Operational Performance in Relation to Digital Supply Chain: An Evidence from Pharmaceutical Sector of Khyber Pakhtunkhwa, Pakistan

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Abstract

The concept of "digital supply chain" (DSC) pertains to the utilization of up-to-date information systems and advanced technologies in order to augment the amalgamation and flexibility of a company's supply chain. This research examines the effect of DSC strategy on operational performance (OP). Employees working in the pharmaceutical sector of KP, Pakistan, provided their input for the data collection using quota sampling techniques. A comprehensive analysis of precisely 237 observations has been conducted utilizing partial least square structural equation modeling with the aid of the software SmartPLS 3.0. The findings indicate that DSC significantly and positively affect operational performance (β=0.58) and its constituent dimensions (cost reduction, productivity and quality performance). The results imply that digitization of supply chain adds to operational performance and managers shall adopt digitization of supply chain activities. Organizations that have digitalize their supply chain processes or intends to do so shall benefit from the findings regarding positive affect of DSC on operation performance. The discoveries also add to the academic body of knowledge on the DSC and fill a research gap by providing evidence that operational performance can be enhanced through digitization of supply chain activities.

Keywords: Digital Supply Chain, Operational Performance, Pharmaceutical Sector, PLS-SEM

Introduction and Background

The phrase "supply chain" denotes the intricate web of enterprises and vendors that are developed in order to manufacture and distribute a certain product. It stands for the actions required to give clients a good or service. The concept denoted by the expression "digital supply chain" (DSC) pertains to the utilization of state-of-the-art technology and information systems to optimize the flexibility and amalgamation of the supply chain, thereby elevating the caliber of service rendered to customers and bolstering the sustained profitability of the enterprise (Ageron, Bentahar & Gunasekaran, 2020). The

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implementation of the fourth industrial revolution, brought about by digital transformation, provides organizations with the capacity to achieve a superior level of adaptability in the formation of their supply chain strategies and practices (Al-Alwan et al., 2022; Tariq et al., 2022). This opens up new options for organizations and supply chain practices.

DSC places an emphasis on its customers and consumers, implements advanced and modern technology (such as big data, augmented reality, and blockchain), reduces costs incurred by both its internal operations and those of its external partners, and raises the value of its business. The dissemination and implementation of information in both strategic and operational contexts (research, design, product, and competition) among various stakeholders, which includes customers, manufacturers, logistics service providers, suppliers, and regulatory bodies, is known as the "digital supply chain" in the pharmaceutical industry (Singh, Kumar & Kumar, 2016). The complicated supply chain of the pharmaceutical industry is made up of vital life-saving objectives that demand the participation of stakeholders. Hence, the introduction of digitization in the supply chain can be helpful in the construction of a new form of responsive, sustainable, and robust supply network (Haddud, DeSouza, Khare & Lee, 2017; Korpela, Hallikas & Dahlberg, 2017). The rise of digitalization has inaugurated a fresh period of competitiveness via the utilization of digital strategies, enablers, system integrators, and application technologies (Ehie & Ferreira, 2019). Thus, digitalization must be used to lower operational costs and improve the process for the pharmaceutical sector to be profitable. According to Büyüközkan and Göçer (2018), it branches out into the Technology and Human Relationship, Management Process, the Development of Technology Infrastructure, and Technology Enablers. However, the "human dimension" associated with the installation and growth of the digital supply chain has received little attention in previous studies. DSC’s technological catalysts, such as the Big Data (BD), Cloud Computing (CC), Internet of Things (IoT), and Unmanned Aerial Vehicle (UAV), were the focus of previous studies.

New changes in the workplace are made possible by technology and digitization, but there are drawbacks as well (Cazan, 2020). It affects both work performance and how work is organized (Korunka & Hoonakker, 2014). The digitization of SC is seen as an important problem in academic and professional worlds of logistics and SCM. In order to assure that DSC implementation will be successful, there are still a number of technological, organizational, and strategic challenges that need to be resolved. The most important factors in an organization's success in a globally competitive economy are supply chain agility and reliability, yet the current state of affairs is less certain (Jacques, 2017). Managing a supply chain system is becoming more difficult, supply chain interruptions that cause a negative impact on performance and raise costs are a problem that managers in an organization need to address (Kamalahmadi & Parast, 2017). Technological advancement Digitalization always impacts businesses, both positive and negative. However, because businesses frequently face intense competition, they must adapt to these technological advances. The primary prerequisite for any firm to properly tackle other functional issues is managing staff and enhancing their performance by making them highly productive (Jeyalakshmi & Rani, 2019). The interaction between technology and people has proven to be a significant challenge in DSC deployment. To fully utilize the advantages of technology, organizations must discover ways to balance the two successfully. As a result, it becomes necessary to pinpoint the numerous issues connected to people and digitalization's effects on operational performance. Unquestionably, one of the most crucial analyses for any firm to determine the efficacy and success of any technological implementation is operational performance. Thus, an organization's most vital task is assessing operational performance. According to the new, digitally connected workplace, 32% of employees need to learn new skills to flourish OECD (2019). The utilization of digital technologies within supply chains has enhanced the competences of organizations and effectively facilitated the movement of information and materials along their respective channels, making it simpler to conduct business and carry out activities there. Furthermore, the integration of digital technologies has significantly bolstered the avenues of communication among the various elements constituting the supply chain and this augmentation has led to a notable improvement in the overall cohesion and adaptability of the supply chain network (Rahamneh et al., 2023).

