

# Product Innovation Management and Digital Technology Adoption in Indonesian Digital Startups: Model Development and Measurement Design

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Indonesia's digital startup ecosystem requires firms to innovate products continuously while integrating digital technology into core business processes. This study develops a measurement model for examining Product Innovation Management, Digital Technology Adoption, and Digital Startup Performance in the Indonesian context. The study follows a quantitative research-development sequence combining literature synthesis, conceptual-model refinement, instrument operationalization, and internal focus-group review. The resulting instrument consists of 26 Likert-scale statements organized into three constructs: Product Innovation Management (9 items), Digital Technology Adoption (8 items), and Digital Startup Performance (9 items). The review process strengthened terminology consistency, item clarity, respondent-screening criteria, coding rules, and the alignment between constructs and the planned regression model. A complete empirical-analysis protocol was also specified, covering item validity, construct reliability, residual normality, multicollinearity, heteroscedasticity, and multiple linear regression. The study contributes a context-specific and empirically testable measurement architecture for research on innovation management and digital entrepreneurship in Indonesia. The framework is designed for field application among active startup founders, owners, managers, or other decision makers who understand product innovation and business performance.

**Keywords:** Product Innovation Management, Digital Technology Adoption, Digital Startup, Business Performance, Indonesia

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## 1. Introduction

Digital startups compete in environments characterized by rapid technological change, short innovation cycles, and continuously shifting customer expectations. Product and service features can become obsolete quickly, while customer switching costs are often low. Under these conditions, startup survival depends not only on generating creative ideas but also on managing innovation as an organized process that connects market intelligence, product development, experimentation, evaluation, and strategic decision making [1]–[4].

The Indonesian context makes this issue particularly important. Digital ventures frequently operate under resource constraints while facing pressure to scale rapidly, respond to user feedback, and differentiate their value propositions. Evidence from emerging-market firms shows that innovation orientation, business-model innovation, and strategic agility can strengthen performance and competitive advantage [5]–[9]. Nevertheless, the management of product innovation at the startup level is still less explicitly operationalized than broader constructs such as digital transformation or entrepreneurial orientation.

Digital technology adoption is closely connected with this innovation challenge because digital tools support product iteration, customer interaction, data-based decision making, coordination, and operational efficiency. Prior studies show that digitalization can increase innovation capacity and sustainable business performance when it is integrated with organizational capabilities rather than treated as a stand-alone technology investment [10]–[15]. This implies that a valid empirical model of startup performance should

capture both the managerial discipline of product innovation and the extent to which digital technologies are embedded in business processes.

Accordingly, this study develops and refines an empirical measurement model linking Product Innovation Management and Digital Technology Adoption with Digital Startup Performance in Indonesia. The specific objectives are to synthesize the relevant research gap, operationalize the three constructs into measurable indicators, refine the questionnaire through structured internal review, establish respondent-screening criteria, and specify a complete statistical-testing protocol for subsequent field estimation. The study therefore provides the measurement and analytical foundation required for a rigorous test of how managerial innovation and technology adoption relate to startup performance.

## 2. Literature Review and Problem Statement

Product Innovation Management refers to the coordinated managerial activities through which firms identify innovation priorities, develop and improve products, incorporate user input, and evaluate innovation outcomes. Innovation capability improves performance when it is embedded in repeatable organizational routines rather than denot applicable on isolated creative events [1], [3], [7], [9]. In startup settings, this logic is especially relevant because product-market fit is repeatedly reassessed and product features are continuously adjusted. Product innovation therefore needs to be operationalized through dimensions that capture planning, development, responsiveness, and evaluation.

Digital Technology Adoption represents the integration of digital tools into operational processes, customer-facing activities, data use, coordination, and adaptation. Research on entrepreneurial firms and SMEs indicates that digitalization can enhance innovation performance, business resilience, and market outcomes, but the effect depends on managerial capabilities and organizational integration [2], [10], [12]–[15]. Digital adoption is thus treated in this study as a complementary managerial capability rather than merely the presence of technology.

