SUPPLY CHAIN OPERATIONS RISK MANAGEMENT, RESILIENCE, AND INFORMATION TECHNOLOGY INTEGRATION ON OPERATIONS PERFORMANCE: DOES DEMAND FORECASTING MATTERS

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Research Paper

Abstract: The research aimed to evaluate the impact of supply chain risk management, supply chain resilience, and information technology integration on operational performance, with a moderating effect of demand forecasting in Saudi Arabian pharmaceutical companies. Data were collected via a self-administered survey questionnaire from 310 employees of pharmaceutical companies using a convenience sampling technique. The researchers employed a quantitative research approach, a cross-sectional research design, and Partial Least Squares (PLS)-Structural Equation Modelling (SEM) to test the study's hypotheses. The results indicated that supply chain risk management, supply chain resilience, and information technology integration have a positive and significant impact on operational performance. Furthermore, the moderating effect of demand forecasting was found to be significant, demonstrating that it enhances the relationship between supply chain risk management practices, supply chain resilience, information technology integration, and operational performance. This study significantly contributes to the existing literature by highlighting the importance of demand forecasting in improving operational performance. Additionally, it provides valuable insights for managers and policymakers, emphasizing that competence in demand forecasting management is crucial for enhancing operational performance.

Keywords: Supply Chain Risk Management, Information Technology Integration, Operations Performance, Saudi Arabia

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Supply Chain Operations Risk Management, Resilience, and Information Technology Integration on Operations Performance: Does Demand Forecasting Matters

1. Introduction

In the contemporary industrial environment, operational performance is a paramount concern crucial to the success and competitiveness of companies (Waqas et al., 2023). It encompasses various metrics such as productivity, cost efficiency, and customer satisfaction, all of which are pivotal for organizational effectiveness (Frederico et al., 2021). Given today's dynamic business landscape, organizations face increasing pressures to optimize their operations in response to shifting market demands while also navigating risks and uncertainties. Consequently, identifying the factors influencing operational performance and implementing effective strategies to enhance it have become essential priorities for businesses striving to achieve sustainable growth and competitive advantage (Shevchenko et al., 2022).

Several indicators influence operational performance, with supply chain risk management (SCRM), supply chain resilience (SCR), and information technology infrastructure (ITI) standing out as critical factors for enhancing operations performance (OP) (Fernando et al., 2023; Gu et al., 2023; Lee et al., 2024). The aforementioned indicators are crucial factors in enhancing OP. Hence, SCRM plays a vital role in improving OP by identifying, assessing, and mitigating risks within the supply chain network (Bilişik, 2021; DuHadway et al., 2019). Effective SCRM strategies enable firms to manage various challenges and minimize adverse impacts on business continuity (Monroe et al., 2014; Musa, 2012). Similarly, SCR has emerged as a critical capability for organizations aiming to enhance OP amidst uncertainties and disruptions (Ponomarov & Holcomb, 2009; Shishodia et al., 2023). SCR refers to the ability of supply chains to swiftly recover and adapt to unforeseen disruptions while maintaining continuous operations and meeting customer demands (Ponomarov & Holcomb, 2009). By fostering resilient supply chains, organizations can mitigate disruption impacts, reduce downtime, and sustain OP under adverse conditions (Azmat et al., 2022). This resilience empowers firms to maintain competitive advantage by effectively navigating uncertainties and upholding customer satisfaction levels even in turbulent environments. Similarly, ITI facilitates real-time data sharing within companies, enhancing operational visibility and decision-making capabilities (Al-Nuaimi et al., 2017). Integrating IT solutions within organizations streamlines processes, optimizes inventory levels, and enhances responsiveness to customer demands, thereby improving OP (Abdallah & Ayoub, 2020).

Significantly, competencies in demand forecasting management (FMC) play a crucial role in enhancing SCRM, SCR, and ITI to bolster organizational OP. Effective forecasting enables organizations to anticipate demand fluctuations and potential disruptions, aiding in the identification and mitigation of various supply chain strategies (Gurtu & Johny, 2021; Scholten & Fynes, 2017). Furthermore, precise forecasting enhances supply chain responsiveness and adaptability, empowering organizations to proactively address vulnerabilities and strengthen resilience against disruptions (Manhart et al., 2020). Moreover, FMC is vital for optimizing the utilization of IT solutions by providing reliable data inputs and enhancing the accuracy of predictive analytics, thereby improving OP (Ivanov et al., 2021). Given its pivotal role, FMC emerges as a critical factor influencing the potential positive impact of SCRM, SCR, and ITI on OP. Therefore, this study explores the moderating effect of FMC among SCRM, SCR, ITI, and OP.

Several studies have examined the relationships among SCRM, SCR, ITI, FMC, and OP, revealing some significant gaps. For instance, (Fagundes et al., 2020; Fernando et al., 2023; Waqas et al., 2023) investigated the direct impact of SCRM on OP, finding a positive and significant relationship between SCRM practices and OP. Similarly, Piprani et al. (2020), along with Gu et al. (2023), explored the direct impact of SCR on OP, indicating that higher levels of SCR are associated with improved OP. Additionally, Marchiori et al. (2022) and Lee et al. (2023) studied the direct effect of ITI on OP, revealing a positive and significant association, suggesting that effective IT integration enhances operational efficiency and decision-making capabilities. Furthermore, numerous studies have also highlighted the direct impact of FMC on OP, demonstrating its significant role (Dai et al., 2023; Tadayonrad & Ndiaye, 2023).

