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# Exploring And Development Of Pathways To Supply Chain Agility And Firm Performance: Role Of Competitive Capabilities In CPEC

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## ABSTRACT

*The agile supply chain is the competitive approach of manufacturing firms for developing and achieving sustainable market competitive position, developing better products and customer reach to achieve the objective of enhanced market & financial performance. In any country, Infrastructure has considered as mandatory factor to ensure the smooth operation of logistics activities. Therefore, as countries focus on development of infrastructure in any region, firms also needs to focus on their supply chains to harvest the benefits of infrastructure for achieving the efficiency & effectiveness. The study aimed to examine the role of infrastructure framework in relation with firm's performance, through appropriately matched logistics activities for competitive capabilities through procreating role of SC agility. The systematic[1] review of previous studies has provided base for development of theoretical framework of the proposed relationship. The data has collected through a large-scale questionnaire from individuals of 100 CPEC associated firms, selected across the Pak-China Economic Corridor. The hypothesis testing deductive approach has used to validate the proposed framework by using SEM technique through deployment of smart PLS. The empirical evidence proposes that infrastructure framework takes no significant direct impact on performance of manufacturing firms however; relationship of infrastructure framework and firm's performance has mediated through SC agility. The study result also shown that logistic activities for competitive capabilities mediate the relationship between supply chain agility and infrastructure framework. Further the results validate that serial mediation exits between relationships of infrastructure framework, logistics activities for competitive capabilities, supply chain agility and organizational performance. The study provide an overview and empirically indicate a contribution to theory for understanding the enablers of agile supply chains and pathways to understand how infrastructure framework can breed supply chain agility by synchronizing logistic capabilities for competitive advantages.*

***Keywords:*** *Supply Chain Agility, Infrastructure Framework, Organizational Performance, Competitive Capabilities, Pak-China Economic Corridor (CPEC)*

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## 1. INTRODUCTION:

Competition in global dynamic markets and the extensive use of contemporary industrial technologies creates complex and unpredictable competitive environment (Alam, 2022). The three main forces including globalization, rivalry, and new manufacturing technology compelled firms to look for ways to enhance their performance by taking into account how best to satisfy customers' wants. This includes creating products that are competitively priced and delivering goods/services from production origin to consumer through effective and affordable methods (Wu et al., 2017). Supply chain disruptions due to non-availability of crucial skills & information ultimately lead to downstream businesses in temporarily shut down of their production lines (Maemunah, Cuaca, & Review, 2021). Therefore, firms must build the capability to combat these continuously increasing uncertainties. These capabilities are not a result of random activities; rather, they are the outcome of strategic decisions that take into account customer wants, rival actions, supplier capabilities, and the internal strengths and limitations of the company (Nayal et al. 2022).

Diverse capabilities are required for the survival of a supply network, and enhancing SC capabilities enables the SC to obtain sustainable advantages in a vibrant atmosphere (Wan et al., 2023). Dynamic supply chain capabilities are a collection of inter-organizational actions that can use to generate new, reliable skills or to modify existing ones among supply chain partners (Defee & Fugate, 2010). Sensing, grasping, and transformational capabilities are part of such capabilities. The idea of dynamic capabilities has expanded to include the ability of supply chain partners to gain a competitive advantage (Beske & management, 2012; Defee & Fugate, 2010). It is crucial for businesses to identify resources that will give them a competitive advantage (Paul, Lim, Cass, Hao, & Bresciani, 2021). Different SC capabilities are necessary for supply network survival, and improving these SC capabilities allows the SC to gain from competitive advantages in a dynamic environment (Wan et al., 2021). Resource Based View (RBV) states that by creating and using organizational resources, businesses can have superior performance and competitive advantages (Yang et al., 2019). Resources are valuable, scarce, distinctive, and irreplaceable, which aids the SC in gaining competitive advantages (Nandi et al., 2020). Manufacture ring firms need to have integrated relationships with their SC partners for building resources based capabilities. Companies should collaborate with both their downstream consumers and their upstream suppliers to develop a competitive product that will meet both present and future requirements (Nandi et al., 2020).

Supply Chain Agility (SCA) is the dynamic practice of a supply chain to respond effectively and promptly to changes in consumer demand, market conditions, or disruptions. It necessitates the ability to rapidly modify, reconfigure, or reorganize assets, networks, and SC processes to accommodate changing requirements and enhance functionality (Banomyong & Supatn, 2011a; Bargshady et al., 2016b; Borgström & Hertz, 2011; Gligor et al., 2013; Gligor & Holcomb, 2014; L'Hermitte, Tatham, Brooks, Bowles, & Management, 2016; Matawale, Datta, & Mahapatra, 2016; Mehralian, Zarenezhad, Ghatari, et al., 2015). Agility has referred as a firm’s capacity to recognize changes in market (such as opportunity and challenge) and respond to them quickly (Wamba, 2022). Organizations with strong SC agility may experience ongoing innovation (Goncalves et al., 2022).

SCA enables organizations to be flexible, anticipate and respond rapidly to changing customers’ demands, guarantee uninterrupted services and unexpected disruptions to achieve high levels of customer service and operational efficiency. It involves proactive planning, flexibility, collaboration, and the implementation of agile practices and technologies to enhance responsiveness, reduce lead times, ensure quality

products, better customer reach, minimize costs, and seize business opportunities in a fast-paced and uncertain business environment. However, the supply chain managers in manufacturing firms of developing countries like Pakistan are lack in understanding the importance of SCA concept. Even the few organizations, which have applied the SCA concept, they have implemented partially or without spirit. The uncertainty and instability in terms of political and economic environment of such countries demands the need that firms must be agile in their supply chains to absorb the shocks of these uncertainties and instabilities. Therefore, theoretical and empirical validation are required to address the SCA issue in manufacturing firms, especially in developing countries and to validate the pathways and role of logistic competitive capabilities to achieve SCA for sustainable competitive advantage & enhanced organizational performance.

