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Exploring the nexus between Organizationa Capital and Supply chain Adaptability: Empirical Insights from Pakistan Manufacturing Sector

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Research Article

Keywords: Dynamic capability view, Intellectual capital-based view, Organizational Capital, Supply chain adaptability

Posted Date: May 27th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9814934/v1

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Additional Declarations: The authors declare no competing interests.

Exploring the Nexus between Organizational Capital and Supply Chain Adaptability: Empirical Insights from Pakistan Manufacturing Sector

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ARTICLE DETAILS

History
Revised format: Feb 2025
Available Online: Mar 2025

Keywords
Dynamic capability view, Intellectual capital-based view, Organizational Capital, Supply chain adaptability.

JEL Classification
M1, M2

ABSTRACT

Purpose: This study examines the relationship between organizational capital and the different dimensions of supply chain adaptability based on the Intellectual Capital-Based View (ICBV) and Dynamic Capabilities Theory (DCT). This study helps to meet the urgent demand for supply chain flexibility prompted by the COVID-19 pandemic, which has caused the most serious disruption to global supply chains in recent years.

Design/Methodology/Approach: Data were collected from 200 manufacturing concerns in Pakistan, and Smart-Partial Least Squares (Smart-PLS) software was employed for analysis to test the relationships posited. The model with the best goodness-of-fit indices was the saturated model (SRMR = 0.042, d_ULS, d_G = 0.065, Chi-square = 194.040, NFI = 0.911); the data were well-represented by the variables and showed the best adjustment of the overall model.

Findings: The examination demonstrates that the dimensions of organizational capital are strong explication variables (of up to 69.9 percent) of the variation of supply chain adaptability. The findings support the notion that organizational capital has a significant effect on all three dimensions of supply chain adaptability. Organizational capital helps signals rapidly propagate inside supply chains and prepares firms to respond to disruptions flexibly.

Implications/Originality/Value: This research underscores the critical role of organizational capital in enhancing supply chain adaptability, particularly during crises like the COVID-19 pandemic. It suggests that managers should actively develop and leverage their firm's organizational capital its internal routines and intellectual resources to proactively mitigate disruptions and maintain adaptable operations. The findings provide actionable insights for businesses to build more resilient supply chains capable of navigating unforeseen events.

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Recommended citation: Haider, G., and Zia Ul Haq, M. (2025). Exploring the Nexus between Organizational Capital and Supply Chain Adaptability: Empirical Insights from Pakistan

Introduction

Efficient flow of goods and services is promised through supply chain management. Due to development and expansion of business scenario the competition amongst global supply chain firms has intensified. However, supply chains face multiple challenges, including demand volatility, global competition, and disruptions such as economic instability or pandemics. Ivanov, D., Dolgui, A., Sokolov, B., & Ivanova, M. (2019); Xu, L., Beamon, B. M., & Chen, V. C. P. (2020).

Moreover, the unexpected and unanticipated events like US and China trade battle, war between Ukraine and Russian state, continuous change in geo climate has affected supply chain in adverse manner (Srai et al., 2023) and in particular epidemic of the century COVID-19 that started in January 2020 has badly effected supply chain, even N95 mask and similar protective items were difficult to find (Alvarenga et al., 2023; Yu et al., 2022). COVID 19 caused trillions of dollar loss to the world economy World Economic Forum (2020). The firms are forced to develop and strengthen their internal capabilities and routines to meet the global competition and turbulent environment.

Scholars has been searching for the solution to the problems faced by supply chains time to time and adaptability was considered as one of the remedies for the problems faced by supply chain in turbulent environment (Lo et al., 2021). q

Supply chain adaptability (SCA) is the capacity to flexibly respond to disruptions and changing market dynamics. This encompasses flexibility to increase or decrease production/response, change suppliers, and reconfigure operations (Lee 2004).

SCA is gaining importance in today's highly dynamic market situations as the supply chain structures of organizations need to be adjusted to meet customer requirements (Yang et al. 2022). Despite over 20 years of ongoing research on how firms can support the sustainability of their supply chains, exploration of the basic mechanisms that underpin resilience and adaptability is still at a nascent stage, especially with respect to knowledge and intellectual capital. (Ali et al., 2021)

The intellectual capital-based view of the firm (ICBV) suggests that a firm's capability to accumulate and exploit knowledge can build its competitive advantage (Martín-de-Castro et al., 2011; Reed et al., 2006; Su et al., 2013).

Intellectual capital theory provided significant perceptions into several aspects of supply chain management. Volatile and unpredictable nature of economic, political, social, and technological landscapes has compelled businesses to cultivate dynamic intangible capabilities. Intellectual capital is widely recognized as a crucial factor in effective supply chain management (Tooranloo et al., 2018; Dabi´c et al., 2021); Mubarik et al. (2021). Literature review reveals a lack of exploration into the connection between intellectual capital and supply chain adaptability during crises. Moreover, no research was available in context of pandemic that examined the impact of organizational capital on supply chain adaptability responding to the pandemic crisis.

The objective of this study is empirical exploration of Impact of a core dimension of Intellectual capital i.e., Organizational capital on dimensions of supply chain adaptability, taking into consideration the Intellectual capital-based view and dynamic capability view as unpinning theories. This study further divides organizational capital int two dimensions and studies their impact on different dimensions of supply chain adaptability.

Organizational capital also termed as structural capital refers to the nonhuman knowledge embedded in a firm's systems, databases, and processes. This is also known as structural capital (Ahmed et al.,

2019).

Motivation for Study

This study investigates impact of organizational capital on SCA in context of Pakistan's manufacturing sector. The research focuses on understanding how firms leverage OCapital to mitigate supply chain disruptions and enhance adaptability.

I Capital functions as a repository of knowledge and a catalyst for modernization. It fosters continuous generations of new knowledge to equip organizations with the adaptability needed to navigate emergencies and crises. In times of crisis, collaboration between firms and their supply chain partners becomes an essential lifeline for survival.

Introduction of knowledge-driven economy has coincided with growing recognition of OCapital as a critical factor for organizational success (Yaseen et al., 2016). The vary concept encompasses two types of knowledge embedded are tacit and explicit knowledge that is embedded within individuals, firms (Mubarik et al., 2022).

