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Research Article

The Effect of Information Technology Implementation on Retail Manufacturer's Operational Performance: A Moderated Serial Mediation Model

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ABSTRACT

This study explores the impact of "Information Technology Implementation" (IT-Impl) on firms' "Operational Performance" (Op-Per) using the Dynamic Resource-Based View (DRBV), proposing a dynamic influence path including the framework of resources-capability-competitive advantage. The direct effects of IT-Impl on Op-Per have been extensively studied, but not the complex instrumental routes and intermediate processes. This study advances a more sophisticated understanding of the dynamic capabilities in converting IT resources into long-term competitive advantage, particularly identifying the serial mediation of the IT-Impl–Op-Per relationship by supply chain integration (SC-Int) and postponement (Post-P). A quantitative research approach was used to gather data from a sample of 298 top-ranking managers from retail manufacturers to test hypotheses using Smart-PLS. The results show that while IT-Impl positively affects Op-Per through the serial mediating roles, "Information Intensity" negatively moderates these relationships. In practice, Op-Per is influenced by a multitude of factors, including supply chain and internal operating capabilities. The study emphasizes the importance of considering SC-Int and Post-P as dynamic capabilities in leveraging IT-Impl for Op-Per. Organizations should strategically align IT investments with advanced supply chain and internal operating capabilities to gain a sustainable competitive advantage. The results, discussion, contributions, limitations, and potential future directions are provided.

Keywords: dynamic resource-based view, information intensity, information technology implementation, operational performance, postponement, supply chain integration

1. Introduction

IT is crucial for modern business operations, influencing diverse aspects of organizational functioning. It is essential for facilitating efficient communication within supply chains (SCs) and enhancing decision-making processes [1–3]. However, a gap remains in understanding the specific mechanisms and paths through which this influence occurs. Previous studies have primarily focused on the role of IT in achieving "Operational Performance" (Op-Per), neglecting the dynamic aspect of capabilities [4–6]. This study aims to bridge this gap by empirically examining the impact of "Information Technology Implementation" (IT-Impl) on Op-Per, and uncovering the internal mechanisms of this relationship. Acknowledging the importance of dynamic capabilities in transforming IT resources into capabilities for sustained competitive advantage, this study adopts the theoretical perspective of the Dynamic Resource-Based View (DRBV) to explain the effect of IT-Impl on firm's Op-Per through the lens of mediating and moderating factors, including "Supply Chain Integration" (SC-Int), "Postponement" (Post-P), and "Information Intensity" (Inf-Int).

Technology gives businesses the ability to collaborate and make decisions in real time, which improves Op-Per [6]. The impact of IT-Impl on Op-Per is examined in this study at the levels of SCs and internal operations. The study presents two capabilities as mediating variables, SC-Int at the SC level, and Post-P at the internal operations level.

Exploring these variables seeks to contribute to research on the impacts of IT-Impl on Op-Per. Moreover, the study adds to the body of literature, based on the Knowledge Based View (KBV), by suggesting that high Inf-Int throughout the value chain strengthens the direct effect of IT-Impl on SC-Int, and on Post-P and Op-Per indirectly. The notion that businesses should concentrate on creating knowledge-based internal assets and processes is one of the contributions of the KBV [7]. Information-intensive enterprises develop procedures of information collection, assimilation, and conversion because there is "an increasing focus on knowledge as the most important resource for companies" [8]. Processes that digest and use information better have the potential to create a durable competitive advantage for organizations that rely on it. The study's main goal is to provide a solution to the fundamental research questions:

- How can businesses use their resources, such as IT-Impl, to develop dynamic capabilities and further maintain their competitive advantage in terms of Op-Per?
- Are high Inf-Int firms better positioned to take advantage of IT-based resources to gain a competitive edge?

The following sections review related literature and justify the developed hypotheses, present the conceptual framework, expound the methodology underpinning this study, and present and discuss the results.

2. Literature Review and Hypotheses Development

2.1. IT-Impl and SC-Int

IT-Impl expressly refers to "the technical capacity to gather, process, and communicate the data required for more efficient decision-making" [9]. The implementation of IT is positively correlated with supply chain management (SCM), as it enhances integration and management [9]. IT allows businesses to share large amounts of data, such as operational and logistical data, enabling real-time integration of partners along the SC, leading to improved inventory management and production planning [9]. Gu et al. [3] found that balanced IT exploration and exploitation create resilience by ensuring easy information search and adjustment, enabling firms to share information and collaborate with suppliers, and ensuring recovery after disruptions. Vanpoucke et al. [10] found that operational exchange is essential for capturing the benefits of information exchange, and IT is a key element for stronger upstream integration. Ganbold et al. [11] also found that IT capability, specifically cross-functional and SC application, is essential for effective integration within the SC, contributing to positive outcomes such as streamlining inventory and lowering production costs. Overall, IT-Impl plays a crucial role in improving SC-Int. Thus, we proposed the following hypothesis:

H1: IT-Impl is associated with SC-Int.

2.2. SC-Int and Post-P

The definition of SC-Int is "the extent to which an organization manages intra- and inter-organization processes" and collaborates with essential partners in SCs to "achieve effective and efficient flows of products, services, information, money, and decisions, with the goal of providing maximum value to its customers" [12]. Kocoglu et al. [13] highlight the importance of SC-Int in enhancing efficiency and information sharing among retailers and suppliers. This integration enhances inter-functional and intra-organizational information sharing, leading to improved SC performance. In the context of Post-P, integration improves information sharing among partners, including demand forecasts and customer preferences. Access to accurate and timely information allows companies to implement Post-P strategies more effectively.