Infrastructure is considered important due to its major role in raw materials mobility and marketing distribution channel development. A robust infrastructure not only improves operational efficiency but also expands market reach, accessibility, and competitiveness (Abualoush, Bataineh, & Alrowwad, 2018). Literature explains that Infrastructure Framework (IF) includes all fixed, permanent, and fundamental installations required by businesses, nations, and regions, such as road infra, bridges, railway infra, subways, airport infra, seaport infra, energy and communications (Al-Shboul, 2017). IF not only improves operational efficiency but also expands market reach, accessibility, and competitiveness (Abualoush, Bataineh, & Alrowwad, 2018). Globally multiple countries are considering joint projects for development of infrastructure for better reach. Similarly, the Chinese and Pakistani governments, in a strategic partnership, have agreed to establish the 62 billion USD value project Pak-China Economic Corridor (CPEC) from Kashgar in Xinjiang, China, to Karachi and Gwadar, southern coastal cities in Pakistan, via the Khunjerab Pass and several other nodes.

Since organizations are striving hard to achieve a market competitive position, which requires the development of capabilities. Literature has described five dimensions of competitive capabilities that include competitive pricing, premium pricing, customer-centric quality, reliable delivery, and PI (Li, Ragu-Nathan & Rao, 2006; Cleveland, Schroeder, & Anderson, 1989; Rondeau, Vonderembse, & Ragu-Nathan, 2000; Roth & Miller, 1990b; Safizadeh, Ritzman, Sharma, & Wood, 1996; Tracey & Vonderembse, 1999). Based on these studies Price/cost, quality, delivery, and flexibility have considered by the empirical literature as key logistic competitive capabilities (Mentzer et al., 2004; Li et al., 2006; Novais, Maqueira, & Bruque, 2019).

Previous researches have emphasized the significance of IF and SCA. However, the correlation between these variables is ignored, thus it must be investigated (Al-Shboul, 2017). Therefore, in order to investigate the Infrastructure framework important elements and its effect on supply chain agility and validate the relationship between two, the study has proposed a model to validate the impact of IF on SCA. The literature suggests that company-specific logistical capabilities that satisfy can assist to raise the degree of SCA for improved and greater SC efficiency and effectiveness (Gligor et al., 2015). Logistic capabilities are necessary for supply network survival, and improving SC capabilities, which allows the SC to obtain an edge over competitors in a changing landscape (Wan et al., 2022). Gligor & Holcomb, (2012) argues that literature lacks to validate at how logistical capabilities generally relate to achieving agility. Al-Shboul, (2017) argue that several studies in the pertinent literature failed to show that a firm's SCA should successfully aligned with the key components of the IF to achieve improved performance and resource optimization throughout the whole SC. He further validated that SCA mediate by the availability of suitable SC logistical techniques and activities like DD & TM. However it is necessary to validate the all logistic capabilities including Price, Quality,

Demand Dependability, Product Innovation, and Time to Market identified in the literature to examine the association between IF and SCA. Therefore, study proposes that a comprehensive conceptual framework need to view to study the relationship of SC agility enablers. Consequently, a comprehensive conceptual framework has suggested.

In addition to above, the study of serial mediation is also crucial to understand the role of mediator as well as collective shape of outcome variables, which leads to holistic approach to ensure ecological validity of study (Satici, Saricali, Satici, & Griffiths, 2022). In the light of previous studies there would need to propose a comprehensive to explain the complex causal pathways and the interconnectedness of infrastructure framework and organizational performance. Therefore serial mediation analysis has proposed for better understanding of variables and processes by recognizing & combining variables, in association between infrastructure framework and firms performance.

## 2. LITERATURE REVIEW:

Supply Chain Management (SCM) is the organization philosophy that includes administration & coordination of a number of primary corporate practices through distinct sources to ensure delivery of products & services and distinctive value for customers and other partners through logistic partners (Ho, Au, & Newton, 2002).The functional and organizational scopes of SCM seek to improve chain-level profitability, customer service, stock/inventory availability, cost, bullwhip effects, and cycle time (Alam, 2022). The study found that higher-level SCM practice increases competitive advantage and enhances firm's performance (Li et al., 2006). Abu-Alrejal, (2007) investigates the SCM practices and manufacturing firm's performance, which revealed that organizations with superior SCM capabilities experienced improved operational efficiency, customer satisfaction.

The Council of Logistics Management (CLM), a logistic managers professional firm, argue that logistics is an important part of SCM which have the responsibility of effective process management, inventory management, information management, from production to consumption, for better customer services and value (Nunes, Causer, & Ciolkosz, 2020). The RBV perspective perceives agility as a crucial element for successful supply chain management policies and processes (Stank et al., 2022; Gligor and Holcomb, 2012). Agility has been defined as firm's capability/resource, which allows firms in modification of its operations & strategies to respond the dynamic and fast changing external environment (Gligor et al., 2020). SCA is the most crucial competitive element of any effective SCM strategies and processes from a resource-based perspective (Gligor & Holcomb, 2012; Stank et al., 2022).

To achieve sufficient organizational agility, a company must have a pervasive culture of change throughout the complete organization. Strong organizational agility increases the likelihood that an organization will experience ongoing innovation (Goncalves et al., 2022). Christopher, (2000) has extracted and reviewed thirteen variables connected to SCA after consulting with industry professionals (Agarwal et al., 2007). Market sensitivity (MS), delivery speed (DS), data accuracy (DA), new product introduction (NPI), lead time reduction (LTR), process integration (PI), customer satisfaction (CS), quality improvement (QI), minimizing uncertainty (MU), trust development (TD), and minimizing resistance to change (MRTC) are the variables that make up this list.

