Tomas Bata University in Zlín
Faculty of Management and Economics

Doctoral Thesis

Social capital and industry 4.0 readiness: Role of innovative capability, industry 4.0 efficacy, and knowledge based dynamic capabilities

Sociální kapitál a připravenost průmyslu 4.0: Úloha inovativních schopností, účinnost průmyslu 4.0 a dynamické schopnosti založené na znalostech

Author:	**Najam Ul Zia**
Degree Program:	Doctoral program Economics and Management
Degree course:	P6208 Economics and Management
Supervisor:	prof. Ing. Ladislav Buřita, CSc.

Zlin, August 2022

Key Words: *Industry 4.0 readiness, social capital, industry 4.0 efficacy, knowledge based dynamic capabilities, innovative capability, developing Economies*

Klíčová Slova: *Připravenost průmyslu 4.0, sociální kapitál, účinnost průmyslu 4.0, dynamické schopnosti založené na znalostech, inovativní schopnosti, rozvojové ekonomiky*

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ABSTRACT

In this digital age, organizations are confronting the cusp of the fourth industrial revolution. Developed economies have already created new strategic options for the industry 4.0 (i4.0) strategy, however, due to institutional voids, firms in developing economies still rely on developed economies to extract knowledge and buy new technology. Firms in developing economies must use social capital (SC) to obtain knowledge, information, trust, and support from developed economies to show industry 4.0 readiness. Research on industry 4.0 mainly focuses on technical aspects, however, there is less scholarly attention on the management issues of industry 4.0, and most of the studies emphasise developed economies. Particularly, how the firms of developing economies become ready to face the fourth industrial revolution, and how developing economies get industry 4.0 competencies is still scarce in the existing literature.

The presented thesis seeks to establish the role of social capital dimensions to enhance industry 4.0 readiness in selected manufacturing firms in Pakistan. It also fills the missing gap of the mediating roles of innovative capability, knowledge-based dynamic capabilities, and industry 4.0 efficacy between the relationship of social capital and industry 4.0 readiness.

The goal of the study is achieved by using a mixed-method research design. The study first uses the quantitative approach and empirically examines the association of three dimensions of social capital and industry 4.0 readiness of manufacturing firms with the mediating roles of innovative capability, knowledge-based dynamic capabilities, and industry 4.0 efficacy. For the quantitative study, data collection was performed through survey strategy, questionnaire design and cross-sectional technique. Quantitative data analysis is conducted by employing structural equation modelling. There are a total of 320 valid responses that represent 81 manufacturing firms in Pakistan. These responses are analysed through SmartPLS and SPSS. The findings of the quantitative approach are then explained through interviews with top industry specialists. The results of the study are analysed and discussed in detail. The results show that structural social capital, relational social capital, and cognitive social capital are positively related with industry 4.0 readiness, and innovative capability, knowledge-based dynamic capabilities (KBDCs), and industry 4.0 efficacy mediate this relationship.

The thesis theoretically contributes to the existing knowledge of understanding industry 4.0 readiness and offers valuable insights for firms in developing economies to improve their social capital with the firms in developed economies during the industry 4.0 era. This study likewise reveals the significance of industry 4.0 efficacy, KBDCs, and innovative capability to facilitate the relationship of social capital and industry 4.0 readiness between the firms of developing economies and developed economies. Practical implications, limitations and future research directions are also emphasised.

ABSTRAKT

V současném digitálním věku organizace čelí výzvám čtvrté průmyslové revoluce. Vyspělé ekonomiky již vytvořily nové přístupy ke strategii průmyslu 4.0, avšak v rozvojových ekonomikách stále, kvůli institucionálním nedostatkům, se firmy spoléhají na rozvinuté ekonomiky k získání znalosti a nových technologií. Firmy v rozvojových ekonomikách musí využívat sociální kapitál k získávání znalostí, informací, důvěry a podpory od rozvinutých ekonomik, aby prokázaly připravenost na průmysl 4.0. Výzkum Průmyslu 4.0 se zaměřuje především na technické aspekty, problematice řízení Průmyslu 4.0 je věnována menší pozornost a většina studií klade důraz na vyspělé ekonomiky. Zejména to, jak se firmy z rozvojových ekonomik připravují čelit čtvrté průmyslové revoluci a jak rozvojové ekonomiky získávají kompetence Průmyslu 4.0, je v dostupné literatuře stále vzácné.

Předkládaná práce se snaží zjistit roli dimenzí sociálního kapitálu pro zvýšení připravenosti na Průmysl 4.0 ve vybraných výrobních firmách Pákistánu. Zaplňuje také chybějící mezeru ve zprostředkujících rolích inovačních schopností, dynamických schopností založených na znalostech a účinnosti průmyslu 4.0; mezi vztahem sociálního kapitálu a připraveností na Průmysl 4.0.

Cíle studie je dosaženo smíšenými metody výzkumu; vychází z kvantitativního přístupu a empiricky zkoumá spojení tří dimenzí sociálního kapitálu a připravenosti výrobních firem na průmysl 4.0 se zprostředkujícími rolemi inovačních schopností, dynamických schopností založených na znalostech a účinnosti průmyslu 4.0. Pro cíle kvantitativního výzkumu byl uskutečněn sběr dat na základě strategie průzkumu, návrhu dotazníků a průřezové techniky. Kvantitativní analýza dat se provádí pomocí modelování strukturních rovnic. Získáno bylo celkem 320 platných odpovědí z 81 výrobních firem v Pákistánu. Tato data jsou analyzována pomocí SmartPLS a SPSS. Zjištění kvantitativního přístupu jsou získána prostřednictvím rozhovorů se špičkovými oborovými specialisty. Výsledky studie jsou podrobně analyzovány a diskutovány. Výsledky ukazují, že strukturální sociální kapitál, vztahový sociální kapitál a kognitivní sociální kapitál jsou pozitivně spojeny s připraveností na průmysl 4.0 a inovační schopnosti, dynamické schopnosti založené na znalostech a účinnost průmyslu 4.0 tento vztah zprostředkovávají.

Práce teoreticky přispívá k dosavadním znalostem porozumění připravenosti na průmysl 4.0 a nabízí cenné poznatky pro firmy v rozvíjející se ekonomice, aby zlepšily svůj sociální kapitál s firmami ve vyspělých ekonomikách v době průmyslu 4.0. Studie rovněž představuje význam efektivity průmyslu 4.0, dynamické schopnosti založené na znalostech a inovační schopnosti pro usnadnění vztahu sociálního kapitálu a připravenosti na průmysl 4.0 mezi firmami v rozvíjejících se ekonomikách a rozvinutých ekonomikách. Zdůrazněny jsou také praktické důsledky, omezení a budoucí směry výzkumu.

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LIST OF ABBREVIATIONS USED

AI	Artificial intelligence
CCA	Confirmatory Composite Analysis
CFA	Confirmatory Factor Analysis
CPS	Cyber physical systems
DC	Dynamic capabilities
EFA	Exploratory Factor Analysis
IoTs	Internet of things
KBDCs	Knowledge based dynamic capabilities
LGM	Latent Growth Modelling
PA	Path Analysis
PLS-SEM	Partial least square and structural equation modelling
PSX	Pakistan stock exchange
RBV	Resource based view
SMEDA	Small and Medium Enterprise Development Authority

1. INTRODUCTION

1.1. Motivation and need for the study

In this digital era, the adoption of digital technologies is the main requirement for manufacturing companies to embrace the industry 4.0 (i4.0) strategy (de Assis Dornelles et al., 2022; Ghobakhloo, 2020). The concept of i4.0 has become prevalent in businesses because it improves the productivity of business activities through an advanced level of computerisation and automation (Kolberg & Zühlke, 2015; Stock & Seliger, 2016). To automate production processes, companies use IOTs and CPS, where IOTs are known as Internet of Things (IOTs) and CPS is referred to cyber-physical systems (CPS). Nevertheless, this transformation of adopting CPS and IOTs is not an easy task, and companies face various challenges to implant these technologies in different processes of businesses (S. Chen et al., 2014; Hussain et al., 2021; I. Lee & Lee, 2015; Qian & Wang, 2012). Companies pursue showing i4.0 readiness, but indicate lack of plan and digital maturity for implementing i4.0 (Antonsson, 2017). To maximize the benefits of this strategy, it is essential to evaluate and pinpoint the elements that can help firms become more ready for i4.0.

In the existing literature, most studies emphasize technical aspects of the fourth industrial revolution, and studies in the management perspective of i4.0 are scarce (Shamim et al., 2016a; N. U. Zia et al., 2022), and these studies cover mainly the context of industrialized economies (Grabowska, 2020). However, less scholarly attention has been received in the context of developing economies. Particularly, how developing economies are prepared to deal with the fourth industrial revolution and how they are acquiring capabilities related to i4.0 is still in its infancy stage of investigation. The developed and industrialized economies have already gained new strategic options in this digital economy; however, the firms of developing economies are still dependent on low technological and labour intensive skills to serve the low-cost segment of the market (Malik & Kotabe, 2009). The companies in developing economies reflect a record low readiness towards i4.0 due to lack of technological capabilities and less attention on research and development, and therefore it pushes the emerging economies to depend on developed and industrialized economies to buy innovative technologies (Cockburn et al., 2000). Khan et al. (2019) highlight that the developing economies face the concern of institutional voids, which refers to the shortage of assistance from home organizations regarding the creation of knowledge and innovations. This situation brings the importance of external sources of knowledge, that is, customers, the network of suppliers, and partners. In particular, those firms in developing economies that carry out relationship connections with firms in developed and digitally advanced economies can extract knowledge and information from these firms (Khan et al., 2019) in order to boost i4.0 readiness. Social capital theory becomes a relevant lens when the discussion lies to extracting knowledge, resources, and support due to networks of relationships. Social capital (SC) refers to the relationship networks that are based on trust, support, and

information in order to create value (Bizzi, 2015). There are three dimensions of SC, named as structured, relational, and cognitive SC (Tsai & Ghoshal, 1998). Kim et al. (2013) claim that all three dimensions play a crucial role in enhancing organizational outcomes.

In this thesis, the discussion is centred on the use of SC of those firms that are located in developing economies to extract valuable knowledge from firms in developed economies. Sheng & Hartmann (2019) argued that these three dimensions of SC are positively associated to the innovative capability of the firms that are involved in international businesses. The ability of the firms to innovate is one of the coveted capabilities to get ready for i4.0 (Shamim et al., 2016). There is apparent support available in the literature that i4.0 path can be accelerated by innovative capability of firms (Agostini & Filippini, 2019). According to Lasi et al. (2014), innovative capability is a crucial factor for those firms which are operating in the I4.0 environment. The logical believes and literature support that SC is implicitly related to i4.0 readiness through innovative capabilities. However, previous studies have not examined this relationship. The current study fills this gap by analytically researching the relationship between SC, innovation capability, and i4.0 readiness.

This study argues that the acquisition of knowledge and support through SC with foreign firms boosts the confidence in the firm's ability to achieve the desired outcomes, which is taken as i4.0 readiness in the specific context of this study. This phenomenon is also relevant to the concept of efficacy (Bandura, 1977). The concept of efficacy can be discussed in general and in specific contexts such as creative self-efficacy (Shamim, Cang, & Yu, 2017), and internet self-efficacy (Eastin & LaRose, 2000). Furthermore, it can be discussed at the individual and organizational levels (Bohn, 2010). In the context of this study, the term I4.0 efficacy is used. There is shreds of evidence in the literature that confidence in one's ability to achieve the desired outcomes enhances the probability of achieving desired outcomes (Shamim, Cang, & Yu, 2017), which is i4.0 readiness in this context. It is also argued that generating, acquiring, and combining all knowledge resources is based on the firm's knowledge-based dynamic capabilities (KBDCs) to improve i4.0 readiness. This study also investigates the mediating role of KBDCs in the relationship between the dimensions of SC and the readiness for I4.0.

As the context of this study is developing economies, therefore, this study chooses Pakistan to explore the above-mentioned issues. Pakistan becomes an appropriate context for a developing economy and also faces the problem of institutional voids (Khan et al., 2019). Moreover, Pakistan has recently started the adoption of digitization (Nizam et al., 2020) and its firms primarily depend on developed and industrialized economies to acquire industrial and hi-tech products (Malik & Kotabe, 2009)

This research adds to the corpus of knowledge in several ways. The current literature primarily discusses i4.0 in technological aspects; however, research on i4.0 management issues is still in the infancy stage and scarce in the literature. This study contributes to the theory of social capital by examining and associating it with i4.0

readiness. The study also contributes its originality by investigating the mediating role of innovative capability, knowledge-based dynamic capabilities, and i4.0 efficacy in the relationship of SC dimensions and i4.0 readiness. Moreover, it is one of the rare studies that discusses the i4.0 readiness phenomenon from a cross-country perspective. Investigating these issues in Pakistan is an empirical contribution of this study, as Pakistan is considered a developing economies context; most of the current studies on the topic of i4.0 have been performed in the context of western and developed economies.

1.1.1. Research Questions

Based on research gaps, the study addresses following research questions to fulfil the research gap in the current literature.

RQ1: Do SC dimensions play its role in influencing i4.0 readiness?

RQ2: Does innovative capability mediate the relationship between SC (structural, relational, and cognitive) and i4.0 readiness?

RQ3: Does i4.0 efficacy mediate the relationship between SC (structural, relational, and cognitive) and i4.0 readiness?

RQ4: Do knowledge-based dynamic capabilities (KBDCs) mediate the linkage between SC dimensions (structural, relational, and cognitive) and i4.0 readiness?

The hypotheses needed for the conceptual model are described in the following chapters.

1.2. Research Problems and Objectives

The impact of SC dimensions on i4.0 readiness in the framework of developing economies is not currently covered in the literature. Another area that needs more research is the role of knowledge-based dynamic capacities, i4.0 efficacy, and innovative capability as mediators in the interaction between the three dimensions of SC and i4.0 readiness. Therefore, the goal of this study's research is to better understand how SC dimensions—structural SC, relational SC, and cognitive SC—affect manufacturing businesses' readiness for i4.0 in the framework of developing economies.

