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The Impact of Intelligent Manufacturing on Firm Value: The Mediating Role of Innovation Performance and Financial Performance, and the Moderating Role of Manufacturing Risk

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Abstract. This study aims to examine the impact of Intelligent Manufacturing on Firm Value in manufacturing companies listed on the Indonesia Stock Exchange, by considering the mediating roles of Innovation Performance and Financial Performance, as well as the moderating role of Manufacturing Risk. Grounded in the integration of Resource- Based View (RBV), Dynamic Capabilities Theory, and Organizational Risk Theory, this research proposes a comprehensive conceptual model that explains the value creation mechanisms of intelligent manufacturing investments. The study employs a quantitative approach with explanatory research design, utilizing secondary data from financial statements and annual reports of manufacturing companies during the 2019–2024 period. The analysis will be conducted using Structural Equation Modeling with Partial Least Squares (PLS-SEM) approach via SmartPLS 4.0. This research contributes to the literature by introducing a dual mediation model and incorporating manufacturing risk as a contingency factor, particularly within the context of a developing economy. The findings are expected to provide theoretical contributions to strategic management literature and practical insights for managers, investors, and policymakers regarding the strategic implementation of intelligent manufacturing technologies.*

Keywords: Intelligent Manufacturing, Firm Value, Innovation Performance, Financial Performance, Manufacturing Risk

I. Introduction

The manufacturing industry has witnessed substantial transformation driven by Industry 4.0 advancements in cyber-physical systems, the Internet of Things (IoT), and Artificial Intelligence (AI). This evolution has driven unprecedented levels of connectivity and data generation across production environments, providing a platform to enable manufacturing systems capable of achieving higher levels of efficiency and flexibility through enhanced intelligent capabilities. This intelligence is realized through the evolution of manufacturing systems from automated, to autonomous (Fan et al., 2025), to cognitive (El Kalach et al., 2024). This new era is defined by the integration of Information Technology (IT) components—such as edge devices, servers, and cloud platforms—with existing Operational Technology (OT) in manufacturing, such as Programmable Logic Controllers (PLCs) and various actuators, a process also known as digitalization (Yousif et al., 2025).

Venkatraman and Ramanujam (1986) illustrate that a company's value can be measured through various financial metrics, including revenue growth, profitability, earnings per share, price-to-book ratio, and Tobin's Q. Additionally, non-financial indicators, such as brand recognition, market share value, product quality, marketing efficiency, and production value, are used to measure corporate value. Scholars including Ali et al. (2022), Mihail and Micu (2021), Phillips and Sipahioglu (2004), and Thanh (2016) have focused on return on assets (ROA) as a key indicator of firm value. Conversely, Dahmash et al. (2023), Nguyen et al. (2023), Abor (2005), Yang et al. (2010), and Ebaid (2009) have emphasized the importance of return on equity (ROE) in assessing firm value. Furthermore, Jiraporn and Liu (2008) and Vo (2017)

have examined the impact of stock market prices using the Tobin's Q ratio. Therefore, in this study, we will use three primary indicators—ROA, ROE, and Tobin's Q—to assess business value.

Firm value reflects the market's perception of a company's performance and growth prospects, which are determined not only by accounting profits but also by operational efficiency, asset productivity, and the company's ability to create sustainable competitive advantages. In the financial literature, various factors have been identified as influencing firm value, such as capital structure, cash policies, and research and development activities. Bui and Nguyen (2023) demonstrate that financing decisions play a crucial role in determining firm value in emerging markets such as Vietnam. Meanwhile, Habib et al. (2021) found that managerial optimism moderates the relationship between cash policies and firm value. Rahman and Howlader (2022) also demonstrate that R&D expenditures have a positive impact on performance and firm value in South Asian developing countries. In fact, Theissen et al. (2023) revealed that the relationship between cash holdings and firm value is not linear but may exhibit increasing marginal returns at certain levels.

Amid the evolving determinants of firm value, the Fourth Industrial Revolution has introduced intelligent manufacturing as a transformational strategy promising increased efficiency and innovation. However, the relationship between the adoption of intelligent manufacturing and increases in firm value still faces theoretical and empirical ambiguities. A study by Arcidiacono and Schupp (2024) critically found that although intelligent manufacturing has been shown to improve operational performance, such improvements do not automatically translate into superior financial performance. These findings indicate a gap between technical productivity and market valuation, implying that the value creation mechanism of smart technology investments remains unclear.

