Schou and Nesheim (2024) show how experts reclaim power by leveraging their agency under digital surveillance.

These studies illustrate the complex challenges lean professionals face in integrating digital technologies into their lean practices. While a growing body of research explores responses to Industry 4.0 and lean, most adopt a macro-level perspective. When practitioners' views are considered, it is often in service of adapting lean tools to improve performance. Our goal is to explore AI's impact on knowledge work within the context of lean, focusing on how those engaged in lean practice perceive and are affected by it. We seek to understand how AI could support the development of “the next generation learning systems [...] rather than simply adopting AI to optimize existing systems” (Powell, 2024: p. 724), by focusing on what lean professionals think and anticipate. Accordingly, our research question—broad and exploratory by design—is as follows: *What are the challenges of integrating AI into lean environments from the perspective of lean professionals?*

Literature review

Artificial Intelligence in Lean organizations

The integration of AI is beginning to transform companies' business models, while also offering new disruptive innovation opportunities in the design of work. Based on OCDE.AI Policy Observatory definition¹, “AI is a machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptiveness after deployment“. All forms of AI differ in their capacity to interact with employees and incorporate a “human-in-the-loop” approach, ensuring human oversight of critical processes and limiting the risks associated

¹ <https://oecd.ai/en/ai-principles>

with full automation (Castañé *et al.*, 2023; Helo and Hao, 2022; Jackson *et al.*, 2024; Senoner *et al.*, 2022, 2024).

In lean organizations, AI could bring multiple benefits by reshaping operational decision-making by automating routine tasks, analyzing large volumes of data, and enabling data-driven decision-making. Key applications—such as process optimization, predictive maintenance, and demand forecasting—demonstrate AI's potential to eliminate guesswork and identify optimal choices (Helmold, 2020). This synergy not only improves performance but also cultivates an adaptive organizational culture grounded in continuous improvement (Abbasi *et al.*, 2024). Research shows that AI readiness and organizational flexibility positively influence the sustainability and value-creation potential of lean systems (Adiguzel *et al.*, 2024). Furthermore, the integration of AI has the potential to enhance employee experience by supporting cognitive, physical, emotional and behavioral dimensions of work (Passalacqua *et al.*, 2025). By harmonizing AI capabilities with Lean practices, organizations can drive transformative change while upholding human-centric values. For example, Pongboonchai-Empl *et al.* (2025) provide an innovative framework suggesting how AI, and other industry 4.0 technologies, could enhance different tools used through the PDCA process. Looking ahead, future research should explore how this integration can support carbon-neutral goals, enhance the resilience of smart factories, and foster next-generation organizational learning systems (Powell, 2024).

However, AI implementation comes with significant challenges, as highlighted in a systematic literature review by Lee *et al.* (2023), which points out the most salient issues for the adoption of AI in organizations, including organizational-related issues ; information systems related issues ; technology-related issues ; and people-related issues. In the particular context of the integration of Industry 4.0 technologies in lean environments, many similar barriers have also been identified. K. E. K. *et al.* (2025) create a structure in which challenges are interrelated—top management reluctance due to traditional mindset, high investment, data privacy concerns, ethical dilemmas, concerns over data quality, dependence on service providers, lack of trained employees and consultants, complexity in integrating AI with decision making, lack of IT infrastructure, and concern over premature technology—and proposes a roadmap so organizations can overcome such challenges. Furthermore, the risk of goal misalignment across teams, resistance to cultural change, and over-reliance on automation at the expense of human creativity, may be increased (Holweg *et al.*, 2023). Skalli *et al.* (2025) list similar challenges and propose a 14-step implementation process featuring case studies from the automotive and mining industries, providing evidence of increased operational performance. While these studies help us gauge the challenges associated with integrating Industry 4.0 into lean environments, further analysis is needed to specifically address the integration of AI within these environments.

As with every change, implementation of AI within a lean environments depends on involving employees throughout the process to prevent disengagement and to fully realize AI's benefits (Tortorella *et al.*, 2024). Engagement highly depends on lean employees' attitudes towards the benefits and challenges of integrating AI into their lean-related work. Although improved operational performance is the main driver of implementing AI from an organizational point of view, it is the sensemaking and the practices of those doing the work that ultimately matters (Frank *et al.*, 2024). For example, Frank *et al.* (2025) show that the benefits of AI for Brazilian manufacturing firms are only reaped if it positively transforms employees' problem-solving and continuous improvement practices. Galeazzo *et al.* (2024) obtained similar results in the context of Italian manufacturing firms. Addressing people-related challenges should be prioritized.