The principal research gap is the limited availability of an integrated, context-sensitive measurement framework that simultaneously operationalizes product innovation management, digital technology adoption, and performance for Indonesian digital startups. Previous studies often focus on manufacturing firms, conventional SMEs, specific platform mechanisms, or business-model innovation [6]–[13]. To address this gap, the present study formulates an empirically testable model in which Product Innovation Management (X1) and Digital Technology Adoption (X2) are proposed as explanatory constructs for Digital Startup Performance (Y). The hypotheses for the subsequent field-estimation stage are: H1, Product Innovation Management is positively associated with Digital Startup Performance; and H2, Digital Technology Adoption is positively associated with Digital Startup Performance.

## 3. Method

This study applies a quantitative research-development design focused on conceptual-model formulation and measurement preparation. The process began with a structured review of recent peer-reviewed literature on innovation management, digitalization, startup performance, business-model innovation, and entrepreneurial competitiveness. The literature mapping was used to identify construct domains and gaps, after which the conceptual model was refined to distinguish Product Innovation Management (X1), Digital Technology Adoption (X2), and Digital Startup Performance (Y).

The measurement instrument uses a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Product Innovation Management is operationalized through nine statements covering innovation planning, market-oriented product development, responsiveness, and evaluation. Digital Technology Adoption is represented by eight statements addressing digital utilization, process integration,

data use, and technological adaptability. Digital Startup Performance is represented by nine statements covering revenue growth, customer/user development, sustainability, efficiency, and competitiveness. The complete questionnaire therefore contains 26 substantive items.

Instrument refinement was conducted through an internal focus-group review involving the research team. The review assessed construct relevance, wording clarity, one-idea-per-item discipline, consistency of the term 'digital startup', respondent eligibility, scale consistency, and coding readiness. The intended respondents are founders, co-founders, owners, managers, or other personnel who directly understand the startup's innovation process and business performance. Purposive sampling is planned for active digital startups, with a minimum analytical target of 100 eligible respondents. The subsequent empirical protocol includes item-validity testing, Cronbach's alpha reliability testing, residual-normality assessment, multicollinearity diagnostics using tolerance and VIF, heteroscedasticity testing, and multiple linear regression using the model  $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$ .

**Table 1. Research variables and measurement dimensions**

| Variable                      | Code | Dimensions                                                                     | Items |
|-------------------------------|------|--------------------------------------------------------------------------------|-------|
| Product Innovation Management | X1   | Innovation planning; product development; evaluation and learning              | 9     |
| Digital Technology Adoption   | X2   | Digital utilization; process integration; data use; technological adaptability | 8     |
| Digital Startup Performance   | Y    | Growth; sustainability; efficiency; competitiveness                            | 9     |

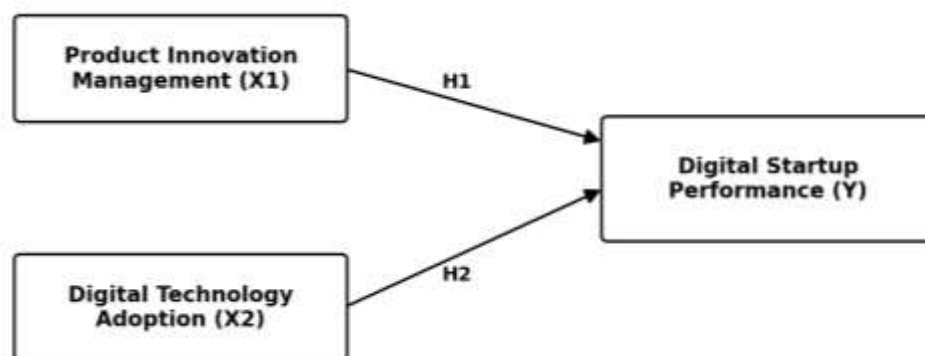


Fig. 1. Conceptual framework of the study

The article reports the completed model-development and instrument-refinement phase. It does not present fabricated causal estimates. Instead, the results document the verified outputs of the research-design process: the research-gap map, the finalized conceptual structure, the 26-item measurement instrument, respondent-screening rules, coding architecture, and the statistical protocol that will be applied to the field dataset.