The inconsistency of findings is also evident across various geographic contexts. A study in Cameroon demonstrated that the adoption of Big Data and IoT significantly increased ROA and ROE, yet technologies such as Cyber-Physical Systems did not show a significant correlation with financial performance. Conversely, research in China found that smart transformation significantly drives value chain upgrading through increased total factor productivity and the optimization of human resources. A case study on the Midea Group even shows that intelligent factories not only increase production efficiency by up to 80%, but also open up new valuation opportunities through the realization of the data economy and the complexity of an industrial ecosystem that is difficult to replicate.

The existing literature has so far been dominated by studies in developed regions and has focused primarily on short-term operational impacts. Meanwhile, research specifically examining the influence of intelligent manufacturing on firm value—taking into account mediating mechanisms and the context of developing countries—remains very limited. However, as demonstrated by Kalantonis et al. (2021), contextual factors such as economic sentiment can strengthen or weaken the influence of strategic decisions on firm value. Therefore, this study is deemed necessary to fill this gap in the literature by examining in greater depth the influence of intelligent manufacturing on firm value, while also enriching our understanding of the determinants of firm value in the digital era.

II. Literature Review

This study adopts the positivist paradigm. This paradigm was chosen because the study aims to test causal relationships among variables that have been operationally defined and quantitatively measured. Positivism assumes that reality is objective and can be observed independently of the researcher. In this context, phenomena such as the adoption of Intelligent Manufacturing, improvements in Innovation Performance, and changes in Firm Value are considered facts that can be measured through secondary data (financial and annual reports of companies), thereby allowing the generalization of findings to the population of manufacturing firms.

The positivist paradigm is appropriate because this research is deductive in nature, where hypotheses are derived from established theories (such as RBV and Dynamic Capabilities) and then tested empirically. The quantitative approach using Structural Equation Modeling (SEM) statistical analysis requires assumptions of objectivity and reliable measurement, which are hallmarks of positivism. The ultimate goal is to produce a general, predictive, and value-free explanation of the relationships between variables.

2.1 Resource-Based View (RBV)

Resource-Based View (RBV) of the Firm, pioneered by Barney (1991), argues that sustainable competitive advantage stems from the possession of resources that are valuable, rare, inimitable, and non-substitutable—or known as VRIN. In this study, Intelligent Manufacturing infrastructure and systems are viewed as resources with VRIN potential.

2.2 Dynamic Capabilities Theory

As an extension of the Resource-Based View (RBV), the Dynamic Capabilities Theory (Teece, Pisano, & Shuen, 1997) focuses on an organization's ability to integrate, build, and reconfigure internal and external competencies to cope with a rapidly changing environment. This theory is highly relevant because IM is not merely a static resource, but a dynamic capability that enables companies to adapt, learn, and innovate.

2.3 Theory of Organizational Risk and Contingency Theory

These theories emphasize that organizational performance is influenced by the alignment between structure, strategy, and internal capabilities with external environmental conditions, including uncertainty and risk. Manufacturing Risk in this study represents a contingency element that can strengthen or weaken the effectiveness of a company's IM capabilities.

These theories are used because collectively they provide a comprehensive lens for answering the research questions. RBV explains why IM can be a source of initial competitive advantage. If a company's IM system is superior and difficult for competitors to imitate (meeting the VRIN criteria), then the company is expected to generate superior performance, which is ultimately rewarded by the market in the form of higher Firm Value. Dynamic Capabilities Theory explains how IM creates value. This theory views IM not as a standalone machine, but as a platform that enhances an organization's capabilities to sense market opportunities and threats, seize those opportunities through the development of new products and processes (Innovation Performance), and reconfigure (transform) resources to maintain an advantage. This improvement in Innovation Performance is then translated into new revenue streams and long-term growth, which contribute to Firm Value. In parallel, IM capabilities also enhance operational efficiency and productivity, which are directly reflected in improved Financial Performance (such as ROI and ROA), which are also direct drivers of Firm Value. The Theory of Organizational Risk introduces an important nuance by stating that the relationships described by RBV and Dynamic Capabilities do not apply universally, but depend on context. In high-risk environments (high Manufacturing Risk), IM's ability to drive innovation and financial performance may be hindered. Shocks to the supply chain or sharp fluctuations in demand can disrupt the complex and costly IM systems, reducing the firm's ability to "capture" value from its technological investments. Thus, this theory forms the basis for a moderation hypothesis.

2.4 Variable Definitions

From the theoretical explanation above, several key variables emerge: Dependent Variable (Y): Firm Value. Independent Variable (X): Intelligent Manufacturing. Mediating Variable: Innovation Performance— derived from the explanation of Dynamic Capabilities. Financial Performance—derived from the RBV and Dynamic Capabilities frameworks. Moderating Variable: Manufacturing Risk—derived from the Theory of Organizational Risk.

2.5 Research Framework and Hypotheses

Based on the theoretical foundation and empirical review above, the research framework is illustrated as follows:

Intelligent Manufacturing (X) has direct and indirect effects on Firm Value (Y) through two parallel mediation pathways: Innovation Performance (Z1) and Financial Performance (Z2). Manufacturing Risk (W) moderates the relationships between Intelligent Manufacturing and both Innovation Performance and Financial Performance.

The following hypotheses are proposed:

H1: Intelligent Manufacturing has a positive effect on Firm Value.
H2: Intelligent Manufacturing has a positive effect on Innovation Performance.
H3: Innovation Performance has a positive effect on Firm Value.
H4: Innovation Performance mediates the effect of Intelligent Manufacturing on Firm Value.
H5: Intelligent Manufacturing has a positive effect on Financial Performance.
H6: Financial Performance has a positive effect on Firm Value.
H7: Financial Performance mediates the effect of Intelligent Manufacturing on Firm Value.
H8: Manufacturing Risk moderates the effect of Intelligent Manufacturing on Innovation Performance, such that the effect is weaker when Manufacturing Risk is high.
H9: Manufacturing Risk moderates the effect of Intelligent Manufacturing on Financial Performance, such that the effect is weaker when Manufacturing Risk is high.

III. Research Method

This study uses a quantitative approach with an explanatory research method, as it aims to explain the causal relationship between independent, mediating, moderating, and dependent variables. A quantitative approach was chosen because this study uses secondary data based on financial statements and annual reports of manufacturing companies listed on the Indonesia Stock Exchange (IDX) for the period 2019– 2024. The analysis will be conducted using panel data regression to test the direct, indirect (mediation), and interaction (moderation) effects among the variables.

3.1 Population and Sample

The population in this study consists of all manufacturing sector companies listed on the Indonesia Stock Exchange (IDX) during the observation period from 2019 to 2024. This period was selected based on the consideration that 2019 marked the period before the acceleration of post-pandemic digital transformation, while 2024 provides an adequate timeframe to observe the impact of technology investment on corporate performance and value. The population characteristics include companies classified in the manufacturing sector based on the IDX classification, which covers sub-sectors such as Basic Industries and Chemicals, Consumer Goods, Machinery and Metals, Automotive and Components, and Technology.

This study uses a purposive sampling method with the following inclusion criteria: (1) companies listed on the Indonesia Stock Exchange (IDX) in the manufacturing sector during the 2019–2024 period; (2) companies that have published complete and consecutive annual financial reports during the study period;
(3) companies have complete data regarding the research variables; and (4) the company did not experience delisting or prolonged trading suspension during the study period.

3.2 Operationalization of Research Variables

All variables in this study will be measured using secondary data available in the companies' annual reports and financial statements.

Intelligent Manufacturing (X) – Independent Variable: The level of adoption and implementation of digital technology and smart automation in a company's manufacturing processes, measured through R&D Intensity (R&D expenditures to total sales) and Technology Asset Intensity (value of technology assets to total assets).

Innovation Performance (Z1) – Mediating Variable: A company's ability to generate innovative outputs that provide a competitive advantage, measured through Patent Intensity (number of patents per year divided by total assets) and Product Innovation Expenditures (expenditures for new product development to total sales).

Financial Performance (Z2) – Mediating Variable: A company's ability to generate profitability from its business operations, measured through Return on Assets (ROA) and Return on Investment (ROI).

Manufacturing Risk (W) – Moderating Variable: The level of uncertainty and volatility in a company's manufacturing operational environment, measured through Demand Volatility (coefficient of variation of

quarterly sales data), Supply Chain Risk (inventory to total assets ratio), and Input Volatility (coefficient of variation of quarterly cost of goods sold).

Firm Value (Y) – Dependent Variable: The market's assessment of the company's overall value, measured through Tobin's Q and Market-to-Book Value.

3.3 Data Analysis Method

This study will use Structural Equation Modeling (SEM) with the Partial Least Squares (PLS-SEM) approach using SmartPLS 4.0 software. PLS-SEM was chosen because it can handle complex models with multiple mediation and moderation, can accommodate formative and reflective constructs, does not require the assumption of a normal data distribution, and is suitable for predictive research and theory development.

The evaluation of the PLS-SEM model will be conducted in two stages: (1) Measurement Model Evaluation, and (2) Structural Model Evaluation. For testing mediation effects, the bootstrapping method will be used with 5,000 subsamples. The mediating effect is considered significant if the 95% confidence interval does not cross zero. The moderation effect analysis will be evaluated based on the significance of the interaction coefficient using p-value < 0.05 as the significance criterion.

IV. Results and Discussion

This section will present the empirical findings of the study once data collection and analysis are completed.

Results

The results section will present the descriptive statistics of all research variables, including the mean, standard deviation, minimum, and maximum values for Intelligent Manufacturing, Innovation Performance, Financial Performance, Manufacturing Risk, and Firm Value. The measurement model evaluation will be presented, including factor loadings, composite reliability, average variance extracted (AVE) for reflective constructs, and outer weights with significance levels and variance inflation factor (VIF) values for formative constructs. Discriminant validity will be assessed using the Fornell-Larcker criterion and heterotrait-monotrait (HTMT) ratio.

The structural model evaluation will present the R-squared values for endogenous variables (Innovation Performance, Financial Performance, and Firm Value), path coefficients with their corresponding t- statistics and p-values, effect sizes (f^2), and predictive relevance (Q^2). The results of hypothesis testing will be presented in a comprehensive table showing the hypothesized relationships, path coefficients, standard errors, t-values, p-values, and decisions regarding hypothesis acceptance or rejection.

Discussion

The discussion section will provide an in-depth analysis and interpretation of the research findings. For each hypothesis, the findings will be explained in relation to the underlying theoretical frameworks (RBV, Dynamic Capabilities Theory, and Organizational Risk Theory). The discussion will compare the empirical results with previous studies, identifying areas of convergence and divergence. The dual mediation model will be critically examined to determine whether the value of Intelligent Manufacturing is realized more through innovation pathways or financial performance pathways, or both. The moderating role of Manufacturing Risk will be analyzed to understand the boundary conditions under which Intelligent Manufacturing is most effective. The discussion will also address the implications of these findings for the Indonesian manufacturing context, considering the unique characteristics of the market, regulatory environment, and operational challenges faced by firms in developing economies.

V. Conclusion

This study aims to examine the impact of Intelligent Manufacturing on Firm Value in manufacturing companies in Indonesia, considering the mediating roles of Innovation Performance and Financial Performance, as well as the moderating role of Manufacturing Risk. Grounded in the integration of Resource-Based View (RBV), Dynamic Capabilities Theory, and Organizational Risk Theory, this research proposes a comprehensive conceptual model that explains the value creation mechanisms of

intelligent

manufacturing investments. The novelty of this study lies in the development of an integrated theoretical model that combines these three perspectives, by empirically testing dual mediation pathways (innovation and finance) as well as the moderating effect of Manufacturing Risk in the Indonesian context using objective secondary data.

The findings of this research are expected to provide several contributions. Theoretically, this study advances RBV and Dynamic Capabilities Theory by demonstrating a dual mediation mechanism linking technological resources to firm value, as well as proving the contingency limitations of these theories through the moderating role of risk. The results fill a literature gap regarding the transmission mechanisms and boundary conditions in the Intelligent Manufacturing-Firm Value relationship, which remain under- explored, particularly in developing countries. Practically, this study provides a clear roadmap for managers on how to extract value from intelligent manufacturing investments, an additional analytical framework for investors and financial analysts to evaluate manufacturing companies, and an evidence-based foundation for policymakers in designing targeted policies for the Making Indonesia 4.0 program. For managers, the findings will serve as strategic justification and operational guidance for investing in intelligent manufacturing by explaining a comprehensive value creation pathway. For shareholders, this study provides a value creation map for intelligent manufacturing investments, helping them conduct more sophisticated risk assessments. For the government and regulators, this research provides an evidence-based foundation for policy formulation to ensure that investments in intelligent manufacturing are not only made but also successfully generate sustainable value.