Effects of AI utilization on employees

AI can enhance the quality and precision of operational task execution while also serve as a means to develop employee skills (Wilkins, 2020). Previous studies showed that AI has effects on employee productivity, motivation, and engagement (Passalacqua *et al.*, 2025). Additionally, employee experience moderates the relationship between AI and operational performance, with AI proving particularly advantageous for those with substantial operational expertise (Wang *et al.*, 2019). AI's mode of integration can significantly influence perceived reliability, trust, and the effectiveness of decision-making processes (Pataranutaporn *et al.*, 2023). Particularly focusing on decision-making, Boussioux *et al.*, (2024) show that while decisions made exclusively by employees are generally more innovative, those made with AI support tend to be of higher quality and reliability.

However, the effects of AI integration on employees' outcomes goes beyond task performance. Employees' needs, skills, and professional identity are often overlooked during the development and integration process of AI (Berretta *et al.*, 2023). Employees often encounter paradoxical challenges, making the integration of AI far from straightforward. AI introduce new tensions—such as balancing reliance on algorithmic recommendations with professional judgment, or navigating shifts in autonomy and responsibility (Pataranutaporn *et al.*, 2023). In regards to judgment, this finding is in line with the work of Pettersen (2019), who argues that many aspects of work require contextual, social, and relational problem-solving—dimensions that are difficult to automate. Where AI systems struggle to incorporate context, human interpretation, and social interactions, employees may retain an advantage over AI systems. Lee *et al.* (2025) adds trust to the complex relationship between AI and critical thinking: higher trust in AI tends to reduce the use of critical thinking, while higher self-confidence tends to strengthen it. Interestingly, likely due to a degree of mistrust stemming from their deep knowledge of organizational mechanisms and the perceived limitations of AI, experienced employees, who could benefit the most from AI, tend to use it less (Wang *et al.*, 2019).

In regards to AI framed as supportive rather than authoritative tool, Freisinger *et al.* (2024) reveal diverging perceptions between managers and operators regarding the impact of AI on their responsibilities and autonomy. Awareness of the risk of being replaced by AI is associated with a decline in organizational commitment and job satisfaction, while also correlated with increased voluntary turnover intentions, cynicism, and depressive symptoms (Brougham and Haar, 2018). Consequently, employees' motivation could be undermined, leading them to adopt various protective strategies or new roles to safeguard their interests in the face of AI-induced transformations (Faulconbridge *et al.*, 2023). It seems necessary to understand how employees evaluate the consequences of AI on their own work, namely on their role. Empirical evidence shows that AI can gradually transform employees from executors to evaluators, supervisors, and more (Simkute *et al.*, 2025).

These paradoxes highlight that the benefits of AI are often accompanied by uncertainty and adaptation demands for lean professionals thereby calling for a deeper investigation into the factors that influence how they perceive the use of AI and how it influences their practices and their roles. In lean environments, little is known about the effects of AI on employees. The next step is to further explore the full range of challenges and their effects on employees' cognitive, emotional, and behavioral dimensions.

Methodology

This study represents the first phase of a broader, multi-stage exploratory research project examining the interactions between artificial intelligence (AI) and lean management practices. By adopting a mixed-methods approach, our aim is to generate rich, contextual insights into how AI is transforming the roles and practices of lean experts—ranging from in-house practitioners to external consultants. Specifically, the research aim to understand challenges and consequences from the position of lean professionals. To initiate this inquiry, we designed

a Delphi-Régnier study to address our initial research question: *What are the challenges of integrating AI into lean environments from the perspective of lean professionals?*

Given the lack of consensus in the existing literature and the emerging, experience-driven nature of the topic, expert input is essential. AI integration into lean environments and therefore lean practices is both complex and forward-looking, often intersecting with sensitive issues such as workforce transformation, data accessibility, and cultural change. These characteristics make the Delphi-Régnier methodology particularly well-suited for our research (Naranjo *et al.*, 2023).