Research Objectives

To explore how organizational capital improves different dimensions of supply chain adaptability

Research Questions

1. Whether there exists a positive and significant impact of organizational capital on SA
2. Whether there exists a positive and significant impact of organizational capital on IA
3. Whether there exists a positive and significant impact of organizational capital on CA

Significance of Study

This study holds significant importance in the context of the Pakistani manufacturing industry. Understanding the relationship between organizational capital and supply chain adaptability is crucial for firms operating in a dynamic and competitive environment. By identifying the key dimensions of organizational capital that contribute to adaptability, manufacturing firms can develop strategies to enhance their resilience and responsiveness to disruptions. Moreover, the insights gained from this study can inform policymakers and industry associations in developing initiatives to support manufacturing firms in building robust and adaptable supply chains, for manufacturing sector in Pakistan.

Theoretical Framework

Literature Review

Organizational capital is not just financial and human capital; it includes the knowledge in the systems, processes, and legal protections like copyrights, embedded in the organization (Bontis,1998); Youndt et al., 2004); Mukaro et al., 2023).

The knowledge that is created through an established operation is critical as it preserves valuable learning and experience of employees that manufacturers can use even after the employee leaves (Lee et al., 2011).

Organizations with the best routines, established procedures, strong systems, and extensive databases are considered more robust in the supply chain and are better able to address disturbances. State-of-the-art information systems and databases are central to improving a firm’s adaptability, analytical skills, and overall responsiveness to a dynamic environment. These elements of organizational capital support the sharing of information with external stakeholders in the supply chain so that they can take action to avoid the consequences of disruption.

Organizational capital, also called organizational infrastructure, encompasses advanced information systems (IS) and internal processes that enhance an organization's flexibility, problem-solving capability, and responsiveness. Organizational capital makes it easier for firms to adjust long-term policies by improving the information flow throughout the supply chain. Organizational capital facilitates and assists in compressing 5 the time of understanding and transmitting learning over the entire supply chain, developing flexibility (Hsu & Walton, 2012).

There is a clear and significant connection between organizational capital and supply chain adaptability. The impact of organizational capital on SCA is profound, as the organizational infrastructure, knowledge systems, and non-physical assets collectively shape firm's supply chain competence to retort to variations and uncertainties. Supply chain adaptability is ability to adjust and thrive in the at times of rapid changes, disruptions, and uncertainties, and is closely tied to the strength of organizational capital. Organizational capital impacts supply chain adaptability across various dimensions. It provides a foundation for informed decision-making, leverages technology, fosters an adaptable organizational culture, and promotes collaboration, each of which is vital for ensuring supply chain adaptability. By navigating changes effectively and responding to emerging challenges in a dynamic business environment, organizational capital plays an instrumental role in maintaining supply chain resilience. For example, a well-organized database allows supply chain managers to access historical data, market trends, and real-time information, enabling them to make timely decisions and adapt to shifting circumstances.

Dimensions of Organizational Capital

There are two dimensions of Organizational capital:

1. Codified knowledge
2. Tacit knowledge (Subramaniam & Youndt, 2005)

Codified knowledge: Knowledge is considered codifiable when it can be documented and shared efficiently with others.

Tacit Knowledge: Tacit knowledge is often acquired through experience and is not easily transferable, as it is often tacit and difficult to articulate. (Longley, 2006)

Codified knowledge is essentially knowledge that has been captured and expressed in a formal, structured manner. It is information that can be easily shared, stored, and accessed. Think of it as knowledge that has been converted from a tacit (implicit) form to an explicit one.
Key Characteristics of Codified Knowledge is that it is explicit, formal, shareable and reusable.
Codified Knowledge may be in the form of**:**
Textbooks, databases, Manuals, Software code and patents etc.

Tacit knowledge is the kind of knowledge that is difficult to put into words or codify. It is frequently acquired through Personal insight, intuition, and hands-on experience. This knowledge is hardwired into an individual's brain.
Key Characteristics of Tacit Knowledge is that it is Implicit, contextual and personal.

Dynamic Capability View

Dynamic capabilities (DC) serve as a foundational framework for examining a firm's capacity to adapt and thrive in dynamic environments. This construct, as outlined by (Teece, 2014), emphasizes the ability to integrate, create, and reconfigure internal and external capacities and competencies to effectively respond to evolving market conditions. DC, therefore, is essentially about a firm's adaptability.

The Dynamic capability perspective involves a continuous process of sensing environmental changes,

seizing opportunities, and reconfiguring organizational assets accordingly (Helfat et al., 2009) . While every firm possesses a unique Supply Chain tailored to its specific operational objectives, the importance of DC becomes particularly pronounced during times of significant supply chain disruption. Under normal conditions, Supply Chain managers proactively develop capabilities to mitigate potential disruptions. However, in the face of unforeseen challenges, DC becomes indispensable for formulating and executing effective supply chain adaptability (Winter, 2003).

Organizational capital, which encompasses a firm's knowledge, processes, culture, and relationships, serves as a foundational resource that supports and amplifies the dynamic capabilities needed for supply chain adaptability.

In alignment with (Kähkönen et al., (2023), DCV offers a valuable lens through which to analyze firms' supply chain adaptability in the context of crises.

Intellectual capital Base View

The Intellectual Capital-Based View (ICBV) offers a more refined and holistic approach compared to the Resource-Based View (RBV) and Knowledge-Based View (KBV). It has broader Scope than Resource-Based View (RBV), it is dynamic, it is focused on intangible assets, it emphasizes knowledge flow and more comprehensive. This theory divides intellectual capital into three parts, Human capital, social capital and organizational capital.

Supply Chain adaptability (SCA)

It is important to mention that supply chain flexibility (SCF), also called adaptability, is a strategic-level capability (Mak & Max Shen, 2021). It was developed to help companies tailor their Supply Chain around fundamental shifts inside the business environment. According to Phadnis & Schoemaker, (2022), a critical indicator of the success of organizations is the pace and ease with which customer services can be obtained in the new context. This adaptability implies that an organization can refine its processes to focus on particular circumstances by using various technologies, saving material providing time, and learning from the past (Zomorrodi et al., 2019) ;Rameshwar et al. 2021).

SCA is an essential requirement in complex and changing market environments for organizational success in terms of profitability and business making risks compared to competitors (Tuominen et al., 2004). SCA is becoming manifestly valued as a dynamic capability. This demonstrates the adaptive intelligence of an organization, allowing it to quickly detect and respond to business-related incidents. The resulting higher resilience in organizations that have developed an Adaptive SC has been proven. Excerpts from the Covid-19 pandemic demonstrate strategies that are effective in reducing adverse effects (Dohale et al., 2023); Ivanov et al., 2021). SCA refers to a firm's capacity to quickly change its supply chain policies and procedures in the presence of environmental turbulence and volatility (Naughton, 2020).