1.2.1. Research Objectives

The major goal of this study is to determine the impact of all three SC dimensions on i4.0 readiness and to look into the role of innovative capability, i4.0 self-efficacy, and KBDCs in mediating the relationship between SC and i4.0 readiness of manufacturing companies in developing economies context. Research objectives are as follows:

RO1: To identify the role of SC (structural, relational, and cognitive SC) in influencing i4.0 readiness.

RO2: To identify the mediating role of innovative capability between SC (structural, relational, and cognitive) and i4.0 readiness.

RO3: To identify the mediating role of i4.0 efficacy towards the linkage between SC (structural, relational, and cognitive) and i4.0 readiness.

RO4: To identify the mediating role of knowledge-based dynamic capabilities (KBDC) towards the linkage between SC (structural, relational, and cognitive) and i4.0 readiness.

2. THEORETICAL FRAMEWORK

2.1. Social capital

The SC theory discusses value creation via the network of connections (Nahapiet et al., 1998). It also refers to the level at which information and network implanted resources are shared in the relationship network (Wang & Ho, 2017). Organizational innovation is also triggered by strong SC (H. J. Lee et al., 2020; Sánchez et al., 2015). The theory of SC indicates that sociability is an essential and vital prerequisite for the valued resource. It also suggests that all interactions between organizational representatives and outside participants represent crucial requirements for knowledge creation, innovation, and information sharing (Ozanne et al., 2022; Zhang & Peterson, 2011). Organizations can perform better after having access to resources and information, which is caused by SC (Johnson et al., 2013). SC can also affect the efficiency of organizations by sharing innovation and knowledge (Tsai & Ghoshal, 1998). According to Alvani, Nategh, & Farahi (2007), SC is referred to a value that is shared by all people within the social networks. Nahapiet et al. (1998) mentioned three aspects of SC, named structural social, relational, and cognitive social capital, which are well used and explained in this thesis.

The first dimension is known as structural SC, which describes who will be responsible for building relationships and what are the ways to attain these relations (Chow & Chan, 2008). There are various factors involved in this dimension, i.e., hierarchy, network patterns, connectivity and density (Chow & Chan, 2008). This dimension discusses the properties of the social system and relationship networks (Nahapiet & Ghoshal, 1998). Structural SC explains a personal people network that is used to draw information and assistance as per need. This dimension also denotes an individual's number of ties, to whom these ties are connected, and how strong are these ties (Taylor, 2007). Structural SC provides a way to communicate and exchange knowledge and information by accessing various parties (Ansari et al., 2012; Singh et al., 2021). Connecting colleagues for the sake of knowledge and capability is also the main attribute of structural SC (Andrews, 2010).

Relational SC implies to assets generated by the relationships networks that are based on friendship, and interpersonal trust (Cabrera & Cabrera, 2005). This dimension shows the quality of a relationship that develops through a history of connections with other parties or with each other (Lefebvre et al., 2016). Nahapiet and Ghoshal (1998) defined the key facets of this dimension as trustworthiness, norms and sanctions, obligations, and expectations. Normative behaviour is supported by relational SC, which is based on reciprocity, trust, obligations and expectations (Broska, 2021; R. Lee & Jones, 2008). The transactional behaviour of relational SC

is also cast-off in this digital environment, which is used to extract knowledge based on trust (Ridings et al., 2002).

Cognitive SC is the third dimension of SC, which indicates the vision, values, shared goals, and language of organizational members (Wasko & Faraj, 2005). Sharing codes and language become the basics of communication for this dimension of SC (Gooderham, 2007). According to Nahapiet and Ghoshal (1998), cognitive SC is linked to mutual narratives and language. Other authors explained cognitive SC as mutual goals, mutual vision, and collective culture (Inkpen & Tsang, 2005; Tsai & Ghoshal, 1998).

The literature proposes that developing economies rely on developed economies to buy smart digital technologies (Cockburn et al., 2000). A vein of research from Khan et al. (2018) argued that firms in developing economies extract knowledge and support from developed economies considering them as external sources. SC theory becomes a most established tool and relevant lens to look into when it comes to knowledge (Ersoy et al., 2022; Maurer et al., 2011). Therefore, it makes SC theory a pertinent and applicable theoretical lens for this thesis.

These three dimensions of SC are connected to each other. Their relationships to each other are well explained in the existing literature. The following are the descriptions of the relationship among the three dimensions of SC.

2.1.1. Association of the structural and relational dimension

The structural dimension of SC comprehends network ties and network configuration to exchange knowledge and knowing activities among different actors. The relational dimension represents the relationships built on trust and expectations (Nahapiet & Ghoshal, 1998, 2017; Tsai & Ghoshal, 1998). The various facets of the structural dimension are systematically associated to access the different parties for exchange and combination of knowledge. These strong social network ties can lead to the development of trust and effective relationships among actors for knowledge exchange (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). Previous studies suggest that structural dimension may stimulate perceived trustworthiness based on its social interaction ties, as trusted relationships evolve from strong network ties (Granovetter, 1985; Gulati, 1995; Tsai & Ghoshal, 1998). Further, the relationship of actors can become trustworthy, as they interact more with each other, and this epitomizes that structural dimensions act as the foundation of relational dimension of SC (Gabarro, 1978). Actors know each other due to repeated and close social interaction, which becomes the ground to build trust and share important information (Tsai & Ghoshal, 1998).

2.1.2. Association of structural and cognitive dimension

The cognitive dimension refers to share language, codes, shaping common goals, and narratives to create value among different actors or organizations (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). The relation between the structural and cognitive dimensions of SC depends on assuming that social ties and interactions play

a crucial role in sharing common goal and narratives among firms (Tsai & Ghoshal, 1998). The structural SC of the members of an organization leads to formulate shared vision, as the strong ties help individuals to learn values and shared narratives among organizations (Tsai & Ghoshal, 1998). Therefore, this process of social interaction directs organizations to adopt codes, languages, practices, and values (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). However, various business units of any organization may have different goals and narratives and they can only share values and vision with each other in case of strong and dense social ties. For example, language sharing can only be possible if there exists a dense network of links.

2.1.3. Association of relational and cognitive dimension

The relationship dimension of SC affects three separate aspects of knowledge exchange, including the parties' access to each other for knowledge exchange, their incentive to create value, and their expectation of value through exchange and combination. (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). Tsai & Ghoshal (1998) posited that sharing goals and narratives, organizations members can incline to trust each other, as they expect that they all can work together for collective goals, and no one can hurt their common interests. Therefore, according to the arguments of Tsai & Ghoshal (1998), cognitive dimension leads to the relational dimension by claiming that any organization with collective goals and values is likely to be trusted by other organizations in the network. These organizations share goals and narratives and then build trust with each other for knowledge exchange (Sitkin & Roth, 1993; Tsai & Ghoshal, 1998). However, we illustrate another facet of this relationship and act contradictory to the lines of Tsai & Ghoshal (1998), which depict that sharing goals among organizations be in the lead to establish trustworthy relationships. We argue that relational dimension of SC establishes the ground to cognitive dimension of SC and claim that sharing goals and narratives can only be possible if there is an existence of trust between the actors or organizations, which means that organizations can share goals and narratives in more precise way when the relationship among them is built on the basis of trust.

2.2. Innovative Capability

The ability of a company to develop new and distinct goods, services and markets, as well as improve existing ones, is referred as innovative capability (March, 1991). Innovation is considered as a success factor for various organizations and businesses. Innovation prepares the organizations and companies to deal with internal and external changes (Ávila, 2022). Therefore, in order to innovate, the companies need change the offerings of customers. On other hand, if company fails to innovate, it initiates the risk of being abolished from market due to the lack of competitive advantage (Barney, 1991; Liao et al., 2007). Innovative capability facilitates the creation of new processes, new products, and new ideas within an organization (Hult

et al., 2004). Many researchers have started to focus this variable of strategic management, and the reason of a major research attention lies because many industrialists are striving to get competitive advantage now a days (Ávila, 2022). Moreover, organizations have taken the factor of innovation as a key element for competitive advantage (Harrison & Samson, 2002).

Innovative capabilities can help a company gain a long-term competitive advantage (Liu et al., 2019; March, 1991; Puspita et al., 2020). In this era of the fourth industrial revolution, competitive advantage depends on the readiness of firms towards i4.0 (Shamim et al., 2016), and i4.0 readiness relies on the innovative capability of firms (Agostini & Filippini, 2019; Lasi et al., 2014; N. U. Zia et al., 2022). As a result, identifying the enablers of a firm's innovation capability is critical in this context.

One of the well-established predictors of inventiveness is SC (Maurer et al., 2011). According to SC theory, a network of interorganizational and intraorganizational relationships is a necessary condition for innovation (Zheng et al., 2011; N. U. Zia et al., 2022). SC can also affect firms' efficiency by sharing knowledge and innovation (Tsai & Ghoshal, 1998). According to Rost (2011), interorganizational ties of any organization play an important role in creating innovation.

Sheng & Hartmann (2019) claimed that SC's structural and relational dimensions have an impact on how innovative enterprises engaged in global commercial operations. A recent study by Zia et al. (2022) argued the importance of all three dimensions of SC in enhancing innovation capability and i4.0 readiness. As exploring and exploiting knowledge is prerequisites of innovativeness(Donate & Sánchez de Pablo, 2015) , therefore the existence of network ties (Inkpen & Tsang, 2005; N. U. Zia et al., 2022) due to structural SC provides greater access to knowledge. Sheng & Hartmann (2019) argued that accessing this knowledge provides a much better innovation (Sheng & Hartmann, 2019). On the other hand, relational SC refers to the relationships based on the trust (Andrews, 2010) and such relationships prompt easily exchange of knowledge between different actors in networks. Sheng & Hartmann (2019) also discussed that trust can improve the learning ability of firms to create a wider scope of knowledge that can build and reconfigure sources of innovation. Relational capital, which is built on confidence, can also give you access to different perspectives (Rowley et al., 2000). Trust motivates companies to seek a variety of information opportunities and helps them try new things, enhancing their ability to innovate (Grillitsch & Nilsson, 2022; Sheng & Hartmann, 2019). These three dimensions of SC are critical in enhancing an organization's capability to innovate (Ganguly et al., 2019; N. U. Zia et al., 2022) and this innovation capability eventually characterizes i4.0 readiness (Sheen & Yang, 2018; N. U. Zia et al., 2022). The third dimension of SC is cognitive SC, which represents the shared vision, values, languages, codes, and goals, and it enables tacit knowledge sharing (Alguezaui & Filieri, 2010) that is a leading and renowned predictor of innovation (Kim and Lee, 2013). Ganguly et al. (2019) discussed that all these dimensions of SC play a crucial

role in developing and improving a firm innovation capability. Based on these arguments, the following are the hypotheses:

H1a: Structural SC is positively related to innovative capability.

H1b: Relational SC is positively related to innovative capability.

H1c: Cognitive SC is positively related to innovative capability.

2.3. Knowledge-Based Dynamic Capabilities

The resource-based view (RBV) of the firms states that enterprises should utilize their strategic resources in order to get a competitive advantage. (Barney, 1991). The dynamic capabilities (DCs) view is an extension of the resource-based view (RBV), which contends that businesses should be able to adjust their competencies in response to shifting business environments rather than relying solely on strategic resources for competitive advantage (Teece, 2007; Teece et al., 1997). KBDCs further extend DCs and argue that knowledge is the main strategic resource of any organization, and the main purpose of an organization is to transform knowledge into commercial outcomes. Therefore, according to KBDCs, knowledge is the main source of DCs (Zhang et al., 2011). Knowledge plays a crucial role for any organization while dealing with various issues, i.e. survival, organizational performance, and business outcomes (Barton, 1995; Parayitam et al., 2022). Teece et al. (1997) discussed that organizations can become more compatible when they start renewing both tangible and intangible assets. The KBDCs view is an expansion of DCs (Shamim, Zeng, Choksy, et al., 2019) and accentuates the ability of any organization to acquire, generate, and combine internal and external sources of knowledge to address environmental dynamics (Zhang & Peterson, 2011). Knowledge is the main ingredient of KBDCs (Zhang et al., 2011), and knowledge extraction is heavily based on the SC of firms. SC at the firm level enables knowledge extraction, trust, and support from the relationship networks. Existing studies also used KBDCs as theoretical lens in the context of digital transformation (Shamim et al 2019b). Scholars have highlighted the application of KBDC e.g. J.-C. Lee and Chen, (2019) examined knowledge absorption as outcome of KBDC. Chen, Stewart, and Panuwatwanich, (2013) examined the learning capacities in industrial manufacturing operations by using KBDC as a theoretical lens and found innovation as outcome of intellectual capital which comes from KBDCs. Cheng, Yang, and Sheu (2016) investigated innovation development and evaluated the influence of KBDC. The current literature strengthens the view that organizations in developing economies obtain knowledge from developed economies through their relationship networks in order to enhance innovation (Khan et al., 2019; Malik & Kotabe, 2009; N. U. Zia et al., 2022), which is i4.0 in the context of this study. Khan et al. (2019) highlighted this fact and argued that Pakistani companies rely on their external network relationships to extract knowledge. Shamim, Zeng, Khan, & Zia (2020) argued that SC can enrich KBDCs in this era of digital transformation. A vein of research by Kim and Lee (2013) also explained that SC accelerates the acquisition of knowledge. Kim and Lee (2013) investigated the role of all three dimensions of SC and explained that these dimensions are positively related with the acquisition and dissemination of knowledge, which are

the main foundation of KBDCs. According to RBV, the capabilities of organizations depend on their resources, while structural, relational, and cognitive SC are important resources of the organisation that influence KBDCs (Kim & Lee, 2013). Based on these arguments, following are the hypotheses:

H2a. Structural SC is positively related to KBDCs.
H2b. Relational SC is positively related to KBDCs.
H2c. Cognitive SC is positively related to KBDCs.