The Delphi-Régnier method combines two complementary approaches:

- The **Delphi technique**, which relies on anonymous, multi-round consultation to build consensus among experts (Skulmoski *et al.*, 2017) ;
- The **Régnier method**, which introduces a scoring mechanism to assess the intensity of agreement or disagreement and to highlight areas of divergence (Maleki, 2009).

This hybrid approach enables both quantitative aggregation of expert opinions and qualitative analysis of differing perspectives. It is especially effective for addressing ambiguous, interdisciplinary topics like the integration of AI into lean environments—where empirical evidence is limited (Mœuf *et al.*, 2017 ; Riemens *et al.*, 2021), but practitioner insights are rich and necessary. Furthermore, the anonymity of Delphi rounds mitigates bias from group dynamics, while the Régnier scoring provides structured, interpretable feedback. To ensure a diverse and relevant expert base, we employed a multi-panel design involving three key groups: (1) CEOs or lean leaders in companies that have implemented lean practices; (2) academics working on lean management and/or Industry 4.0 and 5.0 topics; and (3) strategy consultants involved in digital and operational transformations.

Most of the participants are affiliated with well-known lean-focused non-profit organizations such as the French Lean Institute and the Canadian Kata Practitioners Group. For the first round of the Delphi-Régnier study, we targeted approximately 50 experts across the three key groups. This panel composition is designed to ensure data relevance, precision, and breadth, while also laying the groundwork for identifying and addressing future challenges in AI integration.

The themes addressed in the first round are derived from the key challenges outlined by Lee *et al.* (2023) and are grouped into five broad categories: (1) Organizational challenges, (2) Information systems-related challenges, (3) Technological challenges, (4) People-related challenges, and (5) The evolving role of lean experts in addressing these challenges. Some open-ended questions were added at the end (See Appendix 1) to prepare for the following rounds. The first Delphi-Régnier round is scheduled to take place between April and June 2025.

Anticipated findings

This study is expected to yield insights into the ways AI integration influences lean professionals - ranging from in-house practitioners to external consultants. Most of the challenges will be explored throughout the lenses of lean expertise. It will serve as a comparison with Lee *et al.* (2023) list of challenges. With the several rounds of the Delphi-Régnier, we will be able to identify the challenges related to AI integration into lean environments by presenting a ranked list of challenges by relevance and criticality. Consensus areas and divergent views between experts will be discussed and the comments coupled with additional interviews might enable rich qualitative data. It will serve as a robust foundation for developing implementation frameworks or guidelines for AI-Lean integration.

First, AI's introduction of advanced analytics, automation of routine tasks, and real-time decision-support is likely to reshape lean consultants' activities. However, tension may arise between leveraging these efficiencies and maintaining the human-centric ethos central to lean. Rather than fully displacing traditional practices, we anticipate a hybrid, intricate approach, where AI augments human expertise and fosters complementary teamwork.

Second, the evolving role of lean professionals will likely entail a shift away from primarily executional tasks and toward strategic advisory responsibilities. Thus, it is possible that lean consultants may act as orchestrators of AI integration, requiring enhanced competencies in data interpretation, ethical governance, and cross-functional collaboration. The focus might shift from operations orientation to design orientation. Concerns may arise over entrusting decision-making to AI, potentially fueling debates on cognitive autonomy and identity within the lean profession.

Conclusion

This research will enrich the discourse on AI and lean, both theoretically and practically. Theoretically, we aim to offer a preliminary conceptual framework for understanding human-AI collaboration within lean, addressing gaps concerning decision-making dynamics and hybrid roles (Schou and Nesheim, 2024). By examining the distinction between “executional agency” and “thinking agency,” the study will offer insights into cognitive autonomy in AI-driven workflows.

Practically, the research will identify essential skill sets for lean professionals. These findings will guide training programs or organizational adaptation. The study will offer strategic insights to align AI integration with lean principles, ensuring technology complements established practice. It will also provide policy recommendations on overcoming employee resistance, ensuring data ethics, and promoting equitable decision-making.

