

Linking Intellectual Capital to Supply Chain Resilience; Moderating role of Data-Driven Culture

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Received: March 19, 2025; Accepted: June 19, 2025

Abstract: This study examines how Human structural, and Relational capital influence supply chain resilience in the telecommunication sector, with the moderating role of a data-driven culture. Data were gathered from 201 employees from telecommunication firms in Rawalpindi and Islamabad employing convenience sampling method. Drawing on RBV, the current study shows that human, relational and structural capital support supply chain resilience in mitigating disruptions. Furthermore, the study highlights that the moderating role of data-driven culture between Intellectual capital (relational, structural & human) and SCR, illustrating the crucial role of data-driven culture in optimizing resilience strategies. The results underscore the need to integrate the data-driven culture to maximize resilience capabilities and provide strategic insights for businesses navigating unstable situations. The recommendations are crucial for telecommunication firms aiming to enrich their supply chain resilience in a volatile and competitive environment. The paper concludes by outlining important limitations and suggesting directions for future research to further our understanding of the role that intellectual capital plays in supply chain resilience in dynamic market situations.

Keywords: Supply chain resilience (SCR), Relational capital (RC), Structural capital (SC), Human Capital (HC), Data-Driven Culture (DDC)
JEL Classification Codes:

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1. Introduction

In the era of technological disruptions, changing consumer behavior and demands, erratic and catastrophic events (natural disasters and diseases etc.) have a significant and prominent impact on the supply chains of the organizations (Ciccullo et al., 2018; Ivanov & Dolgui, 2020; Luo & Zhu, 2020; Rahman et al., 2022). The coronavirus pandemic had severe adverse effects and businesses and organizations all across the world has experienced considerable losses because of massive disruptions in supply chain (Magableh, 2021; Mubarik et al., 2022). Because of the high frequency and severe effects for businesses and supply networks, supply chain disruption is a major management concern (Blackhurst et al., 2011; Lengnick-Hall et al., 2011). As a result, businesses create resilience to avoid or expedite recovery from interruptions (Bak et al., 2020; Hsu et al., 2022; Polyviou et al., 2020). COVID-19 caused immense damages across the world with an impact on the entire economy and the intensity of the losses is difficult to forecast (Magableh, 2021). Nevertheless, certain businesses, particularly those with somewhat resilient supply chain appeared to be better prepared for financial and operational disruptions (Ivanov, 2018; Rahman et al., 2022).

“Supply chain disruption management entails increasing organizational resilience through improved abilities to foresee, adapting, responding, recovering, and learning from disruptions” (M. H. Ali et al., 2021; Bui et al., 2021; Pettit et al., 2019). It necessitates coordination and involvement of entire supply chain processes along with stakeholders (Queiroz, Wamba, et al., 2022; Siva Kumar & Anbanandam, 2020). For organizations to develop SCR and minimize SC disruptions, they must establish capabilities

across their value chain (Polyviou et al., 2020; Rahman et al., 2022). The quintessence of SCR is to assist organizations to position themselves to hold out against the disruptions and recover effectively (Asamoah et al., 2020; Queiroz, Fosso Wamba, et al., 2022; Shela et al., 2023).

Intellectual capital makes the supply chain resilient by enhancing the redundancy, manufacturing, sourcing, and collaboration among the supply chains (Mubarik et al., 2022). In knowledge-based economies, IC is known as a critical and crucial resource for businesses (Shela et al., 2023; Tran et al., 2020). Intellectual capabilities can assist the organizations to establish capabilities for their supply chain network, which can enhance the SCR through integrating specialized and diversified experience, understanding, knowledge, and applicable skills from the workers to manage disruptions across supply chains (Asamoah et al., 2020; Shela et al., 2023).

