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Impact Of Supply Chain Collaboration and Supply Chain Flexibility on Operational Performance: Mediating Role of Digital Technologies

[1]Muhammad Sufyan Ramish,
[2]Museara Bhutto,
[3]Samiya Hameed,
[4]Rehan Muzamil Butt,
[5]Ikramuddin Junejo*
[1]Associate Professor, Institute of Business and Health Management (IBHM), Ojha Campus, Dow University of Health Sciences, Karachi, Pakistan.
E-mail: smsufyan@gmail.com
[2]Lecturer, Department of Management Sciences, SZABIST University Hyderabad, Pakistan
E-mail: museara.bhutto@hyd.szabist.edu.pk
[3]Senior Lecturer, Bahria University
E-mail: samiyahameed.bukc@bahria.edu.pk
[4]Assistant Professor, Karachi Institute of Economics and Technology
E-mail: rehan.butt@kiet.edu.pk
[5]Assistant Professor, Department of Management Sciences, SZABIST University Hyderabad Campus, Pakistan.
E-mail: ikramuddin8022@yahoo.com (Corresponding Author)

Abstract

This study aimed to investigate the mediating role of digital technologies on the relationship between supply chain collaboration and supply chain flexibility on the operational performance of private hospitals in Pakistan. The study used a quantitative research paradigm and cross-sectional survey research design. Percipients of the study were 229 managers and administrators from private hospitals in Pakistan. As hypothesized in this study, structural equation modelling (SEM) was used to provide estimates of the relationships between the study variables. The findings of this study confirmed the direct effect of supply chain collaboration, supply chain flexibility and digital technologies on operational performance. Furthermore, the study revealed a partial mediation effect of digital technologies between supply chain collaboration and operational performance in private hospitals in Pakistan. This finding has practical implications for the management of private hospitals in Pakistan, empowering them with actionable insights. It highlights the importance of nurturing strong supply chain relationships, strategically adopting digital technologies, and aligning digital transformation with supply chain improvement efforts. The study also suggests that enhancing organizational collaboration and flexibility and leveraging big data for decision-making can be effective strategies for improving the operational performance of private hospitals.

Keywords: Supply chain collaboration; Supply chain flexibility; operational performance; Private hospitals; Developing country

Introduction

Among them, the efficiency of supply chain management (SCM) and supply chain resilience (SCR) have appeared to be the most recent and fashionable themes in academic and manufacturing flooring (Chowdhury & Quaddus, 2016). Much of this attention is attributed to globalization and global pandemics, which compel the firms to synchronize the total SC to optimize resource utilization, cultivate new capabilities, and secure organizational sustainability. SCM embraces all the processes involving moving goods, information, money, and the associated resources through different companies. While SCM aims to achieve the effectiveness of product flow and increase SC profitability, the risk of every operation in SC is present because of uncertain and vague information that can be distorted (Truong & Hara, 2018). Thus, depending on the definition of SC resilience given at the beginning of this paper, SCR as the ability to avoid most

of the SC disruptions and, if they happen, to keep their consequences minimal is a critical area of concern. Risk is a universally familiar part of a business – each firm experiences various risks that disrupt information and materials. SCs are also susceptible to internal and external disruptions like economic downflows, problems from losing essential buyers, and the quality of new technology/infrastructure (Renne, 2012).

Also, under the pressure of applying digital technologies, most firms have come to acknowledge the significance of SCR in their businesses (Yuan & Pan, 2023). Because of the technological advancement that the world is experiencing, digital technologies have offered assistance in some of the following areas: the decision-making processes concerning the formation of SC operations, examination of various factors in a chronological manner to provide the correct data at the right time; the development of interfaces among the SC partners, hence promoting improved SC integration, and also identifying potential disruption points before they cause a chain effect (). Through automation, firms can contest or adapt to such changes on time. Hence, when disruption occurs, a condition that may constrain the performance of the entire SC, digital technologies can be leaned on to enhance the overall performance of the SC (Belhadi et al., 2024). Hence, some research questions for examining the link between SCR and operational performance and establishing the mediating effect of adopting digital technologies over this relationship.

The following research questions guided this study:

RQ1: Does supply chain collaboration matters for operational performance?

RQ2: Does supply chain flexibility matters for operational performance?

RQ3: Does digital technologies mediates relationship between supply chain collaboration and operational performance?

Some research works argue that developing countries are also involved in the global SC and experience SC disruptions, which means that many firms in developing countries experience many risks and disruptions because of politics (Aman & Seuring, 2023). Consider a country's social, economic, and cultural contexts before extending its arms to those specific countries. It was observed that private healthcare has a massive influence on Pakistan's healthcare sector and is a part of the economic system. The private healthcare sector in Pakistan consumes as much as 70% of the total healthcare expenses at present and contributes to 2-3% of Pakistan's GDP (Saleem, 2023). However, the situation in Pakistan's private sector is challenging in terms of collaboration and flexibility of supply chains. Among them, one of the most important is the need for integration and cooperation between private hospitals, suppliers, and distributors. It often results in disruption of the supply chain, shortage of stocks, and ineffectiveness of the supply chain.

Furthermore, the relationships with hospitals and suppliers are often tactical and non-strategic and, hence, do not involve long-term visions and solving problems (Alhammadi et al., 2023). A fourth significant challenge is that many medical requirements, such as medical devices, equipment, and drugs, are imported. The following significant input resources show this vulnerability and the susceptibility to disruptions in global supply chains, which affects availability and cost. Other problems facing private hospitals include a long procurement cycle, which hampers the ability to respond quickly to demand changes or shortages. Nonetheless, given the significance of analyzing issues of disruption and SCR, the area needs to be focused on adequate academic attention concerning context in developing countries (Gaudenzi et al., 2023). The literature is concerned with the effect of SCR on operational performance under the (assumption) of applying digital technologies to developed countries with scant attention to developing ones.

Theoretical contribution and hypothesis development

According to the Resource-Based View (RBV) theory, a firm's competitive advantage and superior performance stem from possessing valuable, rare, and inimitable resources and capabilities (Salsabila et al., 2022). These resources can be material (financial, physical) or non-material (knowledge, skills, information, technology). Supply chain collaboration could be defined as the level at which organizations in a supply chain conform to one another, interact, share details, and coordinate their decisions and actions to achieve better results (Brun et al., 2020). This might be considered a relational capability that provides information exchange, integrated decisions, and cooperation among the SC members. This can give rise to distinctive hard-to-photocopy supply chain capabilities that could help improve operational efficiencies. Supply chain flexibility, therefore, refers to the capacity of a supply chain to respond to change and manage change in the business environment, as in demand volatility, supply variability, or evolving customer needs (Kazancoglu et al., 2022). Supply chain flexibility can thus be seen as a dynamic capability that measures an organization's ability to react or respond to changes in the business environment. The supply chain resources and more flexible activities allow the organizations to understand better, respond to the customers' requirements, and manage adversity, thus enhancing operations performance. Advanced information and communication technologies include utilizing technology tools in supply chain activities, including ERP systems, SCM software, data analytics, and other novel technologies such as blockchain and the Internet of Things. Information technology can be regarded as an information resource that can moderate supply chain collaboration, flexibility, and operational performance nexus (Imtiaz et al., 2023). By advancing communication and decision-making capabilities, digital technology can easily support the supply chain goals to offer a better overall performance.

Hypothesis development

Suppl chain collaboration

In the current competitive environment, cooperation in the SC network is a necessity for all members of a SC (Hosseini-Motlagh et al., 2021). Partner response is the capacity of an organization to coordinate with its partner in response to SC disruptions by planning, knowledge, and information exchange to organize an immediate response. SCC is defined as the state of affairs whereby two or more separate firms engage in the planning and execution of SC operations (Ramjaun et al., 2024). In SCs, collaborations are essential and, highlighted here, must be emphasized. As the following points reveal, SCC has many benefits concerning efficiency and efficacy, resource consumption and output rates, and, of course, SC transparency, serving the needs and enhancing the trust of stakeholders (Ebinger & Omondi, 2020). Companies gain from relational mutual links for numerous purposes; hence, one is sharing and reducing risks, and the other is on excess information and access to complementary resources that enhance the business's financial performance and competitive strengths. While scholars have paid acceptable attention to the theoretical analysis of collaborative SCs, partners within many SCs have often been deficient in responding to the goal of achieving mutual benefits (Ralston et al., 2020). SCC is viewed as the engine for positive and efficient SCM strategies. The authors noted that such application of SCC practices is necessary to develop stabilized capability and consequently increase performance. Cooperation processes thus assist in developing sound relationships with its SC partners because of collaborative efforts and credible and timely data from all partners (Rejeb et al., 2021).

H1: SSC positively related to OP.

H2: SSC positively related to DT.

Supply chain flexibility

In the current literature, SCF is defined as the capacity of a system, especially a firm involved in manufacturing, to adapt to undesired system changes like equipment breakdowns, inventory control, changes in work time, and reworking (Love et al., 2024). In essence, it is the ability to change or the predisposition to respond to flexibility, and SCF research in the lenses of a firm has been discussed. Many firms have widely applied it to create capabilities and align changes with the market to obtain a competitive advantage and superior business performance (Abdulwase et al., 2020). The following benefits are closely associated with SCF. They may help decrease costs, raise inventory turnover, shorten lead times, and decrease the number of defects, and the advantages push firms to advance their SC. There is dancing in the literature on the classification of SCF; for example, flexibility from upstream to downstream in SC activities, volume flexibility, and process flexibility (Eckardt et al., 2024). Upstream or manufacturing and operational flexibility means a process, scale, diversity, and worker and supplier integration in a particular procedure. The extent to which a company can adjust volume is called volume flexibility .Downstream flexibility is described as logistics activities that involve the control of inventory of the final goods, warehousing, and transportation to suit the customers' needs (Hipólito et al., 2022).

H3: SSF positively related to OP.

Mediating role of digital technologies

Multiple technologies linked to the internet have been used to define digital technologies. Digitalization is the application of computer and internet technologies to produce new economic value added or improve the value-added production process (Valaskova et al., 2022). CPS, AI, IoT, BDA, and cloud computing are some of the DTs that support connection, convergence, and automation in business processes that lie at the heart of business today. By comparing the two, SC digital technologies will be able to find a way of paring lead times, which in turn works to improve overall operational performance (Ning et al., 2023). In addition, with these data analytics tools, it is possible to make them part of digital learning systems that will increase initiative-taking and reactive measures in the case of disruption, thereby increasing the value of SCR and organization performance. Due to enhanced veracity and measurability, digital technology can deliver decision aid for the SC network based on data, possible measures, and solutions for possible disruptions (Park & Singh, 2023). However, the application of technologies such as big data or tracking and tracing technologies, among others, enhances the capability of supply networks to be ready for disruptions in line with the integrated SCs intended to make supply systems more ready for disruption (Razak et al., 2023).

H4: DT positively related to OP.

H5: DT mediates the relationship between SSC and OP.

Methodology

Research approach

Globally, every research study uses two primary categories of research methods: qualitative and quantitative (Strijker et al., 2020). In addition, the meshing of the two approaches is referred to as the mixed approach, where the research is descriptive and numerical. Qualitative research, therefore, ends with generating new ideas or building up a theory. On the other hand, a quantitative study is the relationship of one or several developed concepts or theories to another. In the case of the current research study, the hypothesis examined the relationship between the dependent and

the independent variables. However, these variables were drawn from theoretical frameworks and, as such, made it possible to adopt more of a quantitative research approach to conducting this study.

Data type

The author defined two significant sources of data collection: primary source and secondary source of data collection. Generally, in primary source data, the data is confirmed and collected immediately, and the researcher investigates the data keenly (Zina, 2021). Examples of primary data are questionnaires, observations, experiments, focus groups, and interviews. Admittedly, secondary sources encompass books, newspapers, journals, annual reports, Web sites, and research articles. The current research study employs primary data in its collection process since it will be fresh and collected by administering questionnaires.

Population and sample of study

The number of people that can be in the study, that is, the number of people available to engage in research and for being in research, is referred to as the population of the study (Casteel & Bridier, 2021). In this study, the population will be the employees working in manufacturing firms because the tenets of this study will seek to increase operational performance through flexibility in supply chain factors. Besides, the whole population can be somewhat related to achieving this objective. Thus, the author is more detailed on the population by target population to target the employees working in private hospitals of Pakistan in major cities, including Karachi, Lahore, Quetta, and Islamabad.

The sample size said that the selected sub-group is the representation of the whole population in context of study. The sample size should be one that will provide reliability in the results that are to be achieved. But in the present research study the sample size was taken 229 respondents. Measures for the variables were obtained by borrowing from other studies while modifying construct according to the context of the study. Since the research objectives were stated in terms of the degree of agreement or disagreements, a close-ended 5-point Likert scale questionnaire was formulated with items derived from the study variables (). The next process after data collection was data management processes of the collected data through data management plans.

Sampling strategy

The first process following the establishment of the target population involves data collection. However, it is impossible to cover the complete population targeted by the research as a researcher has limitations in terms of resources. Hence, () advises one to sample a few people from the targeted population and take a sample of a few respondents representing the whole population (Raifman et al., 2022). There are two main sampling types: probability sampling and non-probability sampling methods. The authors employed the non-probability sampling technique, which is precisely convenient sampling in the current study.

Scale development

Supply chain collaboration is the active process of developing cooperation across supply chain members to exchange information and coordinate their decisions and actions to achieve organizational and individual goals (Jraisat et al., 2023). Five research items adopted from the study of (Alkhatib & Momani, 2023) and sample research items was “Our company and partners in the supply chain exchange all relevant information accurately and in a timely manner”.

Supply chain flexibility is the capacity of a supply chain to respond effectively to changes in the organization's environment, such as changes in demand, supplies, or customer requirements (Shukor et al., 2021). Again, five research items were taken from the study of (Alkhatib & Momani, 2023) and sample research item was "Our company has the ability to deliver orders faster to customers leading to a better relationship with them".

Digital technologies relate to utilizing computerized information and communication technologies, such as ERP systems, SCM software, big data and analytics, and trends like blockchain IoT, to facilitate and improve the supply chain (Mohsen, 2023). Five research items from research of (Alkhatib & Momani, 2023) and sample research item was "Our company uses advanced technical capabilities to integrate product development and manufacturing processes together through computer-based systems".

Operational performance refers to several aspects of a firm that are related to its operations, for instance, efficiency, productivity, quality, cost, delivery, and responsiveness (Saragih et al., 2020). The variable was adopted from the study of (Alkhatib & Momani, 2023) and eleven research items were and sample item was "Compared to our competitors, our company can respond faster to changes in demand".

Software tool

SmartPLS is especially appropriate for analyzing the PLS path model since the latter is appropriate for solving models with latent variables relating to the constructs under study. It is proposed that digital technologies will partially mediate the association between supply chain collaboration and supply chain flexibility on the one hand and, on the other hand, the measure of operational performance. According to , SmartPLS offers options for testing mediated effects with SEM, and the study can examine the direct and indirect impact of the variables (Sarstedt et al., 2020). Thus, PLS-SEM is less sensitive to the sample size and only consciously depends a little on the data distribution's normality. This is helpful for research in contexts like the present study country, Pakistan, where the sample sizes can be restricted.

Results and Discussion

The present research adopted the SmartPLS 3 analysis program, tailored to the Partial Least Square Structural Equation Modeling (PLS-SEM) principle, to test the suggested research model and hypotheses. The importance of the SmartPLS 3 data analysis program is that the research model is very comprehensive, and the test of the association between variables can be done in one go (Santoso et al., 2023). The program is non-parametric and does not require the normality assumption. The SmartPLS 3 analysis program analyses the measurement model first, and then the structural model relationships are calculated. To assess the measurement model, one has to assess the confirmatory factor analysis alongside the reliability of the constructs and convergent validity. Since all the measurement items used in the model were formative, estimation was made using the consistent PLS algorithm or the PLS step. Thus, the findings indicate that the measurement model meets all the general requirements (Table 1). First, the value of factor loadings of indicators is greater than 0. 7. Second, for all the constructs, Cronbach's alpha and the composite reliability value are well above 0. 7. Third, all latent variables confirm the convergent validity of research hypotheses and models, unlike the critical value of 0.50 It can be seen that the average variance extracted (AVE) has a value of more than 0. 50. Table 1 below and Figure 1 show the student's responses to the questionnaire.

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Table 1. Reliability and Validity

Factors	Item SPSS coding	Value of outer loading	Value of Cronbach alpha	Value of Composite Reliability	Value of Average Variance Extraction (AVE)
Supply chain collaboration	SCC1	0.822	0.875	0.909	0.667
	SCC2	0.785			
	SCC3	0.823			
	SCC4	0.834			
	SCC5	0.819			
Supply chain flexibility	SCF1	0.824	0.905	0.930	0.726
	SCF2	0.806			
	SCF3	0.853			
	SCF4	0.897			
	SCF5	0.876			
Digital technologies	DT1	0.890	0.895	0.922	0.704
	DT2	0.811			
	DT3	0.816			
	DT4	0.861			
	DT5	0.815			
Operational performance	OP1	0.894	0.959	0.964	0.731
	OP2	0.844			
	OP3	0.869			
	OP4	0.859			
	OP5	0.851			
	OP6	0.881			
	OP7	0.829			
	OP8	0.864			
	OP9	0.826			
	OP10	0.831			

Hypotheses Testing

To form t-statistics, a bootstrapping technique involving 5000 resamples was employed to assess the significance of the factor loadings of indicators belonging to the latent variables. t-tests reveal whether the relationship of an indicator with the latent variable it comes under is statistically significant or not.

The results of the assessment of the Direct Effect of the structural model are reported in Table 2. Therefore, to estimate the study's hypotheses, structural equation modeling Partial Least Square (SEM-PLS) was performed. The study's first hypothesis is that supply chain collaboration has a positive and significant correlation with the firm's operational performance. The structural model analysis results indicate that it positively influences a firm's performance (β =0.376, t-value = 6.160). Thus, it can be inferred that the current study supports H1. (See Table 2 and Figure 1)

The study's second hypothesis is that Supply chain collaboration is positively related to digital technologies. Thus, the findings of structural model analysis indicate that positive is a significant determinant of digital technologies (β = 0.707, t-value= 24.083). Thus, the analysis supports H2. (See Table 2 and Figure 1)

The third hypothesis of the study is as follows: Supply chain flexibility positively correlates to the firm's operational performance. Thus, the structural model analysis concludes that positive influences a firm's performance: (β = 0.311, t-value = 4.903). Thus, the understanding of this research strengthens the H3 hypothesis that has been presented. (See Table 2 and Figure 1)

According to the fourth hypothesis of the study, digital technologies have a significant positive relationship with the firm's operational performance. The studies made for structural model analysis state that positive has previewed a significant impact on a firm's performance with the respective values of (β = 0.205, t-value = 3.648). In this way, the findings of the study corroborate H4. (See Table 2 and Figure 1)

The paths included in the structural model assessment (Indirect Effect) are presented in Table 2. In the case of mediating role estimation, the bootstrapping procedure was employed using PLS-SEM. The study's first hypothesis is that digital technologies positively mediate SC collaboration and Operation Performance. The findings of the current analysis supported H5, and it emerged that there exists a partial mediation effect as postulated, where the results of the analysis reflected those digital technologies positively mediate the relationship between supply chain collaboration and operational performance in (β = 0. 145, t-value = 3. 548). The percentages are summarized in Table 2 and illustrated in Figure 1; the numbers are presented in Table 2.

Table 2. Path directions

Paths	Value of Beta	T-Value	Remarks
Supply chain collaboration -> Operational performance	0.376	6.160	Supported
Supply chain collaboration -> Digital technologies	0.707	24.083	Supported
Supply chain flexibility-> Operational performance	0.311	4.903	Supported
Digital technologies -> Operational performance	0.205	3.648	Supported
Supply chain collaboration-> Digital technologies ->Operational performance	0.145	3.548	Partially accepted

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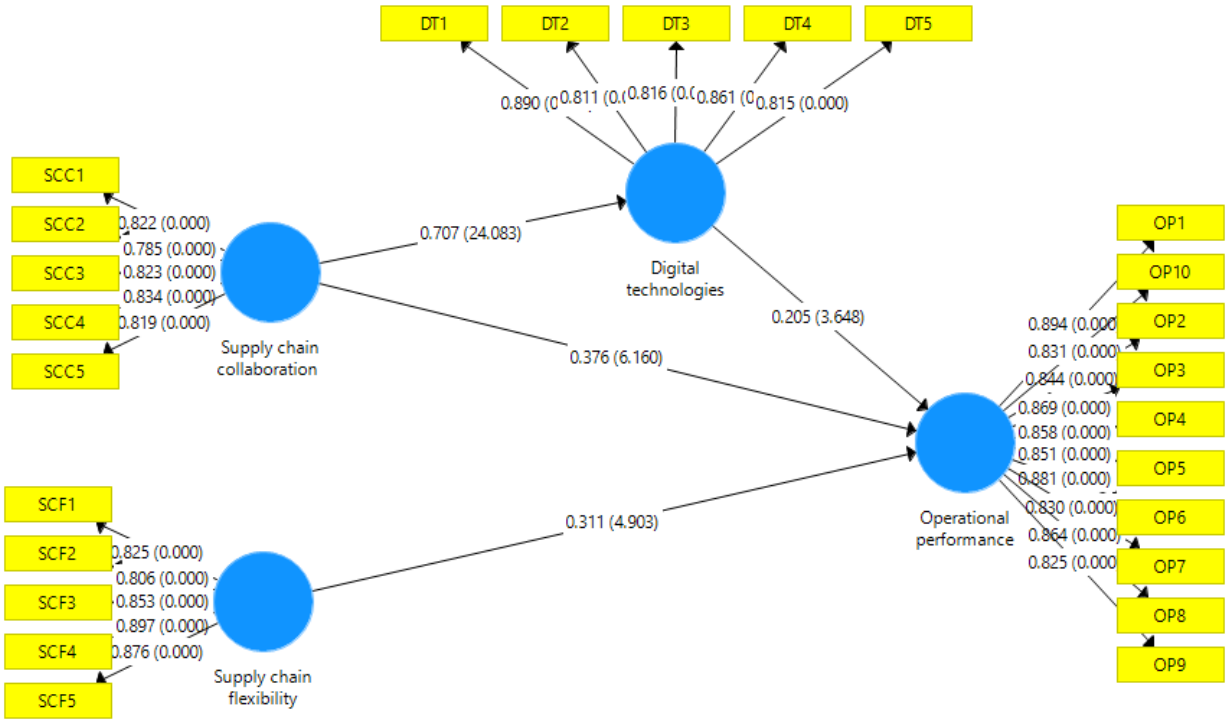

Figure 1. Structural Model

Discussion on results

In it has been argued that firms that get involved in attaining high levels of SCR are likely to get higher levels of SCR in future. Concerning the SCR-SCR-operational performance perspective, the study results showed positive statistical significance between total SCR as measured by its two dimensions, SSC and SCF and operational performance. This means that resilient SCs promote the enhancement of the level of operation (Zhang et al., 2023). This outcome aligns with comparable studies to indicate positive outcomes from SCR of enhancing operating performance across various environments (Laguir et al., 2023). However, as pointed out by, the strength of the relationship between the environment and the degree of product standardization issues is likely to occur. It has been ascertained that for the development of greater resilience, the costs have been more worthwhile for clients with unique products and where clients' contribution' is higher than for those where goods are standardized (Grossman et al., 2023). Thus, it is necessary to carry out further research that can reveal the fundamental nature of the relationship between SCR and operational performance across different sectors, economies, and contexts.

The findings of this study support the views of (), who stated that proactive flexibility and reactive flexibility will enhance operational performance by sharing timely and accurate information and concur with (Al Khalifa, 2021) to the effect that SCF plays a vital role as a mediation factor between SC integration and SC performance as this study revealed that when a firm is flexible in its SC, SC integration is likely to have a more positive impact of on SC performance. As a result, in the present highly competitive business environment, firms have no option but to engage their SC partners to enhance their SCs' competitiveness and boost SC performance (Garrido-Vega et al., 2023). For the flow of the mediating role, the results of this research work support the mediating effect of digital technologies on the SCC – operational

performance relationship. It has been argued that digital technologies, in general, have not been effectively utilized to create potential scenarios through virtual reality types that might enhance an agile response to address disruptions.

Concluding Remarks

This study aimed to examine the effects of supply chain collaboration and flexibility on the operational performance of private hospitals in Pakistan, with the moderating role of digital technologies. The research findings from this study have practical implications, as they can help to elucidate the various interactive linkages between supply chain collaboration, supply chain flexibility, digital technologies, and the operational performance of private hospitals in Pakistan. The study provides evidence that the source supply chain collaboration and the degree of supply chain flexibility are significantly related to the source's operational performance in private hospitals. Notably, the study also shows that the use of digital technologies partially mediates the link between supply chain collaboration and operational performance.

The first and most significant contributive factor discovered from the study is supply chain collaboration, which significantly influences the adoption and use of digital technologies in private hospitals. The fact that the effect of supply chain collaboration on digital technology is more significant than supply chain flexibility means that supply chain collaboration ability determines the extent of hospitals' digital transformation.

Managerial implications

The findings can be used as evidence to support that the efficiency of operations depends on the cooperation within the supply chain. The managers need to maintain a long-term, cooperative, and based-on-trust relationship with their supply chain partners, such as suppliers, distributors, and logistics providers. It can mean cooperation by sitting down and collectively devising strategies, sharing information, and intervening to solve problems affecting supply chain operations.

The role played by digital technologies as a mediator is especially indicative that private hospitals have no other option but to adopt, invest in, and manage several facets of digital solutions in the organization’s supply chain and operation. Managers should evaluate their requirements in digital technologies, implement crucial solutions, and align the technologies effectively throughout the organization.

Implementing this approach means that data and information technologies, especially data analytics technologies, can be used to improve supply chain decisions in private hospitals in line with the value strategies to be adopted. This powerful tool can empower managers to make better resource decisions, better understand the supply chain and its complexities, and improve operation performance.

Limitations of study

The research was confined to private healthcare units in Pakistan, which may reduce the study's credibility in other regions or healthcare provisions. Extending the study to other countries or comparing results between public and private sectors may give a richer picture of the observed relationships.

Using a cross-sectional research structure, it was seen that it provided only the picture of the relationship at that particular point. Some extension of these findings into dynamic complexities of the relationships may be derived from a longitudinal study. Hence, this type of study design could help explore further the changes that may be implemented in this study as

private hospitals continue to expand their practice in the supply chain management and implementation of digital technologies.

One of the study's key limitations was the lack of control for contextual variables, which could potentially influence the relationships under investigation. Research suggests that these contextual variables could have moderated or contingent effects, offering a deeper and richer understanding of the phenomenon.

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