Problem Statement

The most important factors in an organization's success in a globally competitive economy are supply chain agility and reliability (Jacques, 2017). Managing a supply chain system is becoming more difficult, supply chain interruptions that have a negative impact on performance and raise costs are a problem that managers in an organization need to address (Kamalahmadi & Parast, 2017). Adoption of a digital supply chain aids in business development and process management. Workplace conditions are impacted by digitization (Autor, Levy & Murnane, 2003; Chesley, 2014; Cooper and Kurland, 2002; Kirchner, 2015), which in turn affects performance and job satisfaction (Hackman and Oldham, 1976; Anderson Jr & Parker, 2002; Ergeneli, Ilsev & Karapınar, 2010; Warr, 2007). An organization's most vital task is assessing operational performance. Moreover, Pflaum, Prockl, Bodendorf, and Chen (2023) argued that future studies on data-driven firms and supply chains must investigate the influence of digitalization on business performance and industries. Theoretical advancements and empirical analyses in this area, however, are lacking, particularly in the context of developing economies. The focal point of this research is to bridge the mentioned disparity by investigating how the utilization of digital supply chain processes influences the operational efficiency within the pharmaceutical sector of the Khyber Pakhtunkhwa province in Pakistan. Through a comprehensive analysis, this study aims to shed light on the intricate relationship between digital supply chain strategies and the overall performance dynamics of the pharmaceutical industry in this region.

Research Question and Objectives

The primary question of this research is 'what is the influence of the digital supply chain on overall operational performance of pharmaceutical firms operating in Khyber Pakhtunkhwa?' The corresponding research objectives are:

i. To examine the influence of DSC on Operational Performance (OP).
ii. To analyze the influence of DSC on Productivity Performance (PP).
iii. Examining the influence of DSC on Cost Reduction Performance (CRP).
iv. To evaluate the effect of DSC on Quality Performance (QP).

Research Significance

The results of this investigation deliver a noteworthy contribution to the understanding of the "human aspect" involved in adopting a digital supply chain. Managers can add value by adopting digitalization to expand the supply chain's planning, implementation, and improvement processes and enhance work satisfaction and performance. Organizations that now utilize or intend to digitalize their supply chain processes may benefit from the findings regarding positive effect of DSC on operational performance. The study's results add to the academic literature on the DSC.

Operational Definitions

Digital supply chain

It denotes the application of sophisticated information systems and innovative technologies that augment the amalgamation and elasticity of the supply chain, thus optimizing customer service and ensuring the sustainability of the enterprise.

Operational Performance

Operational performance is a firm's overall performance to produce better results and is measured through constituent factors of productivity, cost reduction, and quality performance.

Literature Review

Digitalization

According to Traum, Müller, Hummert & Nerdinger (2017) "The process of digitization involves the implementation or heightened utilization of information and communication technologies (ICT) by people, businesses, sectors, and communities, resulting in notable outcomes such as swiftness, augmented abstraction and flexibility, and the personalization of procedures and end results." (p. 4). To generate new income and value-adding opportunities, digitalization may be comprehended as the undertaking of implementing digital technology to enhance the generation of value, streamline occupational processes, and modify business models (Gobble, 2018; Gong & Ribiere, 2020). The implementation of digitalization facilitates the progression of the organization towards digital transformation through the mechanization of processes resulting in enhanced outcomes. The goal is to bring about radical innovation and improvement within an organization so that it may strategically leverage its resources and competencies to produce value for its stakeholders (Gong & Ribiere, 2020). The digitalization of business processes advances new models for processes and design, influencing how businesses produce increased values for the corresponding business partners, including clients and suppliers (Nadeem, et al., 2018). Digitalization creates and harvests value using digital technologies and information (Gobble, 2018; Ritter & Pedersen, 2020). The two main objectives of firms planning to invest in digitalization are to reduce the risk of market uncertainties and to gain competitive advantages (Gong & Ribiere, 2020). Incorporating novel digital technologies, including but not limited to the 5G, sensors, Internet of Things (IoT), Artificial Intelligence, Blockchain, data analytics, virtual and augmented reality, collaborative robots, and portals for supplier collaboration, facilitates the metamorphosis of manufacturing and logistics firms' operations (McCarthy & Ivanov 2022).

Challenges of Pharmaceutical Supply Chain

The supply chain in pharmaceutical sector is comprised of a complex web of stakeholders and the corresponding connections. This network is responsible for the manufacture, supply, distribution, and sales of essential pharmaceutical goods, which are then disseminated to consumers at the appropriate location and time (Sabouhi, Pishvaee & Jabalameli, 2018). Numerous public sector organizations, hospitals and medicine makers, clinics, pharmacy chains, distributors, retailers, and research institutions are the major participants in a pharmaceutical supply chain (Kapoor, 2018). Pharmaceutical companies lose millions due to temperature changes that cause spoiling, significant patient dangers, and subsequent regulatory actions (Sharma, Kamble, Gunasekaran, Kumar & Kumar, 2020). Most biologic goods, which are extremely sensitive to storage conditions, are made by pharmaceutical producers. When transporting or storing certain pharmaceuticals, cold chain procedures must be followed to control temperature (Singh, Dwivedi & Srivastava, 2020). The active substances in biological goods tend to be highly valuable, have a limited shelf life, and have tight temperature requirements. According to Singh et al. (2020), cold chain procedures include cold storage, cold transport and associated personnel. Biological products include many valuable active components with a limited shelf life and strict temperature requirements.

Digital Supply Chain (DSC)

The group of companies and suppliers that are involved in the manufacturing and sale of a certain item is referred to as the "supply chain". The term pertains to the activities that are required in order to offer customers with some market offerings. According to the Supply Chain Council, the aforementioned phases can be effectively managed through the utilization of the model of Supply Chain Operations Reference, which encompasses various processes like Sourcing, Planning, Manufacturing, Delivering, and Returning. This model can be used to manage the various stages (Seyedghorban, Tahernejad, Meriton, & Graham, 2020). The DSC is a mechanism that is advanced, customer-focused, system-integrated, globally linked, and data-driven. It makes use of modern technology to generate products that are useful to consumers as well as services that are more easily available and more affordably priced. The DSC is a component of the Industry 4.0, which is also referred to as 4th industrial revolution, that offers assistance to enterprises in the process of integrating ecosystems within the context of their respective functional areas. According to Wu, Yue, Jin, and Yen (2016), another name for the intelligent supply chain is the DSC. It is made up of innovative networked work processes that outspread beyond local, secluded, and single-company applications to supply chain-wide smart implementations that are systematic in nature.

The supply chain network's stakeholders and ecosystem may be broken down into a number of categories, i.e.: suppliers, producers, warehouses, and distribution centers. According to Sabouhi et al. (2018), the connections in the supply chain ecosystem are liable for the purchase of raw materials, the creation of a product, its distribution, and the sale of that product to clients. According to Sabohi et al. (2018), an SCM has to incorporate effective management of the movement of information, finances, and resources across the many constituents of the web in order to boost both customer satisfaction and total profit. According to Kapoor (2018) the administration of sourcing, procurement, conversion, and logistics operations is what the council of SCM specialists describes as supply chain management (SCM). When developing a digital supply chain, the goal for a management pertains to the maintenance of the supply chain's efficacy so that it can successfully satisfy the customers demand and thrive in a market that is very competitive. Charting a course for the future of the Digital Supply Chain in the Pharmaceutical Businesses, the company's strategy relative to its strategic ingenuities is referred to as the digital strategy (Schallmo, Williams, & Lohse, 2019). This strategy includes end-to-end procedures including collection of requirements, planning, risk identification, finding and evaluating opportunities, and sustaining the digital strategy (Schallmo, Williams, & Lohse, 2019).

According to the findings of a poll (Lehmann, 2018), seventy-three percent of respondents said that digitization has assisted them in achieving operational excellence. According to Schallmo et al. (2019), the objectives of a firm to become more digital take the form of a "digital strategy" when digital technology and methodologies are implemented in the context of products, services, procedures, and commercial frameworks, they can facilitate significant enhancements and transformational changes. According to Alice, Racher, and Seiffert (2020), supply chain managers have the ability to transition the present non-digital supply chain model into a digitized version of the supply chain known as supply chain 4.0. In this model, computerization and digitization will enhance supply chain efficiency by automating operational activities. Business managers in the pharmaceutical business need to be aware of the benefits that an integrated digital supply chain eco system has over a traditional supply chain system. Traditional supply chains are gaining intelligence as they grow increasingly dependent on sensors for improved communication, automation, and decision-making as well as they transition from analog to digital formats. According to Wu et al. (2016), this overlays the means for a wealth of chances to cut costs and increase operational efficiency. According to Seyedghorban et al. 2020, a digital supply chain has several benefits, including improved inter-company logistics, increased information accessibility, visibility, and transparency, efficient inventory management, integration, and collaborative efforts.

DSC and Operational Performance

Information and communication technology (ICT) advancements have significantly impacted the development of human resource management (Thite, Kavanagh & Johnson, 2012). ICT has changed the role of the time unit in many ways, principally freeing up time and resources needed for participating in new strategic work in addition to authorizing financially simpler HR activities (Thite et al., 2012). As a result of every industry digitizing, including the pharmaceutical sector, it is inevitable that the sector continuously tries and adopts new technology. By giving personnel the appropriate tools and data at the right times, digital supply chains reduce expenses while increasing efficiency (Jeyalakshmi & Rani, 2019).

Performance is how well a task is completed compared to the lofty standards of accuracy, completeness, cost, and speed originally envisioned. Technology use outside moral boundaries and performance improvisation in groups and individually unquestionably push the firms to the edge. The demand for improved service performance drives technological trends toward more potent, integrated, and ascendible system elements. The majority of employees thought that digitalization had boosted their skills. Most employees said that their workload had significantly decreased and that the digitization of the supply chain had made the processes simpler and more user-friendly (Jeyalakshmi & Rani, 2019). Along with cost savings, the digitalization of the supply chain has a stronger effect on performance. According to HSBC (2017), digitization is more likely to boost worker performance than financial enticements, supporting the beneficial impact. Due to digitalization, performance has significantly grown, but on the other hand, it is also noticed that some performance difficulties have a negative impact on operational performance (Jeyalakshmi & Rani, 2019).

Additionally, productivity, quality, and cost are chosen as the performance criteria based on earlier research by Ward and Duray (2000), Maani and Sluti (1990), Wong, Boon-itt & Wong (2011), and Tracey, Vonderembse, and Lim (1999). The majority of published research (Wong et al., 2011; Abdallah, Obeidat & Aqqad, 2014; Dehning, Richardson & Zmud, 2007; Fynes, Voss & de Brca, 2005; Boon-itt, 2011) has examined customary SCM components and their corresponding effects on operational performance. Such previous research serves as the basis for our research, which emphasize on many cutting-edge technologies used in SCM. Additionally, when the supply chain is integrated and coordinated with industrial activities, it becomes more sustainable and lowers operating costs (Junaid, Zhang & Syed, 2022).

Conceptual Framework and Study Hypotheses

The conceptual framework and hypothesis for the study are constructed using the knowledge from the prevailing literature and the theoretical foundation of the theories mentioned as follows.

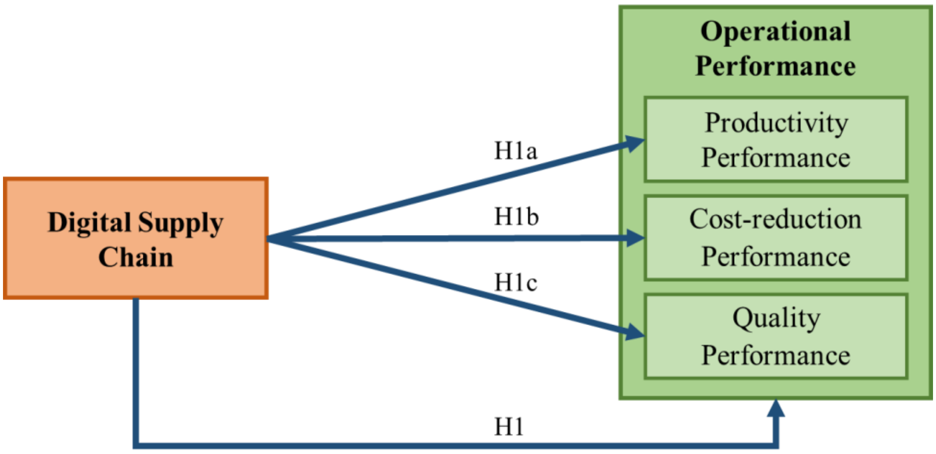

Figure 1: Conceptual framework and hypothetical model of the study (Source: Adapted from Saryatmo & Sukhotu (2021))

Theory of Constraint

Theory of Constraints (TOC) serves as the study's intellectual foundation. According to the TOC, most systems in everyday life are naturally straightforward and not complex due to a lack of significant core causes or restraints. By digitalizing the integrated supply chain ecosystem, Goldratt's (1990) TOC is utilized to evaluate organizational performances in terms of efficiency, visibility, and profitability. Business managers have chosen TOC as the conceptual framework mostly because they have found it successful in helping them achieve their objectives. Most business managers use TOC as a comprehensive operation management method to raise profitability, efficacy, and efficiency across the manufacturing process (Modi, Lowalekar & Bhatta, 2019). Managers in the pharmaceutical industry also use the theory of competitive advantage to supplement the TOC and attain a competitive edge. Competitive advantage theory is based on a value chain as a framework for planning and innovation, and each link constitute activities that improve the chain as a whole (Pontinha, Wagner & Holdford, 2020).

According to Porter's (1980) competitive advantage theory, decisions should be taken at all levels, including national, corporate, local, and individual. Manufacturing executives can utilize the competitive advantage hypothesis to distinguish their goods and services from their rivals by providing customers with certain goods and services at a reduced price (Bel, 2018). Focus, distinction and the cost of leadership are three generic strategy development techniques that Porter (1980) discussed. Business leaders may serve a particular segment and niche by concentrating on distinctive products and services specifically created for that market. Business leaders can reduce their exposure to competition by focusing on a focused aim. Differentiation enables business leaders to develop distinctive goods or services to outperform rivals. Corporate leaders' ability to control expenses to maximize return on investment is referred to as the cost of leadership. According to Lee and Falahat (2019), digitalization may not have a direct influence on a company's competitive advantages, but it does have considerable indirect implications on the benefits that goods and services provide. According to Porter (1980), a company's competitive advantage may be referred to as the extent to which it is able to build a position that can be defended against its competitors. According to Liao, Deschamps, Loures, and Ramos (2017), some examples of competitive advantages include a shortened product development cycle, affordable pricing, flexibility, quality, timely delivery, and environmental friendliness. According to Lee and Falahat (2019), business managers need to embrace digitalization and be ready for the appropriate digital technologies in order to speed the process of gaining a competitive edge over their competitors.

The following hypotheses are put up for this research based upon the conceptual framework and theoretical underpinning that was discussed previously:

H1: DSC positively affect Operational Performance (OP).

H1a: DSC positively affect Productivity Performance (PP).

H1b: DSC positively affect Cost Reduction Performance (CRP).

H1c: DSC positively affect Quality Performance (QP).

Research Methodology

This study examines the influence of DSC on operational performance. In this study, a deductive approach is used. The results are derived utilizing the original theoretical foundation since the underlying theory provides frameworks for measuring their respective constructs. The study constructs are linked with cause and effect relationships to produce a theory that can be examined and has a solid theoretical underpinning. The study's nature is descriptive and used a mono-method quantitative technique as its method of choice. Many types of research methodologies are used in business and management studies, including surveys, experiments, case studies, action research, ethnography, grounded theory and archive studies. The survey strategy is deemed appropriate for this study since it is thought to be the most in line with the quantitative methodology and deductive approach used in this investigation. Furthermore, a cross-sectional temporal horizon is considered suitable given that it was impossible to collect a list of every employee due to firms' privacy concerns.

Table 1
Samples Demographics

Demographic Variables	Group	Occurrence	Percentage
Industrial Estate	Peshawar	94	40
	Gadoon	79	33
	Hattar	64	27
Gender	Male	163	69
	Female	74	31
Age (Years)	20-29	37	16
	30-39	52	22
	40-49	87	37
	50-59	44	19
	60 and above	12	5
	Non-response	5	2
Experience (Years)	1-9	49	21
	10-19	93	39
	20-29	74	31
	30 and above	19	8
	Non-response	2	1
Education	Intermediate	29	12
	Bachelor	98	41
	Master	81	34
	MS/M.Phil	26	11
	PhD	3	1

Notes: N=237

Population and Sample

Employees of pharmaceutical companies in Khyber Pakhtunkhwa, Pakistan, operating in Hayatabad, Hattar, and Gadoon Industrial Estates who are in charge of a company's supply chain or a higher position with authority over the operation of the business are the study's target population. However, pharmaceutical firms that have used digital supply chains were specifically chosen. List of pharmaceutical companies was acquired from KPEZDMC. Companies using DSC were selected companies using the following inclusion criteria:

- Having digitized processes and activities in their supply chain.
- Using automated/digitized record keeping.
- Using third-party Enterprise Resource Planner (ERP).
- Using self-developed Enterprise Resource Planner (ERP).
- Digitized processes are performed for at least 3 years.

The target sample was determined by first taking into account the overall size of these firms, measured in terms of the number of workers. The sample size for this investigation was determined using power analysis (Faul, Erdfelder, Buchner & Lang, 2009) through G*Power software. According to G*Power's findings, 108 subjects were deemed fit for the purpose of this study. The minimum sample required was further computed to be 220, per Kline (2005) and Hair, Sarstedt, Ringle & Gudergan (2017)'s guideline of 10–20 cases per construct indicators as a good sample. Then, samples from each of these companies was chosen using a quota sampling approach. Quota sampling was used to give appropriate representation to both small and large companies. Quotas were determined using the following formula.

$$Quota_{Comp} = \frac{Sample\ Size}{Total\ Population}\ x\ Population_{Comp}$$

There were total of 250 survey questionnaires sent out, and out of them, 241 were returned. Finally, data for 237 respondents were analyzed, since four of the return questionnaires were discarded due to incompleteness. The demographics of the study participants are presented in Table 1.

Measures

In order to evaluate all of the study variables, standardized and validated scales derived from previously conducted research were utilized. To measure Digital Supply Chain, the scale was adopted from

Saryatmo and Sukhotu (2021). Operational performance was evaluated in terms of productivity, quality, and cost-reduction also adopting the scale from Saryatmo and Sukhotu (2021). Responses for both the scales stretched from 1 to 5, with 1 suggesting highly disagreement, 2 suggesting disagreement, 3 suggesting neutrality, 4 suggesting agreement, and 5 suggesting strongly agreement.

Data Analysis and Results

Using first-generation approaches for multivariate analysis has been widespread in the social sciences. However, over the course of the past twenty years, academics have increasingly turned to structural equation modeling, a method of analysis that belongs to the second generation. As a first step in the process of data analysis, descriptive statistics were compiled with SPSS 25 in order to gain some understanding of the features of the sample. The statistical data analysis procedures used in this study were quite thorough, and they were performed in accordance with the research strategy and design. PLS-SEM path modeling was used to design and evaluate the hypothesized model in line with the suggestions made by Rigdon (2016), Ringle, Sarstedt, Mitchell & Gudergan (2020), and Sarstedt, Ringle, Henseler & Hair (2014). This was done in accordance with the recommendations made by Rigdon (2016). In the PLS-SEM route model, Operational Performance was designated as a Type I higher-order reflecting-reflective construct, and Digital Supply Chain was incorporated as a lower-order reflective construct (Sarstedt, Hair Jr., Cheah, Beckle, & Ringle, 2019). Additionally, the PLS-SEM path model featured lower-order reflective constructions. The evaluation started with the evaluation of the exterior measurement model, then moved on to the evaluation of the inner structural model.

Table 2
Correlations among variables and descriptive statistics

	Minim.	Maxim.	Mean Values	SDev	Correlation Val.		
					1	2	3
1-DSC	1.1	5.0	3.261	0.907			
2-QP	1.00	5.00	3.268	1.018	.522**		
3-PP	1.00	5.00	3.269	0.987	.519**	.700**	
4-CRP	1.00	5.00	3.247	0.957	.484**	.645**	.639**

Notes: N-237, **. Correlation is significant at the 0.01 level (2-tailed).

Correlations and Descriptive Statistics

Descriptive statistics of the variables and correlations among study constructs are shown in Table 2. The results point out positive correlations among all study variables.

Measurement Model

In PLS-SEM context, assessing a measurement model involves examining internal consistency reliability, and the presence of convergent and discriminant validity. Scholars have proposed using Composite Reliability (CR) as a preferable gauge of internal consistency, a departure from the traditional reliance on Cronbach's alpha (Hair et al., 2017). For research explorations, it's considered suitable if a composite reliability score reaches 0.6, however, values surpassing 0.95 might signal redundant measures (Avkiran, 2018, p. 4).

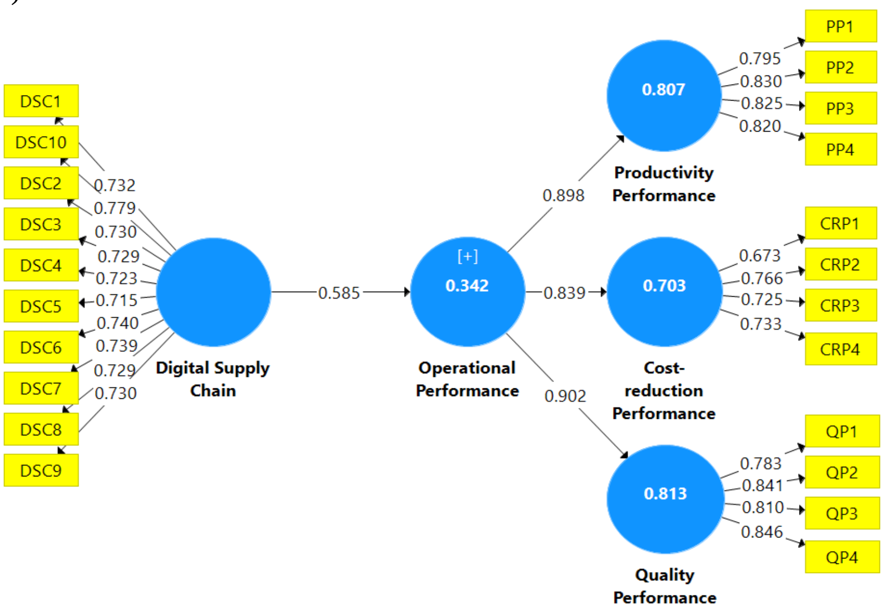

Figure 2: Measurement Model (PLS)

Table 3

Indicators loadings, internal consistency reliability and validity

Variables	Indicators	Loading	t statistics	CA	CR	AVE
Digital Supply Chain	DSC1	0.73	16.93			
	DSC2	0.73	15.32	0.905	0.921	0.540
	DSC3	0.73	17.31			

	DSC4	0.72	15.94			
	DSC5	0.72	13.79			
	DSC6	0.74	18.34			
	DSC7	0.74	15.77			
	DSC8	0.73	18.12			
	DSC9	0.73	18.27			
	DSC10	0.78	22.88			
Cost-reduction Performance	CRP1	0.67	13.99	0.698	0.816	0.526
	CRP2	0.77	19.87			
	CRP3	0.72	14.04			
	CRP4	0.73	15.69			
Productivity Performance	PP1	0.80	25.63	0.834	0.890	0.668
	PP2	0.83	33.04			
	PP3	0.82	35.62			
	PP4	0.82	31.71			
Quality Performance	QP1	0.78	20.64	0.837	0.891	0.673
	QP2	0.84	35.87			
	QP3	0.81	21.88			
	QP4	0.85	30.42			

Table 3 presents the CR values encompassing all constructs, which span from 0.816 to 0.921 as affirmed by the works of Nunnally and Bernstein (1994) as well as Hair et al. (2017). These readings notably endorse the tenets of internal consistency reliability. CV determination is a function of an indicator's outer loading and the Average Variance Extracted (AVE), a notion elucidated by Hair, Ringle, and Sarstedt (2011) alongside the subsequent publication of Hair et al. (2017). To meet the general criterion, outer loading ought to surpass 0.708%, a standard stipulated by Nunnally (1978) and further corroborated by Hair et al. (2017). The extraneous loadings, as depicted in Figure 2 and expounded upon in Table 3, surpass the pivotal threshold of 0.708, thereby indicating commendable outcomes. This underpinning of construct validity is further mirrored in the AVE values, which span from 0.526 to 0.673 across all constructs.

Table 4
Discriminant Validity (Fornell-Larker Criterion and HTMT Ratios

Variables	Fornell-Larcker Criterion				HTMT Ratios		
	1	2	3	4	1	2	3
1-CRP	***0.725***						
2-DSC	0.489	***0.735***			0.608		
3-PP	0.640	0.524	***0.817***		0.837	0.598	

4-QP	0.646	0.529	0.704	***0.820***	0.842	0.598	0.839

Notes: DSC=Digital Supply Chain, CRP=Cost-Reduction Performance, PP=Productivity Performance, QP=Quality Performance
The values at diagonal (bold and italicized) represents square root of AVE

"The extent to which a concept can be considered genuinely separate from other concepts based on empirical criteria" is what is meant by the term "discriminant validity (DV)", according to Hair et al. (2017), page 115. For assessing DV, the criteria developed by Fornell and Larker (1981) as well as the Heterotrait-Monotrait (HTMT) correlation ratio developed by Henseler, Ringle, and Sarstedt (2015) were utilized. According to the Fornell and Larker criterion, the square root of the AVE for each construct ought to be bigger than the bivariate correlations with all of the other constructs (Hair et al., 2017). The square root of the AVE values (Table 4) for each component were higher than the correlation between the constructs. This was the case for all of the components. According to Clark and Watson (1995) as well as Gold, Malhotra, and Segars (2001), the HTMT ratio must be lower than 0.85 or 0.90. At the HTMT0.85 level, all of the components displayed discriminant validity, as seen in Table 4, which contains the HTMT ratios.

Structural Model and Hypothesis Testing

The structural model was evaluated based on factors such as the Path coefficients (β value) and related T-statistic values, bias-corrected Confidence Intervals, the coefficient of determination (R^2), the Effect size (f^2), and the Predictive relevance of the model (Q^2).

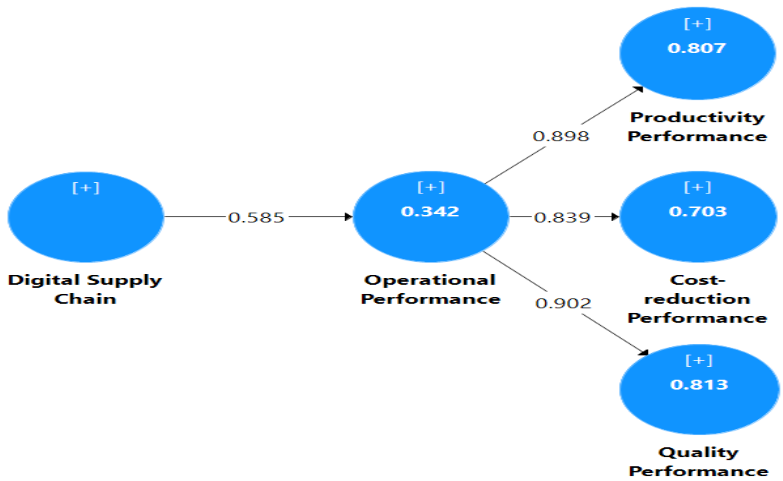

Figure 3: Inner Structural Model

Table 5
Internal structural model and testing of hypothesis

Relationships	Coef.	T Statistics	P Values	Confidence Interval		R^2	F^2	Q^2
				LL	UL			
DSC → OP	0.58	14.42	0.00	0.50	0.66	0.34	0.52	0.15
DSC → CRP	0.49	13.23	0.00	0.42	0.56			
DSC → PP	0.53	13.68	0.00	0.45	0.60			
DSC → QP	0.53	13.65	0.00	0.45	0.60			

Notes: Notes: DSC=Digital Supply Chain, OP=Operational Performance, CRP=Cost-Reduction Performance, PP=Productivity Performance, QP=Quality Performance

The findings demonstrate a satisfactory R^2 (0.34) for the Operational Performance (OP) construct, signifying that the Digital Supply Chain (DSC) can account for 34.5% of the variance in OP. Moreover, the outcomes suggest that DSC has a significant impact on OP (F2 = 0.52). The predictive relevance of the model for OP is apparent from the Q^2 value (Q^2 = 0.15) displayed in Table 5. Additionally, utilizing the bootstrapping procedure (5000 subsamples), the path coefficient results reveal that DSC has a substantial positive effect on OP (β=0.58, T=14.42, p=0.00). Consequently, the results affirm H1, which posits that DSC has a favorable influence on OP in the pharmaceutical sector of KP. The result also indicated that DSC has significant positive effect on dimensions of operational performance (OP). It is evident that DSC positively affect Cost-Reduction Performance (CRP) (β=0.49, T=13.23, p=0.00), Productivity Performance (PP) (β=0.53, T=13.68, p=0.00) and Quality Performance (QP) (β=0.53, T=13.65, p=0.00). This provided grounds for acceptance of the hypotheses H1a, H1b, and H1c. The results therefore supported all the study hypotheses.

Discussion

The study provides a substantial contribution to our grasp of the "human aspect" of transitioning to a digital supply chain. Although digital transformation is becoming increasingly important to assure supply chain efficiency, visibility, speed, and quality, certain pharmaceutical sector managers have historically been reluctant to technology change (Jacques, 2017). This is despite the fact that digital transformation is becoming increasingly necessary. However, managers may add value by applying digitalization to increase employee happiness and performance, as well as the planning, implementation, and improvement processes of the supply chain (James, 2017). This will strengthen the supply chain's overall ability to meet customer demands. The findings demonstrating the favorable influence that DCS has on operation performance may be beneficial to organizations who are either in the process of digitalizing their supply chain operations or have plans to do so in the near future. The findings of the present investigation are consistent with those of prior studies. Bartezzaghi and Turco (1989) suggest that operational performance is composed of the tangible outputs resulting from implemented operational strategies, which are influenced by operating conditions and reflect the inherent qualities of a manufacturing system. The authors also propose that operational performance is a gauge of a manufacturing system's overall effectiveness. Similarly, Lu, Ding, Asian, and Paul (2018) contend that operational performance is a fundamental facilitator of the comprehensive supply chain performance, which is ordinarily a product of multiple factors and enablers in the system. These scholars assert that operational performance is a critical enabler for the comprehensive supply chain performance. Prior research has established that quality, productivity, and cost are the performance metrics (Maani and Sluti, 1990; Ward and Duray, 2000; Wong et al., 2011; Tracey and colleagues, 1999).

According to the results of the research, implementing a DSC has a wide impact on qualitative performance, which is the most important component of operational performance. According to the findings of Fawcett, Wallin, Allred, Fawcett, and Magnan (2011), the two factors that have the largest impact on the level of success that a business achieves are supply chain integration and the organizational environment of a culture of information sharing. Kwon, Lee, and Shin (2014) found that there is a favorable association between the use of digital technologies, such as big data, and the performance of a corporation. Their findings suggest that digitizing a company's supply chain may both enhance data quality management and the company's ability to compete effectively in the market. In addition, companies that conducted research on the consequences of adopting digital technologies, particularly big data analytics, found that the implementation of such technologies had a beneficial impact on the quality of their products or services (Sharma & Joshi, 2020). As a consequence of this, the findings of the study provide evidence that supports the conclusions of previous investigations. The findings also provide credence to the findings of Agus (2011), which suggested that quality-related performance in Malaysian manufacturing enterprises is favorably connected with the use of conventional supply chains. The results of this study complement these findings. The results of a recent research (Wang, Altaf, Al-Hussain, and Ma, 2018) confirm that the application of new IoT technologies in supply chain management settings increases product quality visibility and traceability.

The outcomes of this study provide credence to the idea that a digital supply chain might have a beneficial impact on the level of productivity achieved. According to the findings of Abdallah et al. (2014), supply chain practices have a significant and positively significant impact on performance in terms of both effectiveness and productivity. They proposed that manufacturing businesses in Jordan strengthen information sharing and customer integration in order to improve supply chain performance, and their recommendation was based on a sample of 104 manufacturing enterprises in Jordan. In addition, Ellis, Morris, and Santagate (2015) state that the incorporation of IoT into the supply chain will boost industrial productivity in all aspects, including speed, flow, and quality. In addition, Zhou, Liu, and Zhou (2015) come to the conclusion that the use of digital technologies like blockchain can result in considerable increases in both productivity and efficiency. According to Foidl and Felderer (2023), digital technology offers a tremendous amount of untapped potential since it has the ability to enhance production procedures all the way through the value chain.

The favorable impact that digital supply chains have, in terms of cost reduction the outcomes of the study, which are in line with the conclusions of earlier studies, lend credence to the performance. Previous study has demonstrated that digital technologies are built to promote performance that is geared at reducing costs. For instance, Gunasekaran and Ngai (2004) found that supplier-customer integration of digital information technology systems is a cost-effective choice for collaborative work. This was one example of their findings. In addition, Zhu and Kraemer (2002) conducted an investigation into the data collected from 260 different manufacturing organizations and discovered that digital information technologies are significantly and favorably connected with corporate performance (cost reduction, profitability, and inventory efficiency). Researchers Yu, Chavez, Jacobs, and Feng (2018) discovered that a data-driven supply chain improved supply chain capability and was substantially connected with the success of financial performance using data obtained from the Chinese manufacturing sector. In addition, Raman et al. (2018) conducted a poll with workers of international firms located in the United States of America, Asia, Australia, Europe, and the Middle East. According to their results, data analytics and the Internet of Things have an effect on the amount of money saved in the supply chain, the level of happiness felt by consumers, and the level of operational excellence.

Implications of the study

The study's results enhance understanding of operational performance in relation to digital supply chain. The findings can help managers to add value by adopting digitalization to improve the supply chain's planning, implementation, and improvement processes and enhance work satisfaction and performance. Organizations that now utilize or intend to digitalize their supply chain processes may benefit from the findings regarding positive effect of digital supply chain on operational performance. Managers in pharmaceutical firms are recommended to adopt digitization of supply chain. In the process the productivity performance and cost reduction performance can be enhanced. This will also lead to increase quality performance; thereby quality products can be produced in the most important pharmaceutical sector. In addition to contributing to the academic literature on the digital supply chain, the study's findings on the impact of DSC on operational performance offer viable directions for future research.

Limitations of the Study

This research has a number of limitations. The scope of the study is restricted to the pharmaceutical business of KP, which is located in Pakistan. Inferences about the chain of events that led to the observed effects can only be made with some degree of precision because the research design was cross-sectional. In order to choose samples from within the quotas, a method called non-random sampling was utilized. This method has the potential to result in self-selection bias as well as the non-representativeness of the sample, both of which restrict the generalizability. The current study solely looked at the correlation between DSC (as an independent variable) and OP (as an outcome), but a significant number of other studies have also indicated looking into mediating and moderating models. The only thing that was looked at in this study was the relationship between the two.

Future Research Directions

As a result of several limitations of the study, it is suggested that future research should (1) make use of longitudinal designs in order to obtain more accurate results in terms of the causality between variables, (2) select and study samples from a variety of fields and industries in order to validate the findings of this study, and (3) make use of probability sampling techniques in order to increase the extent to which the findings can be generalized. The direct association between DSC and OP was investigated in this study; however, (4) future research that includes mediating and moderating models may provide interesting findings. According to Ergeneli et al. (2010), one of the most important factors that determines operational effectiveness is job satisfaction. However, it is not explored as a mediator between dynamic systems thinking and its outputs (such as quality, productivity, and cost reduction performance). It has been suggested, based on both empirical and theoretical data, that the mediating function played by work satisfaction between DSC and OP need to be studied. According to Hair et al. (2017), the intermediate values of R2 for OP show that other factors are also at play, and it is recommended that any future research investigations of DSC and OP incorporate other theoretically relevant domains.

Conclusion

This study examined the impact of digital supply chain strategy on the operational performance of KP, Pakistan pharmaceutical industry employees. The findings suggest that digital supply chain has a significant and positive effect on operational performance and its constituent dimensions (cost reduction performance, productivity performance, and quality performance). The results of the study contribute significantly to our comprehension of the "human aspect" of adopting a digital supply chain. By employing digitalization to enhance the supply chain's planning, implementation, and improvement processes and operational performance, managers can add value. Organizations that are currently digitalizing or plan to digitalize their supply chain processes may benefit from the findings concerning the positive impact of DCS on operation performance.

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