The supply chain practitioners seek to enhance the decision-making capabilities to better understand the proneness of disruptions (Kusi-Sarpong et al., 2022; Singh et al., 2023). The real-time data assists firms to analyze supply chain risks and can determine the recovery actions for the organization (Hosseini et al., 2019). A DDC is a valuable tool in the organization that allows companies to turn data into actionable insights that can help them make informed data-based decisions (Manzoor et al., 2022; Yu et al., 2018). Digital technology and skills that strive to improve the processes and involve people across the organization to propose new business models that generate value have increased the odds of survival for enterprises (Manzoor et al., 2022; Yang et al., 2021). A company with DDC is seen to be more inclined to improve its data scanning skills and identify the greatest opportunities (Chatterjee et al., 2024; Duan et al., 2020; Storm & Borgman, 2020). By adopting a data-driven culture, organizations are able to effectively improve their ecosystem by responding to the quick and constantly shifting demands of the dynamic market (Chatterjee et al., 2024).

In the globalized world, where organizations are very much vulnerable to disruptions, risk mitigation can be done by information processing capabilities through developing strategies to resolve disruption in supply chain (Blackhurst et al., 2011; Chatterjee et al., 2024; Dubey et al., 2019). The real-time data can help to provide transparency through processes and can effectively contribute to building SCR in future (Dolgui et al., 2018; Ivanov & Dolgui, 2021). Telecommunication companies depend strongly on worldwide supply networks to secure all their essential equipment including fiber optics routers and mobile devices (Golany, 2014; Hamsal et al., 2021; Ngugi, 2013). Geopolitical tensions and natural disasters together with pandemics including COVID-19 create severe obstacles to the availability of essential telecommunications components (Chen et al., 2021; Hamsal et al., 2021). The capability or organizations to handle supply disruptions emerges from supply chain resiliency that allows telecom firms to explore different suppliers and keep essential stock together with nearby manufacturing capabilities (Daou et al., 2019; Hamsal et al., 2021; Kusi-Sarpong et al., 2022; Rimin et al., 2024).

The "Digital Pakistan" initiative along with others function as active promotion tools for digitalization from Pakistan's government. Implementing and sustaining digital initiatives including 5G networks and broadband expansion requires a robust supply chain infrastructure (Malik et al., 2023). The telecom sector presently contributes substantial value to Pakistan's economic production. The interruption of supply chains results in finance losses together with growing expenses while reducing funds available for infrastructure development. Supply chain resilience maintains stability in the sector because it supports continuous growth which generates economic benefits (Golany, 2014; Hamsal et al., 2021).

Maintaining supply chain resilience in the face of rising environmental instability, technological upheaval, and competitive market pressures is becoming more and more difficult for Pakistan's telecom industry. In the academic literature on resilience-building processes, this sector is still understudied, despite its crucial significance in national infrastructure and connectivity. Additionally, data-driven culture's transformative potential in enhancing the impact of intellectual capital on supply chain resilience is still theoretically undeveloped and practically unexplored. Addressing these gaps, this study draws on the Resource-Based View (RBV) to investigate how intellectual capital fosters supply chain resilience in Pakistan's telecommunication sector, and how data-driven culture serves as a strategic enabler in this relationship. Hence the research objectives that this study caters to (1) is to study the impact of Intellectual capital (RC, SC, HC) on supply chain resilience and (2) to study the moderating role data driven culture between IC and SCR.

Scholars and practitioners are becoming more interested in SCR as a result of the external environment's growing unpredictability (Cheng & Wang, 2024). Previously the researchers have addressed the importance of SCR (Abourobah et al., 2023; Agostini & Nosella, 2022; Ahangama et al., 2019; Al-Ayed & Al-Tit, 2023; Aldrighetti et al., 2023; Aldrighetti et al., 2021; Ali et al., 2023; M. H. Ali et al., 2021; Altay et al., 2018; Asamoah et al., 2020; Aslam et al., 2020; Azadeh et al., 2014; Brandon-

Jones et al., 2014; Craighead et al., 2007; El Baz & Ruel, 2021; Ivanov, 2018; Ivanov & Das, 2020; Qader et al., 2022; Spieske & Birkel, 2021; Tukamuhabwa et al., 2015). The organizations that have a resiliency in their supply chains, can cope up with adverse effects of disruption like the coronavirus pandemic by leveraging synergy with suppliers and customers while providing the employees with state-of-the-art abilities that result in the administration of a well-integrated business process (Chowdhury & Quaddus, 2017; Emrouznejad et al., 2023; Mubarik et al., 2022). In spite the growing recognition of SCR several challenges remain (Chowdhury et al., 2023).