## 4. Results and Discussion

The results are presented in seven subsections to show how the research gap was translated into an operational and empirically testable measurement architecture. The emphasis is on outputs that are already complete and verifiable at the instrument-development stage.

### Research-Gap Mapping for Indonesian Digital Startups

The literature synthesis shows a recurring separation between innovation studies and digital-startup performance studies. Product innovation research frequently examines manufacturing or established

SMEs, while startup research often emphasizes funding, platforms, value creation, or business-model innovation [3], [5]–[10]. Digitalization studies, in turn, tend to measure broad transformation capabilities rather than the managerial process through which a startup plans, develops, and evaluates product innovation [2], [14], [15]. This separation creates a measurement gap: researchers need an integrated model that captures both the discipline of product innovation management and the operational use of digital technology in a startup-specific context.

**Table 2. Synthesis of the research gap and model response**

| Literature stream                       | Dominant object/focus                               | Gap identified                                                            |
|-----------------------------------------|-----------------------------------------------------|---------------------------------------------------------------------------|
| Product innovation and firm performance | Manufacturing and established SMEs                  | Limited startup-specific operationalization                               |
| Startup performance                     | Funding, platforms, value creation, business models | Innovation-management process often not explicit                          |
| Digital transformation                  | Broad digital capability and adoption               | Technology integration rarely combined with product-innovation management |
| Model response                          | Indonesian digital startups                         | Integrated X1-X2-Y measurement framework                                  |

### Conceptual Model Development

The refined model contains two explanatory constructs and one outcome construct. Product Innovation Management captures the managerial organization of innovation, while Digital Technology Adoption captures the extent to which digital tools are integrated into processes and decisions. Digital Startup Performance captures business outcomes through growth, sustainability, efficiency, and competitiveness. The model deliberately avoids using 'UMKM' as the analytical object because the funded research title and target population refer specifically to digital startups. This terminology decision improves construct validity and reduces ambiguity during respondent screening.

**Table 3. Final construct architecture**

| Construct                     | Code | Core dimensions                                     | Items |
|-------------------------------|------|-----------------------------------------------------|-------|
| Product Innovation Management | X1   | Planning; development; evaluation                   | 9     |
| Digital Technology Adoption   | X2   | Utilization; integration; data use; adaptability    | 8     |
| Digital Startup Performance   | Y    | Growth; sustainability; efficiency; competitiveness | 9     |

### Operationalization of Product Innovation Management

Product Innovation Management is represented by nine items. Three items capture innovation planning, including the existence of a clear innovation plan, the use of customer or market needs when developing ideas, and alignment between innovation priorities and business strategy. Three items capture product development and responsiveness, including continuous feature improvement, use of customer input, and rapid adjustment to changing needs. Three items capture evaluation and organizational learning, including periodic evaluation of innovation outcomes, use of evaluation findings for improvement, and coordination of innovation activities. This structure is consistent with research showing that innovation contributes to performance when it combines strategic direction, development capability, market learning, and evaluation [1], [3], [7], [9].

**Table 4. Product Innovation Management item structure**

| Dimension               | Item codes | Measurement focus                            | Scale      | Output  |
|-------------------------|------------|----------------------------------------------|------------|---------|
| Innovation planning     | X1.1-X1.3  | Direction, market needs, strategic alignment | Likert 1-5 | 3 items |
| Product development     | X1.4-X1.6  | Iteration, customer input, responsiveness    | Likert 1-5 | 3 items |
| Evaluation and learning | X1.7-X1.9  | Evaluation, improvement, coordination        | Likert 1-5 | 3 items |

### Operationalization of Digital Technology Adoption

Digital Technology Adoption is represented by eight items designed to measure the practical integration of technology rather than simple technology ownership. The items cover the use of digital tools in daily operations, integration of digital systems across processes, digital customer interaction, data-supported decision making, technology-enabled coordination, adoption of new digital solutions, adaptability to technological change, and the use of technology to accelerate innovation. This operationalization reflects evidence that digitalization generates value when it is embedded in routines, leadership, and innovation processes [10], [12], [14], [15], [18].