Dimensions of Supply Chain Adaptability

Unlike previous models that have concentrated on more traditional or linear viewpoints of flexibility, this study considers the modern-day complex, changeable, and interdependent supply chain setting. Previous studies, for example, those of Marin-Garcia et al. (2018), based on models of operations management relative to production systems, highlighted flexibility as a possibility of operational efficiency and process improvement. Hallikas et al. (2004) emphasized flexibility in risk control and supplier relationships. Although these views are still relevant, they may not be all-encompassing of the newer, larger, and multi-faceted issues that supply chains encounter in the current global, tech-relevant world.

The SCA employed herein is a more robust measure that considers the high complexity, advanced technology, and worldwide distribution of 21st century supply chains and, thus, is more adequate to

deal with the challenges facing businesses today. Enhancing the understanding of how adaptability can be used to develop superior, more agile, resilient, and sustainable supply chain systems Supply chain managers are provided with a better understanding of adaptability and how it can be utilised to design more agile, responsive and sustainable supply chain systems, something hitherto not offered by prior research in the area. (Vega et al., 2023)

Expanding Yang's (2020) model, we attempt to offer an extensive and deep investigation of the topic of Supply Chain Adaptability. This is clarified by dividing it into three particular and related dimensions. These aspects emerge based on the complex and dynamic interdependencies among various actors in an SC network ecosystem.

By classifying Supply Chain Adaptability in this manner, this study offers practical guidance to supply chain managers regarding how their supply chain strategies can be enhanced to better adapt to market dynamics and achieve a greater level of resilience to disruptions. The results will be especially important for firms in turbulent environments, where organizational flexibility is a determinant of long-term success.

- IA (Internal Adaptability)
- SA (Supplier Adaptability)
- CA (Customer Adaptability)

Internal Adaptability (IA) focuses on generative abilities that are endogenous to a focusing firm and are largely embedded in the firm's internalized routinized behavior. Among these are the ability of a firm to change well-established internal systems and routines effectively and fold in information pertinent to long-term strategic reorientations. This is the basis of IA: these interior protocols — whether they are processes, interdisciplinary cooperation, continual progressive thinking, or technology—are fundamental. Once institutionalized, such routines provide the flexibility that allows focal companies to adjust to both anticipated and unanticipated variations in the external environment over time. IA is a foundational pillar of long-term resiliency that provides firms with the internal muscle to coordinate across silos, re-architect processes, and change practices.

Supplier Adaptability (SA)SA represents the synergy that may result from a focal firm's relationship with its upstream partners. such as raw material availability, supplier competency, or the introduction of new technology. These capabilities are necessary to maintain the Supply Chain as flexible and dynamic, even in the presence of changes in the supply conditions to which the Supply Chain is subject. SA enables the focal firm to collaborate with suppliers to help them redesign and reconfigure supply chain processes in real time to minimize disruptions and ensure that operations continue seamlessly.

The high-SA capability firms may participate in joint problem solving with their suppliers by providing information such as demand forecasts or production schedules. This level of cooperation will allow the supply chain to synchronize its efforts so that it is more flexible in responding to market changes or unforeseen disruptions, such as geopolitical events or weather patterns. It is not just about being nice to suppliers; it is about designing a seamless and collaborative environment in which information moves quickly, and decisions are made jointly. This shared visibility of information – around issues such as on-hand inventory, plant capacity, and lead times – helps manufacturers react faster to the unexpected, helping to avert blockages and keep supply lines flowing. This flexibility can be especially important in industries that experience supply chain constraints, which can snowball into significant delays and cost escalations.

Customer Adaptability (CA)
CA focuses on the later interactions between focal firms and customers. CA stresses a customer

centric approach, "in so much as, the company will actively listen to its customers, in a dynamic sense, to understand and meet their evolving needs and change what it does."

CA requires the ongoing reframing of a company's resources, such as reassigning inventory, shifting production schedules, or changing product designs, to meet customer needs more accurately. This adaptation process includes strategic adjustments designed to secure the firm's future viability and customer fulfillment. A company with powerful CA abilities can regularly collect feedback from customers, observe market trends, and proactively modify its products or way of delivering services. In the ever-changing competitive market of today, flexibility to customer demand is crucial to success. Customers have become accustomed to this high degree of personalization and are demanding a much more flexible approach; those (firms) that can adjust more quickly will be able to keep their customers and win the competitive battle. CA enables companies to deepen their connection to customers by focusing on customer needs; however, these needs may change.

In conclusion, SA and CA are two dimensions of SC adaptability, focusing on the upstream and downstream capabilities of organizations, respectively. SA promotes collaboration with suppliers to achieve agility and innovation in supply chain operations, and CA allows companies to remain customer-oriented by adjusting their practices to fit the new needs of customers. Taken together, these capabilities are prerequisites for an agile, adaptable supply chain to not only survive but also maximize value in normal or even turbulent markets. The integration of both SA and CA enables firms to gain a holistic view of supply chain adaptability, which, in turn, assures their long-term competitiveness and success in an increasingly complex global market.

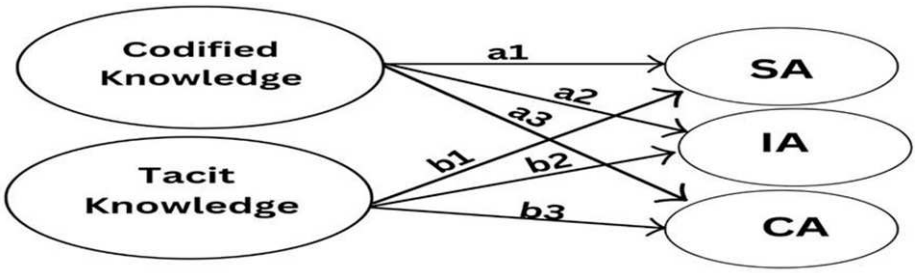


Figure 1: Research Model

Research Model & Hypothesis

Impact of Codified & Tacit Knowledge on Supplier's Supply Chain Adaptability

Formalized, recorded information, or codified knowledge, is particularly influential in improving supply chain flexibility. By encoding knowledge, standardized routines and best procedures can be transferred to the suppliers. This standardization allows the same responses to be used for different supply chain disruptions, enhancing flexibility (Capestro et al., 2024). I now have a clear guideline that creates a bridge of communication between the company and the contractor. Employees with processes and expectations well documented can introduce change and requirements more easily (Martin, 2012). With a standardized set of policies and practices, codified expertise guarantees that all suppliers conduct operations uniformly. This consistency aids in the more effective control and coordination of changes throughout the supply chain. Based on documented solutions and historical information, supplier problems can be solved (Xu et al., 2024). Personal, contextual, and difficult-to-formalize tacit knowledge has a significant impact on improving supplier supply chain adaptability. Tacit knowledge is a reservoir of experiential knowledge and an intuitive grasp of knowledge, which is difficult to articulate and, as such, difficult to write down. Those with deep tacit knowledge of their processes can more readily spot and fix unforeseen problems and respond more agilely to disruptions. Tacit knowledge also facilitates stronger buyer supplier relationships. Informal communication and experience sharing allow suppliers and firms to develop mutual trust and understanding, which are necessary for collaborative problem solving and flexibility. Although tacit knowledge is hard to