DDC has started gaining attention by researchers and practitioners. Various studies have shed light on the significance of DDC for various dimensions such as strategic management (Kiron et al., 2013), decision making (Akter et al., 2019; Anton et al., 2023; Carillo et al., 2019; Holsapple et al., 2014), for developing products and processes (Davenport & Kudyba, 2016; Rehm & Goel, 2015), evidence based data driven approaches (Mortenson et al., 2015), people process technology (Abbasi et al., 2016; Wedel & Kannan, 2016), business strategies (Akter & Wamba, 2016; Hindle & Vidgen, 2018; Kunc & O'brien, 2019; Medeiros et al., 2020), marketing organization journey (Johnson et al., 2019), supply chain finance (Yu, Wong, et al., 2021), innovation and firm performance (Chatterjee et al., 2024; Chaudhuri et al., 2024; Duan et al., 2020; Karaboga et al., 2023; Vidgen et al., 2017), disaster immunity and SC performance (Yamin, 2024), blockchain driven scm (Yamin, 2024).

Despite all the global ripple effect, and emphasis on supply chain resilience, there is insufficient data-driven evidence to advise global supply chains (Belhadi et al., 2021). There is no such study that has examined the relation among IC and SCR with a moderation of data driven culture as of yet. In this uncertain environment, there is a compelling reason to examine supply chain resilience based on intellectual capabilities in a data-driven culture. The study aligns with SDG 9: Industry, Innovation, and Infrastructure. By encouraging the strategic integration of intellectual capital to improve supply chain resilience in Pakistan's telecommunications sector. The study promotes innovation and digital transformation two essential elements of sustainable industrial development, by highlighting the moderating influence of a data-driven culture. This promotes more resilient and future-ready infrastructure systems while strengthening the industry's ability to tolerate disturbances

The present study offers a fresh and novel perspective on intellectual capital and data driven culture in the context of supply chain resilience, an area that has not before been theorized or applied empirically, particularly in Pakistan's telecom sector. This paper conceptualizes data-driven culture as a component of strategy moderating the intellectual capital with SCR relationship, where IC is conceptualized in terms of human, structural, and relational dimensions. This is in contrast to earlier studies that treat supply chain resilience and data-driven decision-making as two distinct constructs. Based on the Resource-Based View, it suggests conceptualizing IC as a dynamic source of resilience while also introducing the idea of DDC as a boundary condition that modifies the degree to which IC functions.

The study intends to explore meaningful insights into mitigating the impacts of disruptions and identifying effective response options in establishing resilient supply chains using existing data. As a result, our research, backed by RBV strives to assist the supply-chain practitioners in telecom industry by establishing resilience to deal with future disruptions. The study caters to research questions:

RQ1: What is the impact of Intellectual Capital (RC, SC, HC) on Supply Chain Resilience?

RQ2: Does the Data-driven culture moderate the relationship between Intellectual Capital (RC, SC & HC) and Supply chain resilience in an organization?

2. Literature Review & Hypotheses Development

2.1. Theoretical underpinning

“A firm's competitive advantage might come from the competencies it possesses, and the resources which are valuable, scarce, hard to imitate, and not possibly substitutable” (Barney, 1991). The tangible and intangible assets of the organization are its resources and capabilities that include the organization's managerial skills, procedures and routines, and the knowledge and information it controls (Barney, 1991; Delen & Zolbanin, 2018; Gunasekaran et al., 2017; Ordóñez de Pablos, 2004). The resource-based view is used to figure out how the organizations use their resources and perform differently to keep their competitive advantages (Gunasekaran et al., 2017; Sonnier, 2008).

Relational, structural, and human capital, when combined with a data-driven culture, become difficult for competitors to imitate or substitute. The specific combination and interaction of these resources create a unique organizational capability that contributes to SCR (Caputo et al., 2019; Di Vaio et al., 2021). This reinforces the RBV perspective that firms achieve sustained competitive advantage through unique

resource combinations (Mubarik et al., 2022). By utilizing data, organizations can enhance decision-making processes, foresee potential disruptions, and develop more robust resilience strategies (Yu et al., 2018).