References

- Abbasi, M., Nishat, R.I., Bond, C., Graham-Knight, J.B., Lasserre, P., Lucet, Y. and Najjaran, H. (2024), “A review of AI and machine learning contribution in business process management (process enhancement and process improvement approaches)”, *Business Process Management Journal*, Emerald Publishing Limited, Vol. ahead-of-print No. ahead-of-print, doi: 10.1108/BPMJ-07-2024-0555.
- Adiguzel, Z., Cakir, F.S. and Özbay, F. (2024), “Examination of the effects of artificial intelligence readiness on lean sustainability and value creation in the mediation variable effect of organizational flexibility in technology-focused companies”, *Kybernetes*, Emerald Publishing Limited, Vol. ahead-of-print No. ahead-of-print, doi: 10.1108/K-01-2024-0046.
- Alavi, M. and Westerman, G. (2023), “How Generative AI Will Transform Knowledge Work”, *Harvard Business Review*, 7 November.
- Berretta, S., Tausch, A., Peifer, C. and Kluge, A. (2023), “The Job Perception Inventory: considering human factors and needs in the design of human–AI work”, *Frontiers in Psychology*, Frontiers, Vol. 14, doi: 10.3389/fpsyg.2023.1128945.
- Boussieux, L., Lane, J.N., Zhang, M., Jacimovic, V. and Lakhani, K.R. (2024), “The Crowdless Future? Generative AI and Creative Problem-Solving”, *Organization Science*, INFORMS, Vol. 35 No. 5, pp. 1589–1607, doi: 10.1287/orsc.2023.18430.
- Brougham, D. and Haar, J. (2018), “Smart Technology, Artificial Intelligence, Robotics, and Algorithms (STARA): Employees’ perceptions of our future workplace”, *Journal of Management & Organization*, Cambridge University Press, United Kingdom, Vol. 24 No. 2, pp. 239–257, doi: 10.1017/jmo.2016.55.
- Castañé, G., Dolgui, A., Kousi, N., Meyers, B., Thevenin, S., Vyhmeister, E. and Östberg, P.-O. (2023), “The ASSISTANT project: AI for high level decisions in manufacturing”, *International Journal of Production Research*, Taylor & Francis, Vol. 61 No. 7, pp. 2288–2306, doi: 10.1080/00207543.2022.2069525.
- Chiarini, A. and Kumar, M. (2025), “Crafting a synergistic convergence: an integrated approach for lean and industry 4.0 transformation”, *International Journal of Production Research*, Taylor & Francis, Vol. 0 No. 0, pp. 1–21, doi: 10.1080/00207543.2025.2473702.
- Faulconbridge, J., Sarwar, A. and Spring, M. (2023), “How Professionals Adapt to Artificial Intelligence: The Role of Intertwined Boundary Work”, *Journal of Management Studies*, Vol. n/a No. n/a, doi: 10.1111/joms.12936.
- Feuerriegel, S., Shrestha, Y.R., von Krogh, G. and Zhang, C. (2022), “Bringing artificial intelligence to business management”, *Nature Machine Intelligence*, Nature Publishing Group, Vol. 4 No. 7, pp. 611–613, doi: 10.1038/s42256-022-00512-5.
- Frank, A.G., Sturgeon, T.J., Benitez, G.B., Marodin, G.A. and Ferreira e Cunha, S. (2025), “How Lean and Industry 4.0 affect worker outcomes and operational performance: A quantitative assessment of