codify, it can be communicated one-to-one, for example, through mentorship and training or problem-solving together. Workers from suppliers who are proactively involved in sharing tacit knowledge help them understand things correctly and adjust to the situation easily. Employees, with their tacit and explicit knowledge, can then provide personalized and more adaptable solutions. The flexibility to start up products or processes on short notice to accommodate specific requirements or shifts in demand is becoming increasingly important.
The above discussion leads us to the following hypothesis:
H1a: Codified knowledge has a positive and significant impact on SA.
H1b: Tacit knowledge has a positive and significant impact on SA.

Impact of Codified & Tacit Knowledge and Internal Supply Chain Adaptability (IA)
Codified knowledge is the information in which we can store, index, retrieve and use regarding the flexibility of the internal supply chain, the codification of knowledge is an effective way to improve performance. Reducible knowledge makes it possible to construct routine and optimal procedures. This uniformity fosters a sense of oneness within the team, increases productivity, and eliminates mistakes. Standardized inventory control strategies may be able to maintain inventory at desirable levels, even in the case of a supply chain disturbance (Hu et al., 2024). Once moment understanding is codified, it becomes instantly available, resulting in faster decision-making. Evidence-based guidelines for managing supply chain disruptions allow managers to react promptly and effectively to disturbances as they occur. Transparency in procedure and process documentation improves communication between parties. This is even more crucial in complex supply chains, where different units and agents must collaborate (Al-Omoush et al., 2022).

Tacit information can be communicated between various areas of the organization, thus enabling a more holistic approach to the supply chain. Best practices for documenting and sharing previous supply chain disruptions to avoid reoccurrence (Irfan et al., 2022). Tacit knowledge, which is individuals' informal, experiential, and context-specific knowledge, is very important for enhancing internal supply chain adaptability. The person knows tacitly can enable a person to make more informed and timely decisions by using intuition and personal experience. This facilitates the efficient handling of uncertain and dynamic supply chain situations (Zhang et al., 2023). Employees with tacit knowledge are in a better position to recognize and solve any unexpected problems as they arise and adapt more successfully internally. Tacit knowledge encourages creativity and innovative solutions to challenges and problems, as employees use their experience and learned practices to improve processes and systems and are more adaptable (Harrington et al., 2019). Sharing knowledge that is not codified in documents or similar is mentored or happens informally to disseminate has practices that are of value throughout and improve internal adaptiveness. Tacit knowledge promotes coordination and cooperation between disparate organizations by improving their understanding of interdependency and informal processes (Y. Yang et al., 2023).
Considering the discussion above, the following hypothesis is proposed:
H2a: Codified Knowledge has a positive and significant impact on IA.
H2b: Tacit knowledge has a positive and significant impact on IA.

Impact of Codified & Tacit Knowledge on Customer Supply Chain Adaptability
Codified knowledge can significantly enhance customer supply chain adaptability by providing a structured and easily accessible repository of information that can be used to make informed decisions, streamline processes, and quickly adapt to changes.

Standardization helps in maintaining consistency and quality across the supply chain, making it easier to adapt to new challenges or integrate new customers.

With well-documented procedures and historical data, decision-makers can quickly access relevant information to make informed choices. This ability is crucial in responding to supply chain disruptions

or changes in customer demand (Amin et al., 2022).

By analyzing codified data, companies can leverage predictive analytics to forecast potential disruptions or demand fluctuations. This proactive approach enables better customer services and responsiveness to their queries.

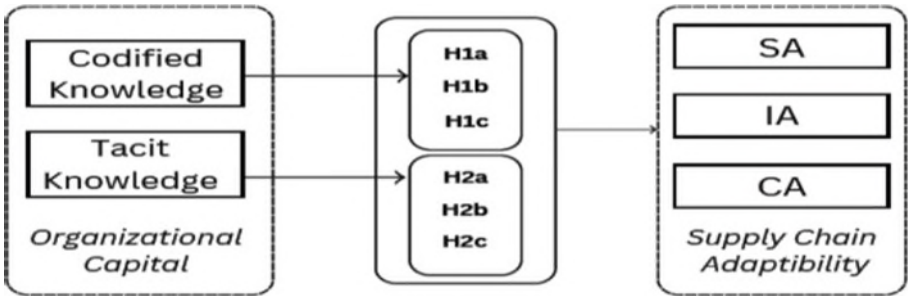
Codified knowledge provides a common reference point for all stakeholders in the supply chain. This shared understanding improves communication and collaboration, which is essential for coordinating responses to dynamic customer needs and changes or disruptions (Irfan et al., 2022).

Tacit knowledge, characterized by informal, experiential, and often unspoken insights possessed by individuals, is essential for improving customer supply chain adaptability. Tacit knowledge often drives innovation by providing unique insights and creative solutions that are not readily available in codified formats. This innovation can lead to new processes, products, or strategies that improve supply chain responsiveness.
Tacit knowledge often includes insights gained from personal experience and situational awareness.

Impact of Codified and Tacit Knowledge on Customer Supply Chain Adaptability
Codified knowledge can also increase the robustness and agility of the customer's supply chain by providing them with a structured source of 'know-how' that can be used to make informed decisions (KMS), speed processes, and facilitate quick changes. Standardization facilitates and ensures quality and consistency through the supply chain, which in turn allows for easy adjustment to new challenges or accommodating new customers. The documented procedures and a history of information, executives can refer to pertinent information to enable them to make informed choices. Such capability is essential for dealing with disruptions within the supply chain or changing customer demand (Amin et al., 2022). The structured data, businesses can use predictive analytics to predict potential ruptures or spikes in demand. This will help us better serve customers and respond quickly to their requests. Codification makes knowledge a common point of reference for everyone in the supply chain. This mutual understanding leads to effective communication and collaboration, which is necessary for responding to fast-changing customer needs and changes or disruptions (Irfan et al., 2022).

