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“Leveraging Human Capital for Enhancing Supply Chain Adaptability in Volatile and Dynamic Markets”

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Abstract

Global supply chains have experienced severe disruptions in recent years, yet limited attention has been given to how internal organizational resources particularly human capital drive supply chain adaptability. Existing research has largely focused on resilience and sustainability, leaving a gap in understanding mechanisms through which human capital shapes adaptability, especially across its different dimensions and in emerging economy contexts. Grounded in Intellectual Capital-Based View (Martín-de Castro et al., 2019) and Dynamic Capabilities Theory (Teece, 2023), this study examines effect of human capital on supply chain adaptability. Data from 200 manufacturing firms in Pakistan were analyzed using Smart-Partial Least Squares structural equation modeling. The saturated model demonstrated strong fit. Results affirms that human capital significantly enhances all three dimensions of adaptability. Conceptually, this study advances understanding of intellectual capital and dynamic capabilities by positioning human capital as a key enabler of adaptive supply chain performance. Empirically, it offers evidence from an emerging economy context. Practically, findings encourage managers to leverage skills, reputation, and creativity within their workforce to embed adaptability in supply chain strategies.

Keywords: Human Capital, Supply Chain Adaptability, Intellectual capital-based View, Dynamic Capability Theory, Organizational Resources.



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1.0. Introduction

In the past decade, global supply chains have been repeatedly tested by disruptions of unprecedented scale. Geopolitical pressures such as United States–China trade conflict, ongoing Russia–Ukraine war, and the accelerating consequences of climate change have collectively unsettled trade flows and production networks worldwide (Srai et al., 2023). COVID-19 pandemic, which emerged in early 2020, marked a critical turning point, causing severe shortages of essential goods, including N95 masks and protective equipment (Poshdar et al., 2023), and resulting in trillions of dollars in economic losses globally (World Economic Forum, 2020). These shocks have not only disrupted physical flows of goods but have also strained managerial functions across finance, production, marketing, and human resources (Sajadi & Hartley, 2022).

In such volatile conditions, Supply Chain Adaptability (SCA) has become an indispensable organizational capability. SCA reflects the capacity of a supply chain to adjust quickly and effectively to unexpected changes in demand, supply, or environmental conditions. This may involve scaling operations, diversifying sourcing, or reconfiguring processes to maintain continuity (Lee, 2004).

Although adaptability has been acknowledged as a cornerstone of competitive advantage in turbulent markets (Yang et al., 2022), most studies have concentrated on resilience and sustainability. As a result, the internal organizational drivers that underpin adaptability remain insufficiently examined, particularly in the context of emerging economies where vulnerabilities are amplified by resource limitations.

Despite recognition that adaptability is one of the pillars of competitive advantage in turbulent markets (Yang et al., 2022), in majority of latent research adaptability do not receive due focus, especially in case of emerging economies.

One of the internal assets that contribute significantly to adaptability is human capital in terms of employee skills, experience, creativity, and credibility. According to Intellectual Capital-Based View (ICBV), such knowledge assets must be developed in a strategic manner and used to generate sustainable competitive advantage (Martín-de-Castro et al., 2019). Likewise, Dynamic Capabilities perspective (Teece, 2023) emphasizes the capability to sense, seize and reconfigure the assets in the evolving environments, and human capital is at the center of it. Employees who are good will be able to redesign processes, employees who are trusted will maintain confidence of the stakeholders and employees who are creative will produce innovative answers to disruption. In context of supply chains, the capabilities form basis of identification of new suppliers, reorganization of logistics, and introduction of contingency measures (Caputo et al., 2019; Nikookar & Yanadori, 2022).

Despite its potential significance, three notable **gaps** emerge from the literature. First, there is limited empirical evidence on how human capital affects specific dimensions of SCA—namely, supplier adaptability, internal adaptability, and customer adaptability. Second, the relationship between human capital and adaptability has been underexplored in **emerging economy** contexts, where structural vulnerabilities and institutional constraints shape supply chain behavior. Third, while human capital is often treated as a broad construct, few studies disentangle its components—

such as employee skills, reputation, and creativity/innovation—to examine their distinct contributions to adaptability (Mubarik et al., 2022).

This study addresses these gaps by investigating the effect of human capital on the three dimensions of SCA within Pakistan's manufacturing sector. In doing so, it responds to calls for greater integration of intellectual capital theory with dynamic capabilities in the study of supply chain performance, and it provides context-specific insights from a developing economy where adaptability is essential for survival.

The aim of this research is to determine the extent to which human capital enables organizations to counter supply chain disruptions and enhance adaptability across supplier, internal, and customer domains. Specifically, it seeks to:

1. Examine whether human capital positively and significantly influences supplier adaptability.
2. Assess whether human capital positively and significantly influences internal adaptability.
3. Evaluate whether human capital positively and significantly influences customer adaptability.

By linking the micro-level competencies of employees to macro-level supply chain performance, this research makes both conceptual and practical contributions. Conceptually, it advances understanding of how human capital functions as a dynamic capability in turbulent environments. Practically, it offers managers evidence-based guidance on how to cultivate, deploy, and leverage workforce capabilities to embed adaptability into supply chain strategies and operations.

2.0. Theoretical Background and Hypothesis Development

2.1. Literature Review

2.1.1. Human Capital (HCapital)

Human capital encompasses knowledge and skills that employees have acquired through education as well as experience and therefore it constitutes a significant contributor of production and economic value Samad, (2020), this definition has since been revised to the extent that it includes a wider scope of attributes. (Serenko et al., 2024) emphasized importance of multitasking aptitude, commitment and engagement in influencing human capital. As we tend to think about these views, we can define human capital as the combination of knowledge, abilities, the capacity to multitask, dedication, involvement, attitude, experience, intelligence, and creativity that an organization has in its workforce (Mubarik et al., 2022).