Despite these direct effects, empirical research has reported inconsistent findings regarding their impact on operations performance (Gurtu & Johny, 2021; Luftman et al., 2017; Pagell & Shevchenko, 2014). These discrepancies may stem from variations in industry contexts, methodological approaches, and operational definitions across studies. Moreover, the dynamic nature of supply chain environments, alongside contextual factors such as organizational culture and market dynamics, can further contribute to divergent research outcomes. Previous studies have suggested that when such inconsistencies arise, it may indicate the presence of moderating variables (Baron & Kenny, 1986). Therefore, there is a pressing need for additional empirical research to clarify the relationships between SCRM, SCR, ITI, and OP, as well as to identify potential moderators that could influence these relationships in diverse contexts.

Furthermore, previous studies have predominantly focused on countries other than Saudi Arabia (Fernando et al., 2023; Gu et al., 2023; Waqas et al., 2023), thereby limiting attention on this region. Addressing these gaps in the literature, this study concentrates on Saudi Arabian pharmaceutical companies to examine the moderating effect of FMC on the relationships between SCRM, SCR, ITI, and OP. This specific objective aims to provide comprehensive insights into the factors influencing OP and offers valuable guidance for organizational decision-making to enhance OP.

The significance of exploring the moderating effect of FMC among SCRM, SCR, ITI, and OP in Saudi Arabian pharmaceutical companies is paramount. In the dynamic Saudi Arabian market, pharmaceutical demand fluctuates due to factors like regulatory changes and socio-economic shifts. Understanding how demand forecasting impacts the relationships between these critical variables is essential for strategic decision-making. Therefore, through both direct and indirect moderating effects, this study not only contributes insights into optimizing supply chain operations but also enhances the performance of pharmaceutical companies in Saudi Arabia. Ultimately, these findings offer actionable recommendations for stakeholders to adjust their supply chain strategies, capitalize on market opportunities, and effectively mitigate risks in a continuously evolving business environment. Furthermore, this study can inform Saudi Arabian pharmaceutical company policymakers about the importance of demand forecasting in supply chain dynamics. This understanding could guide strategic policies aimed at optimizing operations, ensuring supply chain resilience, and fostering innovation to effectively meet evolving market demands.

The study was structured into four chapters: literature review, research methods, data analysis and interpretation, and discussion and conclusion.

2. Theoretical and Empirical Literature

2.1 Research Framework Development

The study proposes relationships grounded in various theories. The Resource-Based View (RBV) asserts that a firm's competitive advantage derives from its unique resources and capabilities (Madhani, 2010). In this context, SCRM and SCR are seen as organizational resources enabling firms to recover from disruptions and enhance performance (Ponomarov & Holcomb, 2009). Similarly, the Theory of Constraints (TOC) focuses on identifying and mitigating bottlenecks in the supply chain to improve efficiency and effectiveness (Goldratt, 1990). Integrating IT aligns with TOC principles by enhancing visibility and control over critical supply chain nodes, thereby minimizing disruption impacts and risks (Sutrisno et al., 2023).

Moreover, Contingency Theory suggests that the effectiveness of supply chain practices depends on how well they align with organizational characteristics, environmental factors, and management strategies (Stonebraker & Afifi, 2004). Demand forecasting serves as a moderating variable in this relationship, providing essential information for adapting supply chain strategies to meet evolving market conditions (Fildes et al., 2008).

Based on these theoretical foundations, the research framework depicted in Figure 1 has been formulated.
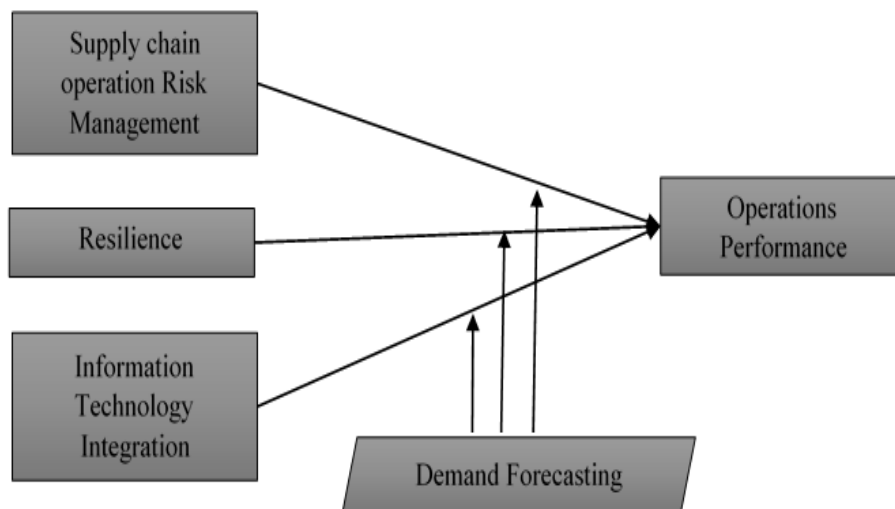