2.4. Industry 4.0 efficacy

Efficacy plays an important role in the motivation and outcomes of the work, adopting a projecting role related to different sides of work activity (Judge et al., 2007). Ideally, self-efficacy falls under the framework of social cognitive theory and is stated as beliefs about one's abilities and skills to plan and execute the necessary courses of action in order to obtain desired goals (Bandura, 1977). Efficacy can be discussed at different levels such as organizational efficacy (Bohn, 2010), individual level self-efficacy (Bandura, 1977; Shamim et al., 2017), or team level efficacy (Siregar & Chang, 2020). The dominant paradigm in this area is individual-level self-efficacy, which is the foundation of organizational level efficacy (Lunenburg, 2011). Self-efficacy provides confidence to people in their ability to control the different aspects of life (Judge et al., 2007). In this way, self-efficacy can be categorized as an individual competence that is triggered by certain stressors and these stressors can increase or decrease psychological discomfort (Vayre & Vonthron, 2017). People seek or avoid tasks on the basis of their capabilities and positive self-concept people are more willing to perform tasks and confident to handle challenges (Judge et al., 2000). The collective perception of an organization's members' sense of their collective talents, sense of their collective purpose and mission, and their sense of resilience is known as organizational level efficacy (Bohn, 2010).

Efficacy can better be observed in a particular domain (Bandura, 2012), dealing with this in a way that a more effective domain may lead to more determining self-efficacy (Azanza et al., 2013). Shamim et al. (2017) discussed self-efficacy in the context of creativity and termed it creative-efficacy. Eastin & LaRose (2000) discussed internet-efficacy to measure the belief of respondents that how confident they are to use the internet. Siregar and Chang (2020) examined the efficacy of cybersecurity incident detection. Therefore, it is important to measure the efficacy in its specific context like in the industry or organizational field rather than to measure it in general (Salanova et al., 2005). This study contextualizes organizational-level efficacy in terms of i4.0 efficacy. This study defines the efficacy of i4.0 as an organization's judgment of its sense of confidence in accepting i4.0.

Existing literature discusses efficacy in relation to influence number of important factors such as leadership (Salanova et al., 2020), organizational behaviour (Erum et al., 2020) organizational performance (Bartol et al., 2001; Peterson, 2020), digital creativeness (J. Kim et al., 2020; Saks, 1995), stress and anxiety (J. Chen et al., 2020; Razzaq et al., 2019), political effect behaviours (Bozeman et al., 2001; McDonnell,

2020), and cooperation & processes of group team (Alnoor et al., 2020; Feltz & Lirgg, 1998).

Scholars have highlighted the relationship of SC with organizational level and collective efficacy (C. R. Collins et al., 2014; Sulistyani & Suhariadi, 2022). Stanley and McDowell (2014) argue that inter-organizational SC can influence organizational efficacy. Collins & Clark (2003) supported the view that SC is positively related to collective efficacy in a given context. Siregar and Chang (2020) also reported the relationship between SC and team level efficacy. SC influences the desirability, intentions, and perceived efficacy of businesses (Hindle et al., 2009). The social structure of an organizational network provides two-way information benefits: one way is redundant contact and the second way is non-redundant contact (Koçak et al., 2013). In redundant contact, similar information is exchanged, while in non-redundant contact additive information is exchanged. This non-redundant contact provides richer information (Koçak et al., 2013). The recognition opportunity increases due to accessing and processing both types of information. When organizations access information through SC, they are more likely to implement with high organizational efficacy (Koçak et al., 2013). Furthermore, since strong relations and networks are difficult to make and uphold, organizations may have fewer social networks and may get less diverse information that can affect optimism (D. M. De Carolis & Saparito, 2006) which is linked with efficacy. Consequently, the current study assumes that SC has a positive influence on i4.0 self-efficacy. Kim and Lee (2013) argued that the structural, relational and cognitive dimension of SC ensures the provision of knowledge resources, which leads to efficacy in a given context (Shamim et al., 2017). In the context of this study, it is assumed that the SC of firms in less developed economies with firms in industrialized and developed economies helps them extract knowledge related to i4.0 and enhance their efficacy of i4.0. These arguments lead to the following hypotheses:

H3a: Structural SC is positively related to i4.0 efficacy.
H3b: Relational SC is positively related to i4.0 efficacy.
H3c: Cognitive SC is positively related to i4.0 efficacy.

2.5. Industry 4.0 readiness

I4.0 is closely linked to connecting the analogue, a physical and tangible world with the cybernetic, database or digital world (de Assis Dornelles et al., 2022; Quint et al., 2015). Figure 1 illustrates the concept of i4.0 that started with Industry 1.0, which was introduced in the 1780s and was characterised as mechanization that was launched with the use of steam power and weaving looms. The next industrial transformation is called industry 2.0, which targets mass production with the help of high usage of electrical energy. The third industrial revolution involved automation powered by electronics and computers. Finally, the fourth industrial revolution also known as i4.0 has been introduced to the current system that involves high-scale customized and low-cost production with the use of cyber physical systems, the Internet of Things, and networks, and it involves the least human machine interaction (Lasi et al., 2014).

I4.0 is defined by Haddara & Elragal (2015) as the computerization of the industrial sector, where Cyber-Physical Systems (CPS) are recognized as a key component of it and industry experts as i4.0's technological drivers. To achieve competitive advantage and profitability over the long term with acceptable results, businesses must adopt the i4.0 strategy in the new digital economy (Drath & Horch, 2014). Because of this, businesses need to be prepared to meet this new competitive threat and demonstrate their readiness to adopt the new technology paradigm. (J. Lee et al., 2014).
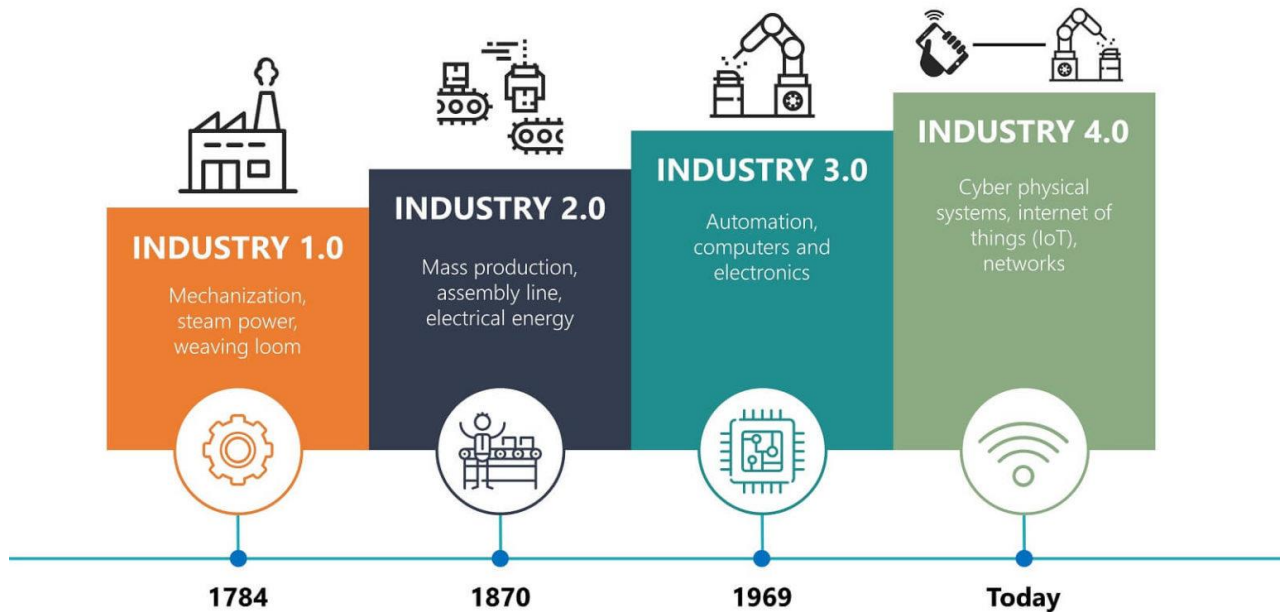
Figure 1: Industry 4.0 evolution, Source (Lvivity, 2020)

It is important to assess an organization's digital readiness before implementing the fourth industrial paradigm, and doing so works with understanding an organization's strengths and shortcomings (Sony & Naik, 2019). Companies must therefore be ready to meet this new global challenge and change to the new technology paradigm (J. Lee et al., 2014). Before implementing this digital paradigm, the fundamental step toward i4.0 adoption is to monitor the organization's digital readiness and start to understand the current strengths and weaknesses (Geissbauer et al., 2016; N. U. Zia et al., 2022). The literature already in existence recognizes the significance of i4.0 readiness (Basl, 2018; Basl & Doucek, 2019; Stentoft et al., 2020; N. U. Zia et al., 2022). The argument over a methodology to evaluate an organization's i4.0 readiness was started by Pacchini et al. (2019), who also emphasized the dearth of recent research on the topic of determining an organization's i4.0 readiness level. A company's preparation for i4.0 technologies, such as CPS, IoTs, and big data, can be described as its capacity to do so.

Organizations can check their i4.0 readiness using a variety of techniques (Rajnai & Kocsis, 2018). These tools are used as a standard to assess how effectively the

organization is moving toward digital transformation. Therefore, a successful i4.0 adaption can only be planned once an assessment of i4.0 readiness is made (Maisiri & van Dyk, 2019). There are different degrees of i4.0 readiness that may be assessed, including at the corporate, departmental, and national levels (Basl, 2017). Information on the availability of knowledge and organizational strategy are also needed in order to be considered ready for I4.0, in addition to sophisticated technology investments (Maisiri & van Dyk, 2019). i4.0 is a digital transition that involves a number of processes and is gradual rather than abrupt (Rajnai & Kocsis, 2018). The goal of evaluating the readiness of i4.0 is to recognize an organization's step toward digital transformation. After recognizing the current state of the organizational move towards digitization, management must have a specific strategic plan (Rajnai & Kocsis, 2018). Due to the growing value of knowledge, various evaluation models have been developed, using numerical readiness metrics and bundling these points into thematic classes. These indicators are used to obtain an outcome of the digital readiness of organizations by calculating the various measured indices (Rajnai & Kocsis, 2018). Organization management uses the results of the readiness assessment and uses it as benchmark information to develop a strategy and roadmap for the digitalization of the company (A. De Carolis et al., 2017; Pirola et al., 2019).

Firms in less developed economies rely on developed economies to import the technology and products related with i4.0. The SC of firms with more developed and digital economies can be a source of information extraction in this situation. Providing i4.0-related expertise, information, and other tools helps the business building the skills and abilities to adopt i4.0. DCs play a crucial role in developing new competencies (Teece et al., 1997; Teece, 2007), such as i4.0 readiness. Based on these arguments and logical beliefs, it is hypothesized that

H4a: Structural SC is positively related to i4.0 readiness.
H4b: Relational SC is positively related to i4.0 readiness.
H4c: Cognitive SC is positively related to i4.0 readiness.

I4.0 is also enabled by innovative capabilities (Shamim et al., 2016). Existing literature also shows that a firm's capability to innovate supports the transition to i4.0. (Agostini & Filippini, 2019). This skill enables businesses to develop modern, distinct, and enhanced manufacturing processes (March 1991). Firms with innovative capabilities can also gain a long-term competitive advantage (March 1991). Competitive advantage in the era of i4.0 is based on i4.0 readiness (Shamim et al., 2016), which depends on the innovative capability of a company (Agostini et al., 2019; Lasi et al., 2014). High innovation capability, according to Lasi et al. (2014), is an important success factor for businesses operating in the i4.0 climate. Firms' capability to innovate, especially those engaged in international operations, is heavily dependent on their SC (Sheng & Hartmann, 2019). Organizational innovation capability is enhanced by SC (Ganguly et al., 2019), and this innovation capability eventually contributes to i4.0 readiness (Sheen & Yang, 2018).

Existing literature also shows that creative capability plays a mediating role in the relationship between SC and its outcomes (Agyapong et al., 2017). Based on these rational assumptions and claims, it is assumed that innovative capability is positively correlated with i4.0 readiness and that innovative capability mediates the relationship between SC and i4.0 readiness. The following are the hypotheses. The following are the hypotheses.

H5: Innovative capability is positively related to i4.0.

H6: Innovative capability mediates the relationship between SC and i4.0 readiness.

Zhang et al. (2017) argued that KBDCs enable the firm to recognize and seize opportunities and create new competencies. Kim and Lee (2013) suggested that SC can influence KBDCs. These arguments suggest that firms' SC can influence the KBDCs, which leads to the creation of new competencies, such as i4.0 readiness. Based on logical beliefs and these arguments, it is to assume that SC and KBDCs are positively related to i4.0 readiness, and KBDCs mediate the relationship between SC and i4.0 readiness.

H7: KBDCs are positively related with i4.0 readiness.

H8: KBDCs mediate the relationship between SC and i4.0 readiness.

Efficacy in a given context increases confidence in performing specific tasks (Shamim et al., 2017). Existing literature is evidence of the positive influence of efficacy on desired outcomes, such as creative efficacy enhancing creative performance (Abdullah et al., 2017), and internet efficacy facilitates the actual use of the internet (Savage & Tokunaga, 2017). It means that if something is performed with the confidence that we have the ability to do it, it leads to the actual performance of the phenomenon. Based on this evidence and arguments, it can be assumed that the organization's confidence in its ability to embrace i4.0 and use i4.0 technologies can influence i4.0 readiness. In the context of this study, it is established above that the i4.0 efficacy of firms in less developed economies can be influenced by their SC with firms in industrialized and developed economies. With the help of knowledge, trust, support, and other resources, SC can improve the firm's confidence to adapt i4.0 technologies, that is, i4.0 efficacy, which in turn leads to i4.0 readiness. These arguments and logical beliefs allow us to assume that i4.0 efficacy is positively relatedto i4.0 readiness, and there is a mediating relationship between SC and i4.0 readiness. Therefore, the following hypotheses are formulated.

H9: I4.0 efficacy is positively related with i4.0 readiness.

H10: I4.0 efficacy mediates the relationship between SC and i4.0 readiness.

3. THE SCOPE OF THE STUDY AND CONCEPTUAL FRAMEWORK

3.1. Theoretical underpinnings of the research

The thesis lays its grounds on two composite theories. Particularly, SC theory and knowledge based dynamic capabilities.