**Table 5. Digital Technology Adoption item structure**

| Dimension                        | Item codes | Measurement focus                                        | Output  |
|----------------------------------|------------|----------------------------------------------------------|---------|
| Digital utilization              | X2.1-X2.2  | Use of digital tools in operations and customer activity | 2 items |
| Process integration and data use | X2.3-X2.5  | Integration, coordination, data-supported decisions      | 3 items |
| Technological adaptability       | X2.6-X2.8  | New solutions, adaptation, technology-enabled innovation | 3 items |

### Operationalization of Digital Startup Performance

Digital Startup Performance is operationalized through nine perception-based items covering revenue growth, customer or user growth, business continuity, ability to sustain operations, efficiency improvement, market competitiveness, ability to respond to competition, progress toward business targets, and overall performance improvement. Perceptual measures are appropriate for heterogeneous startups because many young firms do not disclose standardized audited financial information. The indicators therefore combine growth, sustainability, and competitive outcomes, consistent with startup and SME performance research [5], [6], [8], [11], [16].

**Table 6. Digital Startup Performance item structure**

| Dimension                     | Item codes | Measurement focus                                          | Scale      | Items |
|-------------------------------|------------|------------------------------------------------------------|------------|-------|
| Growth                        | Y1-Y3      | Revenue, users/customers, progress toward targets          | Likert 1-5 | 3     |
| Sustainability and efficiency | Y4-Y6      | Continuity, operational sustainability, efficiency         | Likert 1-5 | 3     |
| Competitiveness               | Y7-Y9      | Competitive response, market position, overall performance | Likert 1-5 | 3     |

## 4.6. Instrument Refinement Through Internal FGD

**Table 7. Main refinement decisions from the internal review**

| Review issue        | Decision                                   | Rationale                                                          |
|---------------------|--------------------------------------------|--------------------------------------------------------------------|
| Object terminology  | Use "digital startup" consistently         | Aligns instrument with funded research title and target population |
| Item wording        | One principal idea per statement           | Reduces ambiguity and double-barreled measurement                  |
| Response scale      | Standardize Likert 1-5                     | Improves consistency across constructs                             |
| Respondent criteria | Prioritize knowledgeable founders/managers | Strengthens information quality                                    |
| Coding              | Finalize X1, X2, and Y item codes          | Supports cleaning and regression preparation                       |

The internal focus-group review produced concrete refinements before field distribution. First, all references to conventional SMEs were removed and replaced with the term digital startup. Second, double-barreled statements were simplified so that one item measures one principal idea. Third, the five-point scale was standardized across all constructs. Fourth, respondent eligibility was tightened to prioritize individuals with direct knowledge of innovation and performance. Fifth, the coding scheme was finalized to support subsequent data cleaning and analysis. These decisions increase content consistency and reduce avoidable measurement error before statistical validation.

## Empirical Readiness, Analytical Protocol, and Implications

The finalized design is ready for empirical testing using purposively selected active digital startups. The statistical sequence is intentionally conservative: respondent screening and completeness checks precede coding and cleaning; item validity and construct reliability are evaluated before regression; residual normality, multicollinearity, and heteroscedasticity are assessed before interpreting coefficient estimates. The regression specification  $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \varepsilon$  allows the model to distinguish the contribution of product innovation management from the contribution of digital technology adoption. For managers, the framework also functions as a diagnostic instrument because it separates innovation discipline, technology integration, and performance outcomes. For researchers, it provides a replicable measurement structure that can later be extended with mediators, moderators, sectoral comparisons, or longitudinal designs.