HCapital is a vital force that assures firm survival to the fittest in the changing and uncertain environment (Misagh Tasavori Nayereh Eftekhari & Zaefarian, 2021). HCapital, defined as collective dexterity and knowledge possessed by employees, stands as crucial factor contributing to Supply chain adaptability. Human capital significantly enhances a firm's ability to redefine and optimize its resources, processes, and procedures in areas such as supplier adaptability and customer relationship improvement. (M. S. Mubarik et al., 2022)

2.2. Dimensions of Human Capital

Although researchers have classified human capital into various dimensions, but for this study we use two dimensions of Human Capital:

1. Employee Skill and reputation
2. Employee creativity and innovation (Subramaniam & Youndt, 2005).

For this study, human capital is measured through two dimensions from Subramaniam and Youndt (2005): (i) employee skill and reputation (ii) employee creativity and innovation. These were adopted due to their strong relevance to the manufacturing sector of Pakistan, where competitive advantage depends on workforce competence, reputational capital, and the ability to innovate. Other dimensions (e.g., education, experience, training) were considered but excluded to avoid conceptual overlap and because industry feedback indicated that skill-driven reputation and innovative capability are more critical for supply chain adaptability. Moreover, anchoring these dimensions within the dynamic capability perspective provides a logical basis for hypothesizing their positive influence on supply chain adaptability.

Skillful employees possess a range of abilities and attributes that make them valuable in the workplace. These can include both hard skills (technical abilities and knowledge specific to a job) and soft skills (interpersonal and personal attributes). Skillful employees often have a combination of these traits, making them adaptable, efficient, and valuable team members. An employee's reputation is a critical aspect of their professional identity, influencing how they are perceived by colleagues, managers, and other stakeholders. Reputation can be built on several factors, including work performance, reliability, ethics, and interpersonal skills. (Steinbauer et al., 2020). Employee innovation refers to the process by which employees generate new ideas, processes, or products that lead to improvements and advancements within an organization. Innovation is creative, risk-taking, and outside box thinking. Employee creativity is capacity of individuals in an organization to come up with innovative and useful ideas. It is an essential element of innovation as it is engine of the development of new products, services, processes, and strategies. (Yesuf et al., 2023).

2.3. Supply Chain adaptability (SCA)

SCA, which is emphasized by (Mak & Max Shen, 2021) is a strategic feature that helps firms to adapt their supply chains to changes in business environment. One of the most crucial metrics by which companies could be considered successful (Phadnis & Schoemaker (2022), is how fast and efficient they are able to provide their services to customers in transformed environment. Adaptability is how a firm can adjust its routines, given dynamics of environment by relying on diverse technologies, reducing time needed to get materials, and utilizing experience gained in the past (Dubey et al., 2021).

The concept of Supply Chain Adaptability (SCA) is obtaining an impressive momentum as a significant dynamic capability, meaning the fact that an organization can respond extremely fast in the event of any disturbance of the business environment.

2.3.1. Dimensions of Supply Chain adaptability

This study, unlike the earlier models that have in many cases taken more traditional or linear perceptions of adaptability, does appreciate the growing, multi-dimensional and interwoven nature of modern-day supply chains. Supply chains have to deal with in the current tech-driven as well as globalized world. Dimensions of SCA that is taken into consideration of this paper take into consideration the incremented complexity, technological development and global integration that

characterizes the current supply chains to explain why they are better placed to respond to the challenge of the new business environment experienced in the 21st century.

Expanding framework (Yang et al., (2022) this study provided is a profound excursion into Supply Chain Adaptability in disaggregating it into three dimensions that are interrelated. This classification of adaptability allows to offer inordinate perceptions to the supply chain managers on how to augment their strategies to be responsive to market dynamics and stand firm against effects of disruptions.

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

Internal Adaptability (IA)

IA refers to the internal capabilities of an enterprise, grounded in its routines and procedures, that enable it to respond positively to the transformation of its strategic strategy in the long run. It is concerned with changing the internal aspects, e.g., streamlining processes, encouraging cross-functional cooperation, continuously enhancing processes, and the incorporation of technology. These routines can be institutionalized so that the firms can embrace changes in the external environment whether in the anticipated or in the unexpected ways. IA plays a pivotal role in supporting long-term adaptability because it equips companies with the internal mobility to work across organizational boundaries, reorganize the work processes, and modify and adapt practices as warranted.

Supplier Adaptability (SA)

Collaborative potential of a firm and its upstream partners is an important part of the supply chain flexibility and is identified as (SA). It allows companies to deal with fluctuations in supply situations, e.g., changes in raw material stocks or new technologies or in the ability of suppliers to provide. SA facilitates modifications on supply chain activities at any given time to minimize any disruptions and ensure the operations take a smooth course. SA capabilities also allow a Firm to engage in joint problem solving with suppliers where they can share essential data about demand predictions or production plans. This kind of collaboration assists both parties to coordinate their actions and to adapt more quickly in case of either a change in market demand or of a stoppage in the chain, a geopolitical phenomenon or an unexpected natural catastrophe.

Customer Adaptability (CA)

CA is a downstream relationship between a firm and its customers whereby more focus is on the client-oriented approach. It is concerned with active engagement of customers in order to understand their evolving needs and implement them in the practice. Some of the items which CA touches are reconfiguration of resources, traditionally by rearranging inventory, altering production schedules or modifying products or services offered. CA helps companies in establishing customer relationships with demonstrating their loyalty in regards to meeting the evolving needs.

2.4. HCapital and SCA

HCapital acts as a facilitator of organizational learning where firms are proactive in their attempts to identify, acquire and utilize external knowledge. Organizational ability to learn about the external sources is dependent on the availability of skilled and knowledgeable workforce. Employees who exhibit high level of knowledge acquisition and application skills by the customers and the suppliers are especially useful in building organizational resilience in the face of environmental variation. (Zheng et al., 2024).

Skills to learn from suppliers and customers depends on the existence of informed workforce. Workers who have a high potential of learning and applying knowledge provided by both customers and suppliers are very helpful in improving organizational abilities to make a recovery against the environmental changes (Shou et al., 2018).

2.5. Dynamic Capabilities & HCapital:

To capitalize on new possibilities in a dynamically changing environment firms need dynamic capabilities that enable them to better harness their resources so as to realize a potential increase in firm performance (Teece, 2023). Such capabilities are not directly observable and can only be concluded based on the practices and results that they bring into being (Kaur, 2023). Dynamic capabilities are established and exploited in the organizational and managerial processes within one firm. Managers can utilize these processes in order to create new and helpful skills that will allow the firm to evolve in accordance with the changes in the environment (Díaz-Chao et al., 2021).

Wu et al., (2023) note that in order to maintain dynamic capabilities, companies have to constantly invest in their human capital. This continuous process keeps employees dynamic and ready to handle the changing business environments and excel in it.

2.6. Hypothesis Development:

Human Capital and Supplier Adaptability:

A firm having robust Human is equipped with proficient and knowledgeable staff members who possess expertise in technical aspects and are attuned to customer needs.

Highly qualified employees are very good at seeking and absorbing knowledge, getting accustomed to working in a team, and communicating well with the outside stakeholders (Martín-De-Castro et al., (2011) and (Subramaniam & Youndt, 2005).

Experienced workers will have a profound knowledge and experience in their areas of expertise, and this may enhance communication and bargaining with suppliers. Their technical skills can make them solve problems more efficiently, offer possible solutions, and make sound decisions. Professional employees in the domain of supply chain management can come up with more effective procurement strategies and improved control of relationship with suppliers (Johnson et al., 2020).

Interpersonal skills and good reputation among the employees may help build trust as well as relationships with suppliers. Clear communication, reliability and professionalism are areas of

concern that would matter a lot in proper relationship management; an area that would be of great significance in establishing and maintaining healthy supplier relationships.

Due to their thinking creatively, problems are also solved collectively and also there are ways in which their solutions improved processes. (Van Nguyen et al., 2024). Efficiency is enhanced due to skilled employees who can streamline their operations thereby benefiting the supplier adaption. Workers with skills in dealing with data may offer good feedback when it comes to analyzing the performance of the supply chain and this assists them in finding and solving the problem even before it comes out of control. (Xia et al., 2024).

Capable employees who comprehend the strategic goals of such firms can integrate supplier relationships to the goals. objective of this alignment is that the suppliers can play an additional role in developing the strategic long-term strategy of the firm, and this results to greater joined-up and coherent adaptability (Zhang et al., 2023).

Employee reputation and skills help a firm to restructure its relationship with suppliers through better communication, negotiation, development of trust in supplier relationships, promotion of innovation, development of strategic alignment and better management efficiency.

A firm embedded with high rates of employee creativity can easily incorporate its suppliers to come up with new solutions that are beneficial to them (Mannucci & Perry-Smith, 2022).

Creative thinking will result to creation of better processes and systems which merge suppliers' operation with the supply chain of this firm. According to the previous studies, this kind of process improvements is pegged on attaining smooth cooperation between companies and their suppliers and alignment in their operations.

Employees taking the face of innovation would ensure redefining of the relationship with the suppliers by making them transition into strategic partnerships. These employees are helping in establishing more profound strategic relations with suppliers by bringing on board new business models or cooperation frameworks. Research points out that when companies pay attention to innovation, they are more likely to create mutually beneficial relationships with the suppliers in the long run (Chen et al., 2021).

Exploiting such imaginative potential of workers can result in better and two-way beneficial relationships with suppliers which will go toward total supply chain accomplishment (Patel, 2023). Our hypothesis can therefore be as follows:

H_{1a}: Employee skills level and reputation has a positive and significant impact on SA

H_{2a}: Employee creativity & innovation has a positive and significant impact on SA

2.7. Human capital and Internal supply chain adaptability (IA)

Employee skills and reputation are critical factors that can boost a firm's supply chain adaptability. Employee skills and capabilities promotes Internal adaptability, which plays a critical role in fostering cross-functional integration, allowing various departments such as procurement, logistics, marketing, and research and development to collaborate effectively. This integration enhances coordination among departments, accelerates decision-making processes, and facilitates the development of comprehensive solutions to complex supply chain issues. Past research

highlights that robust internal collaboration not only streamlines operations but also improves the responsiveness of organizations in addressing supply chain challenges (Patel, 2023).

Creative employees are instrumental in developing innovative solutions to address unforeseen supply chain disruptions, including delays, shortages, and logistical issues. COVID-19 pandemic presented numerous challenges that required companies to rethink and adapt their supply chains rapidly. Organizations demonstrated remarkable ingenuity in reconfiguring their supply chain operations to manage abrupt changes in demand and supply constraints.

Employee skills enable the firms to adequately react and recover to the supply chain adverse situations through their arrangements and thus have high adaptability and efficiency within.

Creative employees also perform a central role in the process of driving the adoption and adoption of new technologies in organizations. The studies have demonstrated that active technological innovation among employees is the key to the successful introduction of new tools (Bouzakhem et al., 2023). We suggest therefore:

H_{1b}: Employee skills level and reputation has a positive and significant impact on IA

H_{2b}: Employee creativity & innovation has a positive and significant impact on IA

2.8. Human Capital & Customer supply chain adaptability (CA)

Human capital is a keystone around which organizational processes and innovation revolve and hence results in the amplification of customer base and ultimately helps in overall improvement in business performance. Employee skills, knowledge and competencies are also key in terms of innovation of new ideas and the customer relationship. This is due to the current business environment in that, because of quick technology changes and changing customer demands, it is very important to have skilled personnel, who have the capacity to go through such changes. past research emphasizes the need to develop an array of human capacities like creativity, empathy, and flexibility, to bring innovation and consumer satisfaction. Having the capacity to utilize them will help companies to have better customer relationships and to offer more to customer specifications i.e., customer adaptability.

Customer adaptability is a rather wide range of actions and attitudes that help and support others to meet certain needs. CA is not only the knowledge of customer needs; it is a wide realization of differing, conflicting, and constantly changing views on a number of things. Such flexibility even incorporates the proper knowledge of the needs of customers, their buying procedures, and the multiple means of communication that everyone uses to convey information between the organization and the customers.

Customer adaptability is also significant ability of firms that could aspire to be best in competitive markets. It anticipates employing trained personnel to meet a customer need and it is all about knowledge and ability of staff to meet customer demands and hence business has success in long run (S. Arifin et al., 2022). High-performance work practices may establish a culture whereby creativity may be expressed, and lead to achievement of creative outputs that may lead to development of new ways of getting customer experiences and satisfaction (Xu & Wang, 2020).

Employee innovation is crucial for both the effectiveness and long-term sustainability of organizations (Cabral & Marques, 2023). This process involves employees generating novel ideas or devising new problem-solving strategies within their roles and striving to implement these innovations (Wood, 2003) thereby satisfying customer needs. Successful innovation relies heavily on the active engagement of both employees and customers, with feedback serving as a vital component of the creative process (D. Liu et al., 2017). According to ICBV, Intellectual Capital, including the expertise of employees, is vital to make informed decisions quickly. This enhances the Supply chain manager ability to adapt to changing circumstances.

Therefore, we hypothesize as:

H1c: Employee skills level and reputation has a positive and significant impact on CA

H2c: Employee creativity & innovation has a positive and significant impact on CA

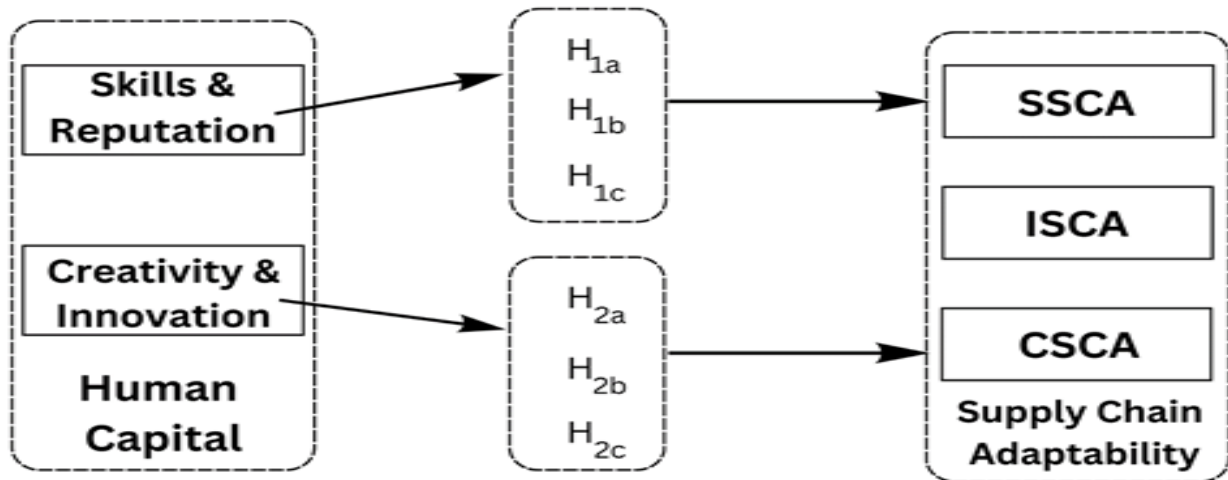


Figure 1: Conceptual Model

3.0. Research Methodology

3.1. Questionnaire Design

The questionnaire was developed through a structured, multi-step process to ensure alignment with the research objectives and to achieve reliability and validity in measurement. Given that the study focuses on firm-level analysis in Pakistan's manufacturing sector, a cross-sectional survey design was employed, which is non-experimental in nature and suitable for collecting perceptions and attitudes from a broad participant base (Sidharth, 2023).

Items for each construct were primarily adapted from established and widely cited measurement scales to ensure content validity and comparability with prior research. Specifically:

- Human Capital items were drawn from Subramaniam and Youndt (2005).
- Supply Chain Adaptability items were adapted from Srari et al. (2023).

This approach ensured standardization of responses and facilitated subsequent statistical analysis.

In some cases, the wording was changed to reflect the manufacturing context of Pakistan and to remain clear to respondents having different educational and professional backgrounds.

All constructs were assessed on the basis of structured, close-ended items, where attitudinal measures were conducted with the help of five-point Likert scales, and the dichotomous/multiple choice forms were used when it was necessary (Blumberg et al., 2014).

3.2. Population & Sampling

This study target population included manufacturing companies in Pakistan since this sector is a critical contributor to the Pakistani economy and is significantly vulnerable to supply chain issues. The sampling frame was developed using updated listings from national industry directories and chamber of commerce databases, ensuring broad coverage of firms across diverse sub-sectors, including textiles, food processing, chemicals, pharmaceuticals, and engineering products.

A two-stage sampling procedure was employed. In the first stage, non-probability sampling was used to select 200 manufacturing firms that were actively engaged in supply chain activities and had established internal supply chain management functions. This stage was guided by firm accessibility, willingness to participate, and sectoral representation. In the second stage, purposive sampling was applied to identify respondents within each firm. Eligible respondents were employees occupying managerial, supervisory, or operational roles directly linked to supply chain management, procurement, logistics, or production planning, as these roles require a comprehensive understanding of supply chain processes and adaptability.

The final sample consisted of 319 respondents, representing a mix of small, medium, and large enterprises, with variation in industry type, years in operation, and ownership structure. While this approach enhanced sectoral coverage, it is acknowledged that the non-random selection may limit statistical generalizability. However, purposive selection ensured that data were collected from knowledgeable informants, thereby improving the quality and relevance of responses.

4.0. Analysis, Results & Hypothesis Testing

To investigate hypothesized model of the study, Smart PLS 4.01 was employed, utilizing PLS-SEM methodology as adopted by (Ringle et al., 2020).

4.1. Estimating of Measurement Model

4.1.1. non-Response bias and common method bias

Based on the responses from the participants, the findings have been derived. This should be considered by assessing the possibility of biases in influencing the responses. To help reduce this risk, all the respondents were guaranteed anonymity and confidentiality levels throughout the survey, and therefore, were free to give their most objective answers. Nevertheless, Common Method Variance (CMV) was also used to continue the measurement of the potential bias. Harman Single Factor Test (SFT) has been used with finding being that, the first factor had 44% variance, which falls short of the generally identified baseline of 50% (Podsakoff et al., 2003). Thus, one can draw a conclusion that the validity of the results was not likely to be affected by the data (Fuller et al., 2016).

Test of collinearity was conducted according to the methodology proposed by (Kock et al., 2017) to check the CMB in PLS-SEM. Collinearity testing returned VIF values that were less than recommended above-3.3 value in the study (Kock et al., 2017) which proves that the common method bias was not a major issue in the study.

4.2. Reliability and Validity

Construct reliability was measured using two-stage approach outlined by (Hair Jr et al., 2019). In first stage, we tested the one-dimensionality of the constructs through exploratory factor analysis (EFA).

Then, reliability was estimated using Cronbach alpha and composite reliability (CR) which are recommended by (Lai, 2021) (See Table 1). Findings indicated that all the Cronbach alpha and CR values were over 0.75 hence exceeding the recommended limit (Lai, 2021). This shows that the reliability of such measures in this study is guaranteed.

It has been shown in our model that factor loading of constructs exceed 0.70 and average variance extracted (AVE) values had been equal to or more than 0.50 (see Table 1). It is stated that these findings confirm that the constructs have a high convergent validity that is supported by (Lai, 2021) and (Fornell & Larcker, 1981); (Hair et al., (2019)

Discriminant validity was used to ask questions relating to the square roots of AVE showing correlation coefficients that tend to be between plots and other constructs. correlation coefficients are lower than the square root of AVE, another evidence of the fact that discriminant validity is demonstrated (Table 2) (Fornell & Larcker, 1981)

4.3. Estimating Model:

This step includes the evaluation of following items: Factor loading, Composite reliability (CR), Average variance explained (AVE) and Cronbach's Alpha (Alpha).

Measurement Model Properties

Table 1: *Measurement Model Properties*

Construct	Factor Loading	Cronbach's Alpha	CR	AVE	VIF
IA	0.859	0.859	0.913	0.677	2.035
CA	0.811	0.902	0.903	0.629	2.988
SA	0.855	0.904	0.947	0.717	2.973
HCapital	0.872	0.877	0.910	0.706	2.997

Table 2: Discriminant Validity

	IA	CA	SA	HCapital
IA	.906			
CA	.844	.892		
SA	.784	.780	0.920	
HCapital	.823	.785	.745	0.904

4.4. Evaluation of Measurement Model:

To evaluate the hypothesized relationships in the research model, this study adopted a PLS approach. In particular, path coefficients were calculated by PLS algorithm and tested on their statistical significance with PLS bootstrapping, 5% level ($p < 0.05$). Model Fit:

Using PLS-CB for data and model, following fit indices were found:

This table presents the results of a statistical model, likely from a structural equation modeling (SEM) analysis, regression analysis, or a similar statistical method. (See Table 3)

Table 3: Model Fit indices (HCapital & SCA)

	Saturated model	Estimated model
SRMR	0.054	0.076
d_ULS	0.106	0.208
d_G	0.108	0.217
Chi-square	211.125	364.112
NFI	0.891	0.812

Model fit indices were SRMR (Standardized Root Mean Square Residual) = 0.054, d_ULS (Unweighted Least Squares Discrepancy) = 0.106, d_G (Geodesic Distance) = 0.108, Chi-square= 211.125, NFI (Normed Fit Index) = 0.891, which are better than suggested threshold values. Therefore, the model was in order and acceptable (Hair et al., (2019).

4.5. Quality Criteria-R-Square:**Table 4: Quality Criteria**

	R-square
CA	0.625
IA	0.681
SA	0.557

Research Implications

- CA (0.625): The model explains a substantial portion of the variance in CA, indicating good predictive power.
- IA (0.681): model demonstrates strong explanatory power for IA, with the highest R^2 among the three constructs
- SA (0.557): While the model explains a slightly lower proportion of the variance in SA compared to the other constructs, it still shows a good fit. These statistics suggest that the models for these constructs are generally well-fitting, with a strong ability to explain the variance in the dependent variables.

4.6. Results:

This study proposes six hypotheses. Using the PLS-SEM technique, the results indicate that all hypotheses are supported.

H1a evaluates whether employee skills and reputation have a significant impact on SA. results showed that employee skills and reputation have a significant effect on SA ($\beta=.419$), $t= 7.599$ and $p<0.05$. Therefore, H1a is supported.

H1b evaluates whether employee skills and reputation have a significant impact on IA. results showed that employee skills and reputation have a significant effect on IA ($\beta=.820$), $t= 31.089$ and $p<0.05$. Therefore, H1b is supported.

H1c evaluates whether employee skills and reputation have a significant impact on CA. results showed that employee skills and reputation have a significant effect on Supply CA ($\beta=.785$), $t= 26.734$ and $p<0.05$. Therefore, H1c is supported.

H2a evaluates whether employee creativity and innovation have a significant impact on SA. results showed that employee creativity and innovation have a significant effect on SA ($\beta=.300$), $t= 3.382$ and $p<0.05$. Therefore, H2a is supported.

H2b evaluates whether employee creativity and innovation have a significant impact on IA. results showed that employee creativity and innovation have an insignificant effect on IA ($\beta=.212$), $t= 2.697$ and $p>0.05$. Therefore, H2b is not supported.

H2c evaluates whether employee creativity and innovation have a significant impact on CA. results showed that employee creativity and innovation have a significant effect on CA ($\beta=.298$), $t= 4.041$ and $p<0.05$. Therefore, H2c is supported.

5.0. Discussion

Improving SCA by Strengthening HCapital

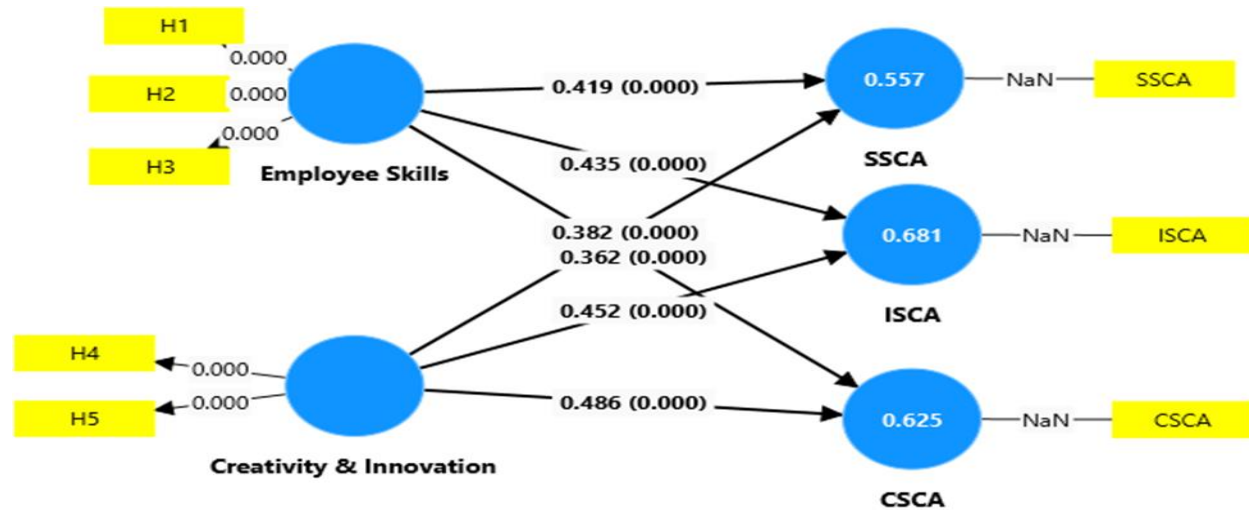


Figure 2: HCapital & SCA

Table 5: Hypothesis Testing

Hypothesis	Path Coefficient	Original sample (O)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values	Decision
H1 _a	Employee Skills -> SA	0.419	0.055	7.599	0.000	Supported
H1 _b	Employee Skills -> IA	0.435	0.050	8.769	0.000	Supported
H1 _c	Employee Skills -> CA	0.362	0.053	6.826	0.000	Supported
H2 _a	Creativity & Innovation -> SA	0.382	0.059	6.485	0.000	Supported
H2 _b	Creativity & Innovation -> IA	0.452	0.048	9.405	0.000	Supported
H2 _c	Creativity & Innovation -> CA	0.486	0.056	8.700	0.000	Supported

Analysis in Table 5 shows the relationships between dimensions of human capital and dimensions of Supply chain adaptability. There is a no negative association between dimensions of Human 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 dimension of Human 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 Human capital have a positive and significant impact on different dimensions of supply chain adaptability.

6.0. Theoretical and Managerial Implications

6.1. Theoretical Implications:

Building upon the traditional resource-based perspective, the Intellectual Capital-Based View (ICBV) posits that intangible assets, such as knowledge, expertise, relationships, and intellectual property, are paramount in driving organizational success. This study delves deeper into the multifaceted nature of human capital by examining its individual components and their specific contributions to supply chain adaptability. Our findings reveal a robust positive correlation between these human capital dimensions and the various facets of supply chain adaptability. SRMR Value of 0.054, d_ULS 0.106, d_G value of 0.108, NFI 0.891, while R Square value for CA is 0.625, IA 0.681 and SA is 0.557 shows that model exhibits a good fit based on the SRMR, d_ULS, d_G, and NFI values, and it also demonstrates strong explanatory power for the variables CA, IA, and SA based on the R-squared values.

Using ICBV and DCV frame work, the study has shown that there is a strong positive correlation between the dimensions of Human capital and the dimensions of the supply chain adapts. research provides a unique contribution to the ICBV literature because it explores directly the influence of such components of human capital as skills, creativity, and expertise on the enhancement of different aspects of supply chain adaptability. Competent employees are able to have quick problem-solving abilities, technological expertise and sound crisis management. Furthermore, Wang et al. (2012) add that the dynamic capabilities can be maintained only when the firms invest in their human capital as well as continue its development. In this manner organizations can stay fixed to a situation of constant growth and be certain that their employees are flexible and prepared to adapt and make success in a continuously changing business climate. This strategy focuses on how the dynamic capabilities can play a major role in making an organization resilient and set it on a path of long-term success in turbulent markets. Human capital dimensions have been regarded as dynamic capabilities that are able to cope with changes that occur in the dynamic external environment. study adds to the existing literature under the theory of Dynamic Capabilities View (DCV) and also under ICBV by testing the empirical evidence on how different dimensions of human capital can affect the different elements of supply chain adaptability.

6.2. Managerial Implications:

This implies that talent and reputation of employees has a positive impact on the capabilities of an internal, customer and supplier adaptability of the focal firms. Reputable employees can inspire and motivate teams to embrace change and innovate, driving the organization's adaptability. reputation of employees can influence the firm's capability to meet varying customer needs and maintain supplier relationships, thereby affecting the supply chain's adaptability. Employee creativity and innovation also exerts a positive and significant impact on three dimension of supply chain adaptability. So, we can conclude that employees who are cable of devising innovative solutions to unexpected supply chain disruptions can strengthen supply chain adaptability. Creative thinking enables firms to tailor their supply chain strategies to specific supplier and customer needs and to meet market conditions.

7.0. Conclusions, Limitations and Future Research

This research not only reinforces significance of human capital in dynamic capabilities but also offers practical implications for firms aiming to optimize their supply chain management practices in response to market fluctuations and disruptions.

Since the study relies on cross-sectional data, it may only capture a snapshot of supply chain adaptability and performance at one point in time. This study is limited to the manufacturing sector in Pakistan, which may limit the generalizability of the findings to other industries or geographical regions. study used only one dimension of ICapital i.e., HCapital, still other elements of ICapital like Organizational Capital and Social capital can also be considered for future research.

The study paves way to new research in the field of supply chain management.

Conflict of Interest

The authors showed no conflict of interest.

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References

- Ahmed, Z., & Wang, Z. (2019). Investigating the impact of human capital on the ecological footprint in India: an empirical analysis. *Environmental Science and Pollution Research*, 26(26), 26782-26796.
- Alfalla-Luque, R., Medina-Lopez, C., & Dey, P. K. (2013). Supply chain integration framework using literature review. *Production Planning & Control*, 24(8-9), 800-817.
- Ali, M. A., Hussin, N., Haddad, H., Alkhodary, D., & Marei, A. (2021). Dynamic capabilities and their impact on intellectual capital and innovation performance. *Sustainability*, 13(18), 10028.
- Arifin, E. N., & Ananta, A. (2023). Employment of highly-skilled migrants during the pandemic: Focus on internal migration in Indonesia. *Asian and Pacific Migration Journal*, 32(1), 60-82. <https://doi.org/10.1177/01171968231169474>
- Arifin, S., Darmawan, D., Hartanto, C. F. B., & Rahman, A. (2022). Human resources based on total quality management. *Journal of Social Science Studies (JOS3)*, 2(1), 17-20.
- Benner, M. J., & Tushman, M. (2015). Process management, technological innovation, and organizational adaptation. In *Business process transformation* (pp. 333-342). Routledge.
- Blumberg, B., Cooper, D., & Schindler, P. (2014). *Business research methods*. McGraw Hill.
- Bougie, R., & Sekaran, U. (2019). *Research methods for business: A skill building approach*. John Wiley & Sons.
- Bouzakhem, N., Farmanesh, P., Zargar, P., Ramadan, M., Baydoun, H., Daouk, A., & Mouazen, A. (2023). Rebuilding the workplace in the post-pandemic age through human capital development programs: A moderated mediation model. *Administrative Sciences*, 13(7), 164.
- Cabral, A. M., & Marques, J. P. C. (2023). How innovation can influence customer satisfaction – case study of the Saccharum Hotel in Madeira. *International Journal of Innovation Science*, 15(1), 80-93. <https://doi.org/10.1108/IJIS-03-2021-0061>
- Caputo, F., Cillo, V., Candelo, E., & Liu, Y. (2019). Innovating through digital revolution: The role of soft skills and Big Data in increasing firm performance. *Management Decision*, 57(8), 2032-2051.
- Chen, Y., Liu, D., Tang, G., & Hogan, T. M. (2021). Workplace events and employee creativity: A multistudy field investigation. *Personnel Psychology*, 74(2), 211-236.
- Díaz-Chao, Á., Ficapal-Cusí, P., & Torrent-Sellens, J. (2021). Environmental assets, industry 4.0 technologies and firm performance in Spain: A dynamic capabilities path to reward sustainability. *Journal of Cleaner Production*, 281, 125264.
- Diaz-Fernandez, M., Pasamar-Reyes, S., & Valle-Cabrera, R. (2017). Human capital and human resource management to achieve ambidextrous learning: A structural perspective. *BRQ Business Research Quarterly*, 20(1), 63-77. <https://doi.org/10.1016/j.brq.2016.03.002>