- **Social capital theory:** Value creation through a network of relationships refers to the SC theory(Nahapiet et al., 1998). The degree to which people share information and other resources within their network of contacts is strongly related to SC (Wang & Ho, 2017). For the adoption and improvement of new technology, it is crucial to add resources into the structure of organizations (Parellada et al., 2011). SC plays a significant role in the innovation and presentation of organizations (Sánchez et al., 2015). The theory of SC discusses that sociability is a critical and necessary requirement for a valuable resource. SC theory also highlights the importance of relationships between members of organizations and outside players for knowledge creation, innovation, and information sharing (Zhang & Peterson, 2011). Access to important resources and information is made possible through SC, which enhances organizational performance(Johnson et al., 2013). Additionally, SC can affect an organization's efficiency by innovation and sharing knowledge (Tsai & Ghoshal, 1998).

  According to Alvani, Nategh, and Farahi (2007), SC is a value that all participants in social networks share. Due to shared cultural norms, extensive interpersonal engagement, and personal connections, these people engage in such activities. The three types of SC that are employed and discussed in this study are structural SC, relational SC, and cognitive SC (Nahapiet et al., 1998).Who will interact in order to establish relationships and how these relationships will be achieved are explained by structural SC. (Chow & Chan, 2008). This dimension includes elements such as connectedness, hierarchy, network patterns, and density (Chow & Chan, 2008). It alludes to the characteristics of social systems and their relational web (Nahapiet & Ghoshal, 1998). It is an impersonal configuration of relationships between individuals and groups, including protocols, examples, guidelines, and roles that are seen as manifestations of this configuration. (Uphoff & Wijayaratna, 2000). The structural SC of a person is the group of contacts from which they can access support and information when needed. It also has to do with how many links a person has, who these ties are to and how strong they are. (Taylor, 2007). In the framework of structural SC, several academics have explained the distinction between bridging, linking, and bonding the SC and have identified many types of network relationships. (R. Lee & Jones, 2008). Access to other parties for

knowledge transfer and exchange is made possible by structural SC, which also helps to expand the possibility for exchange. (Ansari et al., 2012). In addition, it makes it easier for people to connect with their peers to gain information and skills. (Andrews, 2010).

Relational SC, which characterizes relationships networks in terms of common standards, interpersonal trust, and connections with other network members, is the most sentimental part of SC.(Cabrera & Cabrera, 2005). This aspect of SC focuses on the type and degree of connections that can be made throughout the course of interactions with other people or other parties. (Lefebvre et al., 2016). Several behavioral characteristics, such as duties, trustworthiness, shared group standards, and identity, are influenced by relational SC. (Davenport & Daellenbach, 2011). This contributes significantly to SC, which represents a relationship in terms of shared standards, interpersonal trust, and affiliation with other people. The primary components of this dimension, according to Nahapiet and Ghoshal (1998), are commitments and expectations, rules and penalties, and confidence and trustworthiness. Expectations, reciprocity, trust, and obligations serve as the foundation for normative behavior, which is supported by relational SC. (R. Lee & Jones, 2008). Through knowledge sharing and transactional behavior, trust can be built in digital contexts. (Ridings et al., 2002).

Finally, the third element is cognitive SC, which also comprises the members of the organization's shared values, vision, and objectives.(Wasko & Faraj, 2005). Resources that provide common interpretations, means systems, and representations between participants are termed cognitive SC. (Nahapiet & Ghoshal, 1998). It is a common language and code that serve as the building blocks of communication. (Gooderham, 2007). While other authors have articulated cognitive SC in terms of shared culture, vision, and aspirations, Nahapiet and Ghoshal (1998) connected it to shared narratives and shared language. (Inkpen & Tsang, 2005; Tsai & Ghoshal, 1998). According to Ganguly et al. (2019), these three facets of SC are crucial to improving any organization's capability for innovation, which ultimately reflects readiness for i4.0 (Sheen & Yang, 2018).

According to published research, less developed nations depend on industrialized nations for smart digital technologies. (Cockburn et al., 2000). Additionally, Khan et al. (2018) claimed that businesses in less developed economies go to outside sources for knowledge and assistance. When it comes to knowledge extraction, SC is one of the best theories to investigate this context (Maurer et al., 2011). As a result, SC provides a pertinent theoretical framework for this research.

- **Knowledge-Based Dynamic Capabilities:** According to the resource-based view of firms, businesses should employ strategic resources to gain a sustained competitive edge. (Barney, 1991). The dynamic capabilities (DCs) view of

firms extends the resource-based view and argues that using the strategic resources is not enough and organizations should be able to create and reconfigure competencies according to changing business environment (Teece, 2007; Teece et al., 1997). According to the knowledge-based view, knowledge is the primary strategic resource of an organization, and the fundamental goal of companies is to translate knowledge into profitable results. The KBDCs' view argues that the main source of DCs is knowledge (Zhang et al., 2011). Knowledge is important in dealing with different issues regarding organizational performance, survival and business outcome (Barton, 1995). (Teece et al., 1997) explained that the organizations are more compatible when they start renewing tangible and intangible assets. The view of KBDCs view is an extension of DCs (Shamim, Zeng, Choksy, et al., 2019) and put emphasize on "ability to acquire, generate and combine internal and external knowledge resources to sense, explore, and address environment dynamics" (Zhang & Peterson, 2011).

Knowledge is important in dealing with different issues regarding organizational performance, survival, and business outcome (Barton, 1995). It has become a strategy to enhance organizational performance (An et al., 2014). There are two types of knowledge, explicit knowledge and tacit knowledge (Nonaka & Takeuchi, 1995). Conversion of tacit knowledge into explicit knowledge often happens in an organization. Teece, Pisano, & Shuen (1997) explained that the organizations are more compatible when they start renewing tangible and intangible assets. They created the idea of dynamic capabilities (DC), or an organization's capacity to combine, create, and reorganize internal and external skills in response to quick environmental changes. (Teece et al., 1997). Knowledge-based dynamic capabilities (KBDCs) is one of the latest forms of DC and KBDC states the "ability to acquire, generate and combine internal and external knowledge resources to sense, explore and address environment dynamics" (Zhang & Peterson, 2011).

The main ingredient of KBDCs is knowledge (Zhang et al., 2011) and is heavily based on SC. SC at the firm level ensures the provision of knowledge, trust, and support from the network of relationships. The literature supports the view that firms in less developed economies use their relationship network to extract knowledge to enhance innovations (Malik & Kotabe, 2009; Khan et al., 2019). Khan et al. (2019) examined this phenomenon in the context of Pakistani firms and argued that firms there rely on their external network to extract knowledge and their ability to absorb the knowledge plays a crucial role. Shamim, Zeng, Khan, & Zia (2020) examined this issue in the context of digital transformation and suggested that SC can enhance the KBDCs, and it can facilitate the digital transformations in a given context. Kim and Lee (2013) also suggested that SC facilitates the acquisition and dissemination of knowledge. Kim and Lee (2013) investigated the structural, relational, and cognitive dimensions of KBDCs and

suggested that all these dimensions are positively related to knowledge acquisition and dissemination, which are the basic elements of KBDCs. The resource-based view suggests that organizational capabilities are dependent on organizational resources, where structural, relational, and cognitive SC are important organizational resources influencing KBDCs (Kim & Lee, 2013).

3.2. Conceptual Framework
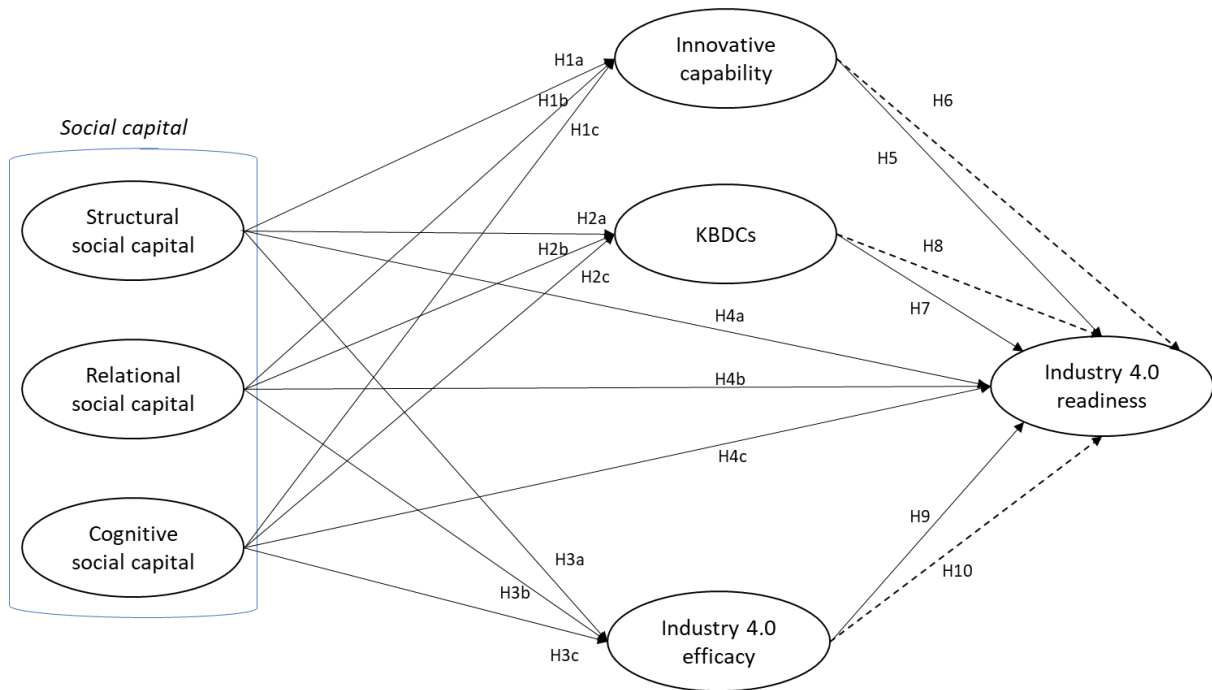
Figure 2: Conceptual Framework (Source: Author's own)

3.3. Definition of constructs and literature sourced

Table 1: Definitions and summary of constructs (Source: author's own)

S/N	Constructs	Definition	Literature adapted from
1	I4.0 readiness	Before implementing i4.0, the first step is to assess the organization's digital readiness, which begins with an awareness of its current strengths and weaknesses.	(Geissbauer et al., 2016)
2	I4.0 efficacy	I4.0 efficacy is an organization's judgment of	(Azanza et al., 2013; Bandura,

		its sense of confidence in embracing i4.0.	2012; Eastin & LaRose, 2000; Salanova et al., 2005; Shamim, Cang, & Yu, 2017; Siregar & Chang, 2020)
3	Structural SC	Who will interact in order to establish relationships and how these relationships will be achieved are explained by structural SC. This dimension includes elements like connectedness, hierarchy, network patterns, and density	(Chow & Chan, 2008; Nahapiet & Ghoshal, 1998)
4	Relational SC	Relational SC focuses on the type and degree of connections that can be made throughout the course of interactions with other people or other parties	(Cabrera & Cabrera, 2005; Davenport & Daellenbach, 2011; Lefebvre et al., 2016)
5	Cognitive SC	Cognitive SC comprises the members of the organization's shared values, vision, and objectives. Resources that provide common interpretations, means systems, and representations between participants are referred to as cognitive SC.	(Gooderham, 2007; Nahapiet & Ghoshal, 1998; Wasko & Faraj, 2005)
6	Knowledge based dynamic capabilities	KBDC is the grouping of two different aspects, dynamic capability refers to	(Han & Li, 2015; Júnior et al., 2019)

		the renewing of resources in order to get operational enhancement, whereas knowledge creation aspect refers to the using of tacit knowledge by its transfer and use.	
7	Innovative capability	The ability of a company to develop new and distinct goods, services, and markets, as well as improve existing ones, is referred to as innovative capability	(March, 1991)
8	I4.0 efficacy	Organization's judgment about its sense of confidence to embrace i4.0 is called as i4.0 efficacy	(Bohn, 2010)

4. METHODOLOGY

4.1. Research Design

The study begins with theoretical research on "the effect of SC on i4.0 readiness of firms with the mediating role of innovative capability, i4.0 efficacy, and knowledge-based dynamic capabilities". The conceptual framework developed earlier in the literature (see Figure 1) is applied based on the research design. The researcher uses to implement the objectives of the study that are presented in the methodological procedure of the proposed research design. The literature review supports the proposed model with the theoretical concept of the study model. Deductive and inductive approaches have been implemented to achieve the overall objectives of the study.

The study follows a mixed-method approach and empirically examines the association of three dimensions of SC and i4.0 readiness of manufacturing firms with the mediating roles of innovative capability, i4.0 efficacy, and KBDCs. Then the findings of this quantitative approach are explained through qualitative approach by interviewing top industry specialists.

