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Linking Open Innovation to Supply Chain Flexibility

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Abstract

This study aimed to explore the impact of open innovation, with its dimensions (inbound innovation, outbound innovation, and hybrid innovation), on supply chain flexibility, including supply flexibility, operational flexibility, distribution flexibility, and delivery flexibility. The applied aspect of the study was conducted at Cementra Company in Jordan. The researchers adopted a descriptive quantitative approach to achieve the study objectives. The study used a comprehensive survey of the company's employees via an electronic questionnaire, from which 104 valid questionnaires were returned and subjected to statistical analysis. The descriptive aspect of the study concluded that there are high level of open innovation implementation and high level of supply chain flexibility within the company. There is a significant impact of open innovation on supply chain flexibility, and open innovation significantly affects each dimension of supply chain flexibility. The study recommended continuing to focus on balanced reliance on both inbound and outbound innovation activities, by encouraging employees to present creative ideas and develop them into innovative products and processes, as well as seeking innovative ideas externally. It also recommended enhancing activities that support distribution flexibility by identifying new distribution points to meet the increase in unexpected customer demand.

Keywords: Open Innovation, Supply Chain Flexibility, Cementra Company, Jordan

Introduction

In today's highly dynamic and competitive global markets, the pharmaceutical industry faces unprecedented challenges driven by evolving customer needs, regulatory complexities, globalized supply chains, and technological changes. Supply chain resilience has therefore become an indispensable strategic imperative. Cementra, a major sector contributing to national GDP and regional pharmaceutical exports, is particularly vulnerable to changes due

to its reliance on imported raw materials, its sensitivity to regulatory compliance, and the critical nature of its products. Addressing these challenges requires innovative approaches that enhance the adaptability and responsiveness of supply chains.

Open innovation has emerged as a transformative model that enables organizations to overcome innovation constraints by leveraging external ideas, technologies, and networks alongside internal capabilities. In contrast to closed innovation models, open innovation fosters collaboration with academic institutions, research laboratories, suppliers, and even competitors, accelerating the flow of knowledge and expanding the scope of creative problem-solving. In the construction sector, open innovation has been used to accelerate product development, reduce R&D costs, and promote resilient supply chains. Previous studies have emphasized the potential of open innovation in enhancing operational capabilities such as responsiveness, customization, and supply flexibility—key dimensions of supply chain resilience (Chesbrough & Bogers, 2014; Peng & Ding, 2023).

The link between open innovation and firm performance has been widely recognized, but the mechanisms through which open innovation impacts supply chain resilience, particularly in developing economies, remain unexplored. Although Cementra has demonstrated a strong regional presence, innovation practices and the adoption of artificial intelligence in supply chain management are still in development (Amayreh & ALArabiat, 2025).

Understanding how open innovation contributes to supply chain resilience offers both theoretical and practical value. This study aims to fill this gap by empirically examining the impact of open innovation on supply chain resilience at Cementra. The findings are expected to provide practical insights for industry leaders and policymakers seeking to enhance open innovation-based supply chain resilience in Jordan and similar emerging markets.

Despite the growing importance of open innovation as a driver of competitiveness in the construction sector, there remains a significant gap in understanding its direct impact on supply chain resilience, particularly in emerging markets like Jordan, where Cementra operates in an environment characterized by regulatory constraints, volatile demand, limited local resources, and geopolitical turmoil, making the adaptability of supply chains critical. However, traditional innovation models, which are often closed and inward-focused, fail to provide the flexibility needed to respond to such fluctuations. Studies in advanced economies have revealed the strategic value of open innovation in enhancing operational responsiveness and dynamic capabilities (Peng & Ding, 2023). However, there is a lack of empirical studies examining whether and how open innovation contributes to supply chain resilience in resource-constrained environments. In particular, there is insufficient evidence to assess whether Cementra—despite its prominent regional position—leverages external collaboration and knowledge acquisition to increase supply chain responsiveness and customization. This creates an urgent need to explore whether open innovation practices, such as inbound and outbound knowledge flows, can serve as enablers of supply chain resilience. This knowledge gap is critical in a sector that must balance the speed of innovation with quality control and compliance. Therefore, the lack of robust, context-specific research on how open innovation impacts supply chain resilience at Cementra Jordan is the core problem this study seeks to address. Based on the above, the study problem can be formulated with the following questions:

1. What is the level of interest in open innovation at Cementra?
2. What is the level of supply chain resilience at Cementra?
3. What is the impact of open innovation on supply chain resilience at Cementra?
4. What is the impact of open innovation on supply flexibility at Cementra?
5. What is the impact of open innovation on operational flexibility at Cementra?
6. What is the impact of open innovation on distribution flexibility at Cementra?
7. What is the impact of open innovation on delivery flexibility at Cementra?

Study Objectives

1. Identify the level of interest in open innovation at Cementra.
2. Identify the level and dimensions of supply chain flexibility at Cementra.
3. Identify the impact of open innovation on supply chain flexibility at Cementra.
4. Identify the impact of open innovation on supply flexibility at Cementra.
5. Identify the impact of open innovation on operational flexibility at Cementra.
6. Identify the impact of open innovation on distribution flexibility at Cementra.
7. Identify the impact of open innovation on delivery flexibility at Cementra.

Theoretical Framework

Open Innovation

Innovation is the primary determinant of organizational success. Organizations that do not innovate will decline in performance or even go bankrupt. Innovation adoption refers to the successful exploitation of new ideas. This combines new ideas involving new products, processes, or services, the implementation of the ideas, and success where the innovation is adopted by the market from the organization's perspective regarding increased profitability (Yulianto & Supriono, 2023).

Open innovation reflects a new open mindset for implementing innovation, provided that all potential collaborators within the stakeholder ecosystem are leveraged and willing to contribute. This contribution can be driven by collective effort, co-creation, and collaborative innovation. What truly matters is that innovation processes integrate the insights, knowledge, and creativity of various actors, enriching the innovative concept and making it more relevant for all types of stakeholders to use directly or indirectly once implemented (Khairat et al., 2025).

According to Chesbrough and Bogers (2014), open innovation is a distributed innovation process that involves managing the flow of knowledge across organizations. From this perspective, internal research and development is as important as gathering external knowledge from other sources. However, this approach plays a limited role in shaping the innovations of most organizations.

Open innovation is a concept that challenges the traditional model of innovation, whereby organizations rely solely on their internal capabilities to create new products and services. Open innovation encourages organizations to look beyond their boundaries to collaborate with external partners, such as universities, research institutions, suppliers, and even customers. Through this, organizations can access a broader pool of knowledge, technologies, and markets, ultimately enhancing their capacity to innovate and accelerating the development of new ideas (Khairat et al., 2025).

1. Inbound Innovation: Inbound innovation refers to organizations obtaining information and ideas from sources outside their own organization. By integrating the organization's knowledge with that of suppliers, customers, and external sources, this approach enriches the organization's knowledge base and facilitates the creation of new ideas (Sayed & Abd Rabbo, 2024). Inbound innovation represents a specific approach to innovation that relies on the ideas and assets of external organizations, as well as the ideas of independent researchers and academics, in the product and technology development process. This manifests itself in forms including: co-development with external organizations or companies, licensing, venture capital, and mergers and acquisitions (Song & Kim, 2024).

Organizations seeking to learn more by utilizing ideas and information from external sources such as customers, suppliers, universities, research centers, institutes, external consultants, and competitors can do so by working with customers, utilizing informal networks, conducting university research, working with public R&D associations, hiring external R&D service providers, holding competitions to launch new project ideas and innovative concepts, obtaining intellectual property licenses, and obtaining grants and awards for individual innovators (Aloun and Al-Sabti, 2019).

2. Outbound Innovation: Outbound innovation refers to an organization's practice of exporting internal technology to external entities for commercialization through alternative means. This typically occurs when the internal business model is unable to facilitate the desired commercialization of the organization's proprietary technology (Trabucchi et al. 2018).

External innovation approaches are applied from the inside out, transferring technology from the inside out. Through these processes, business groups seek to maximize their own expertise and technologies by licensing others to exploit the organization's intellectual property rights in exchange for money. Some organizations also establish other businesses that can freely use and promote their own technologies (Sayed and Abd Rabbo, 2024).

Organizations seek to build relationships with external sources to enable them to sell and use the technologies they already possess. This approach is suitable for organizations seeking to generate profits by selling their ideas. These activities include working with external partners on joint ventures, starting joint businesses, licensing intellectual property and selling patents, donating to charities, and splitting or dismantling part of the organization to create a new organization (Aloun and Al-Sabti, 2019).

3. Coupled Innovation: Double innovation refers to organizations using both internal and external innovation approaches. This means that the organization shares internal information with its partners while acquiring knowledge and ideas from the outside world. Double innovation strategies encourage organizations to collaborate with partners with skills that align with their own (Sayed & Abd Rabbo, 2024). Double innovation fosters collaborative partnerships between organizations to jointly develop and commercialize technologies and services with complementary partners, in addition to internal and external innovation (Song & Kim, 2024). The most beneficial aspects of open innovation are reducing risk and maximizing the use of knowledge and expertise. It is important to understand that the

business model determines the organization's operating rules, including which initiatives it chooses and which ones it does not choose (Aloun & Al-Sabti, 2019).

Supply Chain Flexibility

Supply chain resilience is generally viewed as an important strategy for addressing unpredictability and increasing market competition. Researchers and practitioners widely recognize supply chain flexibility as a valuable competitive advantage. However, adaptability comes at a high price, and adapting to evolving organizational demands and conditions is critical for contemporary supply chains, which are characterized by increasing global complexity (Bor & Muthoni, 2025). The supply chain framework adopts a holistic approach that includes a unified perspective on operations, integrating key activities such as procurement, sourcing, distribution, and logistics. Therefore, it envisions a more comprehensive concept of flexibility that takes into account the entire value chain of supply chains (Shukor et al., 2021). Global supply chains have faced numerous challenges due to the impact of economic globalization and pandemics. Companies are confronted with constantly changing internal and external contexts, making the traditional supply chain model more vulnerable and insufficient to meet growing corporate demands (Sarkis et al., 2021).

To adapt to ever-evolving customer demands and navigate environmental fluctuations, companies must collaborate to meet diverse customer needs and survive in the face of intense market competition. Given the increasing uncertainty in the manufacturing environment, supply chain flexibility has become critical, enabling organizations to effectively manage production costs and resources while efficiently meeting consumer needs (Aslam et al., 2020). flexibility refers to supply chains that demonstrate agility and adaptability. This is driven by customers' ability and propensity to pay, which allows them to quickly adapt to fluctuations in customer demand. Furthermore, they have the ability to continually develop and improve to keep pace with ever-changing conditions. Supply chain flexibility refers to an organization's ability to make rapid and adaptive changes to meet customer requirements. This is achieved through effective management of uncertainty and ensuring the smooth flow of products through supply chains (Feizabadi et al., 2021).

Supply chain flexibility refers to the ability to adapt to immediate fluctuations in demand or supply resulting from external disruptions, as well as the ability to adapt to long-term changes in the supply chain environment, both strategically and structurally. flexibility is a combination of agility and adaptability (Calvo et al., 2020).

1. Supply Flexibility: Supply flexibility encompasses a firm's ability to restructure its supply chains, adapt to market changes, and increase supplier responsiveness. All of these different aspects of supply chains can be achieved by incorporating supplier and supply flexibility into purchasing considerations (Tiwari et al., 2015). Supply flexibility means working with an existing supplier who meets the organization's needs, who is flexible in how they receive general materials, and in adjusting the supply schedule to impact production capacity. It also means entering into contracts with suppliers for summer and future supply when working with multiple suppliers, and selecting among them based on objective criteria, becoming a nominal supplier (Escave et al., 2024).

2. Operational Flexibility: Operational flexibility is defined as an organization's ability to produce products that meet customer needs, modify products in terms of quantity, size, and specifications, and develop new products efficiently and on time, while ensuring that the production process is not impacted in terms of time, maintenance, and quality improvement. This is achieved in a manner that maintains a competitive advantage (Escave et al., 2024). Operational flexibility can also be defined as the ability of supply chains to adapt to changes in the environment, such as shifts in market conditions or fluctuations in demand (Tiwari et al., 2015).

3. Distribution Flexibility: Customer expectations for shorter order cycles and increasingly alternative delivery options have highlighted the importance of product distribution as a critical organizational capability for addressing variability and network complexity in customer service centers. Distribution flexibility is a component of the product distribution structure, which refers to an organization's ability to provide widespread and flexible distribution and delivery of products to its customer base (Yu et al., 2013). Distribution flexibility can be defined as the availability of a range of options and the ability to effectively leverage them to adapt the process of controlling the flow and storage of materials, finished goods, services, and related information from origin to end-user in response to changing market conditions (Jafari et al., 2023).

4. Delivery Flexibility: Delivery flexibility refers to the ability to handle scenarios that require changes in delivery schedules and plans so that the product can be delivered to customers without making mistakes that cost more money or lead to customer loss (Al-Rawashdeh and Al-Shoura, 2022). Companies' efforts to manage supply chain risks and volatility in customer demand include a central focus on developing flexibility competencies within their value chains (Jafari et al., 2023).

Relationship between Open Innovation and Supply Chain Flexibility and Hypotheses Development

The link between open innovation and supply chain flexibility has become an important area of research in recent years, particularly in light of increasing environmental and market instability. Open innovation, which focuses on the use of information, technology, and external collaboration, has been shown to significantly improve an organization's ability to adapt and compete. In this regard, according to the results of a study by Chiu and Lin (2022), developing open innovation capabilities in supply chains requires an effective knowledge environment and governance mechanisms that support knowledge flow between partners, which improves supply chain flexibility through collaborative innovation and rapid adaptability. Rashid et al.'s study (2025) demonstrated that supplier trust and integrated technologies are essential for supply chain flexibility and responsiveness, and are linked to open innovation principles such as transparency, data sharing, and systems integration. Yoon and Jeong (2017) found that open innovation approaches among manufacturers and retailers increased the flexibility and market adaptability of reverse supply chains. Open innovation extends beyond internal innovation to encompass elements of the supply chain, including redistribution and processing.

On the other hand, Peng and Ding (2023) found that inbound and outbound open innovation practices help small and medium-sized enterprises (SMEs) in dynamic

environments pool resources and improve performance. This suggests that open innovation makes a company better able to cope with unexpected events and reorganize resource in a beneficial way. Usman et al. (2024) confirmed that open innovation enables knowledge linking, enabling companies to leverage their own and others' skills to create stronger strategic solutions. The results of Supriono and Yulianto (2023) also indicated that open innovation may not directly impact a company's performance, but it is critical for service innovation, enhancing operational flexibility and long-term resilience.

Ho1: There is an impact of open innovation on supply chain flexibility at Cementra.
Ho2: There is an impact of open innovation on supply flexibility at Cementra.
Ho3: There is an impact of open innovation on operational flexibility at Cementra.
Ho4: There is an impact of open innovation on distribution flexibility at Cementra.
Ho5: There is an impact of open innovation on delivery flexibility at Cementra.

Methodology

Sample

The study population comprised 148 employees of Cementra Cement Company in Jordan. An electronic questionnaire was distributed to them, comprising 34 items: 15 items related to open innovation and 19 items related to supply chain flexibility. A total of 104 returned questionnaires were valid for analysis.

Measurement

The study included two variables: the independent variable, open innovation, which was measured through three dimensions: inbound innovation, outbound innovation, and coupled innovation. This measure is considered the most widely used by researchers in the field of open innovation (Peng & Ding, 2023; Usman et al., 2024; Mohammed et al., 2021; Sayed & Abd Rabbo). Supply chain flexibility as dependent variable was measured through four dimensions: supply flexibility, operational flexibility, distribution flexibility, and delivery flexibility, that has been used in numerous studies (Yu et al., 2025; Rashid et al., 2025; Al-Rawashdeh & Al-Shura, 2022; Iskeef et al., 2024).

Results

able 1, which displays the data for the analysis of the open innovation and supply chain flexibility items dimensions, shows that all open innovation items were at high levels according to the five-point scale. The mean values ranged between 4.117 and 4.127. The supply chain flexibility items dimensions were also high, ranging between 4.096 and 4.243. Cronbach's alpha reliability coefficient values indicated that they were within the permissible limits, as they all exceeded 0.70, the minimum acceptable value for data quality (Sekaran & Bougie, 2016, 290).

Table 1
Descriptive statistics

Dimension	Items	Alpha	Mean	Std. deviation
Inbound Innovation	5	0.728	4.127	0.480
Outbound Innovation	5	0.701	4.127	0.553
Coupled Innovation	5	0.729	4.117	0.583
Supply Flexibility	5	0.765	4.148	0.544
Operational Flexibility	5	0.747	4.135	0.595
Distribution Flexibility	5	0.781	4.096	0.577
Delivery Flexibility	4	0.854	4.243	0.714

Table 3 presents the results of testing H1 regarding the impact of open innovation on supply chain flexibility. The results analyzed using multiple regression analysis indicated a significant impact of open innovation on supply chain flexibility. The R^2 value was 0.397, indicating that 39.7% of the variance in supply chain flexibility was attributable to open innovation. The F value was 21.906 at a significance level of 0.000. Regarding the significance of each dimension of open innovation on supply chain flexibility, the results showed that inbound and double innovation were significant, while outbound innovation was not.

Table 2
Impact of open Innovation on supply chain flexibility

Variable	B	Beta	T	Sig.
Inbound Innovation	-0.053	-0.051	-0.531	0.596
Outbound Innovation	0.374	0.421	4.102	0.000
Coupled Innovation	0.268	0.314	3.096	0.003
	R^2 =0.397	F=21.906	Sig.=0.000	

Table 3 includes the results of the simple regression coefficient test for the study's hypotheses H2, H3, H4, and H5, which concern the impact of open innovation on supply flexibility, operational flexibility, distribution flexibility, and delivery flexibility. The regression coefficient values indicate a significant impact of open innovation on the four dimensions of supply chain flexibility, with a percentage of 34.7% for supply flexibility, 22.8% for operational flexibility, 24.7% for distribution flexibility, and 15.5% for delivery flexibility, at a significance level of 0.000.

Table 3
Impact of open innovation on supply, operational, distribution, and delivery flexibility

Hypothesis	**R^2**	**F**	**Sig.**
H2	0.347	54.162	0.000
H3	0.228	30.128	0.000
H4	0.247	33.482	0.000
H5	0.151	18.078	0.000

Discussion

In this study, the researchers focused on investigating the impact of open innovation on supply chain resilience, applying it to Cementra in Jordan. The results of the descriptive analysis revealed high levels of open innovation content across its three dimensions (inbound innovation, outbound innovation, and coupled innovation). This result indicates that the company's management relies on all types of innovation in a balanced and highly balanced manner. It continuously seeks ideas and technologies from the external environment to

acquire them. It believes that it is beneficial to outsource to complement internal research and development activities, in addition to utilizing technology developed by others. Furthermore, it relies on its own research and development activities and does not hesitate to sell these products to other companies. The company markets its licensed patents through various marketing channels. The company also engages in joint development and exploration projects with other companies by signing joint labor agreements to develop its products and distribute its products.

The results of the study indicated high levels of supply chain resilience at Cementra. Supply chains are capable of handling various non-standard requests, offering special order specifications when needed, making significant improvements to the company's products, and adapting to changing operating conditions.

The results showed that open innovation has a significant impact on supply chain resilience. The more diverse sources a company has to source innovative ideas, whether from its own R&D efforts, those of others, or entering into research partnerships, the more this contributes to increased supply chain resilience, including the ability to respond to unexpected changes in the environment, as well as events occurring in operations, transportation, warehousing, distribution, and delivery.

The researchers hope that the study's findings will encourage corporate managers to pay attention to both inbound and outbound innovation, leveraging their own and others' capabilities in development processes. This allows the company to monitor all innovative developments occurring among competitors.

Recommendations

Continue to focus on balanced reliance on both inbound and outbound innovation activities by encouraging employees to present creative ideas and develop them into innovative products and processes, as well as seeking innovative ideas externally. Enhance activities that support distribution flexibility by identifying new distribution points to meet unexpected customer demand and utilizing automated loading and unloading operations.

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