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What Drives Supply Chain Innovations in Public Healthcare? Evidence From Tertiary Hospitals in an Emerging Economy Using a Multimethodological Approach

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Abstract

There are limited empirical studies and information regarding what enables supply chain innovations, as exemplified by e-supply chain adoption in tertiary hospitals. As such, this research aims to close this gap by exploring the factors driving supply chain innovations in Ghana's tertiary hospitals. The research study employs a concurrent mixed-methods approach to collect and analyze data. Ethical considerations were adhered to in this study. For the quantitative data collection, a convenience sampling technique was used, yielding 250 responses from employees and mid- to lower-tier managers. The Smart PLS structural equation model served as the analytical tool for quantitative data. The qualitative aspect involved the utilization of convenience and purposive sampling methods to garner insights from 15 supply chain experts. Subsequently, the qualitative data were thematically analyzed. Grounded within the paradigm of dialectical pluralism, this research study

adopted the Technology, Organization, and Environment (TOE) Framework as its foundational theoretical underpinning. Other theories, including the Innovation Diffusion Theory, Stakeholder Theory, and Institutional Theory, were added to enrich the theoretical rigor. Significantly, a key finding was that the Technological Factors (TF) were not significant in predicting e-supply chain adoption in tertiary hospitals. Recommendations were made to focus on environmental and organizational factors to enhance e-supply chain adoption.

Keywords
Supply Chain Innovation, Dialectical Pluralism, Organizational Performance, Technology, Organization and Environment Framework.

1. Introduction
In today's volatile business environment, where supply chains compete intensely, organizations are prepared to adopt new ideas, technologies, and innovative approaches to outperform rivals. Innovations in the supply chain have become crucial across various sectors, and the health sector is no exception. This point has been supported by numerous researchers, who argue that several factors influence the adoption of technological innovations and the factors, including cultural-cognitive, normative, capital market reforms, and complexity of the technology (Bello et al., 2004; Arlbjorn et al., 2011; Bellamy et al., 2014; Zimmermann et al., 2016; Wong and Ngai, 2019). A World Health Organization report (WHO 2020) highlights the importance of delivering effective and efficient health services to everyone, especially in emerging economies where health system weaknesses are pronounced. The global health sector faces numerous challenges, including inadequate infrastructure, policy gaps, high care costs, counterfeit medicines, limited technological advancements, and issues with national health insurance, among others, with Ghana being a case study (Thomas and Suresh 2024).

Currently, improving hospital supply chain performance is seen as a key factor in enhancing operational efficiency, reducing costs, and preventing the spread of substandard medications worldwide (Chen, 2013; Gao et al., 2017). In Africa, systemic issues are widespread, affecting financial, technological, political, and institutional sectors, leading to persistent disparities that disproportionately impact the poor, through higher disease rates and increased healthcare costs in sub-Saharan regions, World Health Organization (WHO 2020). Despite the recognition of supply chain management's vital role in healthcare, many challenges remain unaddressed. To tackle these issues, countries like Ghana have developed and implemented policies such as the National Health Insurance Scheme and the Ghana Integrated Logistics Management Information System, among others. Still, implementation faces obstacles such as internet connectivity problems, technological complexity, inadequate human resource preparedness, insufficient training, and concerns regarding sustainability (Ali et al., 2021; Abdul et al., 2024). Furthermore, the Ghanaian Ministry of Health introduced a Supply Chain Master Plan (SCMP) for 2021-2025 to address these problems and achieve excellence in healthcare delivery, aligned with Ghana's Universal Health Care Vision. Despite progress, the health sector continues to encounter significant issues like rising patient expectations, technological innovations, increased competition, and shifting market conditions (Tseng and Lin, 2011).

Additionally, a key step toward achieving universal health coverage is enhancing the systems and processes that ensure access to quality care. Therefore, optimizing the supply chain is essential for maximizing benefits. Embracing an e-supply chain capable of enhancing resilience through streamlined processes, better visibility, and increased collaboration is particularly relevant. This approach enables quick access to medicines and other non-drug supplies. An e-supply chain, exemplifying supply chain technological innovation, is described as the integration and coordination of essential business processes across the entire supply chain—from suppliers to consumers-using internet-based technologies that facilitate a seamless flow of products, services, and information. Thus, creating value for various stakeholders within the network (Alsheyaldi et al., 2024).
The primary focus on e-supply chain innovation within this study reflects its pivotal role in transforming healthcare supply chains. Existing research has demonstrated that a digitalized supply chain fosters enhanced collaboration among key stakeholders, including manufacturers, suppliers, regulators, and other partners within the healthcare ecosystem (Chen and Ruan, 2024; Abaku and Odimarha, 2024). In Ghana's tertiary hospitals, despite the institutionalization of the supply chain master plan (2021-2025) which was supposed to be an improvement on the supply chain master plan of 2015-2020, they are yet to resolve several issues concerning extensive queueing at hospital pharmacies, unwarranted delays in supply chain processes, poor environmental performance and the rising cost of healthcare services (Aslam et al., 2021; Vukey et al., 2023; Afesi-Dei et al.,2023). There is further insufficient research on what factors influence e-supply chain adoption in the healthcare industry and its consequent sustainability(Arlbjorn et al.,2011; Habidin et al.,2015 ;Ohene-Botwe et al., 2024; Leone et al., 2024). Therefore, there exists a policy implementation gap. Additionally, there is insufficient literature that addresses factors that lead to the adoption of supply chain innovation efforts in Ghanaian tertiary hospitals. Besides, while the factors that enable innovation in supply chains have been extensively studied (Bello et al., 2004; Arlbjorn et al., 2011;