The numerous benefits of agile manufacturing ultimately assist businesses in surviving and expansion in dynamic environment (Gligor & Holcomb, 2012). The studies shows that agility have positive impact on firms SC efficiency, efficacy, ROA, which leads

to enhanced firm performance (Gligor et al., 2015). Dubey et-al, (2018) investigated the effect of SCA, flexibility & alignment on firms performance and results shows that SCA has a favorable impact on OP. Fawzi Ayoub and Bahjat Abdallah, (2019) examine the impact of SCA on SC reaction, SC innovativeness, and export performance (EP) in Jordan's manufacturing industry. According to Al Humdan et al., 2020; Nath, Agrawal, & Management, (2020) SC Agility and sustainability practices work well together because businesses require supply chains to react fast and effectively to customers' demands for sustainability in the marketplace.

How infrastructure can preserve competitive advantage is one of the most essential topics to examine from the perspective of RBV (Bharadwaj, 2000; Halawi, Aronson, and McCarthy, 2005; Liu, Ke, Wei, & Hua, 2013). The well-established infrastructure enables the achievement and application of a JIT technique, which involves sending the appropriate goods in the appropriate quantities, at the appropriate times, to the appropriate locations, and in the appropriate conditions; also, employing multiple routes for the mode(s) of transportation depending on quality, dependability, speed, and reliability in order to attain the lowest cost plan. This may help to fulfill primary purpose of agile SC, by fast and effectively responding to the rapidly changing demands and expectations of consumers (Bargshady et al., 2016).

According to Coluccia et al., (2022) investment in transportation infrastructure is vital. Infrastructure development is a major force behind economic growth, boosting productivity and fostering long-term economic growth (Stempfle, Carlucci, Gennaro, Roselli, & Giannoccaro, 2021). According to Green, Zelbst, Meacham, and Bhadauria, (2012) infrastructure play a significant part in the firm's ability that qualify for high performance from its aging SC strategies. It always shown to be an important factor in attracting developing countries to foreign direct investment (FDI) (Donaubauer, Meyer, & Nunnenkamp, 2016). For supply chains, which have some specific characteristics that raise the complexity of external logistics, the endowment of the transport infrastructure is particularly crucial (Bottani, Murino, Schiavo, Akkerman, & Engineering, 2019). According to Al-Shboul, (2017), the connection between an organization's SCA and its manufacturing enterprise success has been the subject of recent research. They make it clear that a high degree of SCA will improve and aid the company's performance in the global market, but they did not consider how the availability of an IF with the essential components would affect the firm's SCA.

Diverse capabilities are required for the survival of a supply network, and enhancing SC capabilities enables the SC to obtain competitive advantages in a dynamic environment (Wan et al., 2022). Logistics capabilities are important for firms as they meet the RBV criteria (rare, valuable, indispensable, and difficult to replicate). Indeed, logistical capabilities have empirically established as a way for companies to get a competitive edge (Zhao et al., 2001; Bowersox, Closs, & Stank, 1999). Studies indicates that logistics capabilities are important strategic assets that help companies quickly and effectively respond to changes in the market and/or supply issues (Stank et al., 2005). Ellinger et al., (2012) illustrate how a business's competitive advantage in the market is highly dependent on its capacity to effectively manage a variety of challenges, achieve product quality, cost, and excellent customer service standards. Zhao et al., (2001) argues that effectively logistics management leads to providing competitive edge to firms. Similarly, Gligor and Holcomb, (2012) argues that logistic modes capabilities have validated as source of competitive advantage for companies. However, few studies look at the broader relationship between logistics capability and agility. This gap indicates the necessity for a comprehensive conceptual framework to investigate this link (Gligor & Holcomb, 2012).

Koufteros et al. (2002) and Milgate (2000) offer a research framework for competitive capabilities based on previous literature and identify five dimensions: customer-centric value, competitive pricing, premium pricing, dependable delivery, and manufacturing innovation. Quality, pricing, flexibility, PI, and delivery are all considered competitive aspects (Li et al., 1995; Nemetz, 1990; Safizadeh et al., 1996). Past studies constantly identifies DD as a key logistic capability, along with other logistic processes, which includes cost of product/process, product quality, TM, PI, and flexibility of product and size (Thatte, Agrawal, & Muhammed, 2009). Kivimäki et al. (2012) and Ellinger et al. (2012) elaborated that firm competitive advantage of over its competitors the marketplace is dependent on firm's ability of handling many challenges efficiently. Quality of products, cost differentiation, higher level of customer service, speed, product quality, flexibility, and responsiveness are the main components of SCA which are necessary to satisfy the high demands of markets and customers. (Beni, Mehralian, & Razavi, 2015).

## 3. THEORETICAL FRAMEWORK

### I. Infrastructure Framework & Organizational Performance:

Agnusdei, Coluccia, & Miglietta (2022) validate the direct significant relation between transport infrastructure & firm performance. Green et al., (2008) and Tse et al., (2016) argues that infrastructure has significant role in firm's capability which are suitable for high performance. According to Sahay et al. (2003), a well-organized infrastructure made up of crucial parts helps enable the uninterrupted flow of products and goods to customers. Well-established infrastructure can assist you in implementing Just in Time (JIT) lines to achieve lowest cost strategy (Bargshady et al. 2016). Al-Shboul, (2017) has conceptualized IF into seven-item construct which are road, railway, airport, seaport, IT, telecommunications as well as energy; companies should successfully align the essential elements of IF in order to enhance performance. Previous literature has not measure the Infrastructure framework and its direct relationship on firm performance. The complexity theory also indicates that relationships among variables could be non-linear, with unexpected changes happening, therefore "cause" under certain situations can leads to different effects (Cantele, Kirchoff, & Valcozzena, (2023). As a result, there is need to validate the direct relationship how IF directly affect the OP. In light of these findings, the following hypothesis has proposed to validate the correlation between the IF and SCA:

H1: The presence of a well-organized IF with all the necessary components contributes to, strengthens, and supports the performance of the organization.