- competing models”, *International Journal of Production Economics*, Vol. 279, p. 109475, doi: 10.1016/j.ijpe.2024.109475.
- Frank, A.G., Thürer, M., Filho, M.G. and Marodin, G.A. (2024), “Beyond Industry 4.0 – integrating Lean, digital technologies and people”, *International Journal of Operations & Production Management*, Emerald Publishing Limited, Vol. 44 No. 6, pp. 1109–1126, doi: 10.1108/IJOPM-01-2024-0069.
- Freisinger, E. and Schneider, S. (2024), “Decoding decision delegation to artificial intelligence: A mixed-methods study on the preferences of decision-makers and decision-affected in surrogate decision contexts”, *European Management Journal*, doi: 10.1016/j.emj.2024.10.004.
- Galeazzo, A., Furlan, A., Tosetto, D. and Vinelli, A. (2024), “Are lean and digital engaging better problem solvers? An empirical study on Italian manufacturing firms”, *International Journal of Operations & Production Management*, Emerald Publishing Limited, Vol. 44 No. 6, pp. 1217–1248, doi: 10.1108/IJOPM-06-2023-0477.
- Helmold, M. (2020), “Lean Management and Artificial Intelligence (AI)”, in Helmold, M. (Ed.), *Lean Management and Kaizen: Fundamentals from Cases and Examples in Operations and Supply Chain Management*, Springer International Publishing, Cham, pp. 131–137, doi: 10.1007/978-3-030-46981-8_14.
- Helo, P. and Hao, Y. (2022), “Artificial intelligence in operations management and supply chain management: an exploratory case study”, *Production Planning & Control*, Taylor & Francis, Vol. 33 No. 16, pp. 1573–1590, doi: 10.1080/09537287.2021.1882690.
- Holweg, M., Davenport, T.H. and Snyder, K. (2023), “How AI Fits into Lean Six Sigma”, *Harvard Business Review*.
- Jackson, I., Ivanov, D., Dolgui, A. and Namdar, J. (2024), “Generative artificial intelligence in supply chain and operations management: a capability-based framework for analysis and implementation”, *International Journal of Production Research*, Taylor & Francis, Vol. 62 No. 17, pp. 6120–6145, doi: 10.1080/00207543.2024.2309309.
- K. E. K., V., Rashmi ,Divya, K. ,Sivakumar, Kandasmay ,Jayakrishna, K. P. ,Paranitharan and Venkataraman, B. (2025), “Developing a Delphi assisted total interpretive structural model (D-TISM) for adopting the Industry 4.0 technologies within Lean Six Sigma framework”, *Production Planning & Control*, Taylor & Francis, Vol. 36 No. 1, pp. 20–44, doi: 10.1080/09537287.2023.2251014.
- Khan, A.N., Soomro, M.A. and Pitafi, A.H. (2024), “AI in the Workplace: Driving Employee Performance Through Enhanced Knowledge Sharing and Work Engagement”, *International Journal of Human–Computer Interaction*, Taylor & Francis, Vol. 0 No. 0, pp. 1–14, doi: 10.1080/10447318.2024.2436611.
- Lee, H.-P.H., Sarkar, A., Tankelevitch, L., Drosos, I., Rintel, S., Banks, R. and Wilson, N. (2025), “The Impact of Generative AI on Critical Thinking: Self-Reported Reductions in Cognitive Effort and Confidence Effects From a Survey of Knowledge Workers”, presented at the CHI Conference on Human Factors in Computing Systems, Yokohama, Japan, p. 23.
- Lee, M.C.M., Scheepers, H., Lui, A.K.H. and Ngai, E.W.T. (2023), “The implementation of artificial intelligence in organizations: A systematic literature review”, *Information & Management*, Vol. 60 No. 5, p. 103816, doi: 10.1016/j.im.2023.103816.
- Maleki, K. (2009), *Méthodes quantitatives de consultation d’experts: Delphi, Delphi public, Abaque de Régnier et impacts croisés*, Editions Publibook.
- Meissner, P. and Keding, C. (2021), “The Human Factor in AI-Based Decision-Making”, *MIT Sloan Management Review*, 12 October.
- Mithas, S., Chen, Z.-L., Saldanha, T.J.V. and De Oliveira Silveira, A. (2022), “How will artificial intelligence and Industry 4.0 emerging technologies transform operations management?”, *Production and Operations Management*, Vol. 31 No. 12, pp. 4475–4487, doi: 10.1111/poms.13864.
- Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S. and Barbaray, R. (2017), “The industrial management of SMEs in the era of Industry 4.0”, *International Journal of Production Research*, Taylor & Francis, Vol. 56 No. 3, pp. 1118–1136, doi: 10.1080/00207543.2017.1372647.
- Naranjo, F., Menor, L.J. and Johnson, P.F. (2023), “Lean supply chain management: a contextual contingent reconceptualization and Delphi method study”, *International Journal of Operations & Production Management*, Emerald Publishing Limited, Vol. 43 No. 9, pp. 1456–1480, doi: 10.1108/IJOPM-07-2022-0436.
- Passalacqua, M., Pellerin, R., Yahia, E., Magnani, F., Rosin, F., Joblot, L. and Léger, P.-M. (2025), “Practice With Less AI Makes Perfect: Partially Automated AI During Training Leads to Better Worker Motivation, Engagement, and Skill Acquisition”, *International Journal of Human–Computer Interaction*, Taylor & Francis, Vol. 41 No. 4, pp. 2268–2288, doi: 10.1080/10447318.2024.2319914.
- Pataranutaporn, P., Liu, R., Finn, E. and Maes, P. (2023), “Influencing human–AI interaction by priming beliefs about AI can increase perceived trustworthiness, empathy and effectiveness”, *Nature Machine Intelligence*, Nature Publishing Group, Vol. 5 No. 10, pp. 1076–1086, doi: 10.1038/s42256-023-00720-7.