4.2. Sample, Demographics, Data Collection, and Analytic Technique

The population of this study comprises manufacturing companies in Pakistan. A questionnaire was developed in English based on the proposed model and then distributed among respondents. The questionnaire was created in Google forms and then shared with different levels of employees in manufacturing companies in Pakistan. A list of manufacturing firms in Pakistan was prepared using various

resources, that is, the Small and Medium Enterprise Development Authority (SMEDA), the Pakistan Stock Exchange (PSX) and chambers of commerce in different cities. There are 391 large-scale manufacturing companies that are registered in PSX. While SMEDA is a Pakistani government organization that governs small and medium businesses. In SMEDA, there are more than 1,000 small businesses that have been registered so far. More than 500 firms were requested to participate in this survey by sharing the questionnaire link with a different level of managers through email and LinkedIn. A formal request was sent to the key people in the chamber of commerce of different cities to share the questionnaire with various registered firms. It is important to note that the analysis unit is an individual firm. A simple random sampling technique was applied to explore responses from respondents. This technique is more appropriate and effective, as it gives equal chances of sample selection to the understudying subject, and it also reduces the sample bias.
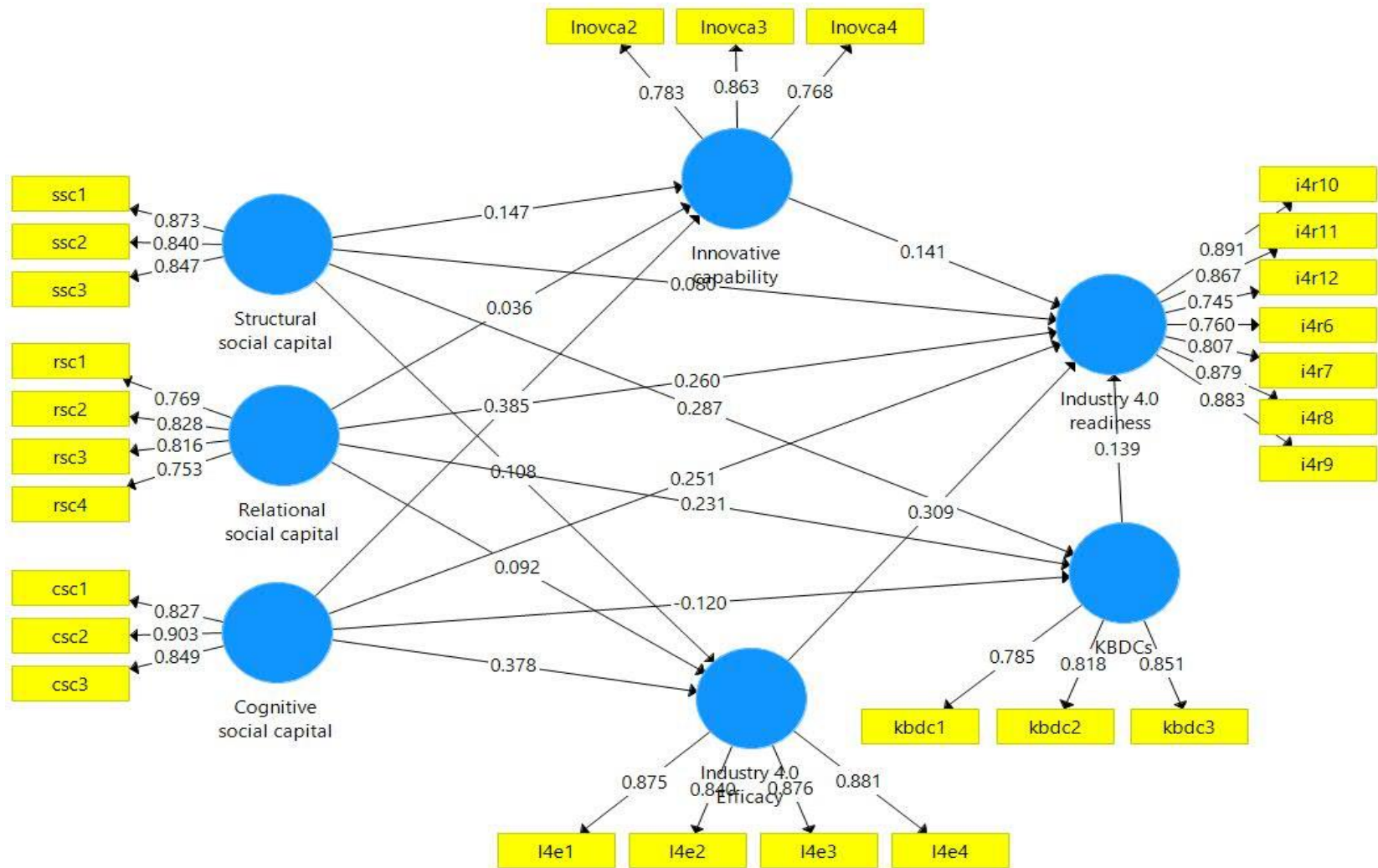
Figure 3: Path analysis (Source: Author's own)

PLS-SEM, a technique for partial least squares data analysis, was employed by the researcher. The SEM statistical technique employs a wide range of mathematical models, computer algorithms, and statistical methodologies to fit the network of constructs to the data. As a multivariate statistical analysis method, SEM is used to look at statistical relationships between measured variables and latent constructs. In a single statistical analysis, it can evaluate the multiple and interrelated dependence. The method is frequently employed, particularly in the field of social sciences, because of its applicability and capacity to infer correlations between latent variables (unobserved constructs) from observable variables. Exploratory factor analysis (EFA), Confirmatory factor analysis (CFA), confirmatory composite analysis (CCA), partial least squares (PLS), path analysis (PA), latent growth modelling (LGM), and path modelling, are sub techniques of the SEM that have been heavily referenced by other research fields (Chin, 1998; Hair Jr et al., 2017; Ullman & Bentler, 2003). Additionally, it is believed that the SEM statistical test is important for validating and testing the constructions of the item created during the research's design science phase. The questionnaire was created using the model, and as part of the evaluation process for the model, the validity and reliability of the hypothesis were tested (Barrett, 2007). The EFA and PLS-SEM are the statistical tests of choice because of their value in developing the theoretical construct, examining the structure of relationships between variables in the theoretical framework, identifying and evaluating the one-dimensionality of the theoretical construct, assessing the construct validity of the scale, and finally proving or disproving proposed theories (Cloud & Granfield, 2008; Yu et al., 2007). The study also evaluates common method bias using Harman's single factor test, as recommended by Podsakoff & Organ (1986). Harman's single-factor test results showed that the first component explained just 36.6 percent of the total variation, ruling out common method bias.
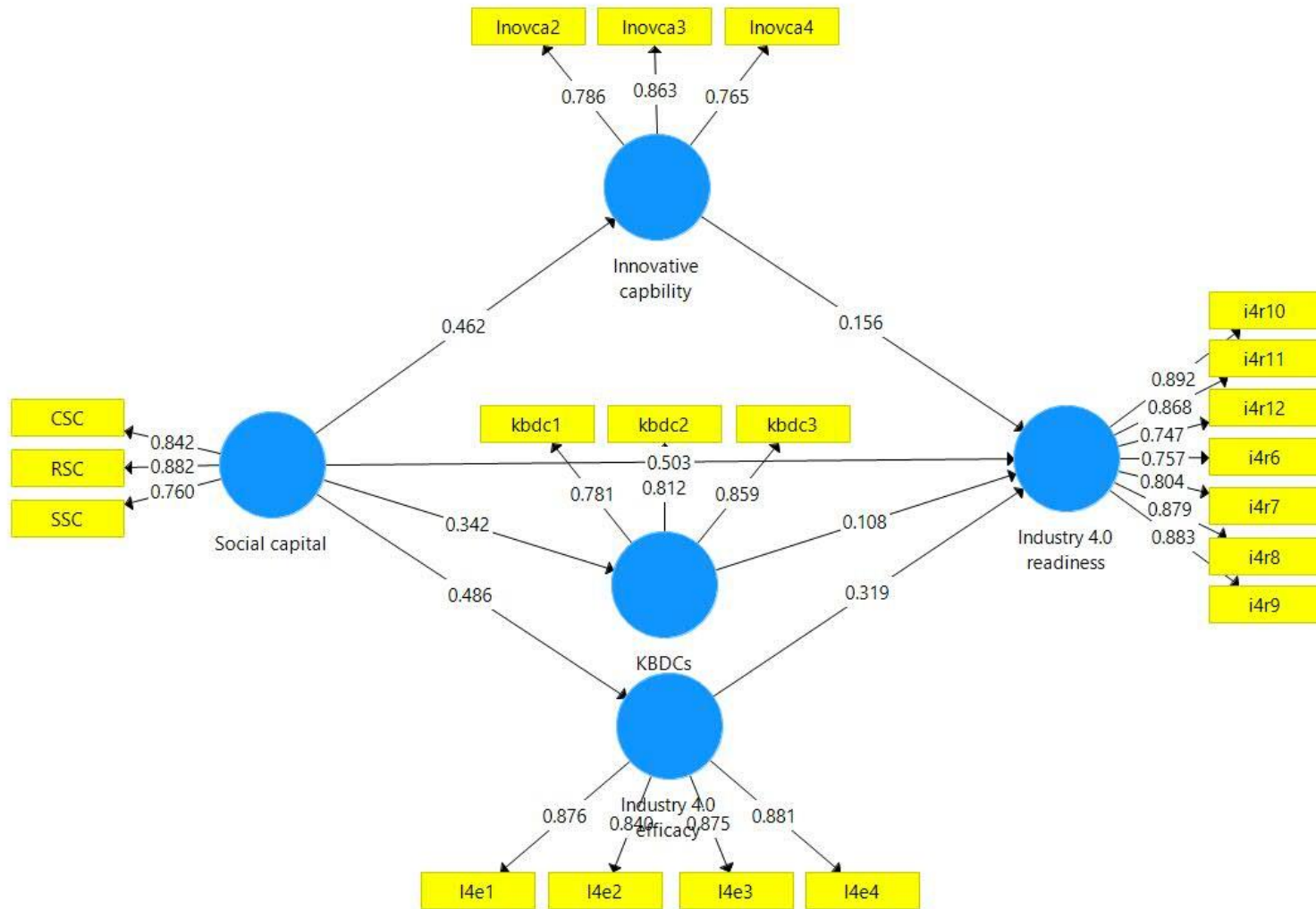
Figure 4: Path analysis-mediation (Source: Author's own)

4.3. Measures of Variables

Three items from Nahapiet et al. (1998) and Chow & Chan (2008) are adapted to measure structural SC. Four items in total, drawn from Nahapiet & Ghoshal (1998) and Chow & Chan (2008), are used to assess relational SC. Three items are adapted from the study of Chow & Chan, (2008) to measure cognitive SC. Four items from the Sheng & Hartmann (2019) study are used to measure innovative capability. Four items from Shamim et al. (2017) are used to measure i4.0 efficacy, while four items from Zheng et al. (2011) are used to measure KBDCs. IBM developed a twelve-item scale to assess i4.0 readiness, which is freely accessible. IBM has given its formal consent for the use of the items for research purposes (see appendix). The elements related to SC dimensions, innovative capacity, i4.0 readiness, and KBDCs are rated on a seven-point Likert scale that ranges from 1 ("strongly disagree") to 7 ("strongly agree").

5. QUANTITATIVE STUDY – Results

The approach of Fornell and Larcker (1981) is used to test the convergent and discriminant validity. The partial least squares method is used to test the hypothesis (PLS). The study carefully considered the benefits and drawbacks of PLS before choosing to utilize it. The literature, including Rönkkö & Evermann (2013), Chin et al. (2003), and Henseler et al. (2014) supports the use of PLS . Chin et al. (2003) claims that PLS has the capacity to concurrently take into account the structural model and measurement model. Testing the measurement of research variables and relatively complex interactions, such as a mediator and moderator, is possible with PLS. Given that this study includes mediators in addition to measuring variables using new scales, PLS is utilized to test the intricate and complex model (Henseler et al., 2014).

5.1. Sample characteristics

Table 4 shows the attributes of the companies and their respondents. It indicates that more than 90% of the companies have more than 250 employees who contribute more than 5 million Pakistan rupees (PKR) to the economy. 90% of the firms are older than 05 years. All respondents are in managerial-level positions, and among them, more than 81% of employees hold either a top managerial position or an executive-level position.

Table 2: Sample characteristics (Source: author's own)

Managerial level	Frequency	%	Age of the firm	Frequency	%
Middle Level Manager	58	18.1	Less than 5 years	8	9.6

Top Level Manager	196	61.3	6 years to10 years	24	29.7
Senior Executive	66	20.6	11 years to 15 years	21	25.9
Highest education			16 years to 20 years	19	24.1
Secondary school Level	31	9.7	21 years to 25 years	5	6.6
Undergraduate Level	72	22.5	More than 25 years	4	4.4
Graduate Level	168	52.5	**Number of employees**		
Masters Level	49	15.3	Less than 250	7	9.1
Age of participant			251 – 1000	58	71.3
<30	107	33.4	Greater than 1000	16	19.7
30-35	75	23.4			
36-40	37	11.6	**Annual Sales (Pakistan Rupees)**		
41-45	80	25.0	Less than 5 million	14	17.5
>45	21	6.6	5 million - 10 million	41	50.6
Experience			More than 10 million	26	31.9
Less than 5 years	104	32.5			
6 years to 8 years	79	24.7			
9 years to 11 years	72	22.5			
12 years to14 years	60	18.8			
More than15 years	5	1.6			

5.2. Construct reliability and validity

The construct reliability is measured through the Cronbach alpha. To establish reliability, the value of Cronbach's alpha should be more than 0.70 (George, 2011). The analysis results show that the Cronbach alpha value for each construct is greater than 0.70, indicating reliability and internal consistency. To establish convergent

validity, the factor loading of each item needs to be greater than 0.70, the average variance extract (AVE) greater than 0.50 and the composite reliability value (CR) should also be greater than AVE (Donate & Sánchez de Pablo, 2015; Fornell & Larcker, 1981). The results in Table 5 show that all constructs met the requirement, i.e., factor loading for the construct of i4.0 readiness ranges from 0.74 to 0.89, innovative capability ranges from 0.76 to 0.86, i4.0 efficacy ranges from 0.84 to 0.88, structural SC ranges from 0.84 to o.87, relational SC ranges from 0.75 to 0.82, and cognitive SC ranges from 0.82 to 0.90. Additionally, the value of AVE is greater than 0.50 and the CR value is also greater than the value of AVE, therefore, the convergent validity is established.

Table 3: Reliability and Convergent Validity (Source: author's own)

Variables	Items	Factor loadings	AVE	CR	Cronbach's Alpha
Structural SC (SSC)	ssc1	0.873	0.728	0.889	0.814
	ssc2	0.840			
	ssc3	0.847			
Relational SC (RSC)	rsc1	0.769	0.627	0.871	0.802
	rsc2	0.828			
	rsc3	0.816			
	rsc4	0.753			
Cognitive SC (CSC)	csc1	0.827	0.740	0.895	0.824
	csc2	0.903			
	csc3	0.849			
Innovative capability (INOVCA)	Inovca2	0.783	0.649	0.847	0.728
	Inovca3	0.863			
	Inovca4	0.768			
Knowledge Based Dynamic Capabilities (KBDCs)	kbdc1	0.785	0.670	0.859	0.756
	kbdc2	0.818			
	kbdc3	0.851			
I4.0 efficacy (I4E)	I4e1	0.875	0.754	0.924	0.891
	I4e2	0.840			
	I4e3	0.876			
	I4e4	0.881			

I4.0 readiness (I4R)	i4r10	0.891	0.697	0.941				0.927
	i4r11	0.867						
	i4r12	0.745						
	i4r6	0.760						
	i4r7	0.807						
	i4r8	0.879						
	i4r9	0.883						

Fornell & Larcker have established the standards for determining discriminant validity (1981). Discriminant validity is demonstrated, in accordance with Fornell & Larcker (1981), when the AVE value is higher than the squared correlation between constructs. Table 6's findings demonstrate that the discriminant validity is confirmed. The squared correlation value is less than the value of AVE. The outcomes of the factor analysis, as well as the reliability and validity checks performed using Smart PLS and a variance based PLS technique, demonstrate the quality of the study model. The dependent variable's R2 value is 0.73, which denotes a good model fit.