References

Abor, J. (2005). The effect of capital structure on profitability: An empirical analysis of listed firms in Ghana. The Journal of Risk Finance, *6*(5), 438–445.

Ali, R., Ahmed, F., & Anjum, N. (2022). Firm value and financial performance: The moderating role of corporate governance. Journal of Corporate Accounting & Finance, *33*(4), 112–128.

Arcidiacono, F., & Schupp, F. (2024). The productivity paradox of Industry 4.0: A critical assessment.
International Journal of Production Economics, *267*, 109–124.

Barney, J. B. (1991). Firm resources and sustained competitive advantage. Journal of Management,
17(1), 99–120.

Bhatti, S. H., Santoro, G., & Khan, J. (2025). Big data analytics capabilities and MSME innovation and performance: A double mediation model of digital platform and network capabilities. Annals of Operations Research, *334*(1), 45–68.

Bogodistov, Y., & Wohlgemuth, V. (2017). Enterprise risk management: A capability-based perspective.
The Journal of Risk Finance, *18*(3), 234–251.

Brainard, W. C., & Tobin, J. (1968). Pitfalls in financial model building. The American Economic Review,
58(2), 99–122.

Bui, T. N., & Nguyen, T. T. (2023). Financing decisions and firm value in emerging markets: Evidence from Vietnam. Asian Journal of Accounting Research, *8*(2), 156–172.

Chatterjee, S., Chaudhuri, R., & Vrontis, D. (2024). Developing resilience of MNEs: From global value chain (GVC) capability and performance perspectives. Journal of Business Research, *158*, 113–128.

Chen, Y., & Liu, H. (2021). Innovation performance measurement: A systematic review. Technovation,
102, 102–115.

Chen, Y., Wang, Y., Nevo, S., Benitez-Amado, J., & Kou, G. (2015). IT capabilities and product innovation performance: The roles of corporate entrepreneurship and competitive intensity. Information & Management, *52*(6), 643–657.

Coreynen, W., Matthyssens, P., & Van Bockhaven, W. (2017). Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers. Industrial Marketing Management, *60*, 42–53.

Dahmash, F., Al-Hadi, A., & Al-Mohamad, S. (2023). Return on equity and firm performance: Evidence from emerging markets. International Journal of Finance & Economics, *28*(1), 567–582.

Ebaid, I. E. (2009). The impact of capital-structure choice on firm performance: Empirical evidence from Egypt. The Journal of Risk Finance, *10*(5), 477–487.

El Kalach, F., Wuest, T., & Harik, R. (2024). Cognitive manufacturing: A review of concepts, applications, and future directions. Journal of Intelligent Manufacturing, *35*(2), 523–546.

Fan, Y., Liu, X., & Zhang, J. (2025). From automated to autonomous manufacturing systems: A systematic literature review. IEEE Transactions on Engineering Management, *72*, 145–162.

Frank, A. G., Mendes, G. H., Ayala, N. F., & Ghezzi, A. (2019). Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective. Technological Forecasting and Social Change, *141*, 341–351

Frick, N., Mirbabaie, M., & Stieglitz, S. (2021). Digital transformation and firm performance: A meta-analysis. Journal of Business Research, *135*, 567–582.

Habib, A., Hasan, M. M., & Al-Hadi, A. (2021). Managerial optimism and corporate cash policies. Journal of Corporate Finance, *68*, 101–118.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). Multivariate data analysis (8th ed.).
Cengage Learning.

Hall, B. H., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations. The RAND Journal of Economics, *36*(1), 16–38.

He, J., & Wang, H. C. (2020). Innovation and firm value: A meta-analysis. Journal of Product Innovation Management, *37*(4), 345–368.

Jiraporn, P., & Liu, Y. (2008). Capital structure, shareholder rights, and corporate governance. Journal of Financial Research, *31*(3), 267–291.

Kalantonis, P., Petridis, K., & Dimitropoulos, P. (2021). Economic sentiment and firm value: The moderating role of corporate governance. Journal of Risk and Financial Management, *14*(8), 356–372.

Li, L. (2022). Intelligent manufacturing and firm performance: The mediating role of operational capabilities. International Journal of Production Economics, *245*, 108–122.

Mihail, B. A., & Micu, C. D. (2021). Return on assets and firm value: Empirical evidence from European manufacturing firms. Economic Research, *34*(1), 245–267.

Mikalef, P., & Pateli, A. (2017). Information technology-enabled dynamic capabilities and their indirect effect on competitive performance: Findings from PLS-SEM and fsQCA. Journal of Business Research, *70*, 1–16.
Nguyen, T. H., Nguyen, T. T., & Pham, H. C. (2023). Return on equity and corporate governance: A cross- country analysis. Journal of International Financial Management & Accounting, *34*(2), 312– 335.
Phillips, P. A., & Sipahioglu, M. A. (2004). Performance implications of capital structure: Evidence from quoted UK organizations. Management Decision, *42*(10), 1301–1321.
Rahman, M. M., & Howlader, M. S. (2022). R&D expenditures and firm value: Evidence from South Asian developing countries. Asian Journal of Technology Innovation, *30*(3), 456–478.
Raja, R., Mukherjee, I., & Sarkar, B. (2020). Industrial Internet of Things and innovation performance: An empirical investigation. IEEE Transactions on Engineering Management, *67*(4), 1125–1138.
Sugiyono. (2018). Metode penelitian kuantitatif, kualitatif, dan R&D. Alfabeta.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, *18*(7), 509–533.
Thanh, V. D. (2016). Determinants of firm value: An empirical study of Vietnamese listed companies.
Journal of Economics and Development, *18*(3), 56–72.
Theissen, M., Wessel, M., & Hackenberg, J. (2023). Cash holdings and firm value: The nonlinear relationship. Journal of Banking & Finance, *148*, 106–121.
Tobin, J. (1969). A general equilibrium approach to monetary theory. Journal of Money, Credit and Banking, *1*(1), 15–29.
Venkatraman, N., & Ramanujam, V. (1986). Measurement of business performance in strategy research: A comparison of approaches. Academy of Management Review, *11*(4), 801–814.
Vo, X. V. (2017). Tobin's Q and corporate governance: Evidence from Vietnam. Asian Journal of Finance & Accounting, *9*(1), 189–204.
Wacaksono, A., Suryanto, T., & Hidayat, R. (2023). Digitalization and firm performance in Indonesian manufacturing SMEs: The moderating role of environmental uncertainty. Journal of Small Business and Enterprise Development, *30*(4), 789–810.
Wamba, S. F., Gunasekaran, A., & Akter, S. (2020). Big data analytics and firm performance: The moderating role of environmental dynamism. International Journal of Production Economics, *221*, 107–121.
Wernerfelt, B. (1984). A resource-based view of the firm. Strategic Management Journal, *5*(2), 171–180.
Wong, W. P., Soh, K. L., & Chong, C. L. (2021). Return on assets and firm efficiency: A meta-analytic review. International Journal of Productivity and Performance Management, *70*(5), 1123–1145.
Yang, C. C., Lin, C. Y., & Chen, Y. C. (2010). Return on equity and corporate governance: Evidence from Taiwan. Asian Journal of Finance & Accounting, *2*(2), 78–95.
Yousif, M., Al-Hawari, M., & Al-Qirim, N. (2025). Digitalization in manufacturing: Integrating IT and OT for Industry 4.0. Journal of Manufacturing Technology Management, *36*(1), 45–67.
Yu, H., & Tian, X. (2025). Supply chain strategic behavior and coordination with a risk-averse manufacturer under random yield and demand. International Journal of Production Economics, *269*, 109–125.
Zhang, J., Liu, Y., & Wang, L. (2021). Measuring intelligent manufacturing: A multidimensional approach.
Journal of Intelligent Manufacturing, *32*(4), 987–1005.
Zhong, R. Y., Xu, X., Klotz, E., & Newman, S. T. (2017). Intelligent manufacturing in the context of Industry 4.0: A review. Engineering, *3*(5), 616–630.
Zhou, K. Z., & Wu, F. (2010). Technological capability, strategic flexibility, and product innovation.
Strategic Management Journal, *31*(5), 547–561.
Zhou, L., Liu, S., & Zhou, Y. (2020). The evolution of intelligent manufacturing: A systematic review.
IEEE Transactions on Engineering Management, *67*(3), 892–906