The current research highlights relational, structural, and human capital as critical resources that are valuable to the organization (Ordóñez de Pablos, 2004; Schneider, 2004). These resources enhance supply chain resilience by providing firms with unique capabilities to mitigate disruptions (Chowdhury et al., 2019). The research extends the RBV by incorporating the role of data-driven culture as a critical factor in leveraging intellectual capital for SCR. This extension provides a more comprehensive framework for firms to create competitive edge by strategically using IC and data-driven capabilities (Bontis et al., 2018).

2.2. Supply Chain Resilience

Supply Chain resilience can be defined “as the ability of a supply chain to prepare for and/or respond to disruptions, to make a timely and cost-effective recovery, and therefore progress to a post-disruption state of operations” (Mubarik et al., 2021, p.2). SCR impacts the future of a supply chain, “to re-emerge in ideally, a better state than prior to the disruption” (Mubarik et al., 2021). (Chunsheng et al., 2019). Organizations employ information technologies to recover their operations efficiently after fighting against disruptions according to Gu et al. (2021). Researchers have made SCR their core research subject since they aim to discover how supply chains can continue operating during disruptions while maintaining information flow and material and cash availability and achieve effective recovery (Yu et al., 2019; Chowdhury & Quaddus, 2017).

Supply chain resilience remains an essential risk management component for organizations because it requires the development of capabilities for supply chain risk management (Singh & Singh, 2019). Organizations encounter various types of risks stemming from external as well as internal environments (Rezaei et al., 2019). Building SCR through data analytics can generate effective business insights (Fernando et al., 2018). Firms respond to supply chain disruptions by forming institutional memories about how to respond. The organization codify the institutional memories as a risk-response mechanism inside the organization, allowing businesses to deal with future disruptions (Lamba and Singh, 2018).

2.3. Intellectual Capital

“Intellectual Capital (IC) is known as the sum of knowledge resources, intangible in nature, and regarded as a critical source of supply chain expertise and the overall organizational performance” (Bontis, 1998). There three dimensions of IC are named as Human Capital and Structural Capital and Relational capital (Bontis, 2001; Tran et al., 2020).

2.3.1. RC and SCR

Relational capital is regarded as an organization's external interactions and linkages with suppliers, consumers, and staff interrelationships (Mubarik et al., 2022). Stakeholder relationships become the foundational elements of relational capital (Bontis, 1998; Bontis et al., 2018). The term describes how organizations establish relationships with the members who have invested interest in their activities (Fan & Stevenson, 2019). Supply chain resilience success depends on relational capital which establishes networks based on trust, collaboration power as well as the flexibility capabilities (Johnson et al., 2013; Kang et al., 2007). A company can strengthen its abilities to anticipate disruptions and react and recover by developing close supplier relationships (Chowdhury et al., 2019). Determining factors of supply chain resilience include relational capital because it builds trust while enabling effective cooperation and successful teamwork between partners. Relational capital allows businesses to create strong networks with suppliers and consumers which enables mutual resource sharing during disruptive events (Chowdhury et al., 2019; Dubey et al., 2021). Therefore,

H1: RC has a significant impact on Supply Chain Resilience

2.3.2. SC and SCR

“Structural capital refers to the nonhuman knowledge embedded in organizational routines, databases and processes” (Mubarik et al., 2022, p. 720). Firms utilizing established procedures, schedules, mechanisms, and databases exhibit greater SC resilience for dealing with disruptions, and advanced data infrastructure and databases may strengthen the firm's responsiveness, analytical capability, and

flexibility (Bontis, 1998; Mubarik et al., 2022; Mubarik et al., 2019). These aspects of structural capital additionally boost the knowledge flow alongside other SC stakeholders, allowing an organization to employ preventive measures to deal with the impacts of disruptions (Ataseven et al., 2018; Daghar et al., 2023; Yu et al., 2023). A higher level of SCR is achieved through the strategic manipulation and adaptation of standardized supply chain processes against environmental threats, and the development of common comprehension of these procedures and the facilitation of cross-functional knowledge and information sharing (Ataseven et al., 2018).

H2: *Structural Capital has a significant impact on Supply Chain Resilience.*

2.3.3. HC and SCR

“Human capital is defined as the information, competencies, multitasking aptitude, dedication, commitment, temperament, experience, intelligence, and innovation of an organization's personnel” (Bontis, 1998; Bontis et al., 2018; Diaz-Fernandez et al., 2017; Mubarik et al., 2018). SCR improvements stem from human capital which delivers necessary employee expertise with knowledge and skills for shock management (Shela et al., 2023). Employees with advanced problem-solving skills and technical knowledge demonstrate better risk detection abilities and the creation of contingency plans and implementation of adaptive measures (Mubarik et al., 2022). An organization with a high human capital level may be more prepared to fight unexpected supply chain interruptions and come back to original state quickly (Daou et al., 2019). Employee expertise, current knowledge, and a resilient mindset in particular can aid a company in rapidly recovering from any catastrophic circumstances (Al-Omouh et al., 2022; Mahmood & Mubarik, 2020). Hence it is hypothesized that.

H3: *Human Capital has a significant impact on supply chain resilience.*

2.4. Moderating role of Data driven culture

“Data-driven culture is defined as an employee belief that certain types of data could help an organization in improving supply chain operations” (Al-Khatib et al., 2022; Awan et al., 2023). The development of DDC is linked to the success of organizations (Kokkinou et al., 2025; McAfee et al., 2012). A DDC helps to develop a culture in which data-driven insights outperform intuition-based ideas (Chatterjee et al., 2024; Gupta & George, 2016). DDC is a crucial aspect of developing an organization's SCR (Jiang et al., 2024; Wong & Ngai, 2023). Firms can improve SCR by expanding their capability for analyzing data (Kokkinou et al., 2025).

Data driven culture changes how organizations deal with human capital, select, employee and train the employees by utilizing the data effectively and efficiently (Pease, 2015). It also helps in optimizing relational capital as it makes the data sharing across stakeholders i.e., customer and suppliers reliable hence creating stronger relationships with them (Buell Hirsch, 2013; Harlow, 2018). Moreover, data driven culture can enhance the organization learning process thus enabling a more structured knowledge that is embedded in routine activities of organization i.e., structural knowledge (Mithas et al., 2013; Wamba et al., 2015).

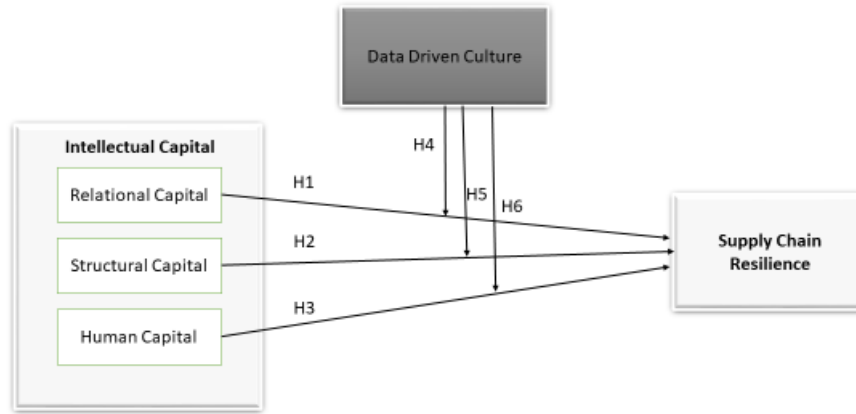
The DDC fosters culture of informed decision making that ultimately helps the organizations to leverage the intellectual capital, relational, structural and human capital in order to build more resilient supply chains (Harlow, 2018). A data driven culture helps organizations to create and manage intellectual capital that benefits the organizations (Uden & Del Vecchio, 2018). The integration of a DDC moderates the relationship between IC and SCR, further supporting the RBV framework. A data-driven culture allows organizations to effectively utilize their intellectual capital by turning data into actionable insights. This aligns with the RBV notion that resources must be effectively utilized to create competitive advantage (Hazen et al., 2014). Hence it can be hypothesized that:

H4: *Data driven culture positively moderates the relation between RC and SCR*

H5: *Data driven culture positively moderates the relation between SC and SCR*

H6: *Data driven culture positively moderates the relation between HC and SCR*

Figure 1: Theoretical Framework



3. Methodology

3.1. Sample and Data collection

The current study employs non-probability sampling technique as it is reliable sampling method. (Kumar, 2005). Convenience sampling has been employed for this research. Questionnaires were distributed among people who were convenient to contact or reach out to. This method is convenient as it allows to gather samples from accessible respondents according to the ease of researcher (Sounders, Lewis, & Thornhill, 2016). The study adopted quantitative techniques, and the data was collected through sharing google document link. A total of 350 telecom employees from Rawalpindi and Islamabad were contacted, with 201 providing complete and valid responses. This sample size is consistent with previous research in similar circumstances (Khan et al., 2014).

The questionnaire employed a 5-point likert scale “where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree”. It was divided into four parts i.e; Intellectual capital (Relational capital, Relational capital, Human Capital), Data-Driven culture, and Supply Chain Resilience. The items and references of each construct are provided in table 1. The study is cross sectional is nature and gathers data using surveys at a single point in time and the data is analyzed through SPSS.

Table 1: Constructs

Constructs	Items	Reference
Intellectual Capital		
RC	4 items	
SC	4 items	Choudhury (2010).
HC	5 items	Adopted
Data-Driven Culture	4 items	Yu, Liu, et al. (2021). Adopted
Supply Chain Resilience	4 items	(Piprani et al., 2020) Adopted

4. Results and Discussion

4.1. Profile of respondents

The data indicates a diverse group of respondents, predominantly male (60.7%), with a majority under the age of 30 (64.3%). The age distribution highlights that younger individuals are highly represented, while only a small fraction are above 40 years old (2.5%). In terms of work experience, over half of the

respondents have experience less than 5 years (53.7%), followed by those with 5-10 years (24.9%) and more than 10 years (21.4%). This distribution suggests a relatively young workforce with limited professional experience. Regarding job roles, the largest group holds middle-level managerial positions (46.8%), indicating a strong presence of mid-tier management. Additionally, support staff (26.4%) and senior managers (9.5%) are also represented, with a notable portion categorized as others (17.4%). Overall, the data reflects a youthful, predominantly male workforce with a strong representation of middle-level managers.

Table 2: Respondents Profile

Category	Sub-category	Frequency	Percentage
Gender	Male	122	60.7
	Female	79	39.3
Age	Less than 30 years	129	64.3
	30-40 years	67	33.3
	Above 40 years	5	2.5
Experience	< 5 years	108	53.7
	5-10 years	50	24.9
	> 10 years	43	21.4
Designation	Senior Manager	19	9.5
	Middle Level Manager	94	46.8
	Support Staff	53	26.4
	Others	35	17.4

4.2. Correlations and Reliabilities

Cronbach's Alpha is the measure of the reliability and internal consistency of a construct. Values above 0.7 are typically considered acceptable, and all constructs exceed this threshold, indicating that the items within each construct are consistent and reliable. The correlation coefficients reveal the direction and strength of the relationships among the variables. HC has a stronger correlation with SCR compared to Relational and Structural capital, suggesting its relatively higher importance in contributing to supply chain resilience. Similarly, SC has the strongest correlation with DDC, indicating a notable relationship between structural capital and DDC. The results suggest that all the variables are positively correlated.

Table 3: Correlations and Reliabilities

	Cronbach Alpha	RC	SC	HC	SCR	DDC
RC	.850	1				
SC	.846	.595**	1			
HC	.850	.548**	.485**	1		
SCR	.869	.290**	.424**	.517**	1	
DDC	.861	.317**	.451**	.369**	.314**	1

** . Correlation is significant at the 0.01 level (2-tailed).

4.3. Average Variance Extracted (AVE) and Composite Reliability (CR)

The validity of the measures given was determined through Average Variance Extracted (AVE) and Composite Reliability (CR). The internal consistency is computed through CR and the CR > 0.7 indicates acceptable range, whereas convergent validity is computed through AVE and values greater than 0.5 suggest that indicators show good convergent validity (Fornell & Larcker, 1981). The AVE and CR values are within the accepted range for all the indicators. RC, (AVE :0.674, CR =0.912), SC (AVE=

0.709, CR= 0.907), HC (AVE =0.573, CR= 0.875) DDC (AVE =0.714, CR= 0.926), SCR (AVE =0.698, CR= 0.902).

4.4.Hypotheses testing

Table 4: Regression

	R	R-Sq.	MSE	F	P
RC	.500	.250	.350	20.0	.000
SC	.498	.248	.344	21.76	.000
HC	.559	.312	.314	29.85	.000

The model has strong R values, suggesting strong relation between variables. The R squared values suggest the variance in SCR explained by the independent variables. The F statistics, with values 20.0, 21.76 and 29.85 suggests overall model is statistically significant. Whereas the $p < 0.05$ shows the significance of the model.

As for the moderation analysis we have used macro process Hayes. For relational capital the direct effect is 0.363, with a p-value of 0.000, showing a strong and reliable positive contribution to SCR. The confidence interval (0.187 to 0.540) confirms the robustness of this relationship. The direct effect of SC is 0.552, with a p-value of 0.000, suggesting a highly significant and impactful positive contribution to Supply chain resilience. The confidence interval (0.360 to 0.744) strengthens this conclusion. For HC The direct effect is 0.571, with a p-value of 0.000, demonstrating the strongest positive direct impact on SCR among the three independent variables. The confidence interval (0.406 to 0.737) supports the reliability of this effect as displayed in Table 5

Table 5: Direct Effects

Direct Effects	Effect	se	t	p	LLCL	ULCL
RC→SCR	.363	.089	4.08	.000	.187	.540
SC→SCR	.552	.097	5.693	.000	.360	.744
HC→SCR	.571	.083	6.828	.000	.406	.737

The indirect effects describe the moderation of Data-driven culture in enhancing the association between RC, SC, HC, and SCR: RC * DDC → SCR as displayed in table 6. The interaction effect is 0.182, with a confidence interval (0.037 to 0.344). This shows that DDC significantly strengthens the positive impact of RC on SCR. SC * DDC → SCR. The interaction effect is 0.125, with a confidence interval (0.035 to 0.345). This indicates that DDC moderately enhances the influence of SC on SCR. HC * DDC → SCR. The interaction effect is 0.121, with a confidence interval (-0.021 to 0.278). The moderation by DDC is nonsignificant in this case, as the LLCI is negative, suggesting variability in its effect.

Table 6: Moderating effects

Indirect Effects	Effect	Boots SE	Boot LLCI	Boot ULCI
RC * DDC→SCR	.182	.085	.037	.344
SC * DDC→SCR	.125	.096	.035	.345
HC * DDC→SCR	.121	.0762	-.021	.278

5. Discussion

The findings of the current research establish that Relational and Structural and Human capital have a positive impact on supply chain resilience. A data-driven organization strengthens the connection of

relational and structural capital and supply chain resilience, while DDC does not moderate the relation between Human capital and Supply chain resilience.

Various past studies have confirmed that RC, SC and HC have significant impact on SCR. Relational capital stands as a crucial asset since it enables companies to obtain information needed during supply chain disruption preparations and responses and recoveries. (Anh et al., 2019; Mubarik et al., 2022; Preston et al., 2017; Wang, 2018). Organizational learning benefits from structural capital creating SCR to disruptions (Jia et al., 2020). Organizations can improve their SCR to disruptions through established processes along with routines and systems and databases (Mubarik et al., 2022). An organization requires employee talent and knowledge as human capital to build strong supply chain resilience (SCR) (M. Ali et al., 2021; Dubey et al., 2021). Various studies have stated that human capital acts as a major influence toward enhancing SC resilience (Al-Omouh et al., 2022; Daou et al., 2019; Yu et al., 2023).

Previous studies have highlighted that while DDC enhances decision-making and operational efficiency, its impact is more pronounced in areas like structural capital or relational capital, where data-driven insights play a pivotal role in optimizing processes and stakeholder relationships (Gardezi, 2025). HC, on the other hand, relies more on individual and collective human attributes, which may not necessarily require the intervention of DDC to influence SCR (Çolak et al., 2024). This distinction underscores why DDC might not moderate the relationship between HC and SCR, as the latter is inherently driven by human-centric factors rather than data-centric ones.

The study demonstrates that supply chain resilience (SCR) in Pakistan's telecommunications industry is positively impacted by all three aspects of intellectual capital: human, structural, and relational capital. The linkages between relational and structural capital and SCR are notably moderated by data-driven culture (DDC), which increases their efficacy in handling disruptions through improved data insights and process optimization. DDC's moderating influence on the relationship between human capital and SCR, however, was statistically insignificant, suggesting that human-driven resilience capabilities like knowledge, experience, and intuition may function without the need for data-centric settings. This discrepancy implies that although digital tools improve stakeholder networks and organizational structures, human capital's resilience-boosting role is still based on implicit, non-technological skills.

Table 7: Results of Hypotheses

H1	Relational Capital has a significant impact on Supply Chain Resilience	Accepted
H2	Structural Capital has a significant impact on Supply Chain Resilience	Accepted
H3	Human Capital has a significant impact on Supply Chain Resilience	Accepted
H4	Data Driven Culture Moderates the relation between Relational Capital and Supply Chain Resilience	Accepted
H5	Data Driven Culture Moderates the relation between Structural Capital and Supply Chain Resilience	Accepted
H6	Data Driven Culture Moderates the relation between Human Capital and Supply Chain Resilience	Rejected

5.1. Managerial and Practical implications

Managers and industry practitioners can gain valuable insights from the current study. By recognizing the significance of intellectual capital managers can prioritize cultivating strong relationships with stakeholders, optimizing organizational structures, and investing in the skills and capabilities of employees. These dimensions collectively create a robust foundation for navigating disruptions. Moreover, fostering a DDC within the organization can amplify the effectiveness of intellectual capital, enabling informed decision-making, predictive analytics, and proactive strategies. Managers are encouraged to embed data-driven practices into daily operations, empowering teams with real-time insights and fostering a culture of continuous learning and adaptation. By aligning intellectual capital with a strong data-driven culture, firms can develop resilient supply chains that can withstand challenges and driving sustainable growth.

Additionally, the usefulness of intellectual capital is increased when a data-driven culture (DDC) is incorporated into the organizations. Proactive risk mitigation, predictive decision-making, and timely access to analytics are all made possible by such a culture. Managers are urged to create an atmosphere of ongoing learning, empower teams with real-time insights, and incorporate data-centric tools into everyday operations. The synergistic integration of intellectual capital and DDC enables organizations with robust supply chains capable of responding to turbulence and delivering long-term sustainable growth.

5.2. Limitations & Future Research Directions

Despite its usefulness, this study has many limitations. First off, because the study is restricted to the telecom sector, the findings' generalizability to other industries is constrained. In order to better understand how industry-specific factors impact the function that various kinds of Intellectual Capital (IC) play in boosting supply Chain Resilience (SCR), future researchers should consider doing comparative analyses of multiple fields.

Second, the study is cross-sectional in nature, hence does not measure the change over time and identify causal relationships. Considering this, it is recommended that upcoming studies employ a longitudinal study to better understand the temporal interactions between IC and SCR as well as to account for their dynamism.

The research doesn't look at the potential of new technologies in enhancing the supply chain resilience. When considering future research prospects, it is important to consider how blockchain technology and artificial intelligence (AI) can support the development and application of IC in businesses, particularly in the context of SCM. Furthermore, the study does not investigate mediating factors that could account for the link between IC and SCR. Future research should identify Supply Chain Learning (SCL) as a potential mediating variable and understand how organizations use, distribute, and absorb information throughout the supply chain to become more resilient.

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