Table 4: Discriminant validity (Source: author's own)

Factors	1	2	3	4	5	6	7
CSC	*0.860*						
I4E	0.482	*0.868*					
I4R	0.687	0.652	*0.835*				
INOVCA	0.469	0.344	0.541	*0.805*			
KBDCs	0.148	0.324	0.443	0.381	*0.819*		
RSC	0.645	0.397	0.687	0.369	0.319	*0.792*	
SSC	0.416	0.318	0.530	0.328	0.371	0.576	*0.853*

5.3. Path analysis and hypothesis testing

The Smart PLS 3.3.9 software version has been used to test hypotheses and path analysis using the structural equation model. We first investigated the direct link between the constructs, as shown in Table 7, and then we looked at the constructs' potential mediating effects. The findings show that cognitive SC ($\beta = 0.39$, $p < 0.001$) and structural SC ($\beta = 0.14$, $p < 0.05$) both positively and significantly affect innovative capability. The association between relational SC and innovative capability is not statistically significant ($\beta = 0.03$, $p > 0.05$). These results support the rejection of H1b and the acceptance of H1a and H1c. The outcomes also demonstrate

the direct impact of all dimensions of SC on KBDCs. Structural SC and relational SC are positively and significantly related with KBDC, accepting H2a ($\beta = 0.28$, $p < 0.001$) and H2b ($\beta = 0.23$, $p < 0.05$). However, there is no significant relationship between cognitive SC and KBDC ($\beta = -0.12$, $p > 0.05$) and therefore H2c is rejected. There is no significant association of structural SC with i4.0 efficacy ($\beta = 0.10$, $p > 0.05$)., and relational SC with i4.0 efficacy ($\beta = 0.09$, $p > 0.05$). These findings do not support H3a and H3b. On the other hand, cognitive SC is positively and significantly related to i4.0 efficacy ($\beta = 0.37$, $p < 0.001$), which supports H3c. Then, the direct effects of the SC dimension with i4.0 readiness are examined. The results indicate that the three dimensions of SC (structural SC ($\beta = 0.07$, $p < 0.05$), relation SC ($\beta = 0.26$, $p < 0.001$) and cognitive SC ($\beta = 0.24$, $p < 0.001$) are positively and significantly related with i4.0 readiness. These results support H4a, H4b, and H4c. The results also revealed that innovative capability is positively and significantly related to i4.0 readiness ($\beta = 0.14$, $p < 0.001$), the KBDCs are positively and significantly related with i4.0 readiness ($\beta = 0.13$, $p < 0.001$) and i4.0 efficacy is positively and significantly related to industry 4. 0 readiness ($\beta = 0.31$, $p < 0.001$). These results support H5, H7, and H9.

Regarding mediating relationships, the results indicate that there is an indirect association of SC with i4.0 readiness through the mediation of innovative capability ($\beta = 0.072$, $p < 0.001$), KBDCs ($\beta = 0.037$, $p < 0.05$), and i4.0 efficacy ($\beta = 0.155$, $p < 0.001$). After entering the innovative capability, the KBDC and the effectiveness of i4.0 efficacy into the model, the direct relationship of SC with the readiness of i4.0 was reduced from $\beta = 0.768$ to $\beta = 0.504$. Partially mediation is demonstrated by the fact that the associations are still significant at $p < 0.05$. The results support H6, H8, and H10.

Table 5: Path analysis and hypothesis testing (Source: author's own)

Path	Direct effect β (t-value)	Indirect effect β (t-value)	Total effect β (t-value)	Hypothesis	Result
SSC -> INOVCA	0.144**(2.08)		0.144**(2.08)	H1a	Failed to reject
RSC -> INOVCA	0.033(0.49)		0.033(0.49)	H1b	Rejected
CSC -> INOVCA	0.392***(6.06)		0.392***(6.06)	H1c	Failed to reject
SSC -> KBDCs	0.289***(4.59)		0.289***(4.59)	H2a	Failed to reject
RSC -> KBDCs	0.230**(2.98)		0.230**(2.98)	H2b	Failed to reject
CSC -> KBDCs	-0.123 (1.71)		-0.123 (1.71)	H2c	Rejected
SSC -> I4E	0.108(1.63)		0.108(1.63)	H3a	Rejected
RSC -> I4E	0.091(1.20)		0.091(1.20)	H3b	Rejected
CSC -> I4E	0.377***(5.74)		0.377***(5.74)	H3c	Failed to reject
SSC -> I4R	0.077**(2.18)		0.172***(3.27)	H4a	Failed to reject
RSC -> I4R	0.262***(4.80)		0.327***(5.02)	H4b	Failed to reject
CSC -> I4R	0.248***(4.80)		0.406***(7.61)	H4c	Failed to reject
INOVCA -> I4R	0.144***(3.55)		0.144***(3.55)	H5	Failed to reject
KBDCs -> I4R	0.138***(4.15)		0.138***(4.15)	H7	KFailed to reject
I4E -> I4R	0.311***(7.75)		0.311***(7.75)	H9	Failed to reject
SC -> INOVCA -> I4R		0.072***(3.65)		H6	Failed to reject
SC -> KBDCs -> I4R	0.504***(12.97)	0.037**(2.96)	0.768***(35.02)	H8	Failed to reject
SC -> I4E -> I4R		0.155***(6.22)		H10	Failed to reject

Note: ** represents p < 0.05 and *** represents p < 0.001

5.4. Determination coefficient

Cohen (2013) established Cohen's f-square to calculate the effect size in a multiple regression and of the independent and dependent variables that are continuous. According to Cohen (2013), this effect size is classified as small, medium, and large. Cohen (2013) stipulated each category; small effect $0.02 \leq f^2 \leq 0.15$; medium effect 0.15 f2 0.35; strong effect f2 0.35. The table shows that most of the significant relationships indicate a medium effect as the effect size falls between 0.15 and 0.35.

Table 6: Effect size overview of structural model- Cohen's f² (Source: author's own)

Effect	Original Sample (O)	Sample Mean (M)	St. d	T Statistics	P Values	Cohen's f²	Remarks
CSC -> I4E	0.378	0.378	0.066	5.743	0.000	0.32	Medium effect
CSC -> I4R	0.248	0.249	0.052	4.801	0.000	0.27	Medium effect
CSC -> INOVCA	0.392	0.392	0.065	6.060	0.000	0.34	Medium effect
CSC -> KBDCs	-0.123	-0.123	0.072	1.714	0.087	0.10	Small effect
I4E -> I4R	0.311	0.311	0.040	7.750	0.000	0.43	Strong effect
INOVCA -> I4R	0.144	0.144	0.041	3.555	0.000	0.20	Medium effect
KBDCs -> I4R	0.138	0.138	0.033	4.155	0.000	0.23	Medium effect
RSC -> I4E	0.091	0.093	0.076	1.205	0.228	0.07	Small effect

RSC -> I4R	0.262	0.264	0.055	4.805	0.000	0.27	Medium effect
RSC -> INOVCA	0.033	0.036	0.067	0.491	0.624	0.03	Small effect
RSC -> KBDCs	0.230	0.233	0.077	2.982	0.003	0.17	Medium effect
SSC -> I4E	0.108	0.109	0.066	1.633	0.102	0.09	Small effect
SSC -> I4R	0.077	0.075	0.035	2.185	0.029	0.12	Small effect
SSC -> INOVCA	0.144	0.144	0.069	2.088	0.037	0.12	Small effect
SSC -> KBDCs	0.289	0.290	0.063	4.597	0.000	0.26	Medium effect

Table 7: Summary of tested hypothesis (Source: author's own)

	Hypothesis	Conclusion
H1a	*Structural SC is positively related to innovative capability*	Failed to reject
H1b	*Relational SC is positively related to innovative capability*	Rejected
H1c	*Cognitive SC is positively related to innovative capability*	Failed to reject
H2a	*Structural SC is positively related to KBDCs*	Failed to reject
H2b	*Relational SC is positively related to KBDCs.*	Failed to reject
H2c	*Cognitive SC is positively related to KBDCs.*	Rejected
H3a	*Structural SC is positively related to i4.0 efficacy*	Rejected
H3b	*Relational SC is positively related to i4.0 efficacy*	Rejected
H3c	*Cognitive SC is positively related to i4.0 efficacy*	Failed to reject
H4a	*Structural SC is positively related to i4.0 readiness*	Failed to reject
H4b	*Relational SC is positively related to i4.0 readiness*	Failed to reject
H4c	*Cognitive SC is positively related to i4.0 readiness*	Failed to reject
H5	*Innovative capability is positively related to i4.0 readiness.*	Failed to reject
H6	*Innovative capability mediates the relationship between SC and i4.0 readiness.*	Failed to reject
H7	*KBDCs are positively related to i4.0 readiness.*	Failed to reject
H8	*KBDCs mediate the relationship between SC and i4.0 readiness.*	Failed to reject
H9	*I4.0 efficacy is positively related to i4.0 readiness.*	Failed to reject
H10	*I4.0 efficacy mediates the relationship between SC and i4.0 readiness.*	Failed to reject

6. QUALITATIVE STUDY – validation and explanation of results

Table 8: Interviewee characteristics (Source: author's own)

Informant ID	Respondent's industrial position	Industrial working experience (years)	Main products of the company
001	Managing director	11	• Air filters • Valves • Screws • Fittings • Tubes
002	COO	17	• Yogurt • Packed Milk • Cheese • Butter
003	Plant head	23	• Lubricants • Oil filter • Vehicle polish • Mechanical screws • Valves
004	Head of procurement department	15	• Air tanks • Air valves • Hoses • Tubes • Seals

005	Supply chain manager	08	• Air conditioners • Condensers • Rubber seals • Water valves
006	CEO	19	• Milk powder • Dry tea whitener • Baby milk powder • Cream filled chocolates
007	International relationship manager	16	• Hoses • Tubes • Pots • Pumps
008	Manager R&D	08	• Fittings • Hydraulic aggregates • Cylinders
009	Deputy manager operations	16	• Auto sensors • Auto cameras • Electrical switches • Floor components
010	Supply chain head	15	• Brake pedal • Tensioner • Chassis electrical equipment • Clutch master cylinder

011	Head of plant operations	22	• Bike axle • Seat stay • Drop bars • Handler stem • Rear cassette • Wheel hub
012	CEO	19	• Lead terminal and connectors • Electrolytes • Resilient plastic container • Battery internal plates
013	Managing director	16	• Inverters • Power knob • Shower hose • Thermal cut out
014	General manager	14	• Torque • Crank shafts • Pin pistons • Oil pumps • Rocker • Rod connector
015	Head of R&D	19	• Power connectors • CPU socket • Headers • Slots

			• Reset buttons • Chipsets • Memory slots
016	CEO	21	• Drop bars • Rear cassette • Wheel hub • Handler stem
017	Operations Manager	11	• Yogurt • Flavoured milk • Packed Milk • Cheese • Condensed milk • Butter
018	National manager operations	08	• Carbonated water • Cola drinks • Purified water • Energy drinks

The study uses qualitative methodology to validate and explain the findings of the quantitative study. To follow the method, semi-structured interviews are conducted from top industry experts. Characteristics of each informant is described in table 9. The findings are explained in more detail as follows.

6.1. Structural SC and innovative capability

Qualitative results that were based on semi-structured interviews with business professionals have confirmed the link between structural SC and innovative capability. Participants are asked to shed a light on how structural SC affects ability to innovative capability. For instance, one of the experts describes how his company's structural SC improves its capacity for innovation.

'In my observation, when we have those employees in the system who are more social and have strong ties to other organizations, it helps us gather information and bring newness to our products [Informant ID #13]'

Another participant argues that

'Due to the increase in import tax rates, the new technical equipment became expensive. However, our team members established contact with foreign colleagues and requested them to share alternative suppliers with low-priced material. This transaction provided great support to our company and helped to develop new products within an affordable price range [Informant ID #18]'

One respondent replies that

'The predefined social network structure is a key strength for firms to bring newness to products and services. We have introduced few rewards for those employees who are more active in building valuable relationships with foreign distributors and helping to bring innovation to the products [Informant ID #14]'

These arguments support the notion that strong social ties help the firms maintain innovation in their products. It also explains the role of solid network patterns of firms with other firms to enhance innovative capability.

6.2. Relational SC and innovative capability

The findings show that relational SC dimension is not positively associated to innovative capability. Although the previous literature has established relationship between the relational SC and innovative capability. For example, Zia et all. (2022) explained relationship of relational SC and innovative capability. However, semi-structured interviews confirmed and explained the findings of this study in their responses. One participant described that

"It is hard for employees to extract knowledge on basis of merely trust and friendship. The workers need various other kinds of relationships as well to come close to other companies' knowledge infrastructure, and then these workers may become successful in obtaining the required information and technology [Informant ID #10]"

Another argument that relational SC might not affect innovative capability is discussed by one respondent. The statement of respondent explains that,

"Not all, but few people, sometimes, become successful in obtaining valuable knowledge from other firms on the basis of friendship or trust. However, according to my personal experience, most of company employees prefer to exchange knowledge based on shared benefits and believes [Informant ID #05]"

6.3. Cognitive SC and innovative capability

Semi-structured interviews of industry experts also explain and confirm the relationship between cognitive SC and innovative capability. Impact of SC on

innovative capability is already established in the existing literature, however, the role of cognitive SC as a dimension of SC needs to be explored and is well explained during these interviews. One respondent stated that

'During the 2015 management committee meeting, we decided to teach German and Dutch to R&D employees, because they are supposed to visit Germany and the Netherlands factories. Although it was a long journey, but now we have a total of 5 employees in the R&D department who are proficient in these languages. It has helped our company build strong relationships and gain more detailed insight to improve our existing products. It could be difficult to obtain such valuable knowledge during interactions with foreign partners without making language learning harmful [Informant ID #1] '

The interviews also retrieved relevant explanation from another expert. He explained the relationship of cognitive SC and innovative capability. The following statement is an example.