In addition, an integrated SC creates more flexibility and responsiveness. Siagian et al. [14] found that SC-Int enabled resilience, flexibility, and innovation, leading to improved business performance during the COVID-19 pandemic. Asare et al. [15] found that innovation-oriented SC-Int facilitated structural flexibility, improving business performance. This flexibility allows companies to adopt Post-P strategies more readily, as they can quickly adjust production processes and customize products in line with changing customer preferences and demands. In accordance with the preceding discussion, we advance the following hypothesis:

H2: SC-Int is related to Post-P.

2.3. Post-P and Op-Per

Post-P is a SC strategy that entails holding off on a product's final configuration, customization, or delivery until the precise needs of the client are known [16]. Organizations are increasingly adopting Post-P strategies to manage uncertainty and unpredictability in the global business world [17]. This approach aims to mitigate risk by acquiring more information before committing to specific activities. Delaying value-added activities, such as customization, reduces operational uncertainty, allowing for more accurate forecasts and optimized inventory management. This leads to improved Op-Per and a sustained competitive advantage. Swaminathan and Lee [18] found that packaging Post-P reduced inventory costs, while manufacturing and assembly Post-P increased responsiveness and improved lead times within the SC. This suggests that different forms of Post-P strategies contribute to improved performance, such as reduced lead times, which contributes to the overall success of a firm. Skipworth and Harrison [19] also found that form Post-P improved responsiveness in the SC, leading to reduced lead time. This strategy can lead to positive outcomes in SC operations, such as reduced risk of overproduction or stockouts, enhancing Op-Per. In light of the established evidences, we propose the following hypothesis:

H3: Post-P is associated with Op-Per.

2.4. IT-Impl and Op-Per

A collection of variables that represent an organization's internal processes is frequently used to characterize Op-Per [20,21]. Effective product development, process enhancements, quality compliance, and quick lead times all contribute to Op-Per [22]. The fundamental aspect that IT influences Op-Per is through its ability to foster efficiency and innovation inside the enterprise. According to Machmud et al. [23] there is a claim that using IT improves decision-making and time efficiency, both of which are critical for raising productivity and promoting innovation. Similarly, Fatafta et al. [24] offer empirical evidence supporting the idea that IT capabilities are essential to operational success, showing that IT, especially through tools like enterprise resource planning and electronic data interchange, positively correlates with organizational performance in the pharmaceutical sector [24]. According to Maimun's [25] research, cloud computing enhances scalability, total system performance, adaptability, and mobility, all of which lead to superior Op-Per [26]. Callaghan et al. concur, pointing out that operational success is positively correlated with efficient business process optimization, which is enabled by IT systems such as like enterprise resource planning, especially in manufacturing contexts [27]. Alabbadi explores how firm performance is positively impacted by IT business strategic maturity, which encompasses IT governance and strategic planning, across a variety of industries [28]. This is consistent with research by Liang et al. [29], who contend that utilizing IT resources efficiently improves organizational capacities and produces better performance measures. Consequently, we introduced the following hypothesis:

H4: IT-Impl is related to Op-Per

2.5. The Mediating Role of SC-Int

A study by Li et al. [9] found that while IT-Impl did not directly affect SC performance, it did enhance it through its positive effect on SC-Int. This highlights the crucial role of IT in facilitating integration within the SC, which contributes to improved performance. An integrated SC is better positioned to implement Post-P strategies effectively by enhancing adaptability, responsiveness, and coordination. Boon-itt and Wong [30] confirmed that internal and supplier integration positively influence customer delivery performance, but these relationships are moderated by technological and demand uncertainties. This indirectly supports the notion that better integration can contribute to improved operational efficiency, potentially enabling later customization or Post-P strategies. IT facilitates better communication and coordination across the SC, ensuring seamless collaboration between suppliers, manufacturers, and customers [31]. It leads to a more synchronized SC, reducing uncertainties and allowing for better coordination in response to changes in demand or supply disruptions [32]. Real-time visibility into inventory levels, production status, and demand patterns enables SC partners to make informed decisions about when to postpone final product customization or assembly [33]. This improves transparency and enables more precise demand forecasts, reducing the risk of overproduction and increasing the efficiency of Post-P strategies. Accordingly, we proposed the following hypothesis:

H5: IT-Impl affects Post-P through SC-Int.

2.6. The Mediating Role of Post-P

Assuming that SC-Int affects Op-Per, this can be given a fillip by Post-P. This is achieved through improved coordination and communication throughout the SC, which is crucial for successful Post-P strategies [13]. Dzogbewu et al. [34] reported that internal process integration positively affects Op-Per, supporting the notion that when internal processes are well-integrated, Op-Per within manufacturing firms are positively affected. Integration within the SC allows for more flexible manufacturing processes, enabling companies to adapt production schedules based on real-time information [14,35]. This flexibility aligns with the Post-P strategy, where product customization and differentiation are delayed until demand is known, contributing to operational efficiency and resource optimization. Internal integration streamlines inventory management, allowing better visibility into inventory levels and enabling the firm to have more control over inventory [36]. This is especially relevant when Post-P is involved, as managing inventory and avoiding overproduction are critical. Research by Flynn et al. [37] reported that internal and customer integration positively affect both operational and business performance. This suggests that improved integration could facilitate Post-P strategies by enabling better coordination and resource allocation within the organization, streamlining production processes and allowing for later customization options. Therefore, we present the following hypothesis:

H6: SC-Int affects Op-Per through Post-P.