### II. Relationship between Infrastructure framework, Supply chain Agility and Firms Performance:

Previous studies argue that SCA and performance appear to be related (Tse et al., 2016; Tarafdar & Qrunfleh, 2013; Qi et al., 2009; Panigrahi, Meher, & Shrivastava, (2023). The primary purpose of infrastructure is to enable the effective flow of raw materials, accessories, and product distribution through multiple SC partners. This improves the company's agility, speed, and flexibility for global trading. Past research has emphasized the significance of IF and SCA (Abdelilah, Korchi, & Balambo, 2023). However, the correlation between IF, SCA and firm performance must be investigated. The impacts of IF elements and SCA on one another have not independently studied by prior researchers (Qrunfleh & Tarafdar, 2013; Sahay et al., 2003). Al-Shboul, (2017) argue that several studies in the pertinent literature failed to show that a firm's SCA should successfully aligned with the key components of the IF to achieve improved performance and resource optimization throughout the whole SC. Having access to well-organized infrastructure is

crucial for making strategic decisions about internal and external transportation operations because it can directly facilitate the actual movement of products, raw materials, completed commodities, and other related components. It also opens up opportunities for cost savings through efficient inventory management, the elimination of excess inventory, and shortened setup times throughout the SC. However there is need to validate the role of SCA between IF and OP to understand the pathways to achieve firm's performance. According, the following hypothesis has emerged in light of the aforementioned.

H2: The association of infrastructure & firm performance has mediated through supply chain agility.

## III. Role of Logistic Competitive Capabilities in relationship of Infrastructure framework and supply chain agility.

The way to improved and greater supply chain efficiency and effectiveness, return on investment, and total operational effectiveness is through supply chain capabilities (Gligor et al., 2015). Sangari & Razmi, (2015) contends that developing a competitive edge requires effective logistical operations having a significant impact on business performance. Supply chain capabilities are one of the most important issues for researchers and practitioners and a number of studies have focused on such capabilities (Wan et al., 2021). Therefore to determine the importance of logistics capabilities in achieving this objective, one must first understand the pathways that make agile SCs possible. P/C, product quality, DD, PI, and TM have identified in studies as important logistical processes for competitive capacities (Li, Ragu-Nathan, Ragu-Nathan, & Rao, 2006). Gligor & Holcomb, (2012) argues that literature lacks to validate that how logistical capabilities generally relate to achieving agility.

The Resource-Based View is a conjectural view, which looks at the impact that specific logistics capabilities play in achieving SCA. According to earlier research, the relationship between IF and SCA should be mediated by the availability of suitable SC logistics activities and practices (Al-Shboul, 2017). While previous study has examined logistic activities such as DD and TM as intermediaries between IF elements and SCA (Al-Shboul, 2017), but have not examined other important logistic activities i.e Quality, Price/Cost and Product Innovation. To empirically validate the role of all logistic capabilities in relationship between infrastructure framework supply chain agility, a comprehensive conceptual framework has suggested. This study employed the resource-based theory to investigate whether the logistic activities for the SC capabilities including Price, Quality, Demand Dependability, Product Innovation, and Time to Market act as intermediaries in the connection between SCA and infrastructure framework. These have the distinctive and challenging-to-imitate SC capabilities that ultimately have an impact on OP. based on above, the following hypothesis are proposed:

H3a: The relation of SC agility and the infrastructure framework is mediated through competitive capability (CC) price/cost.

H3b: The relationship among infrastructure framework and supply chain agility is mediated through Quality.

H3c: The relationship among infrastructure framework and supply chain agility is mediated through delivery dependability.

H3d: The relationship among infrastructure framework and supply chain agility is mediated through product innovation.

H3e: The relationship among infrastructure framework and supply chain agility is mediated through time to market.

## IV. Serial Mediation of Competitive Capabilities and Supply Chain Agility

According to several SCM-related studies, logistics operations are closely related to establishing, maintaining, and obtaining competitive advantage (Sangari & Razmi, 2015; Ou et al., 2010). Further, the relationship between IF and SCA is mediated by the availability of suitable SC logistics activities and practices (Al-Shboul, 2017). Organizational performance positively and significantly impacted by the delivery's dependability (Richey, Chen, Prere, Fawcett, & Adams, 2009). The Supply Chain Agility (SCA) has a strong focus on innovation & organizational performance (Tse et al. 2016). However the past studies lack to propose the complete pathway from infrastructure framework to organizational performance. In order to understand the enablers of supply chain agility and firms performance, the study proposed a serial mediation model based on relational and resource-based viewpoints to validate the mediating impacts of competitive capabilities and SCA (i.e., relational and capability-based determinants) between IF and OP. The following hypotheses of serial mediation have proposed for validation.

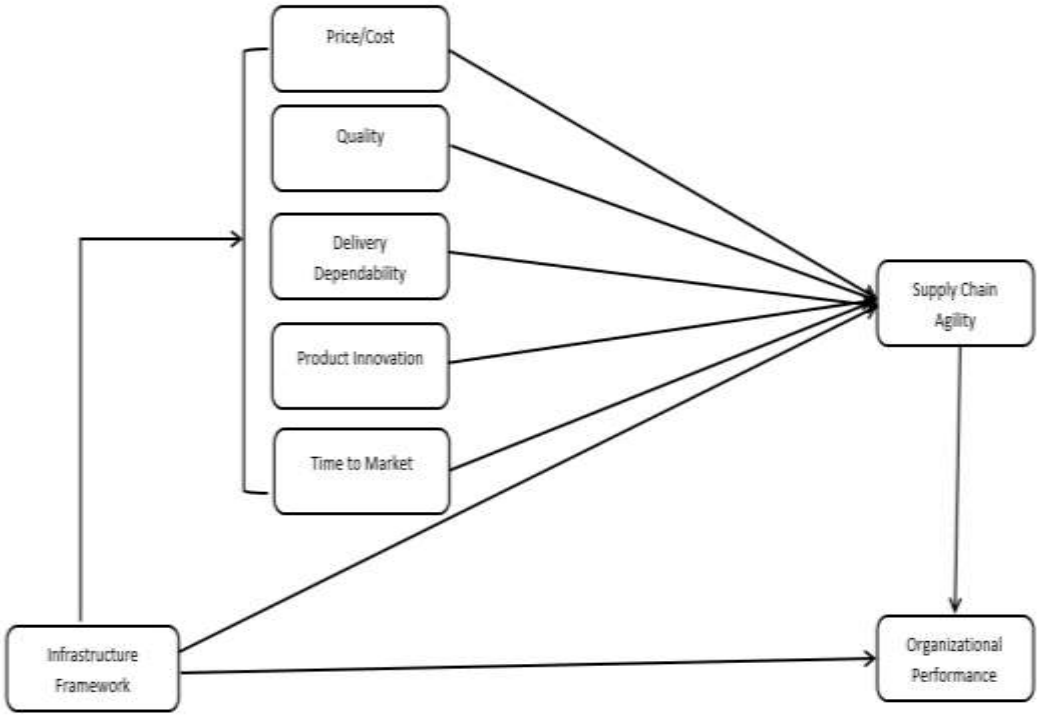
H4a: Competitive Capability Price/Cost and Supply Chain Agility sequentially mediate between IF and OP.

H4b: Competitive Capability Quality and Supply Chain Agility sequentially mediate between IF and OP.

H4c: Competitive Capability Demand Dependability and Supply Chain Agility sequentially mediate between IF and OP.

H4d: Competitive Capability Product Innovation and Supply Chain Agility sequentially mediate between IF and OP.

H4e: Competitive Capability TM and Supply Chain Agility sequentially mediate between IF and OP.




**CONCEPTUAL FRAMEWORK**

## 4. RESEARCH METHOD AND RESULTS

**Instrument Design & pilot testing:** The study scale has adopted from previously established scales. The instruments to measure the IF have been adopted from the study of Al-Shboul, (2017), who formulated and developed the instrument for measuring the IF. The instrument to measure SCA has adopted from studies related to supply chain agility (Qrunfleh & Tarafdar, 2013). In order to measure the OP, the instrument has adopted from the previous studies that are consistent with the measurement of firm performance (Croom et al., 2018 and Kotabe et al., 2003). The instrument to measure TM and DD have adopted from previous studies that measures logistic activities (Green et al., 2008; Li et al., 2006; Chang et al., 2005). Li, Ragu-Nathan, & Rao, (2006) and Al-Shboul, (2017) also used the same instruments to measure the TM for their studies related to supply chain agility of manufacturing firms, which is similar and close to the sample of this study. Product innovation, Price/Cost and Quality have measured by previous studies identified in literature, accordingly construct items are adapted which that are consistent with these studies (Koufteros, Vonderembse, & Doll, 2002; Li, Ragu-Nathan, & Rao, 2006). The questionnaire has gauge by a five-point Likert Scale ranging from "Strongly agree" to "Strongly disagree". For the purpose of the data entry and further analysis, all the variables and items have pre-coded.

Before proceeding to the planned extensive study, the study conducted the pilot study i.e. an approach to pretest the measurement instrument, its reliability and validity. These ensure how well the constructs actually measure what they have supposed to (Cooper & Schindler, 2006; Cooper & Emory, 1995; Gravetter & Forzano, 2012). The instrument has shared and discussed with notable researchers & professionals who have experience of working in the supply chain related variables so that face and content validity of scales have confirmed. The instrument reliability & validity has examined through Cronbach's alpha

and Average Variance Extracted (AVE). The acceptable threshold for Cronbach alpha is ≥ 0.70 and value of 0.50 and higher is the AVE acceptance value (Nunnally & Bernstein, 1994; Hair et al., 2011) The results of pilot testing indicate the instrument reliability & validity.

**Population & data collection:** The study data has gathered from Pakistan's two major manufacturing industries, each of which contributes significantly to the GDP of the nation. The lower, middle & top level managers employed by various manufacturing companies in the CPEC-related regions were the target Population of the study. The data collection through questionnaire has arranged through web-based survey. The web based data collection has many advantages (Szwarc, 2005; Kirkham et al. 2014) however, as per local cultural issue and to seek better response, personal visits have also made by the researcher and team for data collection from respondents. Accordingly, after multiple efforts total 414 valid questionnaires were obtained. Through use of SPSS, the analysis of missing values and their patterns has examined and the missing values have replaced with the series mean.

In order to understand the demographic characteristics of sample, individuals have examined about their gender, age, education, nature of role, name of industry and location of organization. The data provided represents the distribution of respondents from both manufacturing industries (63% from Textile & 37% from Pharmaceutical). The descriptive analysis conducted of each variable's means (a measure of central tendency), variability, and normality statistics (such as skewness and kurtosis).

| Variables | N | Min | Max | Mean | Std. deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| INF | 414 | 1 | 5 | 3.771 | 0.829 | -1.436 | 2.053 |
| SCA | 414 | 1 | 5 | 3.561 | 0.780 | -1.345 | 2.533 |
| TM | 414 | 1 | 5 | 3.666 | 0.822 | -1.384 | 2.335 |
| DD | 414 | 1 | 5 | 3.564 | 0.863 | -1.39 | 1.993 |
| PI | 414 | 1 | 5 | 3.663 | 0.836 | -1.466 | 2.494 |
| Q | 414 | 1 | 5 | 3.674 | 0.950 | -1.277 | 1.478 |
| P | 414 | 1 | 5 | 3.465 | 1.041 | -0.918 | 0.322 |
| OP | 414 | 1 | 5 | 3.493 | 0.906 | -1.152 | 1.117 |

The one-way analysis of variance (ANOVA) has used to determine whether there are any statistically significant differences between the means of independent (unrelated) groups. The results of the one-way ANOVA given in below table revealed no statistically significant difference between respondents from the pharmaceutical industry and those from the textile industry in terms of mean responses.

| SMEAN | Industry | N | Mean | F | Sig. |
|---|---|---|---|---|---|
| SMEAN(TM) | Pharma | 146 | 3.7186 | 0.936 | 0.334 |
| | Textile | 268 | 3.6368 | | |
| SMEAN(DD) | Pharma | 146 | 3.6375 | 1.654 | 0.199 |
| | Textile | 268 | 3.5234 | | |
| SMEAN(PI) | Pharma | 146 | 3.7249 | 1.235 | 0.267 |
| | Textile | 268 | 3.6293 | | |

| | | | | | |
|---|---|---|---|---|---|
| SMEAN(Q) | Pharma | 146 | 3.7466 | 1.319 | 0.251 |
| | Textile | 268 | 3.6343 | | |
| SMEAN(P) | Pharma | 146 | 3.5514 | 1.557 | 0.213 |
| | Textile | 268 | 3.4179 | | |
| SMEAN(SCA) | Pharma | 146 | 3.6350 | 2.043 | 0.154 |
| | Textile | 268 | 3.5204 | | |
| SMEAN(OP) | Pharma | 146 | 3.5535 | 0.992 | 0.320 |
| | Textile | 268 | 3.4607 | | |

**Assessing convergent, discriminant validity and reliability of constructs;**

Examining the factor loadings is the first step in evaluating the reflective measurement model. Items with a factor loading lower than 0.70 should be eliminated for optimal model fit (Hair, Risher, Sarstedt, & Ringle, 2019; Henseler, Ringle, & Sarstedt, 2012). In this study, 05 items of variables had a factor loading less than 0.70, which have removed. Cronbach's alpha and Composite Reliability (CR) are the two main metrics that Hair et al., (2017) suggested to evaluate the internal consistency. The acceptable threshold for Cronbach alpha is $\geq 0.70$ (Nunnally & Bernstein, 1994; Kline, 2016). Hair et al., (2011) recommended that CR $\geq 0.50$ is acceptable. The CR values of the variables in this study are higher than 0.80. The values for Cronbach's Alpha of the study are 0.819 to 0.929, which has also regarded as satisfactory and good. Additionally, Composite dependability values are included in the recommend criterion which demonstrates that both the accuracy of model.

The average variance extracted (AVE) and outer loadings of the indicator have evaluated to determine the convergent validity of the measurement model. According to Hair et al., (2019) an AVE of 0.50 or greater indicates that the construct accounts for 50% or more of the variation of the construct's elements. All variables values of AVE obtained through Smart PLS 3.3 are between 0.611 and 0.861, indicating no validity problem. The Fornell-Larcker technique and the Heterotrait-Monotrait (HTMT) ratio methods have used to evaluate the discriminant validity (Fornell & Larcker, 1981; Henseler et al., 2015). The values of square root of AVE in each factor column are greater than the correlation between variables and HTMT ratio of all constructs is less than its threshold values i.e less than 0.90 as proposed by Hair et al., (2019).

The model fit summary is a key output in SEM that provides information about the overall fit of a model to the observed data. Many different fit indices can use to evaluate SEM models, including the chi-square test, the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the Standardized Root Mean Square Residual (SRMR). SRMR measures the average difference between the observed correlations and the model-implied correlations. The NFI is a relative fit index that compares the fit of a model to a baseline model, which is typically a null model or a model with all variables uncorrelated (Henseler et al. 2014; Hair et al., 2019). The results in below table indicate the results, which confirm the model fitness.

| **Construct** | **Saturated model** | **Estimated model** |
|---|---|---|
| SRMR | 0.071 | 0.156 |
| d_ULS | 4.83 | 23.156 |
| d_G | 6.269 | 7.365 |
| Chi-square | 9986.885 | 11026.572 |

| | | |
|---|---|---|
| NFI | 0.848 | 0.8 |

**Hypothesis testing and results**

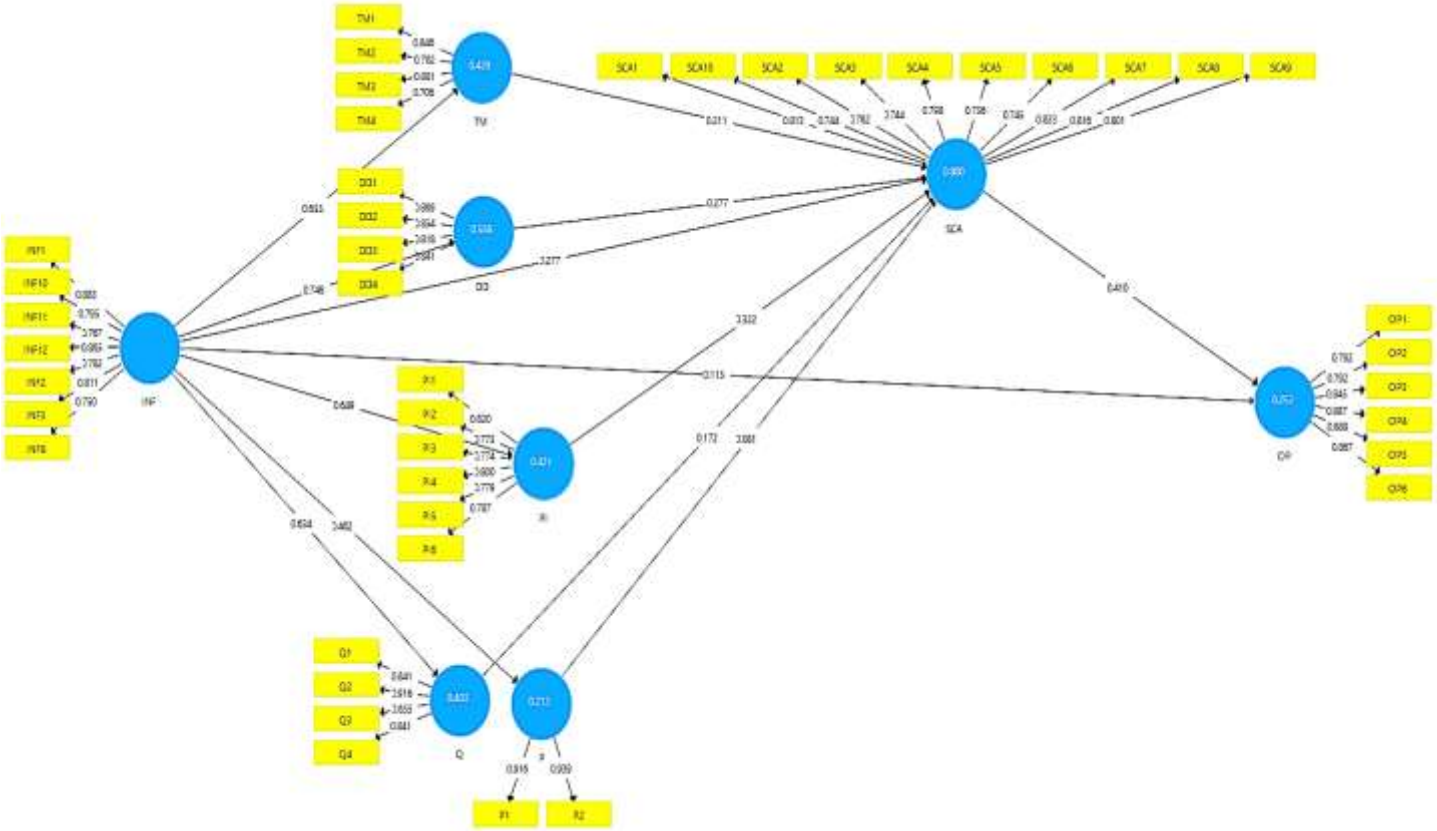
The outer model and inner model multi-collinearity is examined. A VIF value of 5 or higher indicates high multi-collinearity among predictor variables (Hair et al., 2019). VIF assesses how much the correlation between the predictor variables has raised the variance of an estimated regression coefficient. Every item of the study variables have a VIF less than 5.0, which shows the data is reliable and does not contain the problem of Multi-collinearity. The inner model shows the multi-collinearity level between variables. VIF of all Variables lies in 1.000 to 3.929, which indicates multi-collinearity do not exist in the model.

The structural model relationships estimates, which represent the path coefficients that demonstrate the proposed relationship between study variables, have generated through PLS-SEM algorithm. The PLS path model's coefficient values correspond to the beta coefficients of ordinary least square regression. The standardized path coefficient values range from -1 to +1 (Ringle et al., 2018). The significance of the path coefficient has evaluated using the bootstrapping methodology in Smart PLS 3.3. Ringle et al., (2018) recommended level of bootstrapping configuration for sub-samples size = 5,000 and path coefficient threshold for t value 1.96 with significant level of 5%, is used in the study. The greater the t-value (CR value) and smaller the p value, the greater the contribution of the variable, suggest acceptance of the proposed hypothesis. The direct effect and indirect effect analyses of the study has presented in table.

| Hypotheses | Paths | B | T | P | 0.025 LLCI | 0.975 ULCI | Decision |
|---|---|---|---|---|---|---|---|
| H1 | INF -> OP | 0.11 | 1.65 | 0.099 | | | Not Supported |
| H2 | INF -> SCA ->OP | 0.11 | 4.21 | 0.000 | 0.067 | 0.174 | Supported |
| H3a | INF -> P -> SCA | 0.03 | 2.12 | 0.034 | 0.004 | 0.073 | Supported |
| H3b | INF -> Q -> SCA | 0.10 | 3.28 | 0.001 | 0.176 | 0.045 | Supported |
| H3c | INF -> DD -> SCA | 0.20 | 6.08 | 0.000 | 0.139 | 0.271 | Supported |
| H3d | INF -> PI -> SCA | 0.20 | 5.47 | 0.000 | 0.134 | 0.283 | Supported |
| H3e | INF -> TM -> SCA | 0.13 | 4.83 | 0.000 | 0.085 | 0.196 | Supported |
| H4a | INF -> P -> SCA>OP | 0.015 | 1.77 | 0.076 | 0.001 | 0.035 | Not Supported |
| H4b | INF -> Q -> SCA>OP | 0.045 | 3.25 | 0.001 | 0.078 | 0.023 | Supported |
| H4c | INF >DD > SCA>OP | 0.085 | 3.94 | 0.000 | 0.048 | 0.134 | Supported |
| H4d | INF > PI -> SCA>OP | 0.086 | 3.96 | 0.000 | 0.049 | 0.135 | Supported |
| H4e | INF >TM > SCA>OP | 0.057 | 4.02 | 0.000 | 0.032 | 0.088 | Supported |

The result show the non-significance of H1, that IF does not directly contribute significantly to support manufacturing firm's performance at the 5% level of significance, whereas the results of H2 indicates that SCA mediated the relationship between IF and organization performance ($\beta = 0.11$, t value = 4.21). The results of hypotheses H3a to H3e validated the significant mediating role of logistic competitive capabilities between IF and SCA. Finally, the results of serial mediation H4a indicate that logistic competitive capability Price/cost and SCA does not sequentially mediates the relationship among IF and SCA ($\beta = 0.015$, t value =1.77). However results of hypotheses of H4b to H4e validates

that logistic competitive capabilities Quality, Demand dependability, Time to Market, Product Innovation and SCA sequentially mediates the relationship among IF and OP.