'In our company, we usually visit factories in other countries two to three times a year. This is for the purpose of seminars. What we exactly do there is to share the ongoing culture of our company and gain the knowledge in return, that how do they create value? In the last year, we had a success in obtaining information to add one more test kit during the milk collection procedure of farmers. This test addition distinguishes our milk product, and now we can market our product as unique [Informant ID #10] '

Another industry expert explained the relationship. For example, the respondent described the relationship in a following statement.

'Sustainable growth can be achieved by sharing value. It could lead to higher business productivity by identifying and sharing common goals and values between business and society. Therefore, when the firm focuses first on social needs, it creates an innovative mindset throughout all organizational departments, and it leads to a more innovative organization [Informant ID #7]''

These statements and views match our quantitative findings and clearly reflect the influence of cognitive SC in developing the capability of the products to innovate.

6.4. Structural SC and KBDCs

Semi-structured interviews of industry experts reveal a positive relationship of structural SC with KBDCs. Most of the respondents report that due to the density of social networks, their employees were more successful in obtaining the desired knowledge and information. For example, one of the participants argued that

'While we receive knowledge from our company partners and the companies with which we have made contracts to send and receive information or knowledge, but the ability of our employees to interact with as many persons as possible plays a major role in obtaining key knowledge [Informant ID #2]'

This statement highlights the importance of the density of relationships in extracting valuable knowledge. Strong social links enable firms to get closer in exchanging valuable knowledge. A senior industry expert explained the relationship between structural SC and KBDCs in the following statement.

'I think we can take SC as a relationship capital. We, in our company, take it as financial capital. Just like we put money into the bank and take withdrawals, so if we want to withdraw money from the bank, we first need to put some money in the bank. We also invest in SC building in order to get back some rewards, and usually these rewards are in the shape of crucial knowledge and information. Therefore, the core focus of our organization is to build relationships [Informant ID #11]'

One participant argues that

"Gaining the knowledge becomes easier once employees are more social. Sometimes those employees join our firms who hold years of work experience, and they have strong social networks in other firms, nationally and internationally. These employees are more capable of getting knowledge based on their relationships [Informant ID #6]'

This is how top industrial leaders motivate their companies to shape for a strong SC and carry valuable knowledge through these connections. These arguments explain the importance and positive effect of structural SC on KBDCs. Therefore, the structural SC dimension is well elucidated as an influencer to extract knowledge from valuable social networks.

6.5. Relational SC and KBDCs

Qualitative data analysis reveals the relationship between relational SC and KBDCs. Semi-structured interviews with industry professionals reinvestigate the importance of relational SC to enhance KBDCs, and the results validate and confirm the findings. For example, one of the respondents replied on how crucial the role of strong relational capital is in obtaining knowledge in the following way.

'I personally had a very close known member in another company. He always shared healthy knowledge and information about many products that were even in the incubation period. The purpose of such sharing was solely to establish trust on relation and to get somehow the same or matched

information from my side. I never felt reluctant to share any knowledge with him, because we were both on the same platform. I personally believe that the knowledge assets that are built based on friendship play a vital role in developing competitive advantage [Informant ID #9] '

The respondents strongly agree on the central role of relational SC in the development of KBDC. Another study expert responded that

'Our relationships are a huge kind of notion that brings value to our lives. We believe that a typical person in a company keeps 100 and fifty important relationships, and our company encourages our employees to utilize a maximum potion of these relations to make our firms knowledgably strong. The amount of money that we make due to our relationships is dramatic, and the same applies to the firms as well. The more we are friendly with our shareholders, the more value we will take from them in return [Informant ID #3]'

Other industry experts explained that

'Relations that are based on friendship play an important role in value creation. In this case, we can say that the more relationships the firms have with other firms, the more easily the firms can get knowledge that can be used for competitive advantage [Informant ID #12] '

The above arguments support the quantitative findings of the study in which relational SC has a strong positive effect on KBDC. Our qualitative answers confirm and validate that relational SC is vital in enhancing knowledge-based dynamic capabilities of the companies.

6.6.   Cognitive SC and KBDCs

The results show that cognitive SC dimension is not positively related to KBDCs. Semi-structured interviews further explained and confirmed the factors that may contribute to these findings. One participant explained that

"Ideally, sharing values and visions with other companies improves its ability to gain valuable knowledge. In Pakistan economy, the case looks a bit different. People can extend personal relationships and even exchange some knowledge as well, however, once they intend to exchange key norms or values, they face reluctant. It might because of lack of previous practice. But I believe, once one company strengthen its relationships with other companies in developed word, both might be in position to share vision, norms, and key goals with each other [Informant ID #18]"

6.7. Structural SC, relational SC and industry 4.0 efficacy

The results of the quantitative data analysis indicate that structural and relational SC does not positively associate with i4.0 efficacy. The study conducted semi-structured interviews from industry experts and the interviewees described the results. One participant argued that,

"Only relations that are based on friendship cannot enable any company to show confidence in embracing industry 4.0 technology. Getting confidence towards industry 4.0 looks solely dependent on technical abilities. Companies achieve confidence for industry 4.0 when their employees are able to handle more technical jobs and when the employees are more innovative as compare to their competitors [Informant ID #07]"

6.8. Cognitive SC and industry 4.0 efficacy

The results of the quantitative data analysis show that cognitive SC is positively related to the efficacy of i4.0. This relationship was also explained through semi-structured interviews of key industry experts. The interviews enlightened the relationship between cognitive SC and i4.0 efficacy. One of the respondents elucidated that

'Discussing and sharing common languages or norms is often helpful for companies to advance their technologies. Same goes with the fourth industrial revolution. The more we are socially active; more we can obtain the relevant knowledge to support i4.0 environment [Informant ID #15] '

Another participant argued that

'Our one employee visited a factory in an EU country to obtain the latest technology in vehicle oil and air filters. This exchange of information supported us to obtain exact technological information related to the product. Here, I would say that the SC between both companies, home and host companies, made this happen and collected knowledge that was a supportive tool for the enhancement of the product in our factory [Informant ID #17] '

One respondent replies that

'The principles of shared values and shared vision encourage trust and transparency between the firm's business and society. Therefore, the firm for its profit and the society for its environmental benefits, both can coordinate together to induct new technology into the business that can be beneficial to business and society [Informant ID #4] '

These statements reflect that the positive role of cognitive SC plays a crucial role in knowledge creation that may lead to enhanced i4.0 efficacy.

6.9. Structural, relational, cognitive SC and industry 4.0 readiness

The quantitative finding of the study shows a positive relationship between all three dimensions of SC with i4.0 readiness. Semi-structured interviews explained the existence of an association between dimensions of SC (structural, relational, and cognitive) and i4.0 readiness. One of the interviewees stated the relationship of structural SC with i4.0 readiness in a statement below.

'We know that our employees can bring the knowledge that usually cannot be gained through our contractual partners. Personal relations of our employees always provide quality knowledge about the latest technology that is valuable to add to our existing infrastructure. This addition of technological and digital knowledge enables firms to be ready for the next steps of digitalization [Informant ID #8] '

An industry expert argued that

'Our HR department prefers to hire those people who have worked internationally and who have strong social ties nationally and internationally. Employees with broad social connections feel comfortable extracting valuable knowledge from their social networks. In the current scenario, these social employees are more vital in transforming companies towards the digital environment or, in your words, the i4.0 working structure [Informant ID #16] '

Another participant stated that

'Having common values and languages can give more opportunities to share knowledge with each other. Our government has taken various steps to open language centers for entrepreneurs, and our firm has approved admission of eleven top employees to learn languages such as Chinese, Dutch, and even French. This is not the first time; thought we have already produced dozens of employees who learned foreign languages and now they are leading our R&D projects. In our company, we have a strong belief that sharing knowledge supports innovation in new products, that make companies ready for the next technology challenge [Informant ID # 5] '

The results of the interviews confirm the quantitative findings that all three dimensions of SC have a strong impact on enhancing the i4.0 readiness of the firms.

7. DISCUSSION

This study examines the role of social capital (SC) of firms in developing economies to enhance i4.0 readiness. In this context, the SC of companies in Pakistan is measured and tested in relation to i4.0 readiness. Pakistan is considered a suitable context because the firms in Pakistan are in the primary stage of i4.0 technology adaptation (Nizam et al., 2020) and these firms primarily depend on bringing these technologies from the firms of developed economies (Malik & Kotabe, 2009). This study provides a rich direction of implication to the firms of developing countries, which are striving to adopt I4.0 strategy in this digital transition era. Due to institutional voids, the firms in developing countries need to endow their SC with the external actors to build strong ties with the firms in developed economies. The study examined the mediating role of innovative capability, KBDCs, and i4.0 efficacy in the relationship between SC and i4.0 readiness. The findings suggest that the SC of the firms of developing economies, i.e., Pakistan, with the firms of developed economies is a useful tool to improve the readiness of i4.0. The results show that structural SC and cognitive SC are positively related to innovative capability. In the context of this study, it means that firms in developing countries with strong personal people networks and a dense network link based on shared values and vision are better positioned to extract valuable knowledge from companies in developed economies to promote innovation. Furthermore, the results of the study show that the innovative capability of the firms is positively linked to the readiness for i4.0, which is consistent with the existing literature (Shamim et al., 2016b; Sheen & Yang, 2018). Innovative capability also mediates the relationship between SC and i4.0 readiness. In the context of this study, it means that companies in developing economies can be in a good position to gain knowledge through their strong SC that can gain the innovative capability to enhance i4.0 readiness. It also indicates that firms with strong social networks can increase knowledge sharing and contribute to product and service innovation (Pérez-Luño et al., 2011). Firms with more ability to adapt to the changing environment through uninterrupted innovation, such as adapting the latest technology in the working environment and using big data in decision making, will become more equipped to incorporate i4.0 (Shamim, Zeng, Shariq, et al., 2019).

The results also show that structural SC and relational SC are positively related to KBDC. In the context of this study, it means that companies in developing countries having dense social ties, friendships, and trust are better positioned to acquire and disseminate knowledge from companies in developed economies, and this knowledge is the main foundation of KBDCs (T. T. Kim et al., 2013). The results further show that KBDCs are positively related with i4.0 readiness and KBDCs mediate the relationship between SC and i4.0 readiness. It means that firms with strong knowledge-based dynamic capabilities facilitate the

knowledge flow from developing economies to the developed economies and enhance the ability of the firms to embrace i4.0 readiness.

The i4.0 efficacy of firms in less developed economies can be influenced by their SC with firms in industrialized and developed economies. The findings indicate that of the three dimensions of SC, only cognitive SC is positively related to i4.0 efficacy. In this context of the study, it means that firms in developing economies with a strong organizational structure of shared norms, values, and languages are in a better position to acquire the desired technical knowledge from firms in developed economies. This knowledge becomes a foundation for these firms to increase their confidence in i4.0 technology. The results also show that i4.0 efficacy is positively related with i4.0 readiness, and it also mediates the relationship between SC and i4.0 readiness. It means that firms in developing countries gain more confidence to embrace i4.0 technology through their shared norms and values with firms in developed economies, which can enhance their readiness to embrace i4.0 technology.

7.1. Academic contribution to theory and knowledge

This study contributes to theory and knowledge in several ways. Examination of the SC of firms in developing economies with developed economies is rare in the existing literature. Research in i4.0 readiness is an under researched area, and most of the studies are conducted on the technological aspect of i4.0; however, the studies on the management issues of i4.0 are scarce. The perspective of capability development regarding i4.0 is also an overlooked research area. This study also contributes to the theory of SC and the theory of efficacy by determining that SC improves the efficacy of i4.0. This study uses efficacy as i4.0 efficacy that would consider it the first study to introduce efficacy in the context of i4.0. However, the existing literature only discusses i4.0 in the context of industrialized and developed economies, however; how less developed economies prepare and prepare to embrace the i4.0 strategy is still not addressed in the current literature. This study fills this gap by examining the role of SC to enhance i4.0 readiness in Pakistan, which is considered a well-established context for developing economies. Examining the mediation of innovative capability, KBDCs, and i4.0 efficacy in the relationship between SC and i4.0 readiness is also a novel contribution. Overall, this study presents a very different line of inquiry in the context of i4.0

7.2. Contribution to practice

Pakistan is in the infancy stage of developing and adapting technologies for i4.0 (Nizam et al., 2020) and primarily depends on importing such technologies from developed countries (Malik & Kotabe, 2009). This research activity examines the mediating role of innovative capability, KBDCs, and I4.0 efficacy in the liaison of SC and i4.0 readiness. The expected results can indicate that SC

can be a useful tool for developing countries like Pakistan to extract knowledge from developed countries and prepare for the i4.0 paradigm. Furthermore, the role of innovative capability, KBDCs, and i4.0 efficacy are also crucial. SC is frequently considered a forerunner of innovation and transformation (Maurer et al., 2011), and i4.0 readiness plays a vital role in triggering a digital transformation in organizations and economies as a whole. The investigation of SC role towards i4.0 readiness means that firms in developing economies can be in a good position to embrace i4.0 technology by effectively using SC. Furthermore, the mediation examination of innovative capability, i4.0 efficacy, and KBDCs in the relationship of SC and i4.0 readiness mean that firms of developing economies with strong SC can be in a good position to improve innovative capability, develop i4.0 confidence, and gain KBDCs which can enhance i4.0 readiness.

This study suggests connotations for companies in developing economies, especially those companies that are in the phase of the digital transformation process and are struggling to adapt to the i4.0 strategy. Due to institutional gaps, firms in less developed economies must depend on SC of firms in developed and industrialized economies. SC is a valuable tool for extracting effective knowledge from firms in developed economies by using intraorganizational ties to accelerate the process of innovation (Maurer et al., 2011).