**Table 8. Empirical-analysis protocol for the field-testing stage**

| Stage              | Statistic / criterion                        | Decision rule                                   | Purpose                        |
|--------------------|----------------------------------------------|-------------------------------------------------|--------------------------------|
| Item validity      | Corrected item-total correlation / item test | Items must meet the selected validity criterion | Confirm indicator adequacy     |
| Reliability        | Cronbach's alpha                             | Alpha $\geq 0.70$ preferred                     | Assess internal consistency    |
| Residual normality | Residual test and graphical inspection       | No material departure from normality            | Support regression inference   |
| Multicollinearity  | Tolerance and VIF                            | Tolerance $> 0.10$ ; VIF $< 10$                 | Assess predictor redundancy    |
| Heteroscedasticity | Residual/Glejser-type diagnostic             | No systematic variance pattern                  | Assess constant error variance |
| Regression         | B, beta, t, p, R <sup>2</sup> , F            | $\alpha = 0.05$                                 | Test H1, H2, and overall model |

## 5. Conclusion

This study develops a complete measurement and analytical framework for examining Product Innovation Management, Digital Technology Adoption, and Digital Startup Performance in Indonesia. The final instrument contains 26 statements distributed across three constructs: nine items for Product Innovation Management, eight items for Digital Technology Adoption, and nine items for Digital Startup Performance. The internal review strengthened item clarity, terminology consistency, respondent-screening rules, scale standardization, and coding readiness. The resulting model specifies Product Innovation Management and Digital Technology Adoption as complementary explanatory constructs for Digital Startup Performance.

The contribution of the study is methodological and practical. Methodologically, it translates a fragmented literature into a startup-specific measurement architecture and a transparent statistical-testing protocol that includes validity, reliability, classical-assumption diagnostics, and multiple linear regression. Practically, the instrument can be used to identify whether weaknesses in startup performance are more closely associated with innovation-management routines, digital-technology integration, or both. The next empirical stage is to apply the finalized questionnaire to eligible digital-startup respondents and estimate the proposed relationships using the specified model. The present article therefore provides a defensible, non-fabricated foundation for subsequent causal testing and for further research on innovation management in Indonesia's digital entrepreneurship ecosystem.

## 6. References

- [1] R. Rismayani, B. Manuel, and U. Latifah, "The influence of strategic innovation management on firm innovation performance in the Indonesian mid-size telecommunication industry," *F1000Research*, vol. 11, art. 956, 2023, doi: 10.12688/f1000research.121673.2.
- [2] A. M. Felicetti, V. Corvello, and S. Ammirato, "Digital innovation in entrepreneurial firms: a systematic literature review," *Review of Managerial Science*, vol. 18, pp. 315-362, 2024, doi: 10.1007/s11846-023-00638-9.