Figure 1: Conceptual Framework

2.2 Hypothesis Development

SCRM serves as a crucial indicator in mitigating risks that can impact OP positively. Integrating SCRM strategies into operations enhances organizational

responsiveness, thereby potentially increasing OP (Chopra et al., 2021). Empirical studies, such as those conducted by (Scheibe & Blackhurst, 2018), have demonstrated that companies with robust SCRM processes experience fewer disruptions and achieve superior OP. Similarly, research by Tang and Musa (2011) showed that effective SCRM practices are linked with improved delivery performance and cost efficiency. Munir et al. (2020) also found a positive and significant impact of SCRM on OP, emphasizing its importance as an indicator for enhancing OP. However, it is noteworthy that the implementation of SCRM can sometimes lead to increased costs without proportionate improvements in OP, as highlighted by (Scholten & Fynes, 2017). Despite this, further studies continue to affirm the positive and significant impact of SCRM on OP (Fernando et al., 2023). Therefore, based on these findings, the study formulates the following research hypotheses,

H1: *Operations performance significantly affected by supply chain operations risk management.*

SCR is another crucial indicator for enhancing OP. Resilience enables organizations to recover quickly from disruptions, essential for maintaining OP in dynamic environments (Akhavan et al., 2021). Companies with SCR can effectively adapt to unforeseen challenges and sustain consistent performance levels. Empirical evidence supports this notion, with studies indicating a positive and significant impact of SCR on OP. For instance, Pettit et al. (2019) found that companies with robust SCR capabilities significantly improve OP. Similarly, Zhou et al. (2024) demonstrated that organizations with higher SCR levels exhibit better OP. Further research has corroborated these findings, suggesting that SCR's resilience impact may vary across different contexts, including studies conducted in other countries (Ambulkar et al., 2023). However, it's important to note that while SCR strategies effectively mitigate disruptions, they may also incur additional costs that could offset some of the performance gains (Ambulkar et al., 2023). Despite this, ongoing research continues to affirm the positive and significant impact of SCR on OP (Gu et al., 2023). Given these insights, the study formulates the following research hypotheses,

H2: *Operations performance significantly affected by Resilience.*

ITI is crucial for improving OP by enhancing communication and coordination across supply chain partners (Ganbold et al., 2020). It facilitates process automation and data-driven decision-making, leading to higher OP (Liu et al., 2022). Empirical studies consistently demonstrate the positive and significant impact of ITI on OP. For instance, Zhu et al. (2018) found that effective IT integration enhances operational efficiency and flexibility. Similarly, Maleki Far et al. (2017) showed that ITI investments improve supply chain responsiveness and customer service. Despite potential initial disruptions, complex ITI systems contribute positively to OP (Watera et al., 2023). Focus on IT infrastructure enhances organizational effectiveness, thereby boosting performance (Chatha et al., 2024). Thus, the study formulates the following research hypothesis,

H3: *Operations performance significantly affected by information technology integration.*

Supply Chain Operations Risk Management, Resilience, and Information Technology Integration on Operations Performance: Does Demand Forecasting Matters

Previous research has highlighted inconsistencies in the relationship between SCRM, SCR, ITI, and OP. Baron and Kenny (1986) argued that when studies yield inconsistent findings, the introduction of a moderating variable between independent and dependent variables becomes necessary. Demand forecasting has been explored as a potential moderating variable in various studies (Bai, 2023; Çetindaş et al., 2023). Effective demand forecasting management (FMC) is posited as a potential moderating variable because it enhances SCRM practices' capability to mitigate disruptions and improve OP (Browning et al., 2023). Accurate and reliable forecasting supports proactive risk identification, thereby bolstering the efficacy of risk management strategies (Aghapour et al., 2017; Brau et al., 2023). However, the relationship between FMC and SCRM effectiveness is not always straightforward. For instance, Joel et al. (2024) found that while effective forecasting improved demand prediction accuracy, it did not consistently translate into improved risk management or operational performance outcomes. Similarly, Munir et al. (2020) observed that forecasting errors could exacerbate supply chain disruptions if not aligned with SCRM practices. Despite these challenges, Fernando et al. (2023) identified a positive and significant impact of SCRM on OP, suggesting potential variability in this relationship across different contexts.

Therefore, based on these insights, the following research hypotheses are proposed,

H4: *Operations performance significantly affected by supply chain operations risk management with moderating effect of forecasting management competence.*

Conversely, FMC is suggested to enhance SCR capabilities and thereby improve OP. Accurate forecasting allows organizations to proactively identify potential risks and develop contingency plans, bolstering their supply chain resilience (Ivanov et al., 2018). While it is expected that FMC strengthens the relationship between SCR and OP, empirical research specifically exploring this interaction remains limited. However, Scholten and Stevenson (2024) suggest that the effectiveness of SCR strategies may vary depending on the accuracy and reliability of forecasting processes. Further investigation is necessary to elucidate the moderating role of FMC in the relationship between SCR and OP. Additionally, Gu et al. (2023) identified a significant relationship between SCR and OP, suggesting that this relationship warrants further exploration in different contexts. Therefore, the following hypothesis is proposed,

H5: *Operations performance significantly affected by Resilience with moderating effect of forecasting management competence.*

Conversely, FMC also contributes to enhancing ITI to improve companies' OP by facilitating better decision-making and agility in response to market dynamics (Ganbold et al., 2020). Accurate FMC enhances the reliability and relevance of data generated through IT systems, thereby maximizing the operational benefits derived from ITI in the supply chain (Marodin et al., 2023). Moreover, FMC is expected to amplify the impact of IT integration on OP, although empirical evidence specific to this interaction remains limited. However, studies by Melville et al. (2004) and Liu et al. (2022) suggest that organizations with robust forecasting capabilities may experience greater OP improvements from their investments in IT integration. Further research is essential to delve into the moderating role of FMC in the

relationship between IT integration and operational performance. Therefore, the following hypothesis is proposed,

H6: *Operations performance significantly affected by information technology integration with moderating effect of forecasting management competence.*

3. Research Design

The research aimed to investigate the impact of supply chain risk management, supply chain resilience, and information technology resilience on operations performance, with a focus on the moderating effect of demand forecasting management competence within Saudi Arabia's pharmaceutical companies. The study adopted a quantitative research approach, employing a self-administered questionnaire for data collection through a survey instrument. The cross-sectional research design was chosen to facilitate the simultaneous collection of data from multiple respondents, allowing for the exploration of relationships and trends at a specific point in time (Sardana et al., 2023; Wang & Cheng, 2020). This method ensured standardized responses, thereby enhancing the reliability and generalizability of the findings.

3.1 Survey Instrument

The survey instrument utilized in this study is derived from validated research sources. Operations performance is assessed using a set of 4 items adapted from (Munir et al., 2020), while supply chain risk management also consists of 4 items sourced from the same study. Supply chain resilience, specifically focusing on flexibility, comprises 6 items sourced from (Chowdhury et al., 2019). Information technology integration is evaluated through 7 items based on the work of (Ward & Zhou, 2006). Lastly, demand forecasting is measured using 3 items adapted from (Rexhausen et al., 2012). Responses are recorded on a 5-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly agree." Table 1 provides detailed information on the survey instrument utilized in this study.

Table 1: Construct Items

Variable Name	Number of Items	References
Operations Performance	4	(Munir et al., 2020)
Supply Chain Risk Management	4	(Munir et al., 2020)
Supply Chain Resilience (Flexibility)	6	(Chowdhury et al., 2019)
Informant Technology Integration	7	(Ward & Zhou, 2006)
Demand Forecasting	3	(Rexhausen et al., 2012)

3.2 Data Collection Procedure

The survey instrument, adapted for this study, was administered to 400 employees from pharmaceutical companies using a self-administered approach facilitated by convenient sampling. Convenient sampling was chosen for its practicality and cost-effectiveness, particularly in situations with constraints on time and resources (Berndt, 2020). This method, while potentially introducing sampling bias, was deemed suitable for achieving the study's objectives by securing a sufficiently large sample size within available limitations (Berndt, 2020). Utilizing self-administered questionnaires ensured participant anonymity and promoted

candid responses, thereby enhancing data reliability. Consequently, 310 completed questionnaires were returned, resulting in a response rate of 77.5%, which is considered substantial and recommended in research methodology (Wu et al., 2022).

4. Data Analysis

The collected data were subjected to analysis from both descriptive and inferential statistics perspectives. Descriptive statistics and preliminary screening tests were performed using SPSS, while inferential analyses were conducted using Smart PLS, with interpretations presented below.

4.1 Descriptive Statistics

Table 2 presents descriptive statistics including measures of central tendency, variability, and range. SCRM shows a mean score of 3.75 and a standard deviation of 0.82, indicating a moderate level of perceived risk management across respondents with some variability. SCR exhibits a higher mean of 4.21, suggesting a generally positive perception of resilience within the supply chain. ITI reports a mean score of 3.05, indicating opportunities for improvement in integrating technology within supply chain processes. FMC and OP have mean scores of 3.91 and 3.41, respectively, indicating satisfactory levels with potential for further enhancement.

Table 2: Descriptive Statistics Results

Variable Name	Average	SD	Min	Max
SCRM	3.75	0.82	1	5
SCR	4.21	0.95	1	5
ITI	3.05	0.91	1	5
FMC	3.91	0.75	1	5
OP	3.41	0.81	1	5

Note: SCRM-Supply Chain Risk Management, OP-Operations Performance, SCR-Supply Chain Resilience, ITI-Information Technology Integration, FMC- Demand Forecasting Competencies

4.2 Convergent Validity

Table 3: Convergent Validity

Construct	Alpha	Composite Reliability	AVE
SCRM	0.871	0.890	0.651
SCR	0.822	0.842	0.631
ITI	0.891	0.912	0.732
FMC	0.822	0.831	0.621
OP	0.911	0.922	0.751

Convergent validity is crucial in establishing the reliability and robustness of measurement models, assessed through criteria such as average variance extracted (AVE), Cronbach's alpha, composite reliability, and factor loadings. High factor loadings indicate strong relationships between indicators and their respective constructs, thereby demonstrating convergent validity in measurement models (Hair et al., 2017). Cronbach's alpha evaluates internal consistency reliability, with values above 0.7 considered acceptable (Hair et al., 2017). Similarly, composite reliability, which measures the extent to which indicators reflect a single construct, should ideally exceed 0.7 (Fornell & Larcker, 1981). Additionally, AVE indicates the

proportion of variance captured by the construct relative to measurement error, and values exceeding 0.5 are indicative of satisfactory convergent validity (Fornell & Larcker, 1981). Table 3 illustrates that all criteria for convergent validity are met across the constructs.
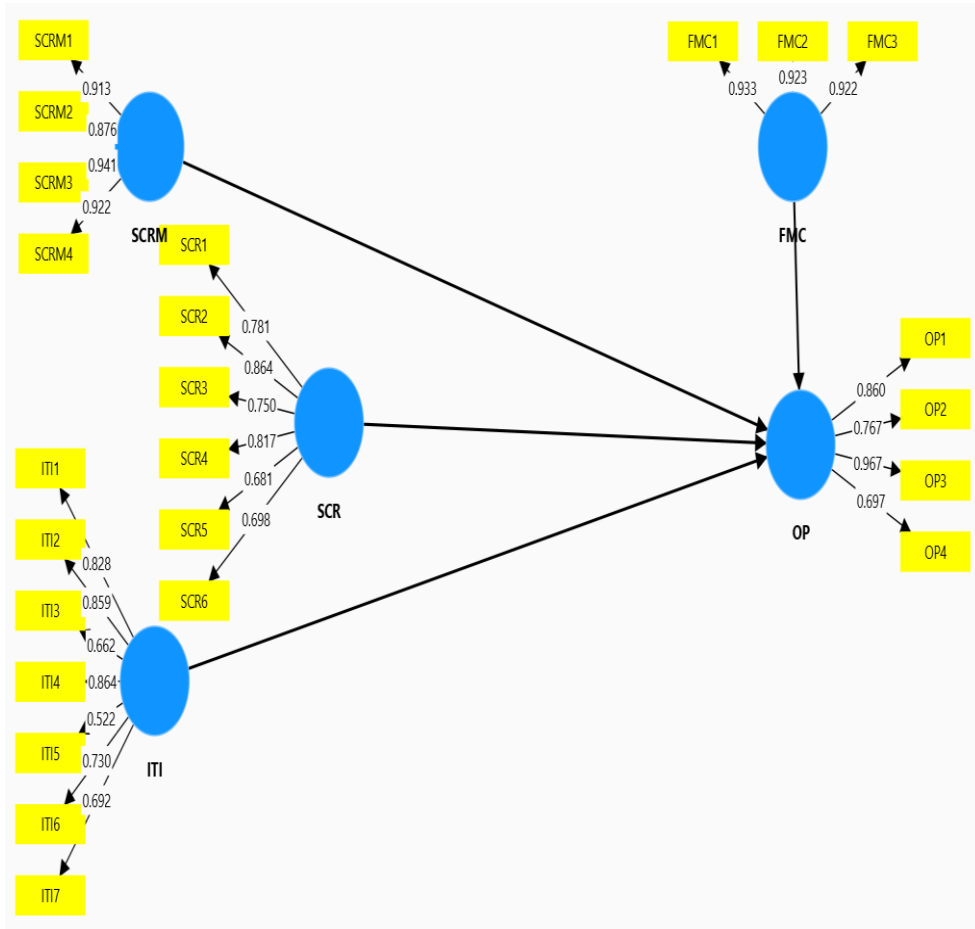

Figure 2: Factor Loadings

4.3 Discriminant Validity

Discriminant validity ensures that each construct in a study measures distinct concepts, as assessed through Fornell and Larcker's criterion, cross-loadings, and the Heterotrait-Monotrait (HTMT) ratio. According to Fornell and Larcker (1981), discriminant validity is confirmed if the square root of the AVE for each construct exceeds its correlations with other constructs. Cross-loadings, which examine how indicators load on their respective constructs, provide further insights into discriminant validity. High cross-loadings, where indicators load strongly on multiple constructs, may indicate potential issues with construct specificity (Henseler et al., 2015). HTMT ratios compare the average correlations between constructs to the correlations within constructs, with lower ratios (below 0.85) indicating satisfactory discriminant validity. This suggests that constructs correlate

more strongly with their own indicators than with indicators from other constructs (Henseler et al., 2015).

In this study, applying the Fornell and Larcker criterion confirms satisfactory discriminant validity, as indicated by the diagonal elements in Table 4 showing that the square roots of AVEs are greater than the correlations with other constructs. This supports the notion that each construct captures unique variance distinct from other constructs, thereby validating their discriminant validity (Fornell & Larcker, 1981).

Table 4: Discriminant Validity

Construct	VIF	SCRM	SCR	ITI	FMC	OP
SCRM	1.21	0.806				
SCR	2.32	0.323	0.794			
ITI	1.89	0.401	0.288	0.855		
FMC	1.23	0.346	0.265	0.246	0.788	
OP	…….	0.393	0.313	0.348	0.274	0.867

4.4 Hypothesis Testing

The next step involves testing the study hypotheses through the structural model assessed via the measurement model. The hypotheses were tested using the SEM technique with 5000 resampling iterations. The results from PLS-SEM indicate a statistically significant positive influence of SCRM on OP. Specifically, a significant positive beta coefficient (β = 0.654) suggests that effective SCRM strategies enhance OP in Saudi Arabia's pharmaceutical companies. These findings underscore that as SCRM practices improve, OP also increases. Similarly, SCR demonstrates a positive and significant impact on OP (β = 0.421). These results underscore the importance of cultivating resilience within Saudi Arabia's pharmaceutical sector. Likewise, ITI shows a positive and significant impact on OP (β = 0.312). This significant relationship highlights the crucial role of technology in boosting efficiency and effectiveness within the pharmaceutical supply chains of Saudi Arabia.

The additional results reveal significant moderating effects of demand FMC on the relationships between various constructs in the study. Firstly, FMC shows a significant moderating effect between SCRM and OP, with a notable interaction effect (β = 0.587). This finding suggests that in Saudi Arabia's pharmaceutical companies, effective SCRM practices combined with strong forecasting capabilities lead to enhanced operational performance by enabling proactive risk identification and mitigation.

Secondly, FMC demonstrates a significant moderating effect between SCR and OP, with an interaction effect (β = 0.498). This highlights that when supply chain resilience strategies are bolstered by accurate demand forecasting, they contribute more positively to operational performance. This underscores the importance of aligning resilience strategies with precise forecasting to optimize performance outcomes.

Lastly, FMC also exhibits a significant moderating effect between ITI and OP, showing an interaction effect (β = 0.543). This indicates that in the context of Saudi Arabia's pharmaceutical supply chains, the benefits derived from IT integration are enhanced when supported by robust forecasting capabilities, thereby improving operational performance. These findings are detailed in Table 5, illustrating the

moderated relationships facilitated by demand forecasting management competence across SCRM, SCR, ITI, and OP in the study.

Table 5: Hypothesis Results

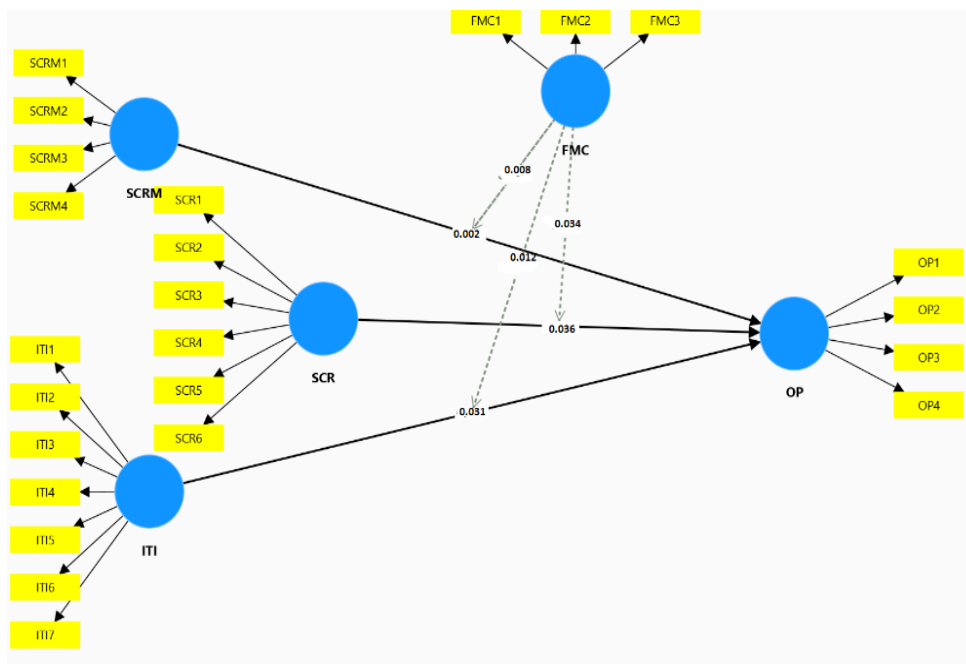| Hypothesis	Beta (β)	T-Value	P-Value	Result	R Square
SCRM->OP	0.654	3.245	0.002	Significant	
SCR->OP	0.421	2.108	0.036	Significant	
ITI->OP	0.312	2.564	0.031	Significant	38%
SCRM*FMC->OP	0.587	2.935	0.008	Significant	
SCR*FMC ->OP	0.498	2.991	0.034	Significant	
ITI*FMC ->OP	0.543	2.721	0.012	Significant	45%

Figure 3: Significant Values

5. Discussion

In the contemporary global business environment, OP is crucial for reducing costs effectively and meeting market demands. Various factors contribute to improving OP, with SCRM mitigating disruptions and thereby enhancing OP. SCR increases adaptability to unforeseen challenges, further boosting OP. ITI plays a pivotal role by improving OP through efficient data management, process automation, and real-time decision-making capabilities. Similarly, demand FMC aligns supply chains with market needs, enhancing SCRM, SCR, and ITI by providing proactive insights. Integration of these strategies optimizes operations, increases efficiency, and enhances responsiveness in pharmaceutical operations.

The study aimed to empirically examine the impact of SCRM, SCR, and ITI on operational performance in the pharmaceutical industry of Saudi Arabia. Additionally, the study tested the moderating effect of FMC among SCRM, SCR, ITI,

and OP. Data were collected from employees within the pharmaceutical industry to achieve these objectives. The study proposed six hypotheses, all of which were supported by the findings indicating significant positive direct effects of SCRM, SCR, and ITI on OP. Moreover, the indirect moderating effect of FMC also positively and significantly influenced the relationships between SCR, SCRM, ITI, and OP.

The study's hypotheses individually confirm that SCRM significantly enhances OP within Saudi Arabia's pharmaceutical industry. These findings underscore the critical role of proactive risk mitigation strategies in pharmaceutical supply chains, emphasizing how effective risk management contributes to overall operational excellence. By mitigating disruptions and enhancing resilience, SCRM enables pharmaceutical firms to uphold robust operational efficiencies, ensuring consistent supply and meeting market demands amidst uncertainties. These results align with previous research by Al-Rawashdeh et al. (2023) and Munir et al. (2020), highlighting the benefits of strong SCRM processes in reducing disruptions and improving operational efficiency. Therefore, these findings advocate increased investment in SCRM within Saudi Arabia's pharmaceutical industry to safeguard against disruptions and ensure continuous product availability.

Similarly, SCR also significantly enhances operational performance within Saudi Arabia's pharmaceutical companies. These findings indicate a strong focus on SCR to bolster OP, underscoring its role in ensuring operational continuity and responsiveness in challenging environments. Given the logistical complexities in Saudi Arabia, SCR helps firms maintain consistent supply, adhere to regulatory requirements, and capitalize on market opportunities, thereby enhancing OP. This assertion is supported by research from Gu et al. (2023) and Hamidu et al. (2023), which emphasize resilience as crucial for sustaining performance amid varying operational challenges in pharmaceutical contexts. Therefore, these findings illustrate that SCR is a crucial factor in enhancing OP and thereby increasing competitive advantage for organizations. Consequently, these results underscore the importance for the pharmaceutical industry in Saudi Arabia to strengthen their SCR by enhancing collaboration with suppliers and implementing robust supply chain practices to effectively respond to market dynamics.

Furthermore, ITI also demonstrates a significant and positive impact on the OP of pharmaceutical companies in Saudi Arabia. This relationship underscores the transformative potential of technology within the pharmaceutical supply chain. Therefore, these findings suggest that establishing effective IT systems for inventory management and process automation enhances efficiency and responsiveness to market demands. Such integration is essential for navigating the complexities of the pharmaceutical sector in Saudi Arabia and sustaining OP in a dynamic business environment. These results and arguments are consistent with previous studies by Zhu et al. (2018) and Marodin et al. (2023), which emphasize the critical role of ITI in enhancing OP through real-time monitoring and coordination. Consequently, it is recommended that Saudi Arabian pharmaceutical companies prioritize leveraging technology to improve efficiency and overall performance. The moderating effect results among SCRM, SCR, ITI, and OP were positive and significant in Saudi Arabian pharmaceutical companies. Specifically, FMC showed a positive and significant moderating effect between SCRM and OP, indicating that amidst uncertain and dynamic markets, Saudi pharmaceutical firms benefit from robust demand

forecasting capabilities, enhancing SCR and ultimately improving OP. These findings align with studies such as (Browning et al., 2023; Joel et al., 2024), emphasizing how effective FMC supports operations by mitigating regulatory impacts and enhancing operational resilience. In Saudi Arabia's pharmaceutical sector, characterized by diverse market dynamics and regulatory changes, accurate demand forecasting enables companies to efficiently anticipate and meet customer needs, thereby reducing costs, minimizing stockouts, and optimizing production planning. This strategic use of demand forecasting not only enhances operational efficiency but also bolsters overall business sustainability and competitiveness. This underscores the pivotal role of predictive analytics and data-driven decision-making in enhancing operational excellence within the sector. Hence, it is advisable for pharmaceutical companies in Saudi Arabia to prioritize effective demand forecasting management to bolster operational performance and sustain their competitive edge.

Furthermore, the relationship between SCR and OP performance is significantly and positively moderated by FMC in Saudi Arabian pharmaceutical companies. These results highlight the importance of aligning SCR strategies with accurate demand forecasting to enhance OP, as it enables firms to anticipate losses more effectively. The effectiveness of SCR strategies, however, depends on accurately predicting demand fluctuations (Joel et al., 2024). Therefore, precise FMC allows firms to proactively adjust production, inventory, and distribution processes in response to evolving market dynamics, thereby enhancing the adaptive capacity of their supply chains. This proactive approach not only mitigates disruptions but also improves operational performance by minimizing stock outs, reducing excess inventory, and optimizing resource utilization to efficiently meet customer demand. These findings and arguments are further supported by previous research (Abaku et al., 2024), which also underscored the role of SCR in mitigating disruptions and enhancing OP. Lastly, ITI also significantly affects OP with FMC acting as an important moderating factor between ITI and OP in the Saudi Arabian pharmaceutical industry. These findings demonstrate that FMC plays a crucial role as a moderating variable, enhancing the efficacy of SCR, SCRM, and ITI strategies to increase overall OP in dynamic industries such as pharmaceuticals. With the rapid digitization and adoption of IT solutions in the region, supply chain processes are increasingly interconnected and data-driven, thereby improving OP. Integrating accurate demand forecasting practices with ITI enhances supply chain visibility and operational agility in Saudi Arabian pharmaceutical companies, aligning with research emphasizing the importance of demand forecasting for operational improvement in ITI (Mir et al., 2020).

6. Implications

The study provides theoretical and practical implications based on its findings. Theoretical contributions include significant insights into the relationships among SCRM, SCR, ITI, and FMC with OP in the Saudi Arabian pharmaceutical sector. By demonstrating the significant and positive impacts of SCR, SCRM, and ITI on OP, this study enriches existing literature. Previous research predominantly focused on the individual impacts of these factors on OP, whereas this study integrates them to present a more comprehensive framework, thus advancing current knowledge. Moreover, by uncovering the moderating effects of FMC on the relationships

between various supply chain factors and OP, the study enhances theoretical understanding of their interactions and influence on organizational outcomes. This deeper insight contributes to evolving theoretical frameworks in supply chain management, offering a more holistic view on optimizing OP in dynamic environments. Furthermore, the study adds to the literature on Saudi Arabian pharmaceutical companies, a context with limited prior research compared to other regions, thus pioneering new insights specific to this industry and geographical context.

Practically, the study offers several contributions for pharmaceutical companies operating in Saudi Arabia and beyond. The significant positive impacts of SCRM, SCR, and ITI on OP underscore the importance of investing in these areas to improve operational performance. Pharmaceutical firms can use these findings to prioritize investments in strategies for mitigating risks, enhancing resilience, and integrating information technologies to optimize their supply chain operations. Moreover, understanding the moderating effect of FMC highlights the crucial role of accurate forecasting in enhancing the efficacy of supply chain practices. Companies can focus on developing robust forecasting models, investing in advanced analytics capabilities, and fostering cross-functional collaboration to improve forecasting accuracy and achieve operational excellence. Furthermore, the study's findings hold implications for policymakers in Saudi Arabia's pharmaceutical sector. They underscore the importance of promoting infrastructure investments, incentivizing technology adoption, and supporting educational initiatives aimed at enhancing data analytics capabilities. These efforts can bolster competitiveness and ensure sustainable economic growth amidst global challenges.

7. Conclusion

The research aimed to empirically assess the impact of SCRM, SCR, and ITI on OP within Saudi Arabia's pharmaceutical industry. Additionally, the study investigated the moderating role of demand FMC among SCRM, SCR, ITI, and OP. Data were collected from employees within the pharmaceutical sector to achieve these objectives. The findings indicate that SCRM, SCR, and ITI significantly and positively influence OP in Saudi Arabia's pharmaceutical industry. Furthermore, FMC was found to positively and significantly moderate the relationships among SCR, SCRM, ITI, and OP. These results underscore the critical role of well-organized SCRM, SCR strategies, ITI, and effective FMC in enhancing OP in this sector. By leveraging these synergies, companies can enhance their ability to navigate uncertainties, mitigate risks, and capitalize on opportunities, thereby fostering sustainable growth in the dynamic healthcare market. Moreover, proactive implementation of SCRM, SCR, ITI, and improved FMC is recommended to enhance OP in Saudi Arabia's pharmaceutical firms. These findings also provide insights for policymakers to invest in robust demand forecasting infrastructure, which can significantly enhance operational efficiency in pharmaceutical companies. Therefore, focusing on effective demand forecasting strategies is crucial for enhancing operational efficiency in the pharmaceutical sector of Saudi Arabia. Addressing these research limitations in future studies could further enhance the reliability of research in this field.

8. Limitations and Future Directions

The research, despite its significant findings, presents several limitations that could enhance the reliability of future studies. Firstly, the reliance on a cross-sectional research design restricts the ability to establish causal relationships among variables. Future research could employ longitudinal or experimental designs to better analyse how supply chain management practices, resilience strategies, and technology integration causally impact operations performance over time. Secondly, while the study examines the moderating effect of demand forecasting, it may overlook other potential mediating variables. Future research could explore the mediating effects of organizational culture and corporate social responsibility to provide a more comprehensive understanding of these relationships within the pharmaceutical industry. Thirdly, the study's focus solely on the pharmaceutical industry in Saudi Arabia limits its generalizability. Future research could conduct comparative studies across multiple countries using multi-group analysis to enhance generalizability. Lastly, the study's restriction to a quantitative research approach leaves out potential insights that could be gained from a mixed-methods approach. Future research could incorporate mixed methods to triangulate findings and provide deeper insights into the studied phenomena.

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Supply Chain Operations Risk Management, Resilience, and Information Technology Integration on Operations Performance: Does Demand Forecasting Matters

Appendix: Survey Instrument

Supply Chain Resilience	1. Production flexibility allows rapid adjustments to manufacturing processes.
	2. Customization tailors products to individual customer needs.
	3. A multi-skilled workforce adapts to diverse job requirements.
	4. Contract flexibility permits adjustments to agreements as needed.
	5. Sourcing flexibility diversifies supply sources to mitigate risks.
	6. Distribution flexibility optimizes logistics for timely deliveries
Supply Chain Risk Management	
	1. Preventing operations risk (e.g. select a more reliable supplier, use clear safety procedures, preventive maintenance)
	2. Detecting operations risks (e.g. internal or supplier monitoring, inspection, tracking)
	3. Responding to operations risks (e.g. backup suppliers, extra capacity, alternative transportation modes)
	4. Recovering from operations risks (e.g. task forces, contingency plans, clear responsibility)
Operational Performance	
	1. Quality Performance
	2. Flexibility Performance
	3. Delivery Performance
	4. Customer Service Performance
Information Technology Integration	
	1. The company has more Advanced MRP
	2. The company has effective Advanced Planning and Scheduling
	3. The company has good ERP System
	4. The company has latest Computerized Integrated Manufacturing
Demand Forecasting	
	1. The company has Clear-cut forecasting process
	2. The company has Regular measurement and modification
	3. The company has monitoring and acting upon accuracy