2.7. The Serial Mediation Effect Hypothesis

Digitalization significantly enhances SC-Int and efficiency, leading to improved performance [38]. SC dynamism positively influences the association between digitalization and SC-Int. The integration of suppliers, customers, and internal processes is a sequential process facilitated by IT implementation, enhancing communication, coordination, and efficiency at various stages of the SC [39]. Various studies have found that SC-Int mediates the positive relationship between IT-Impl and Op-Per. When IT-Impl increases, it has a positive impact on Op-Per, influenced by the mediating factors of SC-Int [36,40]. Research by Qrunfleh and Tarafdar [41] revealed that Post-P partially mediates the relationship between an agile SC strategy and SC responsiveness. This suggests that Post-P practices mediate and enhance SC responsiveness when IT is implemented, just as it does to SC responsiveness when a firm employs SC strategies. Post-P strategies enhance SC flexibility and responsiveness, aligning production more closely with actual demand and positively influencing SCM performance [42]. These Post-P strategies can be effectively facilitated by IT to achieve the desired outcome of improving the firm’s Op-Per. On the basis of the preceding, we posit the following hypothesis:

H7: SC-Int and Post-P sequentially mediate the relationship between IT-Impl and Op-Per.

2.8 The Moderating Role of Inf-Int

The degree of accuracy, the frequency of updates, and the volume and scope of information used in operations are all indicators of Inf-Int, which can be understood as the information component's significance in value chain activities [43,44]. High Inf-Int environments allow firms to capitalize on the abundance of information, facilitating improved communication, coordination, and collaboration across the SC [45]. IT systems can also enhance the speed and accuracy of decision-making processes within a SC, making the positive impact of IT on SC-Int more pronounced in high information-intensity settings. Ali et al. [46] found that business requirements and Inf-Int partially influence the relationship between IT innovation readiness and successful technology adoption outcomes. Neirotti and Pesce [47] found that the Inf-Int of an industry is a critical factor that could influence IT adoption in organizations. The relationship between IT-related variables, IT innovation readiness, and outcomes is not uniform but depends on other factors, such as business requirements and Inf-Int. Vijayasarathy and Robey [48] found that Electronic Data Interchange has a significant positive impact on market channel relationships in retailing, suggesting the presence of Inf-Int in these interactions. Baihaqi and Sohal [49] found that integrated information technologies play a pivotal role in influencing the intensity of information sharing within SCs, with the positive impact of IT-Impl being boosted when Inf-Int is high. Accordingly, we suggest the following hypothesis:

H8: Inf-Int moderates the positive relationship of IT-Impl with SC-Int, such that the relationship is stronger when Inf-Int is high.

2.9. The Moderated Mediation Hypothesis

High Inf-Int implies a greater reliance on information for decision-making, which enhances visibility into various aspects of the SC, allowing for better coordination and synchronization of activities across the SC [50–52]. IT facilitates efficient communication and data sharing among different entities in the SC, such as suppliers, manufacturers, and customers. In high information-intensity industries, data plays a crucial role in understanding markets, predicting trends, and anticipating customer needs [53]. Effective SC-Int, enabled by IT systems, fosters information sharing and transparency across the entire chain, leading to improved SC visibility and reducing the risk of making inaccurate assumptions when implementing Post-P strategies [13]. In an information-intensive environment, the value of SC-Int is amplified, leading to better informed Post-P decisions, reduced inventory costs, improved responsiveness, and more efficient resource allocation [54]. High Inf-Int also mitigates uncertainty and risk associated with Post-P, enabling proactive responses to potential disruptions and enhancing the resilience of Post-P strategies [55]. Thus, we formulate the following hypothesis:

H9: The mediation of SC-Int between IT-Impl and Post-P is moderated by Inf-Int, whereby increased Inf-Int strengthens the mediation.

2.10. The Moderated-Serial Mediation Hypothesis

IT-Impl is a transformative process that connects stakeholders within an organization, enabling seamless information flow and collaboration across the entire SC [56,57]. This interconnectedness fosters a networked environment that enhances Op-Per [58]. IT-driven SC-Int improves communication and coordination, leading to timely deliveries, reduced inventory levels, and increased cost management [59]. IT-driven customer integration provides real-time demand insights, enhancing sales and satisfaction. Internally, IT connects departments, streamlines processes, and promotes efficient data sharing, contributing to the optimization of the SC [60]. Post-P, a strategic approach in SCM, is significantly impacted by IT systems [61]. Companies that adopt IT systems, equipped with advanced data analytics and communication tools, gain quick insights into market dynamics, customer preferences, and emerging trends, enabling informed decisions about product configuration [62]. This reduces carrying costs and mitigates the risk of excess inventory. Inf-Int drives strategic decision-making and operational efficiency, as IT systems ensure seamless data flow across organizational units, facilitating real-time collaboration and decision-making [63]. This leads to improved communication and coordination, a more agile and responsive SC, and the ability to unlock the full potential of IT-driven transformations in the pursuit of operational excellence [64]. Therefore, we formulate the following hypothesis:

H10: Inf-Int moderate the serial mediating association of SC-Int and Post-P between IT-Impl and Op-Per; the higher the Inf-Int, the more significant the serial mediating association of SC-Int and Post-P between IT-Impl and Op-Per.

These developed hypotheses underscore the conceptual model displayed in Figure 1.

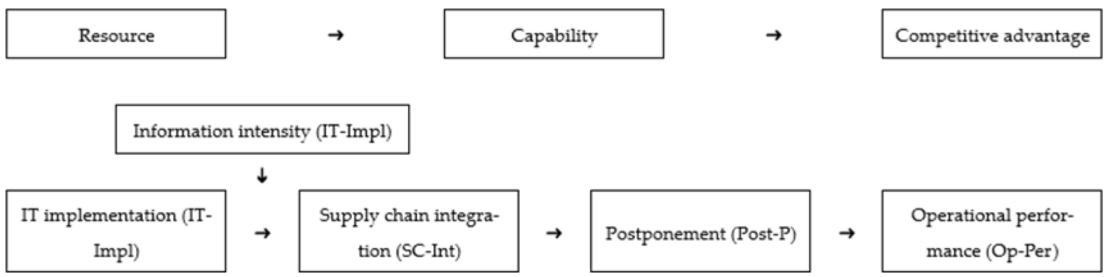

Figure 1. Conceptual model.

3. Materials and Methods

3.1. Measures

We adapted some commonly used scales from existing research to operationalize the constructs of this study, as described below.

IT-Impl: Chen and Paulraj's [65] six-item scale was used, from which three items were excluded on account of having low item factor loadings. Sample items include "There are direct computer-to-computer links with key supply chain partners", and "We use electronic transfer of purchase orders, invoices and/or funds".

SC-Int: Tseng and Liao's [66] nine-item scale was used, from which four were eliminated due to low item factor loadings. Sample items include "My firm exchanges information with supply chain partners through IT" and "Data integration among internal departments in our firm is through networks".

Post-P: Li et al.'s [67] five-item scale was used. Sample items include "Our products are designed for modular assembly" and "We delay final product assembly activities until customer orders have actually been received".

Op-Per: Hong et al.'s [68] six-item scale was used, from which two were removed due to low item factor loadings. Sample items include "We create products that are high-performing and suit the expectations of customers" and "Productivity has been steadily rising".

Inf-Int: The four items concerning Inf-Int with regard to the value chain were adapted from Teo and King [44], of which two were removed due to low item factor loadings. Sample items include "Information used in our production operations is frequently updated" and "Many steps in our production operations require the frequent use of information".

Attitude Toward the Color Blue (ATCB): Based on Miller and Simmering [69], seven items were used to measure ATCB. Sample items include "blue is a beautiful color" and "the color blue is wonderful".

The scales were all originally created in English, and the instrument was administered in the same native language of the studied context (i.e., the USA). Likert-type responses were used, with 1 representing "strongly disagree" and 5 representing "strongly agree", whereby respondents were asked to rate the degree of their disagreement or agreement with the items.

3.2. Sample and Data Collection

This study focuses on retail manufacturers in the US, which is renowned for its high-performance manufacturing and its role in global SCs. The study focuses on the links between IT-Impl, SC-Int, Post-P, and Op-Per in these organizations. The research is empirical and quantitative, employing convenience sampling and structured questionnaires.

Responses were gathered utilizing Qualtrics platform, while Prolific platform was used to recruit participants for data collection. Senior management (e.g., CEOs, directors, and managers of SCs etc.) in the targeted organizations were recruited to complete the survey instrument, as they possess extensive knowledge about studied phenomena (i.e., operational factors, SCM, distribution, procurement, and SC partner and customer relations). The researcher initially provided an explanation of the goals, prospective managerial benefits, and procedures used in the study. All responses provided by participants were treated with strict confidentiality.

Deploying a priori techniques for sample size determinations, for a medium effect size of 0.3 [70], with a view to 0.01 level of significance and 0.8 statistical power, 30 items measuring five constructs necessitates a minimal sample size of 193. Hence, the ultimate sample size (n = 298) used for analysis could be deemed appropriate.

The demographic profile of the 298 senior managers from retail manufacturing organizations that made up the sample showed a wide range of firm ages, sizes, industry types, and job titles. The majority (41.6%) of the firms were over 25 years old, followed by 16.8% that were between 16 and 20 years old, 15.4% that were between 11 and 15 years old, 13.8% that were between 6 and 10 years old, and 12.4% that were under 5 years old. In terms of firm size, 28.5% had above 1000 employees, 27.5% had 250–1000 employees, 27.2% had 50–249 employees, and 16.8% had fewer than 50 employees. The sample's industries were diverse, with the largest percentage (22.1%) going to the "Others" category, followed by the computer and electronics sector 19%, chemicals and materials 11.7%, machinery and equipment 11.4%, and food industry 9.4%. The textile, wood, bamboo, plastic, rubber, and motor vehicle industries had smaller percentages. Last but not least, of those surveyed, 39.6% were managers, 21.5% were directors, 20.5% were presidents or vice presidents, and 18.5% had other titles.

3.3. Analytical Tools

Structure equation modeling using Smart-PLS 4.0 [71] was employed to conduct the analysis, according to the nature and complexity of the model, the model includes both mediation and moderation, a moderated serial mediation model. According to the model, Smart-PLS was found to be the most appropriate statistical package to conduct the analysis, which can be used in various conditions, including exploratory and explanatory studies. The tool is also germane for data that is non-normally distributed, and it is considered a non-parametric analytical approach (e.g., if the data violates the normality assumption). It can also perform very well on a very small sample size and large sample size and provide predictive modeling results [72–74].

4. Results

4.1. Descriptive Statistics

As shown in Table 1, consistent with **H1**, IT-Impl was positively correlated with SC-Int ($r = 0.93$, $p < 0.01$) and Op-Per ($r = 0.89$, $p < 0.01$). Furthermore, SC-Int was correlated with Post-P ($r = 0.79$, $p < 0.01$). Also, Post-P was correlated with Op-Per ($r = 0.83$, $p < 0.01$). Post-P. Table 1 provides the means, standard deviations, and correlations.

Table 1. Descriptive statistics.

