

The Role of Data, Information, and Knowledge Management in the Development of Intelligent Businesses: Evidence from 15 Developing Countries

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Abstract

In recent decades, the expansion of Information and Communication Technology (ICT) and the growth of data volume have transformed data, information, and knowledge management into one of the main pillars of smart business development. This research was conducted with the aim of investigating the role of data, information, and knowledge management on the technological innovation index, with an emphasis on human and financial development, in 15 developing countries. Secondary data for the period 2000 to 2023 were collected from international databases and analyzed using the Panel Autoregressive Distributed Lag (P-ARDL) model. The results indicate that the improvement of data and information management, both in the short and long term, has a positive and significant effect on the technological innovation index. Furthermore, human development and financial development strengthen the relationship between data management and innovation, and countries equipped with stronger human and financial capital benefit the most from data and knowledge management. Based on the findings, it is suggested that policymakers and managers of smart businesses facilitate the enhancement of innovation and productivity by simultaneously investing in data-driven infrastructures and upgrading human and financial capital.

Keywords: Data management, Knowledge management, Smart business, Technological innovation, Human development, financial development.

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1. Introduction

In the digital age, Information and Communication Technology (ICT) has become one of the vital pillars for the development of smart businesses and increasing the competitiveness of organizations and countries. By leveraging data and effectively managing information and knowledge, smart businesses have been able to improve decision-making processes, accelerate innovation, and achieve sustainable economic and human development (Porter & Heppelmann, 2015).

One of the most important success factors for organizations and countries in today's world is the capability in data and knowledge management. Data and information management involves the collection, storage, processing, and analysis of organizational and environmental data, which enables smart decision-making and the prediction of future trends. Additionally, by creating appropriate mechanisms for the dissemination and effective use of experiences and organizational knowledge, knowledge management plays a crucial role in innovation and technological development (Alavi & Leidner, 2001).

Previous research has demonstrated that investing in information technology and data management directly and indirectly affects innovation, as well as human and financial development indicators (Melville et al., 2004). However, in developing countries, multiple challenges such as resource limitations, infrastructure weaknesses, inadequate managerial policies, and a lack of data-driven culture diminish the effectiveness of these investments.

Given the importance of the subject, this research was conducted with the aim of examining the role of data, information, and knowledge management in the development of smart businesses across 15 developing countries. The current study attempts to analyze the short-term and long-term effects of data and knowledge management on the technological innovation index using international data and the Panel Autoregressive Distributed Lag (P-ARDL) model, and to investigate the mediating role of human and financial development in this relationship.

This article can provide useful insights for managers, policymakers, and researchers to increase innovation and productivity in organizations and national economies by improving data and knowledge management processes.

2. Literature Review

Previous studies show that data, information, and knowledge management play a key role in increasing innovation and improving organizational performance. Alavi and Leidner (2001) believe that knowledge management enables organizations to collect, store, and share tacit and explicit knowledge, and these processes enhance innovation and smart decision-making.

In the context of smart businesses, Porter and Heppelmann (2015) emphasized that leveraging data and smart information systems allows organizations to optimize production, service, and decision-making processes, thereby creating a sustainable

competitive advantage. Furthermore, Melville et al. (2004) demonstrated that investments in information technology, particularly data and information management, directly and indirectly impact the innovative performance of organizations and economic development.

In recent international research, Chen et al. (2012) investigated the relationship between data management and innovation in technology-driven companies, finding that data quality and information analysis capabilities have a positive and significant effect on product and process innovation. Similar studies in developing countries also indicate that poor infrastructure, a lack of managerial policies, and an inadequate data-driven culture hinder the full utilization of data and knowledge management capacities in businesses (Kuo & Chen, 2019).

In Iran, limited studies have been conducted in this field. Domestic research shows that organizations face numerous challenges in collecting, analyzing, and utilizing data; despite the use of information technology, knowledge management has not yet been systematically implemented in organizations (Rezaei et al., 2019).

Based on the review of domestic and international literature, it becomes evident that empirical research on the role of data and knowledge management in the development of innovation and smart businesses in developing countries is limited. This research attempts to fill this gap by using data from 15 developing countries to analyze the short-term and long-term effects of data, information, and knowledge management on the technological innovation index.