Tacit knowledge collective, experiential, and often unspoken insights that people have is key to promoting customer adaptability in the supply chain. Implicit knowledge fosters innovation as it offers original thoughts and inventive solutions that are not well captured in a codified form. This development may initiate new procedures, products, or tactics to enhance supply chain agility. Knowledge is often learned through experience and awareness of a situation as it develops. This type of knowledge helps employees and managers make quick, context-sensitive decisions and solve problems creatively, which is vital during supply chain disruptions or changes (Nonaka & Konno, 1998). Tacit knowledge aids in building strong relationships and networks within the supply chain. Employees with deep tacit knowledge about customer needs and preferences can tailor products, services, and responses more effectively. This customization improves customer satisfaction and adaptability to changing demands (Y. Liu & Zhang, 2022). Tacit knowledge and codified knowledge of employees of firm provides depth and context that can significantly enhance the adaptability, flexibility and responsiveness of supply chains (Seow, 2023). The preceding discussion leads us to propose the following hypothesis:

H1c: Codified knowledge has a positive and significant impact on CA
H2c: Tacit knowledge has a positive and significant impact on CA



(SA= Supplier adaptability, IA= Internal Adaptability, CA= Customer Adaptability)

Figure 2: Theoretical model

Research Methodology

Questionnaire Design

The development of the questionnaire was a multi-step process aimed at ensuring comprehensive coverage of the research objectives and reliability and validity of data collected.

Consequently, the focus of investigation in the study directed towards the firm-level examination. The research concentrates on Pakistani Firms within the manufacturing sector. This study utilizes a cross-sectional sample survey method, a non-experimental design (Kerlinger & Lee, 2000). Cross-sectional sample survey design aligns well with this study's objectives of collecting data on multiple perception and attitude variables from a large group of participants. All the constructs in the study were observed and measured through the explanation and operationalization of relevant items (Bougie & Sekaran, 2019). The study utilized: Structured close-ended questionnaires
Dichotomous, multiple-choice rating response options (Cooper & Schindler, 2014),

Development of Measurement Scale

Table 1: Measurement Scale

Research Construct	No. of Items	Reference
Intellectual Capital	15	(Subramaniam & Youndt, (2005);(Sharabati et al., (2010)
Supply Chain Adaptability	21	(Yang et al., 2020)

These were well tested scales and ensure reliable consistency.

The study employs the Likert scale as its measurement tool. As described by (Bougie & Sekaran, 2019), ranging from "1" for "Strongly disagree agree" to "7" for strongly Agree.

Population & Sampling

Population for a research consists on a large number of participants that has been considered as focus for scientific exploration (Hossan et al., 2023).

Our study utilizes a sampling frame, which is essentially a complete list of all manufacturing firms in Pakistan (Bougie & Sekaran, 2019). The demographics of respondents is provided in Appendix 1.
The study used two stage sampling firstly non random sampling then purposive **sampling** techniques to select key employees within each organization who possess knowledge and experience in Supply Chain Management. (Campbell et al., 2020) and (Suseno et al., 2023).

Analysis, Results & Hypothesis Testing

To evaluate the hypothesized model in this study, Smart PLS 4.01 was employed, utilizing the PLS-SEM methodology as proposed by (Ringle et al., 2020). PLS-SEM is especially appropriate for exploratory

research with complicated models and can capture more variation in the data than SEM. The consensus two-step procedure suggested by (Hair et al., (2019), was used to systematically estimate the measurement and structural models.

Estimating of Measurement Model

Estimating Model

This step comprises the assessment of the following factors such as Factor loading, Composite reliability (CR), Average variance explained (AVE) and Cronbach's Alpha (Alpha)

Validity & Reliability

Table 2: Validity & Reliability

Construct	Cronbach's Alpha	CR	AVE
IA	0.902	0.904	0.671
CA	0.902	0.903	0.629
SA	0.934	0.935	0.717
OCapital	0.907	0.907	0.728

Discriminant Validity

Table 3: Discriminant Validity

	IA	CA	SA	OCapital
IA	**0.453**			
CA	**0.422**	**0.446**		
SA	**0.392**	**0.390**	**0.460**	
OCapital	**0.413**	**0.418**	**0.364**	**0.4615**

Evaluation of Measurement Model

To evaluate the hypothesized relationships in the research model, this study adopted a PLS approach. More precisely, the PLS algorithm was used to compute path coefficients, which were statistically tested with PLS bootstrapping at the 5% level ($p < 0.05$).

Model Fit

PLS-SEM analysis of data and model fit indices. The following fit indices were obtained with PLS-SEM on data and model:

This table shows the results of a statistical model (probably from an SEM, regression analysis, or similar statistical procedure).

Table 4: Model fit indices

	Saturated model	Estimated model
SRMR	0.042	0.065
d_ULS	0.065	0.150
d_G	0.098	0.195
Chi-square	194.040	335.942
NFI	0.911	0.845

Interpretation

SRMR (Standardized Root Mean Square Residual)

The values less than 0.08 are generally regarded as good. Both models showed an SRMR below that threshold but was lower for the Saturated Model.

d_ULS (Unweighted Least Squares Discrepancy)

In this case, a smaller value is better. The Saturated Model has a lower d_ULS, which means it fits better than the Estimated Model.

d_G (Geodesic Distance)
d_G is one of the indices for the model fit. Similar to d_ULS, smaller values are better for the fit. The saturated model is better again with a lower value.

Chi-square
The chi-square test checks the goodness of fit of the model. The Saturated Model Chi-square value is smaller, which is better.

Normed Fit Index (NFI)
The closer the value is to 1, the better the fit. The Saturated Model has a greater NFI and thus a higher level of fitness than the Estimated Model.
The Saturated Model fit the data better than the Estimated Model in all indices (SRMR, d_ULS, d_G, Chi-square, and NFI). Therefore, the Saturated Model describes the data more appropriately and has a better overall fit.

Quality Criteria- R-Square

Table 5: Quality Criteria

	R-square	R-square adjusted
CA	0.699	0.697
IA	0.684	0.682
SA	0.531	0.528

Interpretation
The dimensions of organizational capital, when analyzing their relative impact, were shown to have such force of explanation of the degree of variation in CA and IA This means that the variables selected seem to be able to explain the differences in such dimensions observed. In contrast, the explanatory power for supplier SC adaptability (SA) is the weakest with respect to other dimensions of SCA.