Variables	M	SD	1	2	3	4	5	6	7	8	9	10
1. Firm age	3.61	1.45	-	0.62**	0.16**	0.00	0.18**	0.21**	0.13*	0.15**	0.16**	0.12*
2. Firm size	2.68	1.06	0.62**	-	0.00	0.00	0.16**	0.13*	0.21**	0.12*	0.12*	0.00
3. Industry	5.66	2.63	0.16**	0.00	-	.18**	0.00	0.00	0.00	0.00	0.12*	0.00
4. Job title	2.54	1.01	0.00	0.00	.18**	-	0.13*	0.13*	0.00	0.00	0.15*	0.19**
5. IT-Impl	3.77	1.36	0.18**	0.16**	0.00	0.13*	**(0.93)**	0.93**	0.78**	0.89**	0.84**	0.62**
6. SC-Int	3.78	1.32	0.21**	0.13*	0.00	0.13*	0.93**	**(0.95)**	0.79**	0.92**	0.85**	0.65**
7. Post-P	3.36	1.39	0.13*	0.21**	0.00	0.00	0.78**	0.79**	**(0.93)**	0.83**	0.70**	0.53**
8. Op-Per	3.59	1.32	0.15**	0.12*	0.00	0.00	0.89**	0.92**	0.83**	**(0.93)**	0.83**	0.64**
9. Inf-Int	3.85	1.37	0.16**	0.12*	0.12*	0.15**	0.84**	0.85**	0.70**	0.83**	**(0.70)**	0.63**
10. ATCB	27.95	8.17	0.12*	0.00	0.00	0.19**	0.62**	0.65**	0.53**	0.64**	0.63**	**(0.95)**

Note. ***p*<0.01, **p*<0.05, *M* = Mean, *SD* = Standard deviation. ATCB = Attitude toward the color blue. Above the diagonal are "blue color" controlled correlations, and below the diagonal are non-controlled correlations. Diagonal bracketed bold values are reliabilities (α).

4.2. Common Method Variance

Procedural and statistical techniques were implemented to control and minimize possible common method variance (CMV) that could occur due to the data collection method [75]. To lessen the chance that participants would provide deceptive or artificial answers, two attention-checking questions were added [76,75]. Statistically, partial correlation procedure [77] and Harman's single factor test [78] was conducted to check for the existence of common method variance.

First, for the partial correlation procedure, Miller and Simmering's [69] "attitude toward the color blue" was the marker variable used to detect for common method variance. Table 1 displays the related controlled and non-controlled correlations (above and below the diagonal, respectively). It can be seen that significant relationships still exist even after controlling for blue color. The correlations between variables before and after controlling the blue color variable remains the same, and the correlations among the observable variables were within the acceptable range. CMV is of little concern, and it is thus improbable that the interpretation of the results in this research is confounded.

Second, Harman's single-factor test shows that the first component or factor extracted from the data accounted for 35.6% of the total variance, indicating that the single common factor did not account for most variance. The test for Harman's single factor revealed no predominant variable emerging from the analysis of factors, since the percentage of variance explained is not greater than the 50% threshold, thus CMV is not an issue [75]. In addition, the variance inflation factor and levels of tolerance fall within the normative purview [79].

4.3. Reliability and Validity

As a procedure of measurement model, the reliability of the scales was measured with the estimation of composite reliability and Cronbach's alpha (α) coefficient as internal consistency measures [80,81], along with average variance extracted (AVE) and factor loadings of the constructs [82–84], measured for convergent validity, as shown in Table 2.

Table 2. Properties of measurements of reflective constructs.

Constructs	Items	Loading range	Cronbach's α	Composite reliability	AVE
Inf-Int	2	0.79-0.94	0.70	0.86	0.75
IT-Impl	3	0.93-0.95	0.93	0.96	0.88
Op-Per	4	0.87-0.93	0.93	0.95	0.82
Post-P	5	0.86-0.90	0.93	0.94	0.77
SC-Int	5	0.90-0.93	0.95	0.96	0.84

Note. AVE = Average variance extracted.

The outcomes reveal that the Cronbach's α for all variables was ≥ 0.70, while the composite reliability was > 0.70 (within the acceptable range) [80]. Furthermore, the values of AVE for all the variables were considered adequately above the acceptable limit of 0.05. Factor loadings were computed to evaluate the fit of the items with their corresponding constructs/factors. After some of the items were eliminated because of their low factor loadings, the model fit improved and every item had a high loading on its corresponding construct, suggesting that they had converged on their respective constructs [79]. All measurement properties of reflective constructs are illustrated in Table 2. Further the assessment of discriminant validities were carried out and Fornell–Larcker criteria (Table 3) and heterotrait–monotrait ratio (Table 4) were used to assess the discriminant validity.

Table 3. Discriminant validity – Fornell–Larcker criteria.

Variable	1	2	3	4	5
Inf-Int	**0.87**				
IT-Impl	0.84	**0.94**			
Op-Per	0.83	0.89	**0.91**		
Post-P	0.70	0.78	0.83	**0.88**	
SC-Int	0.85	0.91	0.90	0.79	**0.92**

Note. Bold diagonal values indicate the square root of AVE statistic for Fornell-Larcker discriminant validity. Correlations are indicated under the bold diagonal elements.

Table 4. Discriminant validity – heterotrait–monotrait criteria.

Variable	1	2	3	4	5	6
Inf-Int	-					
IT-Impl	0.89	-				
Op-Per	0.87	0.85	-			
Post-P	0.84	0.84	0.89	-		
SC-Int	0.89	0.89	0.88	0.84	-	
Inf-Int x IT-Impl	0.73	0.72	0.69	0.57	0.75	-

The discriminant validity analysis, the Fornell–Larcker criteria, as seen in Table 3 suggested that AVE values' square roots fell within the acceptable range. The value of the square-root of AVE must be greater than the values of the inter-construct correlation; in this regard, the results indicate that no correlation value was found to be greater than the square-root of AVE [85].

In order to evaluate discriminant validity, the heterotrait–monotrait criteria indicated in Table 4 were employed. The findings showed that all of the correlation values fell within the acceptable range since they fully satisfied the criteria, which states that all of the values of each construct in the correlation must be less than 0.90 [80].

4.4. Assessment of the Structural Model

4.4.1. Model Fit

To perform confirmatory factor analysis of emergent factors, AMOS V24 (SPSS Inc., Chicago, IL, USA) was used. As a goodness-of-fit measure, the overall chi-square suggested by Hooper et al. [86] and various model fit indices were utilized to examine the goodness-of-fit of the study model on the provided dataset. The related indicators and the results are adumbrated below.

"Comparative fit index" [87]): 0.94; "Goodness-of-fit index": 0.92; "Normed fit index": 0.93; these values exceed the permissible standard of 0.90.

"Root mean square error of approximation" [86]): 0.06; "Standardized root mean-square residual" [88]: 0.07; these values are below the permissible levels of 0.08, indicating a good fit of the model to the data.

"Chi-square value": 976.37, with 84 degrees of freedom. Normed chi-square (related to the freedom degrees) of 2.17 falls well below the permissible cutoff point of 3.00. Additional fit indices point to a good model fit.

"P-value of significance": 0.00.

All of these findings point to the model's strong predictive and explanatory ability and good fit to the data.

4.4.2. Explanatory Power and Predictive Relevance

The structural model's predictive power combining the impact of exogenous (independent) variables on the endogenous (dependent) variables is determined using the R^2, also referred to as the coefficient of determination; according to Sarstedt et al. [80], the proposed values of R^2 = 0.25 weak, 0.50 moderate, and 0.75 strong predictive power. According to other authors, R^2 values of 0.67, 0.33, and 0.19 indicate significant, moderate, and weak predictive abilities, respectively [89]. Q^2 (with a value between 0 and 1) shows how well the study model can forecast the outcome variables in the model based on the predictor variables. Q^2 values near 1 indicate greater predictive relevance, while values closer to zero indicate lower relevance (while zero indicates no predictive relevance). The relevant statistics are shown in Table 5.

Table 5. Predictive relevance and power of the endogenous variables.

Exogenous variables	Endogenous variables	Q^2	R^2
IT-Impl Inf-Int SC-Int Post-P	Op-Per	0.80	0.84
IT-Impl Inf-Int SC-Int	Post-P	0.60	0.63
IT-Impl Inf-Int	SC-Int	0.88	0.89

4.4.3. Direct Effects

Table 6 shows the direct effects of the exogenous variables on each endogenous variable. **H1** was supported by the significant pathways results, which indicated that IT-Impl was a significant predictor of SC-Int (β = 0.67, t = 11.76, p<.001). Additionally, the findings supported **H2**, showing that SC-Int was a significant predictor of Post-P (β = 0.79, t = 27.32, p<.001). Furthermore, **H3** and **H4** were supported by the findings that Post-P and IT-Impl were significant predictors of Op-Per (β = 0.34, t = 6.84, p<.001) and (β = 0.62, t = 12.49, p<.001), respectively.

Table 6. Evaluation of structural model.

Path	Direct effect	f^2	Bias-corrected CI	
	B		**2.5% CI**	**97.5% CI**
Inf-Int ➜ SC-Int	0.21***	0.11	0.11	0.29
IT-Impl ➜ Op-Per	0.62***	0.96	0.52	0.72
IT-Impl ➜ SC-Int	0.67***	1.09	0.57	0.79
Post-P ➜ Op-Per	0.34***	0.29	0.25	0.44
SC-Int ➜ Post-P	0.79***	1.70	0.73	0.85
Inf-Int x IT-Impl ➜ SC-Int	-0.10***	0.07	-0.14	-0.05

Note. β = Beta, f^2 = Cohen's f^2 for effect size.

4.4.4. Mediation Effects

Specific indirect effects were assessed to determine the mediation and serial mediation effects. As shown in Table 7, SC-Int significantly mediates between IT-Impl and Post-P (β = 0.53, t = 10.17, p < .001), supporting **H5**. Furthermore, Post-P significantly mediates between SC-Int and Op-Per (β = 0.27, t = 6.05, p < .001), supporting **H6**. Moreover, SC-Int and Post-P serially mediate the relationship between IT-Impl and Op-Per (β = 0.18, t = 5.86, p < .01), supporting **H7**. Hence, SC-Int and Post-P partially mediated the relationship between IT-Impl and Op-Per, as both the direct (β = 0.62, t = 12.49, p<.001) and indirect (β = 0.18, t = 5.86, p < .01) effects were significant.

Table 7. Estimation of mediation and moderation effects

Path	Effect	95% CI	
		LL	UL
Inf-Int x IT-Impl ➔ SC-Int ➔ Post-P ➔ Op-Per	-0.03**	-0.04	-0.02
IT-Impl ➔ SC-Int ➔ Post-P	0.53***	0.32	0.55
SC-Int ➔ Post-P ➔ Op-Per	0.27***	0.19	0.37
Inf-Int x IT-Impl ➔ SC-Int ➔ Post-P	-0.08***	-0.09	-0.02
IT-Impl ➔ SC-Int ➔ Post-P ➔ Op-Per	0.18***	0.10	0.21

4.4.5. Moderation Effects

Moderation analyses included simple moderation, and moderated-mediation, and moderated-seral-mediation. The results of the analysis of the direct effects (Table 6), and indirect effects (Table 7) indicated that negative moderation, negative moderated mediation, and negative moderated-serial-mediation effects were found.

Inf-Int negatively moderates the positive association between IT-Impl and SC-Int, such that greater Inf-Int weakens the relationship between IT-Impl and SC-Int.

The study investigated the moderating influence of Inf-Int on the link between IT-Impl and SC-Int. The R^2 value for SC-Int was 0.87 when the moderating impact (IT-Impl*Inf-Int) was excluded. This indicates that IT-Impl accounts for 87% of the change in SC-Int. The R^2 rose to 89% once the interaction term was added, indicating a 2% rise in the variance explained for the dependent variable (SC-Int).

Inf-Int and IT-Impl were revealed to be significant predictors of SC-Int (β = 0.21, t = 4.51, p<.001; β = 0.67, t = 11.76, p<.001, respectively), according to the results of the relevant direct pathways (Table 6). The findings of the analysis of the moderating effect's significance showed that Inf-Int had a significant and negative moderating effect on the connection between IT-Impl and SC-Int (β = -0.10, t = 3.87, p = .00), rejecting **H8**. This indicates that the association between IT-Impl and SC-Int weakened as Inf-Int increased. To further comprehend the nature of the moderating impact, slope analysis is also provided, as displayed in Figure 2.

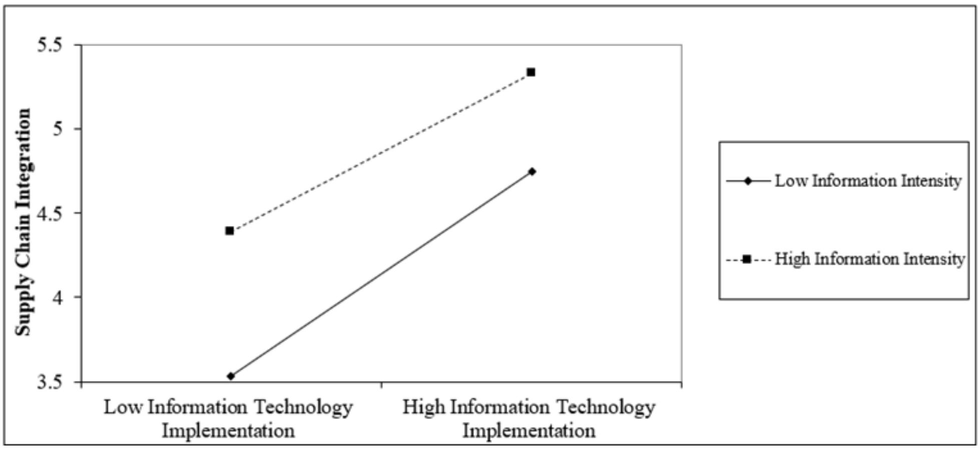

Figure 2. Moderating effect of Inf-Int on the relationship between IT-Impl and SC-Int.

In Figure 2, the steeper line for low Inf-Int indicates that, compared to high Inf-Int, the influence of IT-Impl on SC-Int is greater at low Inf-Int levels. The line does, however, tend to straighten with greater Inf-Int, indicating that an increase in IT-Impl does not cause a corresponding change in the SC-Int. In summary, the effect of IT-Impl on SC-Int is lessened by increased Inf-Int. According to Cohen's [70] proposition, the F-Square effect size was 0.07;

small, medium, and large influence sizes of moderation are represented by 0.02, 0.15, and 0.35, respectively. This demonstrates that while the moderating effect is statistically significant, it does not substantially explain the variance in SC-Int.

As shown in Table 7, the interaction between Inf-Int and IT-Impl predicting SC-Int and further predicting Post-P, in moderated mediation was also found to be negative (β = -0.08, t = 3.85, p = 0.00), rejecting **H9**. Furthermore, the interaction between Inf-Int and IT-Impl predicting SC-Int and further predicting Post-P and Op-Per was also found to be negative, in a serial moderated mediation (β = -0.03, t = 2.95, p = 0.01), rejecting **H10**. Figure 3 demonstrates the statistical model of moderated serial mediation.

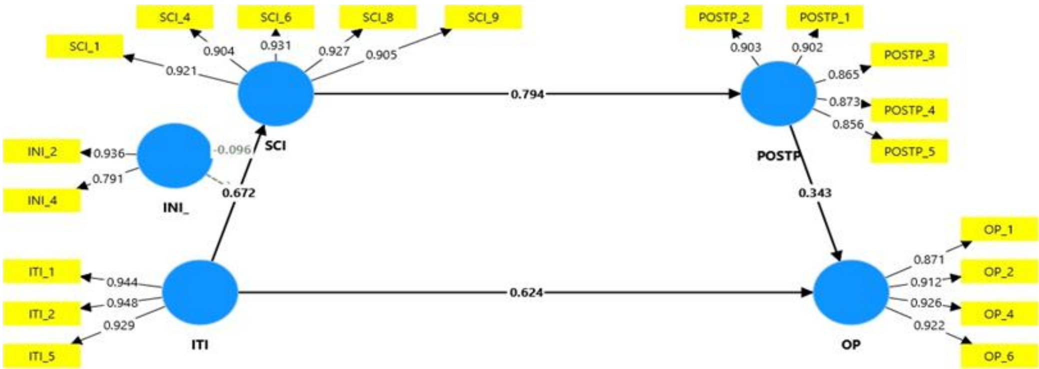

Figure 3. The statistical model of moderated serial mediation

5. Discussion

The study's findings are consistent with the DRBV, which emphasizes that developing, accumulating, and combining different resources and capabilities is a dynamic process that leads to gaining a competitive advantage. The results confirmed that SC-Int and Post-P serially mediate IT-Impl's impact on Op-Per. This means that IT-Impl positively influences Op-Per through a sequential process involving SC-Int and Post-P strategies. Firms should prioritize investments in technology solutions that enable real-time data sharing, enhance visibility, and streamline communication across the SC to achieve seamless SC-Int. The acceptance of the hypothesis in the research suggests that when SCs are effectively integrated, they are better equipped to delay the final customization or configuration of products until they receive customer orders. This delay allows them to respond more efficiently to specific customer demands, thereby optimizing their Op-Per. By delaying final customization until customer orders are confirmed, companies can achieve greater efficiency, reduce inventory costs, and improve responsiveness to customer demand. By leveraging Post-P to delay activities and acquire more information, companies can mitigate risks, improve forecast accuracy, optimize inventory management, and enhance SC responsiveness, leading to improved operational efficiency and sustained competitive advantage. Finally, Op-Per influenced by IT-Impl may be mitigated by high Inf-Int.

5.1. Theoretical Implications

Three vital theoretical implications are provided by this study. First, according to Eisenhardt and Martin [90], DRBV traditionally underscores the importance of dynamic capabilities in obtaining and maintaining competitive advantage. It posits that firms need to continually develop, accumulate, and combine distinct resources and capabilities to adapt to the changing business environment. Previous studies often focused on the direct impact of IT on performance outcomes, neglecting the intricate pathways and intermediary processes [91–97]. This study contributes to a more nuanced comprehension of the dynamic capabilities involved in the transformation of IT resources into sustained competitive advantage.

Second, in extending the DRBV, the study emphasizes the crucial role of SC capabilities and internal operating capabilities in translating IT resources into competitive advantages. The factors that affect Op-Per in practice are not limited to one level; rather, they are the consequence of a confluence of various influences, including the firm's SC and internal operating capabilities.

Third, SC-Int, representing a critical SC capability, involves close collaboration and decision-making among SC partners [98]. This capability emerges as essential components in the dynamic capability's framework, highlighting their significance in managing SC risks and uncertainties. From another perspective, the inclusion of internal operating capabilities (particularly Post-P) in the DRBV framework provides a richer theoretical perspective. This recognizes the importance of internal efficiencies in achieving competitive advantage. The introduction of Post-P as an internal operating capability and recognition of its association with improved process efficiency aligns with the dynamic nature of RBV. At the same time, it contributes to the literature on internal capabilities, shedding light on how firms strategically manage their internal processes to enhance Op-Per.

5.2. Practical Implications

This study provides three main practical insights that can guide organizations in strategically leveraging IT for improved Op-Per. The insights gained from this study have direct applications in SCM, technology adoption, and the development of organizational capabilities in manufacturers in the USA.

First, one of the primary practical implications revolves around the strategic importance of implementing advanced IT. The study reveals that IT is a dynamic (and not a static) resource, which can evolve into capabilities impacting both relational and informational aspects of the SC. Therefore, executives and decision-makers should prioritize investments in IT infrastructure that goes beyond basic automation and integrates seamlessly with SC partners for effective coordination.

Second, the research introduces Post-P as an internal operating capability positively associated with improved process efficiency. Practitioners should recognize the strategic value of Post-P in enhancing Op-Per by structuring internal processes to allow for delayed activities until the latest possible point in time, enabling customization based on specific demand attributes. Such agility in SC operations is crucial in industries where quick responses to market dynamics and changing customer preferences are paramount, ensuring a competitive edge in the market.

Third, the concept of Inf-Int was initially considered as a potential moderating factor, aiming to highlight the significance of context in the effectiveness of IT implementation. However, after analyzing the data, it was found that Inf-Int was a significant negative moderator in the relationships studied. It is possible that firms with high Inf-Int would find it difficult to derive useful insights from the SC as a result of data overload. Effective decision-making and operational efficiency may be hindered by high Inf-Int, which frequently results in more complexity in the management and integration of data across systems. The overall impact of IT on performance may be diminished if high Inf-Int diverts resources away from other crucial operational areas.

5.3. Limitations and Future Research Directions

First, this study's focus on retail manufacturers in the USA narrowed its applicability to a broader context due to the diverse industrial landscape and the differences in operational practices and IT-Impl influence across different sectors. This is because the dynamics of SCs in industries such as technology, healthcare, or services may significantly differ from those in retail manufacturing. Furthermore, regional contexts and market structures introduce additional layers of complexity, as operational challenges and priorities can vary widely. In the future, researchers should aim for a more diverse sample, including companies from various industries and geographical locations.

Second, the study was also limited by its cross-sectional design, which collected data from multiple participants at a single point in time. This approach did not establish cause-and-effect relationships, providing a more comprehensive understanding of how and whether these effects persist or change over an extended period. Future studies should consider adopting a longitudinal approach to examine causal relationships over time.

Third, this study was susceptible to measurement issues with potential subjectivity and variations in respondents' interpretations of survey items. Respondents may have interpreted survey items differently, leading to variations in responses that may not have been fully captured by the measurement tools selected by the researcher. Future research could supplement the survey by using focus groups or interviews as additional data collection techniques. This can help confirm interpretations and offer additional context to help understand how survey respondents are perceiving the questions. This would provide a more comprehensive understanding while minimizing response bias associated with self-reported data, thus improving the credibility of the findings.

6. Conclusions

This research examined the impact of IT-Impl on Op-Per mediated by the serial mediators SC-Int and Post-P, and the moderator Inf-Int. Firms that leverage IT effectively achieve improved Op-Per by enhancing SC-Int and enabling Post-P strategies. This is the case because IT-Impl facilitates SC-Int by enabling seamless communication and collaboration among SC partners. This enhanced integration allows for better coordination of production processes and inventory management, leading to improved operational efficiency. At the same time SC-Int, facilitated by IT, sets the stage for the implementation of Post-P strategies. By aligning production processes and sharing real-time information with SC stakeholders such as suppliers and distributors, companies can delay the final customization or configuration of products until specific customer orders are received. This Post-P strategy in turn enables these companies to optimize inventory management and minimize the risk of overproduction or stockouts, thereby enhancing operational efficiency. This positive impact could be reduced due to high information loads which leads to increased complexity in data integration and administration across systems.

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