8. CONCLUSION

Social capital (SC) can be a useful tool for developing economies in extracting knowledge and information from developed economies. Therefore, each dimension of SC is crucial and plays a different role. The structural dimension of SC can create value for firms in less developed economies with firms in developed economies by building a social structure that is based on network ties and configuration. The dimension of relational SC can bring value through trust, quality of relationship, and expectations of the relationship. Firms in developing economies can also use the dimension of cognitive SC and create value by sharing value, vision, language, attitudes, and beliefs. These three dimensions of SC are considered important resources, and firms should utilize these resources to boost innovative capability, KBDCs, and i4.0 efficacy in order to get ready for the fourth industrial revolution. The existing literature also supports the argument that these three dimensions of SC are crucial strategic resources and can be used to build KBDCs. The study concludes that firms in less industrialised economies should enhance their SC with the firms in industrialised economies and form an environment where firms can remain connected with foreign firms in order to create value, knowledge, and useful information. Therefore, the development of friendly relationships and mutual trust for these firms to extract support from foreign collaborators and allies. Furthermore, firms in developing countries can also connect with firms in developed economies based on sharing mutual goals,

visions, and languages in order to harness the cognitive SC. By following this procedure, firms in developing economies can extract knowledge related to i4.0 and improve i4.0 readiness through innovative capability, KBDCs and i4.0 efficacy. This research work studies the role of SC of firms in influencing i4.0 readiness in the framework of emerging economies. To achieve this objective, the SC of Pakistan's companies is quantified and examined in relation to the readiness of i4.0.

There are a few limitations of this research. This research gathers data from Pakistan that represents a context of the emerging economy. Future study should gather data from other states. Additionally, this study used nested data for the analysis, that is, multiple responses from different managers are nested in firm-level data. However, the study is consistent with Awan et al. (2021). Future study can also investigate the effectiveness of a firm's SC using the framework of DC and resource-based view and testing it in relation to i4.0. It is also crucial to discover the outcomes of i4.0 readiness, especially in the context of emerging economies; future study should also examine this issue in detail.

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LIST OF PUBLICATIONS BY THE AUTHOR

Published articles

1. **Ul Zia, N.**, Burita, L. & Yang, Y. (2022) Inter-organizational social capital of firms in developing economies and industry 4.0 readiness: the role of innovative capability and absorptive capacity. **Review of Managerial Science**. DOI: 10.1007/s11846-022-00539-3

2. Awan, U., Shamim, S., Khan, Z., **Zia, N. U.**, Shariq, S. M., & Khan, M. N. (2021). Big Data Analytics Capability and Decision-Making: The Role of Data Driven Insight on Circular Economy Performance. **Technological Forecasting and Social Change**. DOI: 10.1016/j.techfore.2021.120766

3. Shamim, S., Yang, Y., **Zia, N. U.**, & Shah, M. H. (2021). Big data management capabilities in the hospitality sector: Service innovation and customer generated online quality ratings. **Computers in Human Behavior**. DOI: 10.1016/j.chb.2021.106777

4. **Zia, N. U.** (2020). Knowledge-oriented leadership, knowledge management behaviour and innovation performance in project-based SMEs. The moderating role of goal orientations. **Journal of Knowledge Management.** DOI: 10.1108/JKM-02-2020-0127

5. Shamim, S., Zeng, J., Khan, Z., **& Zia, N. U** (2020). Big data analytics capability and decision-making performance in emerging market firms: The role of contractual and relational governance mechanisms. **Technological Forecasting and Social Change**, 161, 120315. DOI: 10.1016/j.techfore.2020.120315

6. Yasin, R., Namoco, S. O., Jauhar, J., Rahim, N. F. A., & **Zia, N. U.** (2020). Responsible leadership an obstacle for turnover intention. **Social Responsibility Journal.** DOI: 10.1108/SRJ-03-2020-0092

Article Publications (under review)

7. Avoiding crisis-driven business failure through digital dynamic capabilities. A case of B2B distribution firms. **Journal Name: Industrial Marketing Management.**

8. Process and impact analysis of objectively including knowledge sharing in employees' performance appraisal system through cyber-ba. An investigation through accountability theory. **Journal Name: Knowledge Management Research & Practice**

9. Building blocks of cognitive trust in artificial intelligence and its integration into business strategy. **Journal Name: Information Technology and People**

10. The Role of Mindfulness in Building and Diffusion of Relational Quality for Creative Process Engagement. **Journal Name: Journal of Managerial Psychology**

11. Cognitive Trust in Artificial Intelligence Among Front Line Employees in a Low-Tech Developing Economy: Drawing Upon Theory of Planned Behaviour. **Journal Name: Journal of Business Research**

Conference Proceedings

12. European Conference on Cyber Warfare and Security, A Managerial Review and Guidelines for Industry 4.0 Factories on Cybersecurity, [Manchester UK, 2022] DOI: 10.34190/eccws.21.1.499

13. EURAM 2022, Leading digital transformation. Business failure preclusion of B2B distributors during the pandemic epoch: Does digital transformation change the business paradigm? [Switzerland, 15 June 2022 – 17 June 2022]

14. IEOM Society 2021, Proceedings of the International Conference on Industrial Engineering and Operations Management. Social capital and industry 4.0 readiness in developing countries. Role of potential and realized absorptive capacity [Italy, 02 Aug 2021 – 04 Aug 2021]

15. EURAM 2021, Reshaping capitalism for a sustainable world. Inter-organizational social capital of firms in developing economies and industry 4.0 readiness: the role of innovative capability and absorptive capacity [Canada, 16 Jun 2021 – 18 Jun 2021]

16. ECCWS 2020, the 19th European Conference on Cyber Warfare and Security. A viewpoint on Management Practices for Cybersecurity in industry 4.0 Environment [UK, 25 Jun 2020 – 26 Jun 2020] DOI: 10.34190/EWS.20.031

17. 16th International Bata Conference for Ph.D. Students and Young Researchers (DOKBAT 2020). A wider future research agenda and research gaps in the context of industry 4.0, with the focus on management issues [Czech Republic, 2 Sep 2020 – 3 Sep 2020] DOI: 10.7441/dokbat.2020.50

AUTHOR'S PROFESSIONAL CURRICULUM VITAE (C V)

Personal Information
Name: Najam Ul Zia
Temporary Address: Nam. T. G. M. 3050, 76001, Zlin, Czech Republic
Permanent Address: Gill Kalan, P/O Qila Ahmad Abad, Teh & Dist Narowal, Pakistan
Present status: PhD Candidate, Tomas Bata University in Zlin, Czech Republic.
Email: zia@utb.cz ; najamulzia@gmail.com

Research work overview

I am a final year PhD student of Economics and Management and researcher at Tomas Bata University in Zlin with an interest in innovation, industry 4.0, big data management, social capital, and knowledge management. I develop survey tools and analyse large panel data sets to better understand economic decision-making and its psychological underpinnings, generating insights to inform theory as well as real world decision makers in the areas of economics and management. Most of my current research applies the field of industrial knowledge management and economic development in the context of innovation.

Published work:

My first publication appears in the Journal of Knowledge Management in 2020, where I am the sole author. The topic is "Knowledge-oriented leadership, knowledge management behavior, and innovation performance in project-based SMEs. The moderating role of goal orientations". This study aims to examine the association of knowledge-oriented leadership (KOL), knowledge management (KM) behavior, and innovation performance in project-based small and medium-sized enterprises. It investigates the moderation of goal-orientation in the relationship of KOL with knowledge-acquisition, transfer, documentation, and application. Data are collected from 215 employees in 32 small project-based software firms in Pakistan. The partial least squares are used to test the hypotheses. I find that KOL is positively relatedwith KM behavior and innovation performance. KM mediates the relationship between KOL and innovation performance. Furthermore, goal orientations play a moderating role in the relationship of KOL with knowledge acquisition, transfer, and application activities. This study extends the literature on knowledge-based dynamic capabilities by examining the relationship of KOL, KM behavior, and project-based innovation performance. Investigating the moderation of goal orientation in the relationship of KOL with KM behavior is also an original contribution.

The next article published in 2020 in Technological Forecasting and Social Change. The topic is "Big data analytics capability and decision making performance in emerging market firms: The role of contractual and relational

governance mechanisms". This study examines the role of contractual and relational big data governance in the big data decision-making performance of Chinese-based firms. It investigates the mediation of big data analytics (BDA) capabilities in the association of contractual and relational governance with decision-making performance. Furthermore, the moderating role of data-driven culture in the relationship of BDA capability and decision-making performance is examined. Data are collected from 108 Chinese companies engaged in big data-related activities. Structural equation modeling is employed to test the hypotheses. This study contributes to the literature on big data management and governance mechanisms by establishing the relationship of decision-making performance with big data contractual and relational governance directly and through the mediation of BDA capabilities. It also contributes towards knowledge-based dynamic capabilities (KBDCs) view of firms, arguing that dynamic capabilities such as BDA capabilities can be influenced through knowledge sources and activities.

In the first quarter of 2021, an article publishes in Computers in Human Behavior titled 'Big data management capabilities in the hospitality sector: Service innovation and customer-generated online quality ratings". In this paper, instead of treating big data management as a whole, we access big data management capabilities at the strategic and operational level. Using a sample of 202 hotels in Pakistan, we collected the primary data for big data capabilities, knowledge creation, and service innovation; the secondary data on quality rating were collected from Booking.com. Structural equation modelling through SmartPLS was used for data analysis. The results indicated that the ability to manage big data leads to high online quality ratings through the mediation of knowledge creation and service innovation. We contribute to the current literature by empirically testing how strategic-level big data capabilities enable the firm to add value in innovativeness and positive online quality ratings through acquiring, contextualizing, experimenting, and applying big data.

The fourth publication appears in Technological Forecasting and Social Change in the same year under the title "Big data analytics capability and decision-making: The role of data-driven insight on circular economy performance" in collaboration with other authors. In this study, we empirically investigated the association of BDA capability with CE performance and examined the mediating role of data-driven insights in the relationship between BDA capability and decision making. Data were collected from 109 Czech manufacturing firms, and partial least squares structural equation modeling was applied to analyze the data. The results reveal that the BDA capability and BI&A are positively relatedwith the quality of decision-making. The results demonstrate that the ability to make better decisions drives the quality of the decision making in organizations, and data-driven insights do not mediate this relationship. BI&A is relatedwith the quality of decision-making through data-driven insights.

A recent paper from my PhD thesis has been published in Review of Managerial Science in 2022 titled as Interorganizational social capital of Firms in Developing Economies and industry 4.0 readiness: the role of innovative capability and absorptive capacity. This study aims to investigate how social capital (that is, structural, relational, and cognitive social capital) between firms in a developing economy and a developed economy strengthens their innovation capacity and enhances their industry 4.0 readiness. Using Smart PLS-SEM to analyze the data collected from 320 managers representing 81 manufacturing firms in Pakistan, we found that social capital is positively related with the readiness for industry 4.0 and that innovative capability mediates this relationship. The study contributes to the existing knowledge of understanding industry 4.0 readiness and provides useful insights for firms in developing economies to improve their innovation capability during the industry 4.0 era. This study likewise reveals the significance of three dimensions of social capital, which can facilitate the introduction of digital knowledge from developed economies to developed economies to prepare for the fourth industrial revolution.

Current work:

I have submitted a qualitative paper on digital transformation in Industrial Marketing Management special issue. It is titled as "Avoiding crisis-driven business failure through digital dynamic capabilities. A case of B2B distribution firms"

One paper has been submitted as a last minor revision and will be published in Knowledge Management Research and Practice. This article draws insights from two studies; Study 1 proposes the mechanisms of measuring knowledge sharing quantitatively to include it in employee performance appraisal by developing a software application following the mechanism of cyber ba. Study 2 two consists of a longitudinal survey covering five phases of data collection, which is then supplemented with a final round of semi-structured interviews for post hoc analysis. The study chooses sales employees from multinational companies that deal in fast-moving consumer goods that operate in Pakistan. The findings indicate a significant impact of objectively including knowledge sharing in employee performance appraisal through the proposed cyber-ba system.

There are also other articles that are under review in Journal of Managerial Psychology, Journal of Business Research, and Journal of World Business

Academic/ Professional Qualifications

2019 to present PhD candidate
      Tomas Bata University in Zlin, Czech Republic
2021-2022   PhD visiting student (Erasmus+ Traineeship)
      Universidad De Castilla La Mancha
      Plaza de la Universidad, Nº 2, 02006 Albacete, Spain
2013-2015   Master of Philosophy in Business Administration

The Superior College, Lahore, Pakistan

2006-2008   MBA. Finance

University of Central Punjab, Lahore, Pakistan

Career Details (Academic experience)

Project worker: Tomas Bata University in Zlin, Czech Republic

(Feb 2022 to Aug 2022)

Key responsibilities

- Innovative research work
- Publishing in top-tier journals
- Coordinating supervisor in various research activities

Career Details (Industrial experience)

Senior Area Sales Manager:

Dalda Foods Ltd, Pakistan

(May 2005 to Aug 2019)

Key responsibilities

- Launching new products
- Geographic expansion
- Numeric coverage and weighted coverage of business
- Feasibility of business partners
- Handling sales team
- Ensuring assigned target achievement
- Coaching & training of sales team
- Effective route management & call planning

Area Sales Manager:

Haleeb Foods Ltd, Pakistan

(Feb 2002 to May 2005)

Key responsibilities

- Numeric coverage and weighted coverage of business
- Ensuring feasibility of business partners
- Handling sales team
- Ensuring assigned target achievement
- Launching new products

Zonal Incharge:

Haleeb Foods Ltd, Pakistan

Key responsibilities

- Financial Management of milk collection set up with respect to quantity, quality, and cost.
- Managing various projects and preparation of reports

- Develop innovative and cost-effective solutions for enhancing competitiveness, increasing revenues, and improving department services
- Manage staff, preparing work schedules and assigning specific duties.
- Coordinate, manage and monitor the financial workings of all sections.

Territory Sales Manager:

Engro Foods Ltd, Pakistan

Key responsibilities

- Promