

# Exploring the Role of IoT in Enhancing Product Innovation and Firm Performance in Indonesia

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**ABSTRACT-** This study examines how technology implementation and knowledge management enhance product innovation and firm performance in Indonesian SMEs. Drawing from the Technology-Organization-Environment (TOE) framework and the Resource-Based View (RBV) theory, the research explores how digital technologies and knowledge management practices influence innovation and organizational success. Using qualitative methods, data was collected through interviews, observations, and document analysis from senior managers in various Indonesian SMEs.

The findings show that adopting digital technologies and systematic knowledge management drives product innovation, which subsequently improves firm performance. Both technology implementation and knowledge management directly impact organizational outcomes, underscoring the importance of leveraging digital capabilities and knowledge-sharing mechanisms. These factors contribute to long-term competitiveness and sustainable growth.

This study offers valuable insights for business leaders, policymakers, and researchers interested in digital transformation, innovation, and knowledge management in emerging economies. It highlights how Indonesian SMEs can use these elements to boost growth, enhance market position, and contribute to broader discussions on innovation management and organizational performance in the digital age.

**KEYWORDS-** Technology Implementation; Knowledge Management; Product Innovation; Firm Performance; SMEs, Digital Transformation; TOE Framework, RBV Theory.

## I. INTRODUCTION

Digital Transformation (DT) has emerged as a defining force of the fourth industrial revolution, known as Industry 4.0. Characterized by the integration of advanced technologies such as the Internet of Things (IoT), automation, and knowledge management systems, Industry 4.0 has fundamentally reshaped the global business landscape. These technologies enable businesses to optimize processes, enhance connectivity, and foster innovation, thus creating a competitive edge in a rapidly evolving digital economy [1], [2].

In Indonesia, Small and Medium-Sized Enterprises (SMEs) serve as a cornerstone of the economy, contributing significantly to employment and GDP.

However, despite their critical role, many SMEs struggle to fully adopt and integrate these transformative technologies. Challenges such as resource limitations, infrastructural gaps, and varying levels of digital literacy hinder their ability to leverage Industry 4.0 effectively [3], [4].

While extensive research has examined technology implementation and knowledge management in developed economies, studies focusing on the unique conditions of Indonesian SMEs remain limited [5]. This gap underscores the importance of understanding how these enterprises can overcome barriers to harness technology and knowledge for product innovation and improved firm performance. Within Indonesia's vibrant yet complex business ecosystem—marked by dynamic market conditions, cultural diversity, and regulatory nuances—continuous innovation is a necessity for sustaining competitiveness [6], [7].

This study employs the Technology-Organization-Environment (TOE) framework and the Resource-Based View (RBV) theory to explore the interplay between technology adoption, knowledge management practices, and organizational outcomes in Indonesian SMEs. The research posits that product innovation serves as a mediating factor between technology implementation and firm performance, with knowledge management playing a pivotal role in fostering innovation [8], [9].

By investigating these dynamics, this research aims to bridge the gap between theoretical frameworks and practical applications. The findings provide actionable insights for Indonesian SMEs to navigate Industry 4.0, effectively leveraging technological and knowledge resources. This contribution not only enriches the discourse on innovation and entrepreneurship in Indonesia but also offers a roadmap for SMEs to achieve sustainable growth and secure a competitive advantage in the increasingly digital global economy.

## II. MODELS AND METHODOLOGY

### A. Models

- **Technology Organization Environment (TOE) Framework-** The TOE framework helps explain how technological, organizational, and environmental factors influence innovation adoption. In Indonesia, businesses are increasingly adopting technologies like IoT, e-commerce, and cloud computing to drive innovation. Larger companies often have the resources to invest in these

technologies, but government initiatives also support smaller enterprises in overcoming resource challenges. A company's organizational structure, culture, and leadership commitment play important roles in successful technology adoption. Environmental factors, such as market competition and government initiatives like "Making Indonesia 4.0," further encourage technology adoption. With growing internet penetration, there is also increasing consumer demand for innovative products and services. The TOE framework guides businesses in improving their innovation capabilities, gaining competitive advantages, and enhancing overall performance.