TM1
TM2
TM3
TM4
0.428
TM
SCA1
SCA10
SCA2
SCA3
SCA4
SCA5
SCA6
SCA7
SCA8
SCA9
0.211
0.800
SCA
DD1
DD2
DD3
DD4
0.556
DD
0.277
0.277
0.748
0.511
0.410
INF1
INF10
INF11
INF12
INF2
INF3
INF8
INF
0.115
0.752
OP1
OP2
OP3
OP4
OP5
OP6
0.332
0.688
P1
P2
P3
P4
P5
P6
0.421
P
0.172
0.088
0.634
0.462
Q1
Q2
Q3
Q4
0.632
Q
0.213
S
0.915
0.909
F1
F2

The explanatory strength of a model has measured by the value of R2, which looks at the variance that has explained in each endogenous variable (Hair et al., 2019). The values of R2 fall between the values of 0.213 to 0.8, which confirms the explanatory strength of model. Similarly f2 measured to gauge change in value of R2 of overall model. The f2 effect size is used when researcher want to study whether omission of certain variable have significant impact on endogenous variables (Sarstedt, Schwaiger, & Taylor, 2017). Lastly, Q2 is measured and the result of Q2 for endogenous composite constructs are greater than zero that represents and confirms the structural model's predictive relevance (Hair et al., 2019; Hair et al., 2017).

## 5. RESULTS DISCUSSION & THEORETICAL CONTRIBUTION

Understanding and validation of infrastructure framework role for achieving SCA leading to firm's performance is important (Gligor and Holcomb, 2014; Gligor et al., 2015; Gunasekaran et al., 2008; Tse et al., 2016; Bargshady et al., 2016; Giannakis & Louis, 2016). The study presents multiple theoretical contributions. The study finding suggest that IF did not have a direct and significant impact on OP. The complexity theory also indicates that relationships among variables could be non-linear, with unexpected changes happening, therefore "cause" under certain situations can leads to different effects (Cantele, Kirchoff, & Valcozzena, (2023). It is undoubtedly clear that infrastructure in any country is important and crucial for organizations as it important to facilitate multiple SC operational and logistics activities of an organization. The study results of H1 suggest that its effects on overall performance might mediate or reliant on other factors such as agile SCA that may lead to better organizational performance. Further study draws attention on the need for research & analysis of how infrastructure with major elements procreates SCA. The results of H2 confirm that SCA mediates the relationship between IF & Organizational performance. Previous studies also validate that manufacturing firm that have agile supply chains perform better in the market (Wamba, 2022; Al-Shboul, 2017). The study also proposed a research framework to validate how logistic processes for competitive capabilities mediate between IF &SCA, procreates agility leading to achieve firms performance. It is critical to validate the integrated model of logistic capabilities rather than downplaying the significance of any specific logistic practice because the research has unequivocally recognized these five logistic activities as competitive capabilities. Several resource-based theories, such as Resource Based View (RBV), Resource Orchestration Theory (ROT) and Network Theory etc. have emphasis on resource building for sustainable competitive advantage (Queiroz et al., 2022). These theories argued that firms would be more beneficial and effective if they develop and used their key resources rather than simply possessing them (Skipworth et al., 2023; Gligor et al., 2022). The finding of study validates that all five capabilities including P/C, DD, TM, PI and Quality mediates the relationship between IF and SCA. The findings of study can be linked to the ability of a well-structured IF, furnished with its essential elements, to give businesses the adaptability required to successfully respond to changes in client needs. The purposeful use of logistic activities helps to promote this adaptability, leading to increased agility and responsiveness within SCs.

Another important contribution of the study in the existing literature is examination of serial mediation in proposed framework. The study tried to explain the complex causal pathways and the interconnectedness of study variables. The stepwise study of several mediators provides better understanding of variables and processes by recognizing & combining variables, which mediate the association between infrastructure framework and firms performance. Study of serial mediation is also crucial to understand the role of mediator as well as collective shape of outcome variables, which leads to holistic approach

to ensure ecological validity of study (Satici, Saricali, Satici, & Griffiths, 2022). The results of serial mediation have found significant except H4a, validating the model that arrangement of these mediating factors have important role for achieving enhanced SCA and firms performance. However, serial mediation through P/C is insignificant, which could be due to that in pharmaceutical industry respondents may more concerned about quality, time to market and delivery dependability rather than on price/cost of the product.

## 6. STUDY IMPLICATION, LIMITATIONS AND FUTURE RECOMMENDATIONS:

Supply Chain Agility is critical for every manufacturing firm to remain agile and flexible in an uncertain environment, especially in developing countries. To attain SCA, firms need to concentrate on developing procedures and processes like logistic capabilities. The study findings made the case that supply chain managers should allocate resources for building logistic capabilities to take advantages of infrastructure potential for the creation of original, rare, sustainable, and distinctive logistic skills as a source of competitive advantage. The managers need to view supply chain processes holistically, reduction of cost is important but the strategic decision-making should also equally consider quality, innovation, and market approachability. The manufacturing firms need to ensure continuous improvement in logistic processes, which requires preparation of strategies including price strategy, less time to market strategy, innovative products strategies, demands forecasting, and better quality measures to achieve agility as well as efficiency of overall logistic function.

Although the study has produced valuable contribution in literature however it is crucial to recognize that there are also certain limitations, which may affect interpretation of study findings. Quantitative method is good for generalization of study; this research relies on survey approach for data collection from limited selected firms of specific demographic context. However, for holistic understanding future studies may employ combination of quantitative & qualitative or mixed research methods. The combination of survey & interviews may increase the reliability of study. Future studies may conduct comparative study across different contexts through data collection from manufacturing industries throughout the China-Pakistan Economic Corridor (CPEC), which spans both China and Pakistan, which could further validate the findings and improve the research's applicability.

Lastly, based on the literature future research can study the fit between elements of infrastructure framework and logistics capabilities, through examination of moderating role of other variables like product complexity etc., which could help to explore the insights of generality as well as extension of the findings of the study. The above-mentioned limitation should considered by interpreting the study findings further addressing these limitations would help for nuanced & comprehensive understanding of variables under investigation.

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