

Technology Integration and Innovation in Nanostores: A Moderation Analysis of Industry 4.0 on New Product Development and Performance Outcomes

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Abstract- *This study unveils a robust and positive relationship between Industry 4.0 (I4.0) and nanostore performance, with distinct impacts observed through two New Product Development (NPD) factors—internal and external involvement. Specifically, the integration of I4.0 technologies significantly enhances nanostore performance, and this effect is particularly pronounced when considering external involvement in NPD processes. This finding underscores the pivotal role of technology in nanostores and emphasizes the strategic importance of external collaborations for optimal outcomes. Practical implications of this study highlight the strategic imperative for nanostore owners to proactively implement I4.0 technologies. Notably, fostering high levels of external involvement in the NPD process emerges as a key strategy for nanostores seeking to leverage technology for sustained success. Recommendations for nanostore owners include adopting specific I4.0 tools such as [mention examples], establishing collaborative frameworks with suppliers and customers, and actively participating in external NPD initiatives. These strategies aim to capitalize on the transformative potential of I4.0, driving innovation, operational efficiency, and customer satisfaction. While recognizing the limitations, particularly the potential sample bias, this study contributes to our understanding of nuanced relationships in retail nanostores. Future research endeavors could benefit from a more expansive and diverse sample, possibly by widening the geographical scope or incorporating additional demographic factors. Addressing these enhancements will contribute to a more comprehensive understanding of the direct impact of Industry 4.0 on nanostore performance and its crucial moderating role in external NPD involvement.*

Keywords- *Industry 4.0, new product development, nanostores, performance, exploratory factor analysis.*

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I. INTRODUCTION

A. Background and Rationale

The rapid advancement of technology has ushered in the Fourth Industrial Revolution, known as Industry 4.0 [1]. This transformation, marked by the integration of digital technologies like artificial intelligence, robotics, and the Internet of Things, has revolutionized global business operations [2].

This transformation, marked by the integration of digital technologies like artificial intelligence, robotics, and the Internet of Things, has revolutionized global business operations [3]. Nanostores, small retail stores that typically serve low-income consumers [4], face distinctive challenges, making them susceptible to the transformative impacts of Industry 4.0, especially in areas such as inventory management, pricing, and marketing.

As I4.0 reshapes interactions between retailers and consumers, the dynamics of retail operations evolve. The advent of digital technology, automation, and artificial intelligence presents new opportunities for innovation and customer engagement. Retailers are navigating a complex landscape characterized by shifting consumer preferences, emerging technologies, and heightened competition [5]. In this context, new product development (NPD) becomes a focal point for retailers, driving growth and profitability. However, successful NPD strategies hinge on the retailer's adaptability to new technology and responsiveness to changing consumer demands [6] [7].

Honduras, a Central American country experiencing economic growth, has witnessed a surge in retail nanostores, becoming pivotal hubs for economic activity and community engagement [3]. As these nanostores strive to stay competitive amid Industry 4.0, understanding the factors influencing their performance, with a specific focus on the impact of NPD and

the moderating effect of Industry 4.0 [8][9], becomes paramount.

B. Research Gap, Questions, and Objectives

Despite studies on nanostore coexistence and performance in developing economies and the impact of Industry 4.0 on retail commerce, a research gap exists in understanding the specific relationship between Industry 4.0, NPD, and retail nanostore performance [10] [11]. While a study conducted in Honduras focused on nanostore competitiveness and technological inclusion during the COVID-19 pandemic, it did not delve into the relationships between Industry 4.0, NPD, and performance [3]. Despite the growing importance of nanostores and the influence of Industry 4.0 [12] a research gap remains in understanding the moderating role of Industry 4.0 in the relationship between NPD and retail nanostore performance in Honduras. To address this gap, our study aims to answer the following research questions:

- 1) What is the nature and strength of the relationship between NPD and the performance of retail nanostores in Honduras?
- 2) To what extent does Industry 4.0 moderate the relationship between NPD and the performance of retail nanostores in Honduras?

From such questions, the main objectives of this research are to:

- 1) Examine the direct relationship between NPD and the performance of retail nanostores in Honduras.
- 2) Investigate the moderating effect of Industry 4.0 on the relationship between NPD and the performance of retail nanostores in Honduras.

The study seeks to explore the impact of I4.0 moderation on the relationship between NPD and retail nanostore performance, contributing insights to innovation management, retail management, and technology adoption. Understanding these relationships can significantly advance theory and practice, providing practical guidance for retailers and policymakers to optimize their strategies in emerging markets like Honduras.

C. General Overview of the Remaining Content

This paper will present concepts and hypotheses in Section 2. Section 3 will describe the methodology, including research design, data collection, sample details, measurement instrumentation, exploratory factorial analysis (EFA), and moderation methods. Section 4 will present results and discussions, including descriptive statistics, EFA results, factorial loads and interpretation, moderation analysis, and implications. Finally, Section 5 will present conclusions encapsulating research limitations, practical and theoretical implications, economic and social insights, and the originality and value of the paper.

II. CONCEPTS AND HYPOTHESES

A. Industry 4.0 and Its Implications for Retail Industry

Industry 4.0, often termed the Fourth Industrial Revolution, encompasses the integration of digital technologies, automation, and data exchange across various industries [13].

Within the retail sector, the influence of Industry 4.0 has been a focal point in recent research. Scholars emphasize its transformative potential, particularly concerning digital technologies like artificial intelligence, machine learning, and blockchain. These technologies offer retailers opportunities to enhance operations and engage customers more effectively [14]. Simultaneously, concerns have emerged regarding the societal impacts, including employment dynamics and potential disruptions to established retail business models [15].

While the broader retail industry has been extensively studied, the impact of Industry 4.0 on nanostores, a significant segment in many developing countries, remains relatively underexplored. Nanostores, characterized by operating on low margins and heavily relying on local demand, face unique challenges in adapting to rapid technological changes and staying abreast of evolving consumer preferences [16]. As such, they may be particularly challenged by the rapid pace of technological change and the need to keep up with new product trends.

In the context of the retail industry, Industry 4.0 has significant implications for improving operational efficiency, enhancing customer experiences, and driving innovation [17]. The adoption of Industry 4.0 technologies in the retail industry, including innovations like the Internet of Things (IoT) and artificial intelligence, has demonstrated substantial implications. Retailers leveraging these technologies can optimize supply chains, personalize marketing strategies, manage inventory efficiently, and introduce innovative services [18][19]. Given the transformative potential of Industry 4.0, it is hypothesized that:

H1: Industry 4.0 significantly positively impacts the performance of nanostores in Honduras.

B. New Product Development (NPD) and Its Importance in Nanostores: The Two Factors

New Product Development (NPD) stands as a critical process for companies aiming to introduce innovative and competitive products to the market [8]. In the context of nanostores, NPD plays a pivotal role in attracting and retaining customers, responding to their evolving needs, and differentiating from competitors [20]. The introduction of new products allows nanostores to diversify their offerings, enhance customer satisfaction, and stimulate sales [21].

Thus, in nanostores, NPD is important to maintain competitiveness and meet changing customer needs and preferences [22]. Recognizing the centrality of NPD in nanostores, it is posited that:

H2: New product development (NPD) has a positive impact on the performance of nanostores in Honduras.

C. Relationship Between Industry 4.0, NPD, and Performance of Nanostores:

By delving into the dynamic interplay between Industry 4.0 and NPD, a promising synergy emerges, poised to significantly impact the performance of retail nano-stores. This perceived synergy suggests a potential avenue for bolstering operational efficiency, customer engagement, and overall competitiveness

within this niche retail sector [23]. Industry 4.0, as a facilitator of digital transformation and innovation, is expected to enhance the effectiveness and efficiency of NPD initiatives in nanostores, leading to improved performance outcomes [24].

The integration of Industry 4.0 technologies, including real-time data analysis, rapid prototyping, and customization, is anticipated to optimize the NPD process. [25].

While existing studies have delved into the relationship between NPD and retail performance [26], limited attention has been given to the impact of Industry 4.0 on this dynamic, particularly in the context of nanostores [27]. Consequently, the following hypothesis is proposed:

H3: Industry 4.0 moderates the relationship between NPD and retail nanostore performance.

Investigating these hypotheses promises a deeper comprehension of the intricate dynamics between Industry 4.0, NPD, and nanostore performance. The insights gained can prove invaluable for retailers, policymakers, and industry professionals seeking to harness technology and innovation for the enhancement of nanostore performance in emerging markets like Honduras. Refer to Figure 1 for a visual representation of the proposed conceptual model and hypotheses..

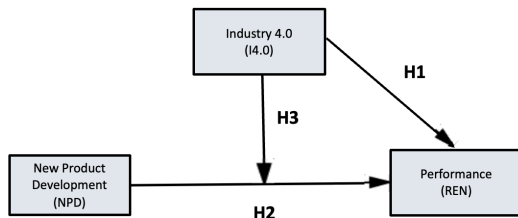


Fig 1 Proposed conceptual model

III. MATERIALS AND METHODS

A. Research Design

- 1) *Research Approach:* The study employed a quantitative research approach, utilizing surveys and statistical analyses to identify and measure factors related to the NPD-nanostore performance relationship.
- 2) *Research Type:* An exploratory research design [28] was chosen to develop an understanding of variables, particularly in the context of Industry 4.0 and nanostore performance.
- 3) *Sampling:* Purposive sampling method was used to select nanostores implementing Industry 4.0 technologies and engaged in NPD. The sample size (N = 143) was determined based on statistical power analysis and practical feasibility.
- 4) *Data Collection:* Primary data were collected through a structured questionnaire survey administered to selected nanostores in Honduras, either online or in-person.

B. Measuring instrumentation

- 1) *Construct Measurement:* Constructs were measured using scales validated in various sectors. Scales related to NPD, nanostore performance, and Industry 4.0 were adapted from previous studies [29], ensuring relevance to nanostores and Industry 4.0 adoption.
- 2) *Questionnaire Development:* A comprehensive questionnaire was developed, encompassing items on NPD activities, nanostore performance indicators, and Industry 4.0 adoption. Likert-type scales were used for multiple-item measures.

C. Exploratory Factor Analysis (EFA)

EFA was conducted using SPSS 23 to identify factors associated with NPD, nanostore performance, and Industry 4.0 moderation. This analysis provided insights into potential factors influencing the NPD-nanostore performance relationship.

D. Moderation by Regression Analysis

After identifying factors through EFA, moderation by regression analysis was employed. This involved hierarchical regression analysis to examine the interaction effect of Industry 4.0 on the relationship between NPD and nanostore performance, evaluating both direct and moderating effects.

IV. RESULTS AND DISCUSSION

Now, based on this collected database, we performed an Exploratory Factorial Analysis (EFA) and a Moderation Analysis to analyze the relationships between the variables.

A. Exploratory Factorial Analysis (EFA)

To begin our analysis, we use an EFA, to explore the underlying factors related to Industry 4.0, NPD, and nanostore performance. The EFA revealed distinct factors related to Industry 4.0, NPD, and nanostore performance. Specifically, Factor 1 represented Technological Integration (Industry 4.0), Factor 2 (NPD_f1) indicated Internal Involvement in New Product Development, Factor 3 (NPD_f2) represented External Involvement in New Product Development, and Factor 4 captured Quality of care, Agility, and Flexibility in nanostore operational performance.

Conducting an EFA helps identify the underlying factorial structure within the variables. In this analysis, we used main component analysis with varimax rotation. The following results were obtained:

1) Technological Integration (Industry 4.0):

Factor 1: Technological Integration captured nanostores' adoption and integration of Industry 4.0 technologies. Higher scores indicated advanced Industry 4.0 adoption.

2) New Product Development (NPD) Capability:

Factor 2 (NPD_f1): Internal Involvement measured nanostores' capability in NPD through employee and owner participation.

Factor 3 (NPD_f2): External Involvement measured NPD capabilities through collaboration with customers and suppliers.

3) *Nanostore Operational Performance:*

Factor 4: Quality of care, Agility, and Flexibility captured nanostore performance in terms of customer service, operational speed, and adaptability

4) *Significance levels of EFA:*

- Kaiser-Meyer-Olkin (KMO): 0.885 (Sample suitable for EFA).
- Bartlett's Test of Sphericity: Significant ($p < 0.001$).
- Eigenvalues: First four factors explained 59.08% of variance.

B. *Moderation analysis*

1) *Direct Effects*

- Direct effect of Industry 4.0 on the performance of nanostores: $\beta = 0.159, p < 0.01$ (Significant).
- Direct effect of NPD_f1 (Internal Involvement) on nanostore performance: $\beta = 0.199, p < 0.10$ (Significant).
- Direct effect of NPD_f2 (External Involvement) on nanostore performance: $\beta = 0.142, p < 0.10$ (Significant).

2) *Moderating Effects*

- Moderating effect of NPD_f1 (Internal Involvement) on nanostore performance through Industry 4.0: $\beta = 0.074, p = 0.317$ (Not significant).
- Moderating effect NPD_f2 (External Involvement) on nanostore performance through Industry 4.0: $\beta = 0.123, p < 0.10$ (Significant).

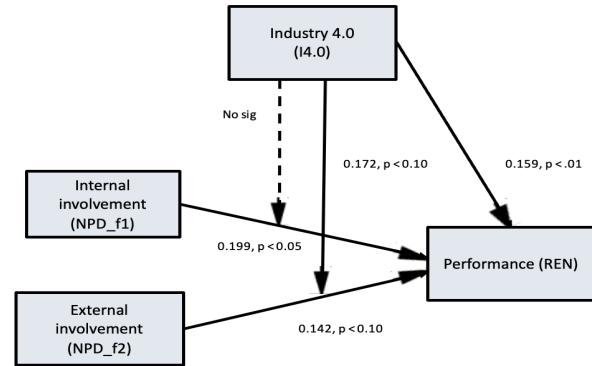


Fig. 2 Moderating Effects of I4.0 on the Relationship between NPD and Nanostore Performance

TABLE 1
EXPLORATORY FACTORIAL ANALYSIS OF ITEMS

Ítem	Componente					
	F1	F2	F3	F4	F5	F6
I often promote my products on social media or phone apps.	0.879					
I have some type of technology that tells me when to supply my store	0.842					
I sell products from my store using the internet	0.837					
I have an application on my phone that tells me when to stock my store	0.825					
I communicate with my clients through social networks or phone applications.	0.791					
I use mobile applications to track suppliers in real time.	0.729					
I make purchases online to supply my store	0.648					
I feel willing to implement technology to improve sales service to my clients.	0.566					
Employees (owner/manager) who participate in the creation of new products or services participate in their promotion and sale		0.800				
The owner/manager fully supports the creation of new products or services		0.749				
The store owner/manager participates in the creation of new products or services		0.731				
We stay informed to take advantage of opportunities and make decisions about the creation of new products or services		0.728				
Most experienced employees (or store partners) are consulted before launching new products or services		0.634				
We have processes, based on data, to select the best ideas for the creation of new products or services		0.544				
We think that the participation of suppliers is very important when creating new products or services.			0.761			
We think that customer participation is very important when we are creating new products or services.			0.722			
We ask customers about their needs before considering a new product or service			0.654			
Suppliers participate in the creation of new products or services			0.611			
Service and customer service in the store				0.802		
Quick attention to customers and suppliers				0.802		
Flexibility to change or add new products for sale in the store				0.596		
We know which line of products or services correspond to each type of customer.					0.669	
My suppliers offer a catalog of their products online.					0.651	
I feel that repetitive activities are automatically carried out (customer payments, closing).						0.570
I use my business's telephone (landline or cell phone) to serve my clients.						0.521
Eigenvalues	8.70	3.26	1.60	1.21	1.09	1.05
Variance percentage	34.79	13.05	6.42	4.82	4.36	4.20
Cronbach's alpha	0.67	0.92	0.86	0.76		

Extraction method: principal component analysis.

Rotation method: Varimax with Kaiser normalization.

This finding underscores the importance of effective NPD processes in driving retail nanostore performance.

TABLE 2
COEFFICIENTS OF REGRESSION MODEL

	Predictors	Coeff	SE	t	p	Stand Coef.
Model 1	(Constant)	3.423	0.146	23.387	0.000	
	I4.0	0.159	0.060	2.644	0.009	0.217
Model 2	(Constant)	2.508	0.275	9.129	0.000	
	NPD_f1	0.199	0.079	2.517	0.013	0.246
	NPD_f2	0.142	0.082	1.732	0.086	0.169
Model 3	(Constant)	3.174	0.535	5.937	0.000	
	NPD_f1	0.132	0.138	0.958	0.340	0.163
	I4.0	-0.239	0.311	-0.769	0.443	-0.326
	I4.0 x NPD_f1	0.074	0.074	1.004	0.317	0.502
Model 4	(Constant)	3.607	0.538	6.703	0.000	
	NPD_f2	0.016	0.137	0.113	0.910	0.019
	I4.0	-0.428	0.287	-1.490	0.138	-0.584
	I4.0 x NPD_f2	0.123	0.067	1.825	0.070	0.841
Model 5	(Constant)	3.285	0.583	5.632	0.000	
	NPD_f1	0.296	0.178	1.665	0.098	0.365
	NPD_f2	-0.171	0.174	-0.978	0.330	-0.203
	I4.0	-0.416	0.324	-1.285	0.201	-0.568
	I4.0 x NPD_f1	-0.062	0.098	-0.632	0.528	-0.421
	I4.0 x NPD_f2	0.172	0.089	1.925	0.056	1.178

C. Testing the Hypotheses

Hypothesis confirmation:

- 1) **H1: Accepted** - Industry 4.0 significantly positively impacts nanostore performance ($\beta = 0.159$, $p < 0.01$).
- 2) **H2: Confirmed** - NPD has a positive impact on nanostore performance, both Internal ($\beta = 0.199$, $p < 0.05$) and External ($\beta = 0.142$, $p < 0.1$).
- 3) **H3: Partially accepted** - Industry 4.0 partially moderates NPD, specifically through External Involvement, in its interaction with performance.

Key Findings:

- Positive impact of Industry 4.0 on nanostore performance emphasizes technological integration.
- Confirmed positive impact of NPD on performance highlights the significance of internal and external involvement.
- Partial moderation effect of Industry 4.0 on NPD, particularly through External Involvement, suggests technology's role in enhancing the relationship between NPD and nanostore performance.

V. CONCLUSIONS

A. Summary of Findings

The confirmation of hypothesis answered the research questions and fulfilled the objectives set out in Section I. Fourth Industrial Revolution (I4.0) and new product development (NPD) significantly impact the landscape of

nanostores, presenting both challenges and growth prospects. The integration of I4.0 and effective NPD emerges as a key driver for enhanced nanostore performance, fostering operational efficiency, improved customer experiences, market agility, innovation, and competitive advantage.

Our study reveals that I4.0 acts as a moderator, influencing the relationship between NPD (NPD_f2) and performance. Retailers investing in technology and personalized experiences are more likely to succeed in the evolving retail landscape. Additionally, as pointed out by [30], large suppliers, who have resources to integrate technologies into their products (promotions through QR codes, smartphone applications, among others) exert greater influence on nanostores for the marketing of these products.

The study results support the current literature on the practices and performance of small retail stores in developing economies [31]. Furthermore, [32] show that differences in the operational capabilities of nanostores affect their ability and willingness to be competitive in the market. Our study also supports the literature on the coexistence of nanostores within the retail landscape in developing countries [3]. Our study suggests that the adoption and integration of Industry 4.0 technologies can improve the performance of nanostores by improving their operational capabilities, customer experience and performance [33]. Our study also supports the literature on the impact of Industry 4.0 technologies on retail development. The results of the study contribute to the literature on the relationship between Industry 4.0, NPD, and the performance of nanostores in developing countries and provide a framework for future research in this area.

B. Practical Implications

The study underscores the importance of technology adoption and customer experience creation for sustained success in nanostores. Investing in technology readiness, digital integration, process automation, and data analytics can elevate nanostores to higher levels of innovation, operational efficiency, and customer satisfaction. Additionally, differentiating through superior customer experiences is crucial, especially considering that nanostores may face challenges in competing solely on price or product selection.

The economic implications highlight how I4.0 technologies can provide nanostores with a competitive advantage, potentially improving market position, attracting more customers, and fostering sustainable growth.

C. Social and Theoretical Contributions

At a social level, the study emphasizes the transformative potential of I4.0 technologies, contributing to a seamless, personalized shopping experience that enhances customer satisfaction and loyalty. The importance of upskilling the workforce and ensuring technological readiness for a smooth transition to the Industry 4.0 era is highlighted.

Theoretical contributions include advancing our understanding of the complex relationship between I4.0, NPD, and nanostore performance, filling the gap in literature found in Section I. The study's focus on developing countries, specifically Honduras, adds to the literature on the practices and performance of small retail stores in such economies.

D. Limitation of the Study

The study's reliance on convenience sampling introduces a limitation, potentially affecting the generalizability of the findings. Future research could consider a more diverse and extensive sample for a broader understanding. Additionally, the study's focus on Honduras restricts the generalizability of results to other developing countries. Future research could expand the study to diverse geographical contexts for a more comprehensive understanding. To address potential bias in self-reported data, future research could incorporate objective performance measures and collect data from diverse sources, enhancing the reliability and validity of the findings.

E. Future Research Directions

Future research could delve into the nuanced mechanisms by which different I4.0 technologies impact the relationship between NPD and nanostore performance. Comparative studies across diverse retail sectors and regions could offer a comprehensive understanding of how I4.0 technologies influence retail innovation and performance.

The study's uniqueness lies in being the first to examine the moderation of I4.0 in the relationship between NPD and nanostore performance, specifically in Honduras. The insights provided hold valuable implications for leveraging technology for retail success in developing countries.

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