- Pettersen, L. (2019), “Why Artificial Intelligence Will Not Outsmart Complex Knowledge Work”, *Work, Employment and Society*, SAGE Publications Ltd, Vol. 33 No. 6, pp. 1058–1067, doi: 10.1177/0950017018817489.
- Pongboonchai-Empl, T., Jiju, A., Jose-Arturo, G.-R., GuilhermeLuz, T., Tim, K. and Stemann, D. (2025), “DMAIC 4.0 - innovating the Lean Six Sigma methodology with Industry 4.0 technologies”, *Production Planning & Control*, Taylor & Francis, Vol. 0 No. 0, pp. 1–22, doi: 10.1080/09537287.2025.2477724.
- Powell, D.J. (2024), “Artificial intelligence in lean manufacturing: digitalization with a human touch?”, *International Journal of Lean Six Sigma*, Emerald Publishing Limited, Vol. 15 No. 3, pp. 719–729, doi: 10.1108/IJLSS-05-2024-256.
- Riemens, J., Lemieux, A.-A., Lamouri, S. and Garnier, L. (2021), “A Delphi-Régnier Study Addressing the Challenges of Textile Recycling in Europe for the Fashion and Apparel Industry”, *Sustainability*, Multidisciplinary Digital Publishing Institute, Vol. 13 No. 21, p. 11700, doi: 10.3390/su132111700.
- Schou, P.K. and Nesheim, T. (2024), “What We Do in the Shadows: How expert workers reclaim control in digitalized and centralized organizations through ‘stealth work’”, *Organization Studies*, SAGE Publications Ltd, Vol. 45 No. 5, pp. 719–744, doi: 10.1177/01708406241233175.
- Senoner, J., Netland, T. and Feuerriegel, S. (2022), “Using Explainable Artificial Intelligence to Improve Process Quality: Evidence from Semiconductor Manufacturing”, *Management Science*, INFORMS, Vol. 68 No. 8, pp. 5704–5723, doi: 10.1287/mnsc.2021.4190.
- Senoner, J., Schallmoser, S., Kratzwald, B., Feuerriegel, S. and Netland, T. (2024), “Explainable AI improves task performance in human–AI collaboration”, *Scientific Reports*, Vol. 14, doi: 10.1038/s41598-024-82501-9.
- Simkute, A., Tankelevitch, L., Kewenig, V., Scott, A.E., Sellen, A. and Rintel, S. (2025), “Ironies of Generative AI: Understanding and Mitigating Productivity Loss in Human-AI Interaction”, *International Journal of Human–Computer Interaction*, Taylor & Francis, Vol. 41 No. 5, pp. 2898–2919, doi: 10.1080/10447318.2024.2405782.
- Skalli, D., Cherrafi, Anass, Charkaoui, Abdelkadir, Chiarini, Andrea, Shokri, Alireza, Antony, Jiju, Garza-Reyes, Jose Arturo, *et al.* (2025), “Integrating Lean Six Sigma and Industry 4.0: developing a design science research-based LSS4.0 framework for operational excellence”, *Production Planning & Control*, Taylor & Francis, Vol. 0 No. 0, pp. 1–27, doi: 10.1080/09537287.2024.2341698.
- Skulmoski, G.J., Hartman, F.T. and Krahn, J. (2017), “The Delphi Method for Graduate Research”, *Journal of Information Technology Education: Research*, Vol. 6, pp. 001–021.
- Spring, M., Faulconbridge, J. and Sarwar, A. (2022), “How information technology automates and augments processes: Insights from Artificial-Intelligence-based systems in professional service operations”, *Journal of Operations Management*, Vol. 68 No. 6–7, pp. 592–618, doi: 10.1002/joom.1215.
- Tortorella, G.L., Powell, D., Hines, P., Mac Cawley Vergara, A., Tlapa-Mendoza, D. and Vassolo, R. (2024), “How does artificial intelligence impact employees’ engagement in lean organisations?”, *International Journal of Production Research*, Taylor & Francis, Vol. 0 No. 0, pp. 1–17, doi: 10.1080/00207543.2024.2368698.
- Wang, W., Gao, G. (Gordon) and Agarwal, R. (2019), “Friend or Foe? The Interaction Between Human and Artificial Intelligence on Performance in Medical Chart Coding”, SSRN Scholarly Paper, Social Science Research Network, Rochester, NY, 18 June, doi: 10.2139/ssrn.3405759.
- Wang, W., Gao, G. (Gordon) and Agarwal, R. (2024), “Friend or Foe? Teaming Between Artificial Intelligence and Workers with Variation in Experience”, *Management Science*, INFORMS, Vol. 70 No. 9, pp. 5753–5775, doi: 10.1287/mnsc.2021.00588.
- Wilkens, U. (2020), “Artificial intelligence in the workplace – A double-edged sword”, *The International Journal of Information and Learning Technology*, Emerald Publishing Limited, Vol. 37 No. 5, pp. 253–265, doi: 10.1108/IJILT-02-2020-0022.