- [3] M. Dabić, T. Obradović Posinković, B. Vlačić, and R. Gonçalves, "A configurational approach to new product development performance: The role of open innovation, digital transformation and absorptive capacity," *Technological Forecasting and Social Change*, vol. 194, art. 122720, 2023, doi: 10.1016/j.techfore.2023.122720.
- [4] V. Gupta, J. M. Fernandez-Crehuet, and T. Hanne, "Fostering continuous value proposition innovation through freelancer involvement in software startups: Insights from multiple case studies," *Sustainability*, vol. 12, no. 21, art. 8922, 2020, doi: 10.3390/su12218922.
- [5] M. A. Usman and X. Sun, "The impact of digital platforms on new startup performance: Strategy as moderator," *Heliyon*, vol. 9, no. 12, art. e22159, 2023, doi: 10.1016/j.heliyon.2023.e22159.
- [6] P. Chen, "The effect of value creation on startups performance in the digital environment: Evidence from Chinese digital startups," *Sustainability*, vol. 15, no. 5, art. 4116, 2023, doi: 10.3390/su15054116.
- [7] R. Gómez-Prado et al., "Product innovation, market intelligence and pricing capability as a competitive advantage in the international performance of startups: Case of Peru," *Sustainability*, vol. 14, no. 17, art. 10703, 2022, doi: 10.3390/su141710703.
- [8] L. Zhang, X. Yang, S. Zhu, and Z. Xia, "Business model innovation and performance of startups: The moderating role of external legitimacy," *Sustainability*, vol. 15, no. 6, art. 5351, 2023, doi: 10.3390/su15065351.
- [9] S. G. Ayinaddis, "The effect of innovation orientation on firm performance: Evidence from micro and small manufacturing firms in selected towns of Awi Zone, Ethiopia," *Journal of Innovation and Entrepreneurship*, vol. 12, art. 26, 2023, doi: 10.1186/s13731-023-00290-3.
- [10] N. Salfore, M. Ensermu, and Z. Kinde, "Business model innovation and firm performance: Evidence from manufacturing SMEs," *Heliyon*, vol. 9, no. 6, art. e16384, 2023, doi: 10.1016/j.heliyon.2023.e16384.
- [11] I. Farida and D. Setiawan, "Business strategies and competitive advantage: The role of performance and innovation," *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 8, no. 3, art. 163, 2022, doi: 10.3390/joitmc8030163.
- [12] M. Yusuf, B. Surya, F. Menne, M. Ruslan, S. Suriani, and I. Iskandar, "Business agility and competitive advantage of SMEs in Makassar City, Indonesia," *Sustainability*, vol. 15, no. 1, art. 627, 2023, doi: 10.3390/su15010627.
- [13] E. Albats, D. Podmetina, and W. Vanhaverbeke, "Open innovation in SMEs: A process view towards business model innovation," *Journal of Small Business Management*, vol. 61, no. 6, pp. 2519-2560, 2023, doi: 10.1080/00472778.2021.1913595.
- [14] A. Garrido-Moreno, R. Martín-Rojas, and V. J. García-Morales, "The key role of innovation and organizational resilience in improving business performance: A mixed-methods approach," *International Journal of Information Management*, vol. 77, art. 102777, 2024, doi: 10.1016/j.ijinfomgt.2024.102777.
- [15] S. S. Hassan, K. Meisner, K. Krause, L. Bzhalava, and P. Moog, "Is digitalization a source of innovation? Exploring the role of digital diffusion in SME innovation performance," *Small Business Economics*, vol. 62, pp. 1469-1491, 2024, doi: 10.1007/s11187-023-00826-7.
- [16] A. Chen, L. Li, and W. Shahid, "Digital transformation as the driving force for sustainable business performance: A moderated mediation model of market-driven business model innovation and digital leadership capabilities," *Heliyon*, vol. 10, no. 8, art. e29509, 2024, doi: 10.1016/j.heliyon.2024.e29509.
- [17] H. Chen, T. Amoako, C. E. Quansah, S. A. Danso, and D. J. Jidda, "Assessment of the impact of management commitment and supply chain integration on SMEs' innovation performance: Moderation role of government support," *Heliyon*, vol. 9, no. 5, art. e15914, 2023, doi: 10.1016/j.heliyon.2023.e15914.
- [18] F. Kurniasari, E. D. Lestari, and H. Tannady, "Pursuing long-term business performance: Investigating the effects of financial and technological factors on digital adoption to leverage SME performance and business sustainability—Evidence from Indonesian SMEs in the traditional market," *Sustainability*, vol. 15, no. 16, art. 12668, 2023, doi: 10.3390/su151612668.
- [19] M. E. Y. Antara, I. A. O. Martini, and I. A. P. W. Sugianingrat, "Innovation ambidexterity and digital capability as drivers of SMEs' sustainability," *IEEE Access*, vol. 12, pp. 144621-144630, 2024, doi: 10.1109/ACCESS.2024.3470029.
- [20] A. Kallmuenzer, A. Mikhaylov, M. Chelaru, and W. Czakon, "Adoption and performance outcome of digitalization in small and medium-sized enterprises," *Review of Managerial Science*, vol. 19, pp. 2011-2038, 2025, doi: 10.1007/s11846-024-00744-2.