It is further observed that the scores for the adjusted R-square and R-square values of those models are similar, indicating that the number of selected predictor variables is ideal. This good fit suggests that the models are not over fit and that they are reliable, which can be seen as a robust picture for understanding the effect of organizational capital on service capability.

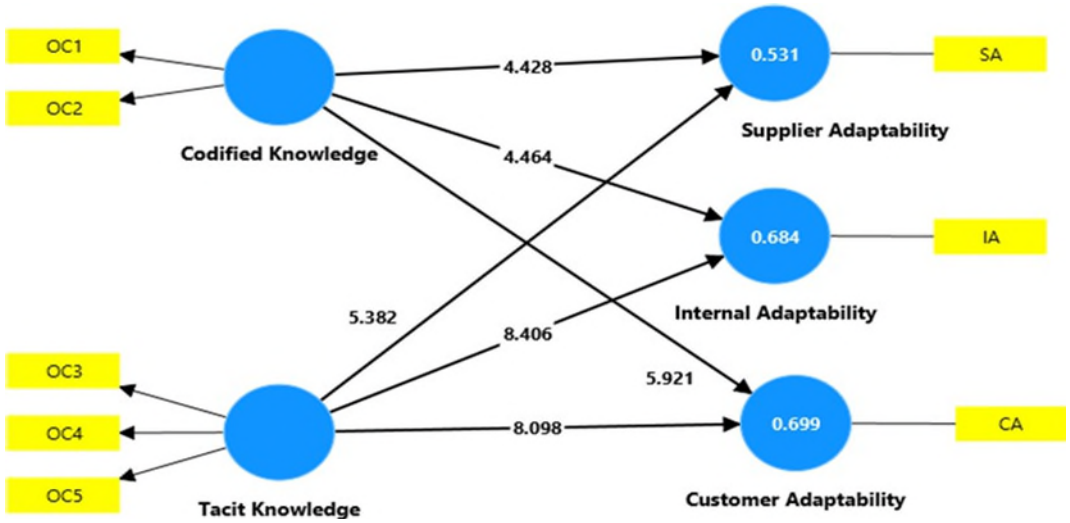


Figure 3: Structured Model

Hypothesis testing Table 6: Hypothesis testing

Hypothesis	Path Coefficient	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
H_{1a}	Codified Knowledge -> Supplier Adaptability	0.346	0.078	4.428	0.000	Supported
H_{1b}	Codified Knowledge -> Internal Adaptability	0.307	0.069	4.464	0.000	Supported
H_{1c}	Codified Knowledge -> Customer Adaptability	0.377	0.064	5.921	0.000	Supported
H_{2a}	Tacit Knowledge -> Supplier Adaptability	0.421	0.078	5.382	0.000	Supported
H_{2b}	Tacit Knowledge -> Internal Adaptability	0.561	0.067	8.406	0.000	Supported
H_{2c}	Tacit Knowledge -> Customer Adaptability	0.503	0.062	8.098	0.000	Supported

Interpretation

H_{1a} evaluates whether Confined Knowledge has a significant impact on supplier adaptability. The results showed that Confined Knowledge has a significant effect on SA (β=.346), t= 4.428 and p<0.05. Therefore, H_{1a} is supported. H_{1b} evaluates whether Confined Knowledge has a significant impact on Internal adaptability. The results showed that Confined Knowledge l has a significant effect on IA (β=.307), t= 4.4674 and p<0.05. Therefore, H_{1b} is supported.

H_{1c} evaluates whether Confined Knowledge has a significant impact on CA. The results showed that Confined Knowledge has a significant effect on customer adaptability (β=.377), t= 5.921 and p<0.05. Therefore, H_{1c} is supported. H_{2a} evaluates whether employee tacit Knowledge has a significant impact on SA. The results showed that tacit Knowledge has a significant effect on SA (β=.421), t= 5.382 and p<0.05. Therefore, H_{2a} is supported. H_{2b} evaluates whether tacit Knowledge has a significant impact on Internal adaptability. The results showed that employee tacit Knowledge has an insignificant effect on IA (β=.561), t= 8.406 and p>0.05. Therefore, H_{2b} is not supported.

H_{2c} evaluates whether employee tacit Knowledge has a significant impact on Customer supply chain adaptability. The results showed that employee tacit Knowledge has a significant effect on CA (β=.503), t= 8.098 and p<0.05. Therefore, H_{2c} is supported.

Analysis in Table 6 shows the relationships between dimensions of Organizational capital and dimensions of Supply chain adaptability. There is a no negative association between dimensions of organizational capital and dimensions of supply chain adaptability, in all cases (P>0.05). It shows that all hypotheses are accepted here. Therefore, the results show that different dimensions of organizational Capital has a positive and significant impact on different dimension of Supply chain adaptability (SCA), with a p-value less than 0.05. So, it can be inferred that different dimensions of organizational capital have a positive and significant impact on different dimensions of supply chain adaptability.

Discussion & Managerial Implications

Organizational capital, a fundamental component of intellectual capital, is pivotal in strengthening supply chains and enhancing their overall performance (Mubarik et al., 2022). The ability of a supply chain to adapt is recognized as a critical dynamic capability, empowering companies to swiftly detect and respond to disruptions. Organizational capital is indispensable in achieving this adaptability. Studies have demonstrated that organizations with supply chains enriched by strong organizational capital are notably more resilient when confronted with challenges (H. Liu et al., 2022)

Organizational capital significantly contributes to a company's knowledge repository, skill development, and innovation capacity, positioning it as a key determinant of organizational success. In

the context of supply chain management, the codified and tacit knowledge embedded in the firm and its employees is important for dealing with the complexity, risks, and efficiency of uncertain and dynamic processes. Quickly adjusting and changing courses has become a business necessity in today's volatile global economy. Organizational capital as an upstream construct in a supply chain antecedent and Bayesian approach to supply chain adaptability (SCA) are determinants of efficiency in operations and the capability to manage unexpected problems in the marketplace.