Bellamy et al., 2014; Zimmermann et al., 2016; Wong and Ngai, 2019), there is a need for further research on the impact of the e-supply chain in other relevant institutions of health, using multimethodological approaches (Arlbjorn and Paulraj, 2013; Kabadurmus, 2020; Liang et al.,2023). That notwithstanding, some organizations have successfully adopted emerging supply chain technologies as well as innovations in their organizational processes, yet others struggle due to technological, environmental, cultural, and organizational deficiencies (Borgman et al., 2013; Chang et al., 2013; Lee and Lee, 2022; Thomas and Suresh, 2024). Hence,the objective of this paper is to analyze the factors that lead to the adoption of supply chain innovations, as exemplified by e-supply chain adoption in Ghanaian tertiary hospitals. The main research question is what factors lead to the adoption of supply chain innovations, as exemplified by e-supply chain adoption in Ghanaian tertiary hospitals.

The rest of the paper is organized as follows: Section II presents the Literature review, while Section III involves the theoretical background and hypotheses. Section IV lays down the methodology used in conducting the research, while Section V presents the data analysis. Finally, Sections VI and VII are the conclusion, limitation, implication, and recommendation for future research.

2. Literature Review

2.1 Supply Chain Innovations

Supply chain innovations involve new ideas, processes, and technologies that enhance or alter the significance of elements within the supply chain to create new value for stakeholders. Several authors highlight the importance of innovation and argue that it is the ability to leverage unique ideas to generate economic value for a firm, thereby gaining a competitive advantage in the market (Man et al., 2024; Okoye et al., 2024; Donkor et al., 2024). Moreover, it is widely recognized that the role of innovation in helping firms develop economically within global conglomerates cannot be overstated (Melo et al., 2020; Addy et al., 2024; Sarker et al., 2024; Belhadi et al., 2024). Innovation also encompasses activities and processes that firms use to facilitate the commercialization of their products through scaling up novel ideas, as suggested by Frederiksen and Knudsen (2017). Meanwhile, effective diffusion of innovation within firms is essential for integrating unique ideas seamlessly, thereby improving service delivery and new product development. This process enhances opportunities to identify areas within and outside the firm that require both radical and incremental innovative changes, ultimately leading to greater customer value (Baumol, 2016; Chen et al., 2024; Tetteh et al., 2024). Meanwhile, Blome et al., (2013) advocate for a dual focus on exploratory and exploitative innovation, highlighting the importance of development in a firm. Undoubtedly, such perspectives on innovation are critical to the supply chain. Therefore, after reviewing numerous definitions, the researcher suggests that supply chain innovations (SCI) refer to incremental or radical changes in supply chain design, structure, and technologies that generate value and improve stakeholder experience, for satisfaction (Arlbjorn et al., 2011; Kahn, 2018; Wang and Ngai, 2019; Kabadamus, 2020; Addy et al., 2024).

Although radical innovations may seem sudden, they involve significant improvements to products or processes, while incremental innovations typically enhance existing systems. Supply chain innovation combines advancements in information technology with logistics and marketing procedures to improve operational efficiency and service effectiveness (Bello et al., 2004; Hazen, 2012; Senna et al., 2024). It is worth recognizing that SCI is dynamic and can originate within a single company function, spread across other functions, or extend beyond the company to involve other firms. Inter-organizational sharing and implementation of innovation can be a novel approach that improves supply chain transparency through visibility and mutualism. This has the potential to enhance coordination and foster collaborative efforts to integrate innovation into the supply chain, ultimately establishing a strong and sustainable supply chain (Kumar et al., 2023). Technological innovations in the supply chain include modern ideas, actions, and products that companies use to improve performance (Francisco and Swanson, 2019). The focus on supply chain management has encouraged rethinking supply chain processes and product innovation (Carrillo, 2015). So, recent reviews of supply chain innovation highlight the importance of continuous innovation alignment for company success (Arji et al., 2023; Abaku and Odimahar, 2024).

2.2 Factors that lead to Supply Chain Innovation Adoption

Several factors influence the adoption of supply chain innovations, including human resources, customer pressure, financial readiness, compliance, technological integration, cybersecurity, and organizational culture. Each factor plays a significant role in assessing whether a company is prepared and willing to implement innovations in its supply chain operations. Regarding human resources, employee skills and competencies are key indicators of supply chain innovation adoption. Human resources are vital for enabling organizations to benefit from new technologies and innovations. Skilled and knowledgeable staff are better equipped to adopt new technology, reducing resistance to change (Talwar et al., 2023). According to Sulaeman and Nurcholidah (2023), the power of human resources drives organizational activities, helping

businesses achieve their vision, mission, and goals. In this context, investing heavily in training and development prepares staff and equips them for the integration and adoption process.

Additionally, customer pressure on firms should not be overlooked. Customer expectations and behaviors significantly influence organizations' decisions to adopt new supply chain technologies. Customers of today are more sophisticated due to abundant information, making customer pressure the external push from consumers seeking more efficient, transparent, and responsive services. Previous studies show that consumer needs and changing expectations are major drivers of supply chain technology adoption, especially electronic supply chain management (e-SCM) systems (Al Kurdi et al., 2024). Companies strive to enhance their supply networks to stay competitive and responsive to consumer demands (Alzoubi, 2018; Gani et al., 2023; Hugos, 2024). In terms of financial readiness, having sufficient financial resources is also critical since implementing supply chain innovations like e-SCM requires considerable investment in purchasing, maintaining, and system upgrade. According to Baah et al. (2021), companies with more financial resources are better positioned to adopt these systems, as they can fund necessary technology updates and improvements. Consequently, financial preparedness strengthens an organization's capacity to invest in and sustain supply chain innovations.

Moreover, compliance with standards and legislation also plays a vital role in adopting supply chain innovations. The role of compliance in this context is not fully understood in the literature. Adherence to industry standards has been shown to influence adoption decisions for some technologies, such as RFID systems, where clear protocols are established (Eze et al., 2019). However, for newer technologies like cloud-based services, the regulatory frameworks are still developing, leading to mixed findings about how compliance affects adoption (Meri et al., 2023). This suggests that as regulatory frameworks evolve, their impact on technology adoption will likely increase. Challenges related to technological integration can also hinder adoption efforts as the complexity of integrating data across multiple platforms and partners can be a major barrier to adopting supply chain innovations. Data integration is difficult because many stakeholders use different systems (El-Gazzar et al., 2023). As such, the absence of standardized data formats and communication protocols further impedes the process (Odimarha et al., 2024). For digital supply chains to operate effectively, seamless information exchange is essential but, poor data quality and inconsistency can undermine the efficiency of innovative technologies (Bai et al., 2022),thereby distorting the process.

2.3 E-supply Chain Adoption

A key innovation in supply chain management is e-supply chain management because it serves as a conceptual category for holding multiple innovations within it. E-supply chain management (E-SCM) is a modern approach to supply chain management that uses digital technology to improve efficiency, visibility, and collaboration across a variety of supply chain operations, including procurement, manufacturing, distribution, and sale of products or services (Mendonca, 2024; Ahmad et al.,2024). To increase customer value, the term "e-supply chain" refers to the effective use of electronic systems and other technologies for the acquisition and administration of goods, services, and information from production to consumer delivery (Shah et al., 2023). E-supply chain management has emerged as a crucial domain of concentration for companies seeking to optimize their supply chain operations via electronic methods. E-SC intends to integrate the complete procurement, manufacturing, storage, transportation, and distribution processes (Prajapati et al., 2022).

Numerous constraints, trigger factors, and restrictions on the e-supply chain processes have been discovered. Constraints include cyberattacks, operational difficulties, economic reasons, and governmental laws; trigger factors also include integrated supply chain systems, IT support, and service quality (Maniah et al., 2018). Thus, technological integration enables firms to streamline operations, resulting in increased customer satisfaction and lower operating expenses, thereby enhancing digitalizing the supply chain becomes highly significant (Haddud & Khare, 2020; Hrouga, 2023; Nasiri et al., 2020; Rasool et al., 2022; Dai et al., 2021). Digitalization allows for real-time monitoring of supply chain processes, helping staff to make educated decisions and respond to changing market needs (Yu et al., 2021).

The growth of e-supply chain management projects has been emphasized, with a focus on the technological forces that supported the shift to web-based platforms. Furthermore, research has focused on the optimization and modeling of e-commerce supply chains in an Internet of Things environment, highlighting the importance of IoT technology and the creation of supply chain optimization models (Zhu, 2020). Studies have highlighted the advantages of electronic supply chain integration, including cost savings, increased operational efficiency, increased customer satisfaction, and improved overall process performance (Alzoubi et al., 2024; Zhang et al., 2024; Mounia et al., 2024). The significance of global concerns in supply chain management, as well as the role of IT developments in enabling supply chains to combine multiple tasks within e-business settings, have been highlighted (Zhang et al.,2024).

2.4 Conceptual Framework and Hypothesis Development

Tornatzky and Fleischer's (1990) expanded Technology-Organization-Environment (T.O.E.) framework supports this study. The framework explains that three enterprise context factors influence an organization's adoption or implementation of a specific innovation. The TOE Framework is justified as the preferred theory for this research because of its comprehensive analysis of adoption factors. It offers a structured way to assess technological, organizational, and environmental aspects—key domains that impact technological adoption. In the context of tertiary hospitals in Ghana, technological factors include the compatibility of existing technologies with new ones. Organizational factors involve elements like top management and staff support, while environmental factors refer to the external environment and institutional isomorphisms, such as mimetic, normative, and coercive influences, that shape technological progress in healthcare. Again, the framework is multifaceted and complex, making it useful in a complex setting like the hospital environment. The framework has strong empirical support (Awa et al., 2016; Amini and Javid, 2023; Bin Naeem et al., 2024).

Diffusion of Innovation Theory by Rogers (1995), which explains how innovations spread through a social system, offers the theoretical foundation for this study's examination of the technological context. The theory aligns with the TOE Framework as it highlights technological factors, including the technological bases of the framework. Numerous studies exploring the adoption and use of supply chain tools have identified many influencing factors (Francisco and Swanson, 2018; Hahn, 2020; Cheng and Ruan, 2024; Agrawal et al., 2024). The dissemination of innovation is shaped by attributes such as complexity, compatibility, relative advantage, trialability, and observability, as well as the stages of adoption and the influence of opinion leaders. By applying DIT in this study, the diffusion and adoption of innovations within tertiary hospitals can be better understood. Focusing on these three key characteristics—relative advantage, complexity, and compatibility— which have been empirically validated, can help pinpoint the most critical aspects of innovation to promote performance.

Stakeholder theory describes the intricate relationships among different groups or individuals affected by a business's actions or who influence those actions. Its main goal is to create value that benefits all parties involved (Freeman et al., 2020). Using stakeholder theory for this research offers several advantages, as it involves engaging with diverse stakeholders such as medical staff, suppliers, patients, and regulatory agencies. This approach helps hospitals address the concerns and needs of various stakeholders during planning, increasing public trust and improving perceptions, which can lead to greater community support (Longoni and Cagliano, 2018). When internal stakeholders like employees are actively involved in the innovation process, the adoption and dissemination of new practices tend to accelerate.

The institutional theory posits that an organization's operating environment is greatly influenced by the establishment of regulations, norms, and structures designed to enhance its legitimacy and security (Scavarda et al., 2019). As a result, individuals and groups must comply with these norms to improve technical efficiency, adopt innovative structures, and avoid non-conformity, which is viewed as negligent. Typically, these regulations originate from governmental agencies, professional organizations, societal and cultural norms, legal systems, and established conventions, exerting pressure on organizations to conform (Bashir, 2019). From an Information Systems (IS) perspective, this pressure leads to three types of isomorphic changes: mimetic, coercive, and normative influences (Figure 1).

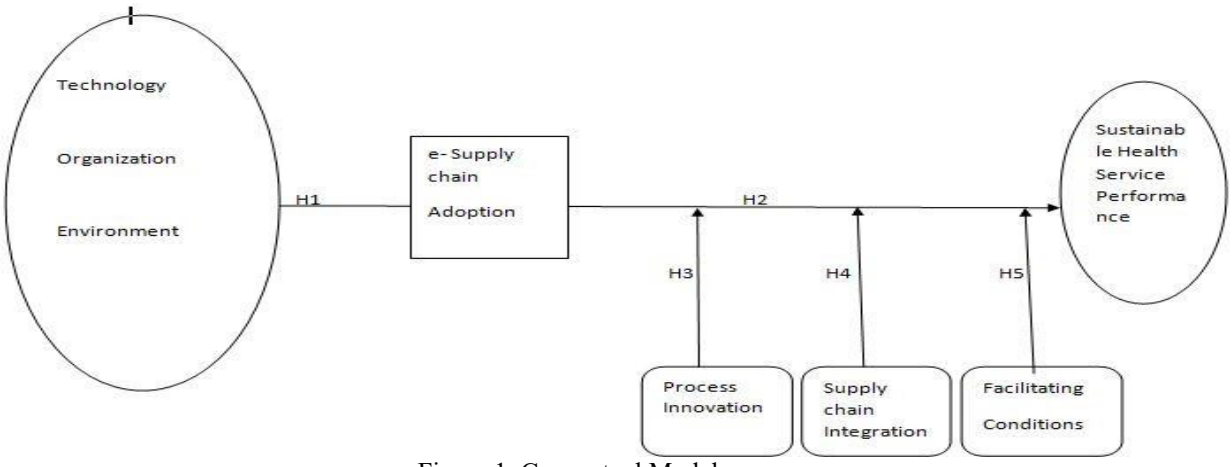

Figure 1. Conceptual Model
Source: Authors' elaboration based on Tornatzky &Fleischer (1990) TOE Framework

3.1 Technological Factors and e-Supply Chain Adoption

The adoption of e-supply chains in tertiary hospitals is heavily influenced by technological factors. The factors include system interoperability's technological readiness, accessibility to cutting-edge digital tools, perceived ease of use, and the benefits of adopting such technologies. According to Sathiya et al. (2023), hospitals are more inclined to accept such technologies when they have strong internet connectivity and adequate information and communication technology, including Industry 4.0 technologies. These technologies include AI, big data analytics, ERP, etc. These technologies have the propensity to enhance data-driven decision-making, inventory management, and operational effectiveness (Kumar et al., 2023). Moreover, a key factor is technological readiness, the hospital's ability to integrate and oversee new technologies. Alzoubi et al., (2024) avow that the benefits, such as increased efficiency, financial savings, and perceived usefulness, can drive the adoption of the technology. However, Hamadneh et al. (2023) contend that the system complexity, its level of compatibility, and the continuous training requirement may hinder the adoption of e-supply chain systems. The innovation capacity and adaptation to changing technological needs of the hospital are an imperative influence for tertiary hospitals' quest for e-supply chain adoption (Adei et al.,2023; Singh et al.,2023). Therefore, tertiary hospitals must strategically align their technological needs to avert such challenges. Hence, it is hypothesized that:

H1a: There is a direct positive relationship between technological factors and e-supply chain adoption.

3.2 Organizational factors and e-supply chain adoption

Organizational factors have a significant role to play in advancing the adoption of innovations. According to (Antwi et al., 2014; Abuosi et al., 2023), for technological systems to be adequately integrated into the hospital's operational framework, the organizational culture cannot be discounted. This is because a learning culture can stimulate and enhance the adoption of a new system. Moreover, a culture that advances information sharing and exchange, which further encourages colleagues to act when needed, typically fosters the innovation experience (Mounia et al., 2023. Therefore, the structure of interdependence of information within the hospitals and its external partners is crucial for adoption. As such, coordination and cooperation within and outside of the hospital have a significant impact on the overall performance (Akam et al., 2023). Also, Hamadneh,(2023) aver that the significance of training and staff competency in information technology can also be a spark for technological advancement. Hence, a well-crafted change management plan that seeks to effectively communicate, train, and continuously enhance the benefits of e-supply chain adoption significantly motivates its adoption (Kumar et al., 2020; Al-Omoush et al.,2023). Various scholars agree that green innovativeness represent a significant factor to advance an organization's reputation (Rubab et al., 2022; Dave and Shaikh, 2022; Adel and Younis, 2023). Again, for a hospital, its size, financial health, and top management support are significant drivers for e-supply chain adoption. Therefore, it is hypothesized that,

H1b: A significantly positive relationship exists between organizational factors and e-supply chain adoption.

3.3 Environmental Factors and E-Supply Chain Adoption

Tertiary Hospitals, which are supposed to be the referral hospitals for exceptional healthcare provision, are inundated with extensive pressure to innovate by the competitive health sector. Therefore, the competitive environment has a significant impact on them to innovate. Studies have shown that hospitals facing such intense competition are more inclined to adopt e-SCM systems to gain a competitive edge (Singh et al., 2022). Simoes et al. (2019) aver that hospitals operate in a highly regulated industry where compliance with government standards, industry standards, and accreditation requirements is very important. Therefore, the need to assure regulators of compliance with supply chain transparency, patient safety, and data privacy may influence the adoption of e-SCM (Kurdi et al., 2022). The availability of government support can also enhance the adoption process. For example, if the government, in its quest to reduce the adverse effects of the COVID-19 pandemic, can build new hospitals in Ghana, then such intervention can also be employed in the adoption of technologies. Again, incentives from governments, including grants and policies aimed at enhancing healthcare infrastructure, can help (Babalola et al.,2024). Therefore, it is hypothesized that,

H1c: Environmental factors have a positive relationship with e-Supply Chain adoption.

4. Methodology

Since this work adopts a dialectical pluralism philosophical stance and a mixed method approach to data collection, both qualitative and quantitative data are gathered (Subedi, 2016; Hall et al., 2023). This study employs a convergent mixed method, where both qualitative and quantitative data are collected simultaneously and analyzed together. Okorli (2023) states that semi-structured interviews, which offer the researcher flexibility with pre-determined themes, are used alongside survey questionnaires for the quantitative phase. Abductive reasoning addresses the limitations of relying on a single method and is suitable for obtaining reliable and realistic results (Proudfoot, 2023). To create a solid research process that achieves the study's objectives, the layers outlined in Saunders, Lewis, & Thornhill's (2023) research onion model were adopted, as

it is straightforward and allows for an organized, step-by-step approach. The researcher employed a case study design for the qualitative phase and a survey design for the quantitative phase to explore relationships between concepts and constructs. The case study approach provides face validity and in-depth understanding, enabling detailed examination of the phenomenon. It also permits document analysis, which is crucial for gaining a thorough understanding of the issue under investigation. Therefore, this study uses a concurrent or parallel design. Top managers were targeted in the qualitative study, while at the same time, SC staff (including lower-level managers) were targeted in the quantitative study. To enhance the investigation, document analysis was incorporated into the data collection method, allowing for data triangulation. Through a mixed research strategy, researchers can reflect on participants' perspectives (Braun and Clark, 2023). Moreover, mixed research encourages scholarly interaction and is preferred for its greater flexibility and adaptability to various study designs (Pyo et al., 2023). Additionally, mixed research helps gather rich, comprehensive data, enabling the researcher to present a more complete story.

5. Sampling and Data Collection

The qualitative aspect of the study focused on top management involved in procurement and supply chain activities across five tertiary hospitals in Ghana. Using a homogeneous purposive sampling method (Collins, 2010), fifteen senior managers (three per hospital) were selected for semi-structured interviews. The number was guided by Saunders et al. (2023) and was considered sufficient when saturation was reached at the fifteenth interview. Convenience sampling was also used to support the process by selecting readily available participants to save time and resources. The selection criteria included experience, credibility, and willingness to participate for about an hour. The interview guide was developed after a literature review, with interview topics shared in advance to facilitate rich data collection from participants (Saunders et al., 2023). The interviews and data were used to gather in-depth insights until saturation. For the quantitative phase, survey questionnaires were distributed to administrative staff, including lower-level managers involved in supply chain activities. With a population of approximately 600, a quota-based approach was employed to reflect the size and location of each hospital, distributing 130 printed questionnaires and additionally sending electronic versions to 245 staff members. In total, 375 questionnaires were distributed. A total of 250 responses were received after rejecting 10 incomplete submissions.

6. Data Analysis

Scholars have argued that a low response rate could lead to nonresponse bias because response rates are typically used to evaluate the quality of the data (Giromini et al., 2022; Jeon and Boeck, 2019). The test for response rate is necessary, especially for surveys (Krishnamurthy and Kumar, 2018). Data for this study were gathered between February 2^{nd,} 2023, and April 26th, 2023. A total of 375 questionnaires were administered, and after weeks of follow-up, 250 were recovered and deemed to be appropriate for the analyses. This constitutes a response rate of 66.7%, which is sufficient for further analysis. According to Fincham (2008), a more than 60% response rate in business management research is considered good for analysis. Therefore, the 66.7% response rate reported for this study served as a sufficient basis for conclusions.

SEM: Applying the Partial Least Squares techniques.

As a multivariate analysis method, it requires both factor analysis and multiple regression analysis. SEM is employed due to its ability to reveal the depth of connections between the study's dependent and independent variables (Hair et al., 2018). Also SEM has built-in capabilities to assess data adequacy and provide empirical assessments of the connections within constructs (model measurement) and between constructs (structural model) (Fauzi, 2022).

Common Method Bias

The introductory instructions of the questionnaire can unintentionally influence responses by implying socially desirable answers, potentially introducing common method bias (CMB). This potentially inflates the path coefficients and distorts key findings. This was mitigated by meticulously designing the questionnaire for clarity and comprehensiveness while targeting experienced staff in supply chain management. Complex words that may be difficult to understand were avoided, and items that appear ambiguous were also eliminated. All double-barreled constructs were avoided confusion. Exploratory Factor Analysis using the principal component extraction method was employed. The analysis revealed that no single factor accounted for most of the variance, indicating an absence of a dominant factor, thus no significant evidence of CMB.

Reliability

For reliability Cronbach's alpha (CA), Average Variance Extracted (AVE), and Composite Reliability (CR) were used for its assessment (Hair et al., 2019).

Composite Reliability

Composite reliability (CR) is an approach to assessing a construct's internal consistency in Smart PLS design. CR values exceeding 0.7 are deemed acceptable (Diamantopoulos et al.,2012; Drolet and Morrison, 2001). Cronbach's alpha as a

metric measures the composite reliability. Prior studies (Vaske et al., 2017; Hair et al., 2017; Purwanto, 2021) state that CA values greater than 0.7 are considered desirable in Smart PLS as shown in Table 1.

Validity
Validity is a concept that is highly relevant to research and refers to how well a particular tool or instrument assesses the desired construct (Hair et al., 2017). According to validity considers how well the measurement model captures the essential concepts that are being evaluated.

6.4.1. Factor Loading

The degree of relationship between each item and its corresponding construct is shown by these factor loadings. So, high factor loadings suggest a valid measurement of the target construct, while low factor loadings suggest an unreliable assessment. In Smart PLS, a factor loading of 0.7 or greater is considered appropriate, according to Hair et al. (2019). This is shown in Table 1.

Average Variance Extracted
Average Variance Extracted (AVE) is a crucial variable that indicates the extent to which indicators of a construct capture the variance within it. Standards set by Fornell and Larcker (1981) state that in Smart PLS, an AVE value of 0.5 or greater is deemed appropriate. The measurement model's convergent validity is evaluated using the statistical parameters used in Smart PLS. For every construct, the AVE value was greater than 0.5, as also shown in Table 1.

Table 1. Reliability and Validity

Construct	Items	Loadings	CA	CR	AVE	VIF
Environmental Factors	EF1	0.796	0.892	0.897	0.650	2.372
	EF2	0.836				2.674
	EF3	0.772				1.945
	EF4	0.760				1.998
	EF5	0.867				3.324
	EF6	0.799				2.492
e Supply Chain Adoption	ESCA1	0.742	0.861	0.902	0.708	1.690
	ESCA2	0.937				4.089
	ESCA3	0.896				3.031
	ESCA4	0.775				1.793
Organizational Factors	OF1	0.881	0.900	0.902	0.770	2.663
	OF2	0.884				2.772
	OF3	0.864				2.570
	OF4	0.882				2.729
Technology Factors	TF2	0.735	0.707	0.709	0.632	1.230

	TF5	0.844				1.637
	TF6	0.802				1.539

Measurement Model

The measurement model focuses on evaluating the relationships between latent constructs and their corresponding indicator variables, encompassing key assessments such as internal consistency reliability (using composite reliability and Cronbach's alpha), indicator reliability (using outer loadings), convergent validity (using average variance extracted - AVE), and discriminant validity (using the Fornell-Larcker criterion, cross-loadings, and HTMT ratio). The structural model assessment examines the relationships between the latent constructs themselves, including path coefficients (showing strength and direction of relationships), R^2 values (explaining variance in endogenous constructs), f^2 effect sizes (measuring the impact of exogenous constructs), predictive relevance through Stone-Geisser's Q^2 value, and the significance of path coefficients through bootstrapping procedures (Table 2).

Table 2. Fornell-Larcker Criterion

Constructs	**1.000**	**2.000**	**3.000**	**4.000**	**5.000**	**6.000**	**7.000**	**8.000**	**9.000**	**10.000**
Environmental Factors	0.526	0.806								
Organizational Factors	0.529	0.687	0.266	0.448	0.877					
Technology Factors	0.333	0.605	0.308	0.476	0.652	0.374	0.359	0.430	0.795	
e-supply Chain Adoption	0.527	0.644	0.373	0.430	0.572	0.507	0.505	0.456	0.448	0.842

The Fornell-Larcker criterion stipulates that the square root of AVE should be higher than its correlations with other constructs; hence, the model is empirically distinct and measures different concepts, demonstrating adequate discriminant validity.

Structural Model Evaluation

Table 3 presents the results of the hypotheses proposed in the study. Some were supported, while others were not. The path coefficients should be between -1 and +1. In this case, EF-ESCA is 0.494, indicating a strong relationship; OF-ESCA is 0.268, also strong; however, TF-ESCA is 0.070, indicating a very weak effect. The T values are supposed to be >1.96. Again, for EF-ESCA, 7.198 is supported; OF-ESCA is 3.843, both above the required standard; however, TF-ESCA is 0.000, indicating a statistically insignificant relationship.

Table 3. Path Analysis

Hypotheses	Path Coefficient	St.D	T statistics	P values	2.5%	97.5% (CI)	Results
Direct effect (Independent)							
EF -> ESCA	0.494	0.069	7.198	0.000	0.356	0.625	Supported
OF -> ESCA	0.268	0.070	3.843	0.000	0.125	0.399	Supported
TF -> ESCA	0.070	3.652	0.000	0.070	-0.165	0.088	Not Supported

7. Results of Thematic Analysis

To ensure the confidentiality of respondents, the demographics presented have been assigned numbers from P1 to P15.

Advantages of new technology
This was ascribed to the transformative influence of innovative technologies as exemplified by the considerable decrease in wait times at the pharmacies of tertiary hospitals. The transition from manual to digital prescriptions was a paradigm shift that obviated the necessity for patients to deliver prescriptions in person at the pharmacy counter. This innovation effectively mitigated the effects of prolonged waiting periods on patients, including anxiety, tension, and discomfort caused by lengthy queues. Similar sentiments were shared by P11, who said, "*technology-oriented tools are readily available to aid effective supply chain and procurement, such as the Ghana Integrated Logistics Information Management System (GhILMIS), which assures a seamless transition from the older version*".

Ease of use of new systems
The theme (compatibility of old with new system complexity overcome with ease-of-use, advantage of new technology) offered empirical evidence regarding the importance of compatibility, usability, and benefits in the healthcare supply chain's technology adoption. A significant point raised by P6 argued that "*the staff in the unit were comfortable with the use of the system due to its user-friendliness and the several hands-on experiences, though it took a longer time to grip".*

Backing by internal stakeholders
The assertion is that the organization suffered when staff growth in knowledge of technology was inconsistent with the firm's growth in technology. Moreover, in terms of the critical influence of internal stakeholders, the theme accentuated the significance of top management support and staff engagement in the process of integrating technological advancements. However, P9 further intimated that *"top management was in support of the inclusion of technology for improving the business offering*".

Mimetic environmental pressure
This illustrated how the adoption of various supply chain technologies was influenced by competitive pressures, resulting in improved service provision and processes. It is in this light that P6 indicated that "*Customers and suppliers are looking up to hospitals to improve their processes innovatively to provide effective interaction for better coordination to the improved corporation and adequate agility".*
The theme, "coercive environmental pressure," posits that a disruption such as the COVID-19 pandemic forced tertiary hospitals to adopt digital technologies to optimize their supply chain. This was consistent with Institutional Theory, which emphasized the necessity for institutions to comply with external regulations and expectations. According to P5, "*punitive measures could potentially prevent players within the supply chain network from improving their service delivery and use new ways to improve customer satisfaction" (Table 4).*

Normative environmental pressures
With a particular focus on the impact that organizations have on the extent to which individuals adopt the technological advancements of successful tertiary hospitals. Hence, organizations adhere to prominent firms' standards and practices. P2 indicated that "*a poorly linked supply chain will result in the Bullwhip Effect, in which orders to suppliers have a greater variance than sales to customers, and this demand distortion propagates upstream in an amplified form".*

Table 4. Summary of Key Qualitative Contribution

Theme	Key Contribution
Advantages of new technology	Digital prescription reduces stress, anxiety, and apprehension. Reduction in wait time at the Pharmacy due to efficient operations while leveraging the power of technology. Validates and is consistent with the Innovation Diffusion theory. Evident advantages crucial for technology usage
Compatibility with existing systems and Ease of use	Respondents are not enthused with complex systems, which could lead to resistance. Empirical evidence regarding the importance of compatibility, usability, and benefits in the healthcare supply chain's technology adoption realized

Backing by internal stakeholders	Crucial role of top management support and staff engagement in the process of integrating technological advancements critical Hospital dwindling value (economic, environmental, and social) when growth in technology is inconsistent with the growth of staff competence in technology utilization. Active involvement of staff from the outset of the innovation process is highly relevant.
Mimetic and Normative	Hospitals forced to utilize digital platforms for ordering goods and services because of competition. Compliance with standards and regulations is a pre-requisite to sustainable health service. Industry norms key to successful deployment of technologies

8. Discussion

The researcher hypothesized three factors (H1a, H1b, and H1c), where it is shown that H1a was unsupported and H1b and H1c were supported. The quantitative aspect of the research showed that TF's influence on ESCA in Ghanaian tertiary hospitals was insignificant. This presents a paradox: despite the recognized importance of TF in academic literature, statistical results in this study indicate that Technological Factors do not significantly predict ESCA in the context of Ghanaian tertiary hospitals, as evidenced by the insignificant link between TF and ESCA. This insight is intriguing, as it reveals a complex story that differs from established patterns in existing literature. Scholars such as Haddud and Khare (2020), Mendònca (2024), and Alzoubi et al. (2024) have consistently highlighted the crucial role of technological improvements in promoting supply chain innovation, especially the adoption of e-supply chains. The gap between expected and actual results underscores the need to explore other factors influencing ESCA beyond technology. Meanwhile, the qualitative themes support a conclusion that aligns with existing literature, showing that technological factors are key in e-supply chain adoption, as reflected in themes like 'complexity is overcome through ease of use' and 'compatibility of old technology with new.' The conflicting findings from the quantitative data suggest that Ghanaian tertiary hospitals have many technological factors; thus, technology itself might not be the main need. The researcher believes that respondents indicate TF should not be the current focus, especially since interviews with key stakeholders highlight the importance and relevance of TF.

Additionally, the qualitative data emphasize ease of use as a key criterion for ESCA acceptance. However, the finding that TF does not influence ESCA aligns with Lin's (2015) argument that, although important, technology is not the only factor affecting e-SCM adoption. Moreover, the qualitative results support the broader consensus in existing literature that technology compatibility and complexity are necessary but not enough for effective ESCA (Marei et al., 2021). The study also found a positive and significant relationship between OF and ESCA, supporting the proposed hypothesis. In today's environment, where supply chains benefit from many technological innovations, top management support has become increasingly important (Narayan & Sidhu, 2020). As P12 mentions, "*top management interest in a technology-savvy staff encourages the pace of service delivery by facilitating quick responses to customers' needs*." Leaders' behaviors and attitudes can either promote or hinder system integration, ultimately impacting the company's ability to create value and succeed in a competitive market (Wang et al., 2023; Dion et al., 2023). Effective training and support reduce resistance to change and improve technology adoption (Li, 2022). These factors highlight the organizational role in e-SC adoption and support the researcher's hypothesis (H1b). The findings suggest that better engagement and regulatory awareness of EF will lead to improved ESCA in tertiary hospitals, thus supporting the researcher's hypothesis (H1c).

The quantitative analysis shows a significant positive correlation between Environmental Factors (EF) and e-Supply Chain Adoption (ESCA) in Ghanaian tertiary hospitals. This is further confirmed by qualitative insights, especially themes like mimetic, coercive, and normative environmental pressures. The regulatory and compliance environment facilitates the smooth deployment of e-supply chain technologies, as noted by Mendoça (2023). As P6 and P9 highlight, recognizing the role of regulations that influence operational decisions by hospital management is essential. Consequently, these hospitals have been compelled to develop and adopt new technologies, especially through enforced rules related to digital platform use, waste disposal, and compliance measures. An example includes regulations implemented to ensure social distancing and reduce staff gatherings via digital platforms and GHilMIS. This supports the hypothesis (H1c), indicating a positive and significant relationship between EF and ESCA.

8. Implications of Research

The findings challenge and expand existing theoretical frameworks by emphasizing the limitations of focusing solely on technological factors (TF) as predictors of ESCA in Ghanaian tertiary hospitals. Re-evaluating technological determinism, the results indicate that ESCA is not considered critical within these hospitals, suggesting that technology is not currently the primary driver of organizational change and innovation. The findings reveal that while technological variables are important, they do not independently predict ESCA sufficiently in Ghanaian tertiary hospitals. The study emphasizes the importance of organizational and environmental factors, supported by Sayyadi Tooranloo et al. (2018). Qualitative data, especially themes like "compatibility of New Technology with Old technology" and "Complexity overcome by the ease of use of new technology," underscore the crucial role of organizational factors in either enabling or hindering ESCA.

Additionally, environmental variables such as external pressures (e.g., the COVID-19 pandemic) and the capacity of supply chain partners to adapt to new technology are key in promoting adoption. This aligns with the broader theoretical view that successful innovation adoption is a complex process influenced by both internal and external factors (Al Hammadi & Hussein, 2019; Haddud & Khare, 2020). However, the study finds an insignificant relationship between TF and ESCA. The researcher argues that this does not invalidate the TOE model entirely but instead shows that, in contexts like Ghanaian tertiary hospitals—where significant investment in technology has already been made—organizational and environmental factors become more critical.

Practically, the results suggest that hospital managers should focus on developing organizational culture and improving stakeholder readiness (P2). Staff may have moved past the stage where they believe acquiring technological tools, including e-supply chain systems, is inherently beneficial without critically examining the supporting structures necessary for successful adoption. Hence, policy efforts should aim to foster an organizational environment conducive to technological advancement. Managers should be telling their staff about how the automation and efficiency provided by these technologies can minimize the strain on staff, especially those involved in logistics and procurement, resulting in increased job satisfaction and lower stress levels.

9. Conclusion

The study's objective was to assess the factors influencing supply chain innovations, as exemplified by e-supply chain adoption in tertiary hospitals in Ghana. From the study, technological factors did not influence the e-supply chain adoption. However, organizational factors and environmental factors have a significant influence on the adoption of e-supply chain as an SCI. As the healthcare industry continues to evolve, the incorporation of supply chain innovation approaches will become crucial for navigating future challenges and ensuring the sustainability of healthcare performance.

10. Recommendations

In strengthening organizational factors in ESCA**,** management could effectively communicate the essential benefits of e-supply chain innovations in enhancing hospital operations and patient care. Tertiary hospitals could create a change management strategy to reduce employee resistance and stimulate the smooth implementation of e-supply chain systems. Capacity-building efforts will encourage employees to possess the requisite skill set and knowledge to facilitate the adoption process. In augmenting Environmental Factors in ESCA**,** tertiary hospitals can benefit from institutional isomorphism by leveraging peer pressure to encourage adoption. Hospitals could share their accomplishment through industry conferences, case studies, and publications to inspire other hospitals. Hospitals can encourage their staff to join professional associations or groups that offer certifications and provide continuous professional development, while involving staff early in the decision-making process.

11. Future research

A Longitudinal study could be conducted to evaluate the long-term influence of supply chain innovations in Ghana's Tertiary hospitals. Also, other theories, such as the Unified Theory of Acceptance and Use of Technology (UTAUT 2), could be used to examine similar research endeavors.

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