- Edeh, F. O., & Dialoke, I. (2020). Effect of human resource planning on organizational performance of the hospitality sector in Nigeria. *Business Perspective Review*, 2(1), 1-12.
- Fornell, C., & Larcker, D. F. (1981b). Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. *Journal of Marketing Research*, 18(3), 382-388. <https://doi.org/10.2307/3150980>
- Fuller, C. M., Simmering, M. J., Atinc, G., Atinc, Y., & Babin, B. J. (2016). Common methods variance detection in business research. *Journal of Business Research*, 69(8), 3192-3198. <https://doi.org/https://doi.org/10.1016/j.jbusres.2015.12.008>
- Gyedu, S., Tang, H., Ntarmah, A. H., & Manu, E. K. (2021). The moderating effect of environmental turbulence on the relationship between innovation capability and business performance. *International Journal of Innovation Science*, 13(4), 456-476.
- 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>
- Hair Jr, J., Page, M., & Brunsveld, N. (2019). *Essentials of business research methods*. Routledge.
- 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.
- Johnson, K. R., Ennis-Cole, D., & Bonhamgregory, M. (2020). Workplace success strategies for employees with autism spectrum disorder: A new frontier for human resource development. *Human Resource Development Review*, 19(2), 122-151.
- Katkalo, V. S., Pitelis, C. N., & Teece, D. J. (2010). Introduction: On the nature and scope of dynamic capabilities. *Industrial and Corporate Change*, 19(4), 1175-1186.
- Kaur, V. (2023). Knowledge-based dynamic capabilities: a scientometric analysis of marriage between knowledge management and dynamic capabilities. *Journal of Knowledge Management*, 27(4), 919-952.
- Kock, N., Avison, D., & Malaurent, J. (2017). Positivist information systems action research: Methodological issues. *Journal of Management Information Systems*, 34(3), 754-767.
- Lai, M. H. C. (2021). Composite reliability of multilevel data: It's about observed scores and construct meanings. *Psychological Methods*, 26(1), 90.
- Lee, H. L. (2004). *The Triple-A Supply Chain*. www.hbr.org
- Liu, D., Gong, Y., Zhou, J., & Huang, J.-C. (2017). Human resource systems, employee creativity, and firm innovation: The moderating role of firm ownership. *Academy of Management Journal*, 60(3), 1164-1188.
- 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>

- Lulle, A., Janta, H., & Emilsson, H. (2021). Introduction to the Special Issue: European youth migration: human capital outcomes, skills and competences. In *Journal of Ethnic and Migration Studies* (Vol. 47, Issue 8, pp. 1725-1739). Taylor & Francis.
- 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>
- Mannucci, P. V., & Perry-Smith, J. E. (2022). "Who are you going to call?" Network activation in creative idea generation and elaboration. *Academy of Management Journal*, 65(4), 1192-1217.
- Martín-De-Castro, G., Delgado-Verde, M., López-Sáez, P., & Navas-López, J. E. (2011). Towards "An Intellectual Capital-Based View of the Firm": Origins and Nature. *Source: Journal of Business Ethics*, 98(4), 649-662. <https://doi.org/10.1007/s10551-010-0644-5>
- Martín-de Castro, G., Díez-Vial, I., & Delgado-Verde, M. (2019). Intellectual capital and the firm: evolution and research trends. In *Journal of Intellectual Capital* (Vol. 20, Issue 4, pp. 555-580). Emerald Group Holdings Ltd. <https://doi.org/10.1108/JIC-12-2018-0221>
- Misagh Tasavori Nayereh Eftekhari, G. M. E., & Zaefarian, R. (2021). Human resource capabilities in uncertain environments. *The International Journal of Human Resource Management*, 32(17), 3721-3747. <https://doi.org/10.1080/09585192.2020.1845776>
- Mubarik, M. S. (2016). *Human capital and performance of small and medium manufacturing enterprises: A study of Pakistan*. Jabatan Ekonomi, Fakulti Ekonomi dan Pentadbiran, Universiti Malaya.
- Mubarik, M. S., Bontis, N., Mubarik, M., & Mahmood, T. (2022a). Intellectual capital and supply chain resilience. *Journal of Intellectual Capital*, 23(3), 713-738. <https://doi.org/10.1108/JIC-06-2020-0206>
- Mubarik, M. S., Bontis, N., Mubarik, M., & Mahmood, T. (2022b). Intellectual capital and supply chain resilience. *Journal of Intellectual Capital*, 23(3), 713-738. <https://doi.org/10.1108/JIC-06-2020-0206>
- Mubarik, M. S., Bontis, N., Mubarik, M., & Mahmood, T. (2022c). Intellectual capital and supply chain resilience. *Journal of Intellectual Capital*, 23(3), 713-738.
- Nasifoglu Elidemir, S., Oztüren, A., & Bayıghomog, S. W. (2020). Innovative behaviors, employee creativity, and sustainable competitive advantage: A moderated mediation. *Sustainability*, 12(8), 3295.
- Nikookar, E., & Yanadori, Y. (2022). Preparing supply chain for the next disruption beyond COVID-19: managerial antecedents of supply chain resilience. *International Journal of Operations & Production Management*, 42(1), 59-90. <https://doi.org/10.1108/IJOPM-04-2021-0272>