Theoretical Implication

The Structured saturated model fits better across the board and has superior values for NFI, SRMR, d_ULS, d_G, and Chi-square. The values of R-square and the adjusted R-square show that the model has a very strong explanatory power on CA and IA and moderate on SA. This study contributes to the growing literature on the Dynamic Capabilities View (DCV) by empirically examining which aspects of organizational capital influence different aspects of supply chain adaptability. By examining how specific dimensions of organizational capital work to enhance a firm's ability to adapt its supply chain, this study provides valuable insights that shed light on the mechanisms through which organizational capital facilitates overall organizational adaptation. Indeed, by exploring the nuanced interplay between organizational capital and supply chain adaptability, this study clarifies how organizations can use their internal knowledge blend to adjust more effectively to shifts in the external environment. The results extend our knowledge of the contribution of organizational capital to dynamic capabilities and provide practical insights for firms seeking to enhance their adaptive capacity in the face of growing turbulence and more intense competition. Examining the influence of various dimensions of organizational capital on various dimensions of SC adaptability within the DCV framework offers a more complete picture of how firms build and maintain dynamic capabilities. It highlights the importance of internal resources in relation to external flexibility and helps develop a theoretical rationale to elaborate how the asset of organizational capital affects the dynamic capability of a firm.

Managerial Applications

It can be deduced from the foregoing that codified knowledge assists supply chain executives in making informed decisions and being adaptable in response to changes in demand, supply, or other external conditions. High Tacit Knowledge Employees with high tacit knowledge analyse the situation and learn to adjust to new surroundings quickly. Their intuitive Knowledge of the supply chain can lead to adjustments in the line to respond quickly to unanticipated events. Informal knowledge is fundamental to managing relationships with suppliers, customers, and other stakeholders. Veterans can exploit their network and knowledge of partner behaviour to drive a better deal, resolve conflicts, and smooth cooperation**.**

Conclusion

This study investigates the dimensions of supply chain adaptability in Pakistani manufacturing organizations and their link with diverse facets of organizational capital. Based on the Dynamic Capability model, we empirically examine these associations through a large survey of 319 supply chain professionals. We scrutinized the hypothesized relationships using partial least squares structural equation modeling (PLS-SEM).

This study explores the practical implications of viewing organizational capital as a strategic resource for improving supply chain adaptability. By extending and elaborating on the ongoing research, we extend the theoretical foundations of the DCV framework and provide new perspectives on its applicability in the supply chain management field.

The evidence from the Pakistani manufacturing firms provides strong support for the model proposed in this study, which confirms that the enhancement of the different dimensions of supply chain adaptability is explained by the development of organizational capital. Our findings emphasize the

critical importance of development organizational capital to improve overall supply chain performance, thus providing valuable insights for both scholars and practitioners in the field.

Limitations

The data chosen for study was cross sectional day, however a longitudinal survey may produce more good results. Moreover, only the manufacturing sector was considered in study, while other sectors like financial may also be included.

Scope for Further Study

The study paves the way to new research in the field of supply chain management. Only one dimension of intellectual capital was considered, however human capital and relational capital may also be considered in future for study.

References

Al-Omoush, K. S., Palacios-Marqués, D., & Ulrich, K. (2022). The impact of intellectual capital on supply chain agility and collaborative knowledge creation in responding to unprecedented pandemic crises. *Technological Forecasting and Social Change*, *178*, 121603.

Amin, F., Khan, K. I. A., Ullah, F., Alqurashi, M., & Alsulami, B. T. (2022). Key Adoption Factors for Collaborative Technologies and Barriers to Information Management in Construction Supply Chains: A System Dynamics Approach. *Buildings*, *12*(6), 766.

Bontis, N. (1998). Intellectual capital: an exploratory study that develops measures and models. *Management Decision*, *36*(2), 63–76.

Bougie, R., & Sekaran, U. (2019). *Research methods for business: A skill building approach*. John Wiley & Sons.

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing*, *25*(8), 652–661.

Capestro, M., Rizzo, C., Kliestik, T., Peluso, A. M., & Pino, G. (2024). Enabling digital technologies adoption in industrial districts: The key role of trust and knowledge sharing. *Technological Forecasting and Social Change*, *198*, 123003.

Cooper, D. R., & Schindler, P. S. (2014). Business Research Method (12th Ed.). In *Proceedings of the Annual Reliability and Maintainability Symposium*.

Dohale, V., Verma, P., Gunasekaran, A., & Ambilkar, P. (2023). COVID-19 and supply chain risk mitigation: a case study from India. *The International Journal of Logistics Management*, *34*(2), 417–442.

Hair, J. F., Sarstedt, M., & Ringle, C. M. (2019). Rethinking some of the rethinking of partial least squares. *European Journal of Marketing*, *53*(4), 566–584. https://doi.org/10.1108/EJM-10-2018-0665

Harrington, T. S., Srai, J. S., & Kumar, M. (2019). Knowledge management in SMEs and MNCs: Matching knowledge mobility mechanisms to supply network configuration profiles. *Production Planning & Control*, *30*(10–12), 971–994.

Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. G. (2009). *Dynamic capabilities: Understanding strategic change in organizations*. John Wiley & Sons.

Hossan, D., Dato' Mansor, Z., & Jaharuddin, N. S. (2023). Research Population and Sampling in Quantitative Study. *International Journal of Business and Technopreneurship (IJBT)*, *13*(3), 209–222. https://doi.org/10.58915/ijbt.v13i3.263

Hsu, I.-C., & Walton, S. M. (2012). *Relationship between Intellectual Capital and Knowledge Management: An Empirical Investigation Rajiv Sabherwal* (Vol. 43).

Hu, L., Zhou, J., Zhang, J. Z., & Behl, A. (2024). Blockchain technology adaptation and organizational inertia: moderating role between knowledge management processes and supply chain resilience. *Kybernetes*, *53*(2), 515–542.

Irfan, I., Sumbal, M. S. U. K., Khurshid, F., & Chan, F. T. S. (2022). Toward a resilient supply chain model: critical role of knowledge management and dynamic capabilities. *Industrial Management*