- **Resource-Based View (RBV) Framework-** The RBV framework emphasizes the importance of a company's internal resources and capabilities in achieving competitive advantage. In Indonesia, businesses like Go-Jek and Unilever leverage resources such as technological expertise, skilled labor, and strong branding to innovate and stand out in the market. RBV suggests that companies that manage their internal resources effectively are more likely to succeed in the long term by continuously improving their products and services, building customer loyalty, and improving financial performance.
- **The SECI Model (Socialization, Externalization, Combination, Internalization)-** The SECI model focuses on how tacit (personal) and explicit (formal) knowledge are shared and transformed to foster innovation. In Indonesian companies, socialization is encouraged through activities like workshops and mentorship programs, while externalization involves converting tacit knowledge into formalized ideas and documentation. The combination phase integrates various sources of explicit knowledge to generate new insights, and internalization turns explicit knowledge into practical skills through hands-on experience. Firms like Go-Jek and Tokopedia use this model to create a collaborative culture, document solutions, and apply new knowledge in product development, helping drive innovation and improve performance.
- **IT-Enabled Dynamic Capabilities Framework-** The IT-Enabled Dynamic Capabilities framework explores how companies use technology to enhance their ability to adapt to rapidly changing environments. In Indonesia, businesses leverage dynamic capabilities like market sensing and agile decision-making to stay competitive in a fast-paced market. The framework shows how dynamic capabilities mediate the relationship between operational capabilities and firm performance, highlighting the role of IT in enabling faster innovation and product development. Companies that integrate technology into their operations can respond more effectively to market shifts and technological advancements, helping them maintain a competitive edge in an increasingly unpredictable business environment.

### **B. Methodology**

- **Population and Sampling Method-** The research focuses on gathering information from various informants to explore how technology implementation and knowledge management influence product innovation and firm performance in SME companies.

Informants are categorized as follows:

- **Key Informants:** Individuals with essential knowledge relevant to the research.
- **Important Informants:** Those actively involved in complex social interactions within SMEs.
- **Extra Informants:** Individuals providing supplementary information despite limited direct involvement. The study targets SME company leaders to gain insights into the research questions and problem formulation.
- **Research Variables and Measurement-** This research adopted a qualitative methodology to examine the relationship between technology implementation, knowledge management, and firm performance in Indonesian SMEs. The study focused on the following variables:
  - **Technology implementation:** the adoption and use of digital tools such as IoT devices.
  - **Knowledge management:** the practices of collecting, sharing, and utilizing knowledge within organizations.
  - **Product innovation:** the creation of new or improved products mediated by technology and knowledge. Data was collected through interviews with senior managers from Indonesian SMEs and analyzed using triangulation to ensure validity. The population included SMEs operating in manufacturing, retail, and services, while the sample was selected based on willingness to participate and accessibility. Data analysis was conducted using themed coding to identify patterns and relationships. Facts analysis involves systematically organizing and analyzing data, such as interview transcriptions and field notes, to identify patterns, assess significance, and communicate findings. This study employs SWOT analysis and triangulation methods using Nvivo tools to evaluate a company's performance by integrating internal factors (strengths and weaknesses) with external factors (opportunities and threats). The SWOT analysis process includes:
    - **Classifying Data:** Organizing internal strengths and weaknesses alongside external opportunities and threats into a SWOT information table.
    - **Comparing Factors:** Using a SWOT matrix to analyze and contrast internal and external elements.
    - **Creating a SWOT Diagram:** Visualizing all factors to assess the company's current status and strategies for leveraging strengths and addressing weaknesses.

## **III. RESULT**

### **A. Technology Implementation Influences Product Innovation-**

The research findings confirm that technological implementation significantly promotes product innovation. Insights from key informants, including Rachmad Saptadi (CEO of PT. Rezka Nayatama), Daka Putera (IoT Specialist at PT. Rezka Nayatama), and Dr. Eddi Husni ST., M.Si., indicate that modern technology enhances a firm's ability to innovate and bring new products to market. The findings highlight the importance of robust technological infrastructure to support R&D efforts, consistent with prior research emphasizing technology as a driver of innovation [7].

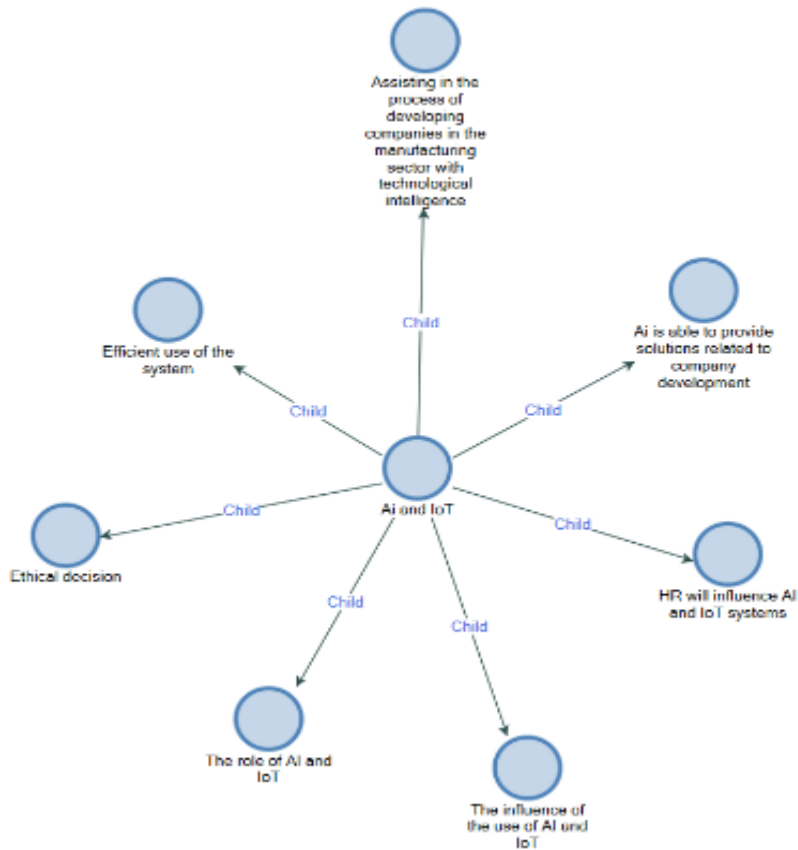


Figure 1: AI and IoT Implementation in Manufacturing

As shown in Figure 1, AI and IoT play a central role in supporting manufacturing processes by enhancing technological intelligence and decision-making.

**B. The Role of Knowledge Management in Fostering Product Innovation-**

Knowledge management practices, such as knowledge sharing and creation, supported by collaboration tools, play a crucial role in product innovation. Informants, including Rachmad Saptadi, Daka Putera, Dr. Eddi Husni ST., M.Si.,

and Prisma Udhiana (PT. Miota Internasional Teknologi), identified significant outcomes, such as increased R&D investments, higher rates of new product launches, and improved innovation success. These findings align with the SECI paradigm [4], which underscores the importance of knowledge creation and utilization in fostering innovation. Figure 2 illustrates the key components of knowledge management, including collaboration tools, knowledge sharing, and learning opportunities, which collectively drive product innovation.



Figure 2: Components of Knowledge Management

**C. Product Innovation Contributes to Firm Performance-**

Evidence from Dr. Eddi Husni ST., M.Si. and Prisma Udhiana highlights that product innovation directly enhances firm performance. Firms with a strong focus on innovation report better financial outcomes, market

performance, and revenue growth, driven by new product introductions. These findings are consistent with the Resource-Based View (RBV) framework [1], which posits that innovation is a strategic resource contributing to competitive advantage.

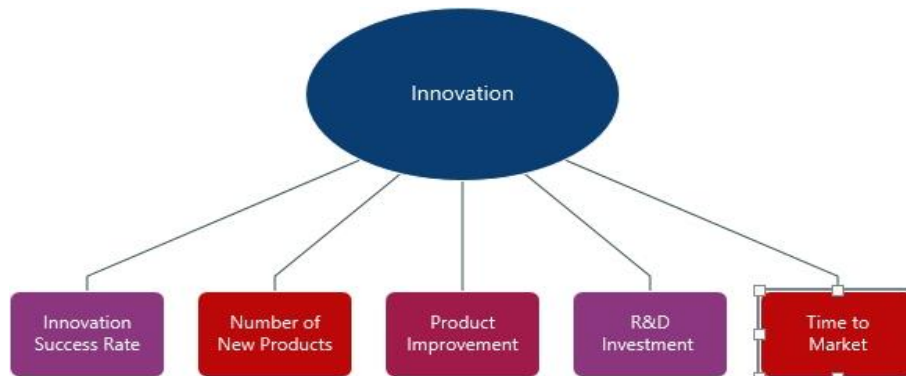


Figure 3: Innovation Metrics and Impact

Figure 3 demonstrates the impact of product innovation on various metrics such as R&D investment, time to market, and product improvement, leading to enhanced firm performance.

#### D. Technology Implementation Affects Firm Performance

The impact of technology implementation on firm performance is mediated by the firm's capacity for

innovation. According to Rachmad Saptadi, Dr. Eddi Husni ST., M.Si., and Prisma Udhiana, companies that adopt technology without integrating it into innovative processes achieve limited performance gains. This finding supports the Dynamic Capabilities Perspective [2], which emphasizes the importance of resource integration and reconfiguration for achieving superior performance.

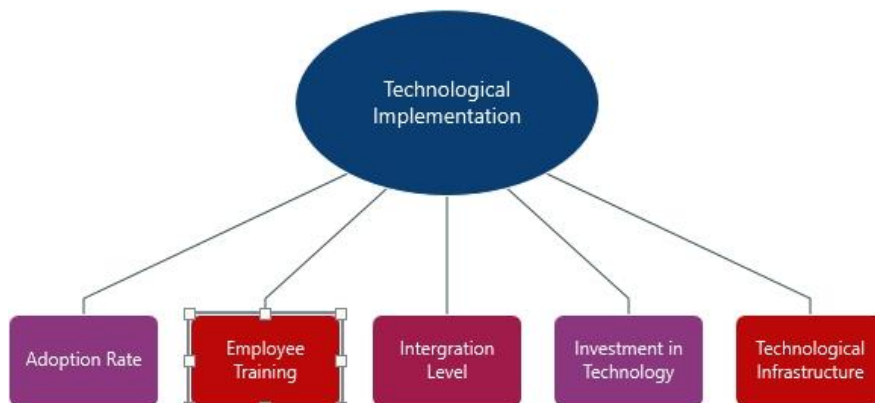


Figure 4: Factors in Technological Implementation

Figure 4 highlights the factors in technological implementation, such as employee training and technological infrastructure, which contribute to better firm performance outcomes.

#### E. Knowledge Management Affects Firm Performance

Efficient knowledge management significantly improves firm performance. Companies like PT. Rezka Nayatama and PT. Miota Internasional Teknologi have demonstrated enhanced operational efficiency, customer satisfaction, and competitiveness by effectively managing their knowledge assets. This aligns with the Intellectual Capital Perspective [3], which highlights the value of knowledge resources in driving organizational success.

## IV. DISCUSSION

The findings of this study emphasize the intricate and interdependent relationships between technological implementation, knowledge management, product innovation, and firm performance within Indonesian SMEs. In the context of Industry 4.0, technology adoption plays a transformative role, enabling firms to streamline their

operations, reduce costs, and increase responsiveness to rapidly changing market demands. Advanced technologies, including artificial intelligence (AI), Internet of Things (IoT), and data analytics, equip SMEs with the tools needed to make precise, real-time decisions that drive operational excellence.

Coupled with effective knowledge management practices—systematic processes of knowledge creation, dissemination, and application—technology becomes a potent enabler of innovation. Knowledge management fosters collaboration, enhances problem-solving capabilities, and supports the efficient utilization of intellectual resources. By leveraging both technological and knowledge assets, SMEs can enhance their innovative capacity and establish a competitive edge in Indonesia's dynamic and evolving market environment.

The integration of cutting-edge technologies within organizational processes has been shown to significantly improve operational efficiency. Technologies such as AI and IoT enable automation of routine tasks, reduce human error, and optimize resource allocation. For instance, IoT-based systems facilitate real-time monitoring and control of production processes, leading to better quality management

and cost savings. AI-powered analytics further empower decision-makers by identifying market trends and forecasting customer preferences.

This ability to adapt to a rapidly digitizing economy aligns with the Resource-Based View (RBV) framework, which positions technology as a strategic resource for achieving competitive advantage. SMEs that effectively integrate these technologies are better positioned to meet customer demands, scale their operations, and remain agile amidst economic and competitive pressures [1], [2].

Knowledge management emerged as a critical driver of innovation within the firms studied. Through practices like knowledge sharing, storage, and collaboration, organizations are able to convert tacit knowledge into explicit, actionable insights. This not only enhances employee competencies but also creates an environment conducive to continuous learning and creativity.

For instance, SMEs that prioritize knowledge sharing through collaboration tools and structured training programs have demonstrated higher rates of successful product development. Knowledge management also plays a pivotal role in fostering Research and Development (R&D), facilitating the generation of novel ideas and innovative solutions. This finding aligns with Nonaka's SECI model, which highlights the transformation of tacit and explicit knowledge as essential to the innovation process [4].

Product innovation serves as a key mediator in the relationship between technological implementation, knowledge management, and firm performance. By leveraging technological capabilities and knowledge assets, SMEs are able to develop new products, services, and business models that align with changing customer preferences. This ability to innovate not only enhances market competitiveness but also builds resilience against external disruptions such as economic downturns or shifts in industry standards. Product innovation has also been shown to drive customer loyalty and market share growth, as firms that consistently introduce innovative offerings are perceived as industry leaders. This finding is supported by the Resource-Based View (RBV) framework, which identifies innovation as a valuable resource for sustaining competitive advantage [9].

## V. CONCLUSION

In Indonesia's fast-changing digital economy, small and medium-sized enterprises (SMEs) are under increasing pressure to innovate in order to stay competitive and grow. A recent study sheds light on how integrating technology adoption and knowledge management practices can drive innovation and improve business performance, with important implications for the future of SMEs.

The study looks at how advanced technologies like the Internet of Things (IoT) and Artificial Intelligence (AI) are helping SMEs innovate their products and boost performance. These technologies improve efficiency, enhance product quality, and enable the creation of new products—key factors for any SME looking to thrive in today's competitive market. The research supports existing frameworks like the Technological, Organizational, and Environmental (TOE) model and the Resource-Based View (RBV), showing how the right technology can strengthen a company's capabilities and fuel innovation.

Along with technology, effective knowledge management is equally important in fostering innovation. The study highlights the SECI model, which focuses on creating and sharing knowledge, and shows that SMEs with strong knowledge management practices are better able to tap into their intellectual resources. This approach is backed by the Knowledge-Based View (KBV) and the IT-Enabled Dynamic Capabilities Framework, emphasizing that organizational knowledge is a powerful driver of long-term competitive advantage.

Most notably, the study reveals that innovation is the key link between technology, knowledge management, and business success. It shows that product innovation directly influences factors like market share, customer satisfaction, and profitability. While technology and knowledge management both improve performance, their greatest impact is seen through innovation.

As SMEs navigate the challenges of Industry 4.0, their ability to innovate will be critical for their growth and sustainability. This research offers valuable insights and practical strategies for businesses looking to adopt technology and knowledge management practices to stay competitive. By embracing these advancements, SMEs can improve their operations and contribute to a stronger, more competitive economy, positioning themselves for success in Indonesia's dynamic market.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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