- Patel, G. M. (2023). *Impact of Employee Engagement Practices on Organizational Effectiveness: A Study of Selected Manufacturing Companies in Gujarat*. Doctoral dissertation, Department of Business Administration, Saurashtra
- Phadnis, S. S., & Schoemaker, P. J. H. (2022). *Visibility Isn't Enough - Supply Chains Also Need Vigilance Please cite as follows: Phadnis & Shoemaker. (2022). Visibility isn't enough: Supply chains also need vigilance. Management and Business Review, 2 (2), 49-59. 2, 49-59.*
- Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879.
- Poshdar, M., Herrera, R. F., & González, V. A. (2023). Success in Interrelated Supply Chain: An Analysis of the Human Behaviour under Crisis. *Proceedings of the 31st Annual Conference of the International Group for Lean Construction (IGLC31), 6*(26), 2023.
- Poyeri, J. B., & Bariweni, T. M. (2023). Employee Participation and Organisational Survival of Small and Medium Enterprises in South-South Region of Nigeria. *International Journal of Advanced Academic Research*.
- Rameshwar Dubey David J. Bryde, C. F. M. T. Y. D., & Schiffing, 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>
- Sajadi, H., & Hartley, K. (2022). COVID-19 pandemic response in Iran: a dynamic perspective on policy capacity. *Journal of Asian Public Policy, 15*(2), 228–249.
- Samad, S. (2020). Achieving innovative firm performance through human capital and the effect of social capital. *Management and Marketing, 15*(2), 326-344. <https://doi.org/10.2478/mmcks-2020-0019>
- Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial least squares structural equation modeling. In *Handbook of market research* (pp. 587-632). Springer.
- 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>
- Serenko, A., Abubakar, A. M., & Bontis, N. (2024). Understanding the drivers of organizational business performance from the human capital perspective. *Knowledge and Process Management, 31*(1), 48-59.

- Shou, Y., Hu, W., & Xu, Y. (2018). Exploring the role of intellectual capital in supply chain intelligence integration. *Industrial Management and Data Systems*, 118(5), 1018-1032. <https://doi.org/10.1108/IMDS-06-2017-0285>
- Sidharth, G. (2023). Research Designs for Contemporary Social Science Research: An Overview. *International Research Journal of Management, Sociology & Humanities*, 14(1), 381-392.
- Srai, J. S., Graham, G., Van Hoek, R., Joglekar, N., & Lorentz, H. (2023). Impact pathways: unhooking supply chains from conflict zones—reconfiguration and fragmentation lessons from the Ukraine–Russia war. *International Journal of Operations & Production Management*, 43(13), 289-301.
- Steinbauer, R., Renn, R. W., Chen, S. H., Biggane, J., & Deitz, G. (2020). The impact of workplace mentors on the moral disengagement of business student protégés. *Journal of Management Education*, 44(2), 165-195.
- 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., Sugianto, E., Purnamasari, E., & Supriadi, A. (2023). Analysis of the Application of Operational Management in Manufacturing Companies in Bandung City: The Effect of Production Efficiency, Product Innovation, and Customer Satisfaction on Financial Performance. *West Science Journal Economic and Entrepreneurship*, 1(11), 535-546.
- Teece, D. J. (2023). The Evolution of the Dynamic Capabilities Framework. In R. Adams, D. Grichnik, A. Pundziene, & C. Volkmann (Eds.), *Artificiality and Sustainability in Entrepreneurship: Exploring the Unforeseen, and Paving the Way to a Sustainable Future* (pp. 113-129). Springer International Publishing. [https://doi.org/10.1007/978-3-031-11371-](https://doi.org/10.1007/978-3-031-11371-11371-)
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533. [https://doi.org/10.1002/\(SICI\)1097-0266\(199708\)18:7<509: AID-SMJ882>3.0.CO;2-Z](https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509: AID-SMJ882>3.0.CO;2-Z)
- Van Nguyen, T., Pham, H. T., Ha, H. M., & Tran, T. T. T. (2024). An integrated model of supply chain quality management, Industry 3.5 and innovation to improve manufacturers' performance—a case study of Vietnam. *International Journal of Logistics Research and Applications*, 27(2), 261-283.
- Wu, Q., Yan, D., & Umair, M. (2023). Assessing the role of competitive intelligence and practices of dynamic capabilities in business accommodation of SMEs. *Economic Analysis and Policy*, 77, 1103-1114.
- Xia, S., Song, J., Ameen, N., Vrontis, D., Yan, J., & Chen, F. (2024). What changes and opportunities does big data analytics capability bring to strategic alliance research? A systematic literature review. *International Journal of Management Reviews*, 26(1), 34-53.
- Xu, F. Z., & Wang, Y. (2020). Enhancing Employee Innovation Through Customer Engagement: The Role of Customer Interactivity, Employee Affect, and Motivations. *Journal of*

Hospitality and Tourism Research, 44(2), 351-376.
<https://doi.org/10.1177/1096348019893043>

- Yang, L., Huo, B., & Gu, M. (2022). The impact of information sharing on supply chain adaptability and operational performance. *The International Journal of Logistics Management*, 33(2), 590-619.
- 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.
- Yesuf, Y. M., Getahun, D. A., & Debas, A. T. (2023). Factors affecting “employees’ creativity”: the mediating role of intrinsic motivation. *Journal of Innovation and Entrepreneurship*, 12(1). <https://doi.org/10.1186/s13731-023-00299-8>
- Zhang, Y., Kumar, S., Huang, X., & Yuan, Y. (2023). Human capital quality and the regional economic growth: Evidence from China. *Journal of Asian Economics*, 86, 101593.
- Zheng, G., Ul Haq, M. Z., Huo, B., Zhang, Y., & Yue, X. (2024). Leveraging intellectual capital for building a supply chain circular economy system: A knowledge-based view. *International Journal of Production Economics*, 272(March), 109225. <https://doi.org/10.1016/j.ijpe.2024.109225>.