& Data Systems, *122*(5), 1153–1182.
Ivanov, D., Blackhurst, J., & Das, A. (2021). Supply chain resilience and its interplay with digital technologies: making innovations work in emergency situations. *International Journal of Physical Distribution & Logistics Management*, *51*(2), 97–103. https://doi.org/10.1108/IJPDLM-03-2021-409
Kähkönen, A.-K., Evangelista, P., Hallikas, J., Immonen, M., & Lintukangas, K. (2023). COVID-19 as a trigger for dynamic capability development and supply chain resilience improvement. *International Journal of Production Research*, *61*(8), 2696–2715.
Kerlinger, F. N., & Lee, H. B. (2000). Foundations of Behavioral Research: The Most Sustainable Popular Textbook. *Journal of Social Development*.
Liu, H., Han, Y., & Zhu, A. (2022). Modeling supply chain viability and adaptation against underload cascading failure during the COVID-19 pandemic. *Nonlinear Dynamics*, *110*(3), 2931–2947. https://doi.org/10.1007/s11071-022-07741-8
Liu, Y., & Zhang, H. (2022). Driving Sustainable Innovation in New Ventures: A Study Based on the fsQCA Approach. *Sustainability*, *14*(9), 5738.
Longley, M. (2006). A. Clarke, P. Allen, S. Anderson, N. Black and N. Fulop (eds)(2004), Studying the Organisation and Delivery of Health Services: A Reader, London: Routledge, 350 pp.,£ 18.99 pbk. *Journal of Social Policy*, *35*(4), 711–712.
Mak, H. Y., & Max Shen, Z. J. (2021). When Triple-A Supply Chains Meet Digitalization: The Case of JD.com's C2M Model. *Production and Operations Management*, *30*(3), 656–665. https://doi.org/10.1111/poms.13307
Mubarik, M. S., Bontis, N., Mubarik, M., & Mahmood, T. (2022). Intellectual capital and supply chain resilience. *Journal of Intellectual Capital*, *23*(3), 713–738. https://doi.org/10.1108/JIC-06-2020-0206
Mukaro, C. T., Deka, A., & Rukani, S. (2023). The influence of intellectual capital on organizational performance. *Future Business Journal*, *9*(1). https://doi.org/10.1186/s43093-023-00208-1
Naughton, C. C. (2020). Will the COVID-19 pandemic change waste generation and composition?: The need for more real-time waste management data and systems thinking. *Resources, Conservation, and Recycling*, *162*, 105050.
Nonaka, I., & Konno, N. (1998). The concept of "Ba": Building a foundation for knowledge creation. *California Management Review*, *40*(3), 40–54.
Phadnis, S. S., & Schoemaker, P. J. H. (2022). *Visibility Isn ' t Enough - Supply Chains Also Need Vigilance Please cite as follows : Phadnis & Schoemaker . (2022). Visi bility isn ' t enough : Supply chains also need vigilance . Management and Business Review , 2 (2), 49-59 . 2*, 49–59.
Rameshwar Dubey David J. Bryde, C. F. M. T. Y. D., & Schiffling, S. (2021). An investigation of information alignment and collaboration as complements to supply chain agility in humanitarian supply chain. *International Journal of Production Research*, *59*(5), 1586–1605. https://doi.org/10.1080/00207543.2020.1865583
Ringle, C. M., Sarstedt, M., Mitchell, R., & Gudergan, S. P. (2020). Partial least squares structural equation modeling in HRM research. *The International Journal of Human Resource Management*, *31*(12), 1617–1643. https://doi.org/10.1080/09585192.2017.1416655
Seow, R. (2023). Entrenching Supply Chain Resilience Beyond Boundaries: a Dynamic Framework in Post-Covid Landscape. *Journal of Technology and Operations Management*, *18*(2), 20–48. https://doi.org/10.32890/jtom2023.18.2.3
Sharabati, A. A. A., Jawad, S. N., & Bontis, N. (2010). Intellectual capital and business performance in the pharmaceutical sector of Jordan. *Management Decision*, *48*(1), 105–131. https://doi.org/10.1108/00251741011014481
Subramaniam, M., & Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal*, *48*(3), 450–463.
Suseno, B. D., Sutisna, Hidayat, S., & Basrowi. (2023). Halal supply chain and halal tourism industry in forming economic growth. *Uncertain Supply Chain Management*, *11*(4), 1433–1440. https://doi.org/10.5267/j.uscm.2023.8.003

Teece, D. J. (2014). The foundations of enterprise performance: Dynamic and ordinary capabilities in an (economic) theory of firms. *Academy of Management Perspectives*, *28*(4), 328–352.

Tuominen, M., Rajala, A., & Möller, K. (2004). How does adaptability drive firm innovativeness? *Journal of Business Research*, *57*(5), 495–506. https://doi.org/https://doi.org/10.1016/S0148-2963(02)00316-8

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, *24*(10), 991–995.

Xu, Y., Wang, L., Wang, W., Chen, H., & Meng, X. (2024). The promotion of digital transformation for supply chain diversification in service-oriented manufacturing paradigm. *International Journal of Logistics Research and Applications*, 1–24.

Yang, L., Huo, B., & Gu, M. (2022). The impact of information sharing on supply chain adaptability and operational performance. *International Journal of Logistics Management*, *33*(2), 590–619. https://doi.org/10.1108/IJLM-11-2020-0439

Yang, Y., Peng, C., Cao, E.-Z., & Zou, W. (2023). Building resilience in supply chains: A knowledge graph-based risk management framework. *IEEE Transactions on Computational Social Systems*.

Yaseen, S. G., Dajani, D., & Hasan, Y. (2016). The impact of intellectual capital on the competitive advantage: Applied study in Jordanian telecommunication companies. *Computers in Human Behavior*, *62*, 168–175.

Youndt, M. A., Subramaniam, M., & Snell, S. A. (2004). *Intellectual Capital Profiles: An Examination of Investments and Returns*.*

Zhang, L., Pu, X., Cai, Z., Liu, H., & Liang, L. (2023). Uniting partners to cope with environmental uncertainty: Disentangling the role of social capital in developing supply chain agility. *Journal of Purchasing and Supply Management*, *29*(2), 100822.

Zomorrodi, M., Fayezi, S., Lau, K. H., & McMurray, A. (2019). Supply chain adaptations for the base-of-the-pyramid business: towards a theoretical model. *International Journal of Physical Distribution and Logistics Management*, *49*(5), 599–624. https://doi.org/10.1108/IJPDLM-01-2018-0045

Acronyms

CA	Customer Supply Chain adaptability
DC	Dynamic Capability
DCV	Dynamic Capability View
ICBV	Intellectual based view
IA	Internal Supply Chain adaptability
SA	Supplier Supply Chain adaptability
SC	Supply Chain

Appendix 1: Respondent' Profile

Position held by Managers	
Supply chain Managers	32.92%
Asst. SC manager	48.59%
Production manager	12.54%
Quality control manager	
Respondents' Length of Service	
Less than Five Years	28.21%
More than Five Years	39.81%
Less than 10 years	17.87%
More than 10 years	14.11 %
Gender	
Male	95 %
Female	05%
Education	
Certification	2.8 %
Intermediate	6.27&
Bachelor	40.75 %
Masters	50.16 %