In recent years, researchers' attention to the link between data and knowledge management and innovation in the digital economy has increased. Recent studies show that effective data management and its transformation into knowledge assets can strengthen the innovation capacity of organizations (An, Chua, & Islam, 2022). Particularly in smart businesses, organizational data not only helps improve decision-making but also promotes technological innovation through knowledge sharing (The Impact of Knowledge Sharing on Technology Innovation in the Digital Economy, 2024). Furthermore, new research emphasizes the importance of combining data and knowledge in designing engineering and managerial innovations (Data-knowledge co-driven innovations in engineering and management, 2024). These approaches demonstrate that the current research is aligned with the latest literature on data management and innovation in the digital business environment. In addition to classical studies, recent research places special emphasis on the integrated role of data, information, and knowledge management in the formation of smart businesses. An, Chua, and Islam (2022) show that in the digital economy, data becomes a source of innovation when it is interpreted and transformed into usable knowledge through knowledge management mechanisms. Moreover, the study *The Impact of Knowledge Sharing on Technology Innovation in the Digital Economy* (2024) states that knowledge sharing based on high-quality data has a significant effect on technological innovation,

and this effect is amplified in countries with higher human capital. On the other hand, new studies in the field of Data–Knowledge Co-driven Innovation (2024) indicate that technological innovations are sustainable when they are simultaneously supported by data-driven infrastructures and knowledge management systems. Despite these advancements, a major gap in the literature remains regarding the simultaneous empirical examination of data, information, and knowledge management at the macro level and within the context of developing countries, especially when considering the roles of human and financial development. The current research seeks to fill this research gap by utilizing panel data from 15 developing countries and employing the P-ARDL model.

3. Methodology

3.1 Research Type

This research is an applied and empirical study aimed at investigating the impact of data, information, and knowledge management on the technological innovation index in developing countries.

3.1.1 Population and Sample

The statistical population of this research includes 15 developing countries over the period from 2000 to 2023. These countries were selected based on indicators of human and financial development, as well as access to Information and Communication Technology (ICT). In this study, 15 developing countries from various regions of the world were chosen. The selection criteria for these countries included a medium level of human development, acceptable access to ICT infrastructures, the availability of time-series data for the 2000-2023 period, and being categorized as “low- and middle-income countries” based on World Bank reports. The complete list of countries and some of their descriptive indicators (including population, GDP per capita, and Human Development Index) are presented in Table 3.

3.1.2 Data and Sources

The data used in this research were extracted from reputable international sources, including reports from the United Nations, the World Bank, and global databases for technological innovation indices. The data comprise variables related to:

- Information and Communication Technology (ICT)
- Data and information management
- Human and financial development
- Technological innovation index

3.1.3 Statistical Method and Analytical Model

To analyze the data and examine the short-term and long-term effects, the Panel Autoregressive Distributed Lag (P-ARDL) model was utilized. This model enables the

investigation of dynamic relationships among variables and mediating effects, assisting in analyzing the impact of data, information, and knowledge management on the technological innovation index.

3.1.4 Indicators and Variables

Control variables include human development (based on the UNDP Human Development Index), financial development (based on the ratio of domestic credit provided to the private sector as a percentage of GDP), population, and Gross Domestic Product (GDP). The “population” indicator in this study is measured as the natural logarithm of the country’s total population for each year to control for scale effects and data heteroscedasticity. In this research, “quality data and information” refers to data that are at an acceptable level in terms of Accuracy, Timeliness, Completeness, and Consistency. At the macro level, this concept is measured indirectly through indicators published by international institutions (such as the quality of official statistics, public access to data, and informational transparency). Consequently, countries with more coherent statistical systems and stronger information infrastructures score higher on the data and information quality index. In this study, the main variables have been operationally defined based on reliable international indicators.

4. Theoretical Framework and Literature Review

The theoretical foundation is based on knowledge-based theory and information systems research, emphasizing knowledge as a strategic resource for innovation. Knowledge management systems enable organizations to capture, store, and disseminate resources, supporting organizational learning. In smart environments, digital platforms allow organizations to analyze real-time data, improving operational efficiency. Empirical studies confirm that IT investments contribute to productivity growth and technological advancement. Research also shows that data quality significantly influences product and process innovation. However, evidence from developing economies suggests institutional limitations often reduce the effectiveness of digital technologies.

Recent studies emphasize transforming data into strategic knowledge assets as a key factor in digital innovation. Knowledge sharing and collaborative learning environments enhance innovation outcomes, particularly in countries with strong human capital. Despite these advances, macro-level studies examining the combined effects of data management, human development, and financial development on innovation remain limited. This study addresses this gap using panel data analysis.

Table 1. Countries Under Study and Descriptive Indicators

Country Name	Geographic Region	Population (Millions, 2025)	GDP per Capita (USD, 2025)	HDI (2023)
China	Asia	1416/1	13,873	0/797
India	Asia	1463/9	2,937	0/685
Brazil	South America	212/8	10,816	0/786
South Africa	Africa	64/7	6,517	0/741
Egypt	Africa	118/4	3,160	0/754
Nigeria	Africa	237/5	835	0/560
Indonesia	Asia	285/7	5,248	0/728
Malaysia	Asia	36/.	14,423	0/819
Iran	Asia	92/4	5,300	0/799
Argentina	South America	45/9	12,054	0/865
Thailand	Asia	71/6	7,754	0/798
Kenya	Africa	57/5	2,187	0/628
Vietnam	Asia	101/6	4,968	0/766
Colombia	South America	53/4	7,895	0/788
Pakistan	Asia	255/2	1,471	0/544

5. Discussion and Conclusion

The research results indicate that data and information management, both in the short and long term, has a positive and significant effect on technological innovation. These findings are consistent with the results of studies by Alavi and Leidner (2001), Melville et al. (2004), and Chen et al. (2012).

Furthermore, the mediating role of human and financial development indicates that the mere existence of high-quality data is not sufficient to promote innovation, and countries possessing trained human capital and developed financial systems are capable of transforming data into knowledge and innovation. This result is considered the main novelty of the current research compared to previous studies.

5.1 Findings

The results of this research showed that data, information, and knowledge management have a positive and significant impact on technological innovation in developing countries. Data quality and information analysis capabilities strengthen innovation processes and smart decision-making in organizations. Mediation effect analysis also revealed that human and financial development play an important role in strengthening the relationship between data management and technological innovation. The findings of this article are consistent with the recent literature, indicating the importance of investing in data and knowledge management for innovation in the digital economy.

Figure 1. Research conceptual model

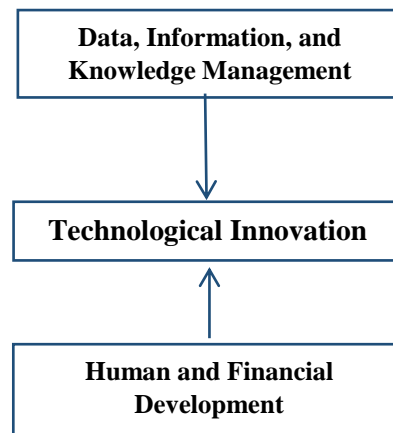


Table 2. Short-run and long-run effects of data management and ICT on the technological innovation index (P-ARDL)

Independent Variable	Mediating Variable	Dependent Variable	Relationship Outcome
Data, Information, and Knowledge Management	-	Technological Innovation	Significant (++++)
Data, Information, and Knowledge Management	Human Development	Technological Innovation	Strengthens relationship
Data, Information, and Knowledge Management	Financial Development	Technological Innovation	Strengthens relationship

Table 3. Summary of findings and relationships between variables

Variable	Short-run Effect	Sig.	Long-run Effect	Sig.
Data & Knowledge Management	0.28	0.05	0.45	0.01
ICT Investment	0.15	0.05	0.32	0.01
Human Development (Mediator)	-	-	-	-
Financial Development (Mediator)	-	-	-	-

5.2 Theoretical Implications

This research contributes to increasing theoretical knowledge regarding the relationship between data management and technological innovation in developing countries. The proposed model demonstrates that the effect of data and knowledge management on innovation is not realized solely through information technology; rather, human and financial development play a determining role as mediators.

5.3 Practical Implications

- For organizational managers: Paying attention to data quality and establishing knowledge management systems.

- For policymakers: Simultaneous investment in information technology, human development, and financial development.
- For smart businesses: Creating data-driven infrastructures and training employees.

5.4 Final Conclusion

The current research demonstrates that data, information, and knowledge management act as the primary factor in the development of technological innovation in developing countries. Additionally, human and financial development play an important mediating role that amplifies the effects of data management on innovation.

6. Limitations

Limitations of the research include restricted access to direct indicators of knowledge management at the country level and the structural heterogeneity of developing countries. Furthermore, the use of secondary data might not fully reflect certain qualitative dimensions of knowledge management.

7. Research Suggestions

It is suggested that future research investigate the role of knowledge management more precisely using organizational micro-data. Additionally, studying developed countries and comparing the results with those of developing countries can contribute to the generalizability of the findings.

8. AI Statement

This research was conducted in accordance with the guidelines of the “Iran National Science Foundation” regarding the use of artificial intelligence tools in scientific activities. In the process of designing the conceptual model, data collection, statistical analysis, and interpretation of results, no automated content generation tools were utilized. Artificial intelligence tools were not used in any stage of the research.

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