Appendix 1 : Delphi-Régnier First Round

Organizational challenges

1. Main challenges for integrating AI in lean environments will be related to related to organizational resistance at different levels
2. Main challenges for integrating AI in lean environments will be related to organizational leaders' misconceptions
3. Main challenges for integrating AI in lean environments will be related to organizational lack of agility
4. Main challenges for integrating AI in lean environments will be related to high cost of investments
5. Main challenges for integrating AI in lean environments will be related to lack of leadership
6. Main challenges for integrating AI in lean environments will be related to lack of knowledge about AI usage

Information systems related challenges

1. Main challenges for integrating AI in lean environments will be related to ethical and legal constraints
2. Main challenges for integrating AI in lean environments will be related to privacy and confidentiality
3. Main challenges for integrating AI in lean environments will be related to mechanisms of controlling AI systems
4. Main challenges for integrating AI in lean environments will be related to maintaining and upgrading AI systems
5. Main challenges for integrating AI in lean environments will be related to biases and security risk
6. Main challenges for integrating AI in lean environments will be related to lack of audit tools and standards/guidelines
7. Main challenges for integrating AI in lean environments will be related to data management issues
8. Main challenges for integrating AI in lean environments will be related to making AI and human intelligence work together

Technological challenges

1. Main challenges for integrating AI in lean environments will be related to immature and unstable AI technology resulting in unsatisfactory results
2. Main challenges for integrating AI in lean environments will be related to technology capabilities being oversold
3. Main challenges for integrating AI in lean environments will be due to AI's lack of transparency (black box)
4. Main challenges for integrating AI in lean environments will be due to AI's inability to perform multiple tasks at once (a single model for a single task only)
5. Main challenges for integrating AI in lean environments will be related to integrating with existing technology, system, and processes

People related challenges

1. Main challenges for integrating AI in lean environments will be related to lack of expertise and trained AI users
2. Main challenges for integrating AI in lean environments will be related to redeployment of "workers"
3. Main challenges for integrating AI in lean environments will be related to depletion of AI users' skills
4. Main challenges for integrating AI in lean environments will be related to negative perception of AI introducing human redundancies
5. Main challenges for integrating AI in lean environments will be related to human isolation
6. Main challenges for integrating AI in lean environments will be related to new knowledge and skillsets required of the workers
7. Main challenges for integrating AI in lean environments will be related to customers' desire for human interaction
8. Main challenges for integrating AI in lean environments will be related to customers' fear and distrust of AI

Lean profession related challenges

1. The ability of lean experts to tackle these challenges will be crucial for the successful integration of AI into their lean environment (specify the role they will have in the comment section)
2. The role of lean experts will change dramatically compared to their current role in their lean environment (specify why and how in the comment section)
3. Lean experts will develop radically new and specific competencies related to the integration of AI in their lean environment (specify in the comment section)
4. The work of lean experts will be negatively impacted using AI (specify the impacted practices in the comment section)

Additional information

1. What other challenges for the integration of AI in lean environments regarding people (ranging from operators to top management) do you foresee?
2. What other challenges for the integration of AI in lean environments regarding the use of lean concepts, tools and practices do you foresee?
3. What other challenges for the integration of AI in lean environments in general do you foresee?
4. Please describe in your own words how do you envision the integration of AI in lean environments?
5. Why is the integration of AI in lean environments important?
6. Which changes do you anticipate in your field (lean profession) due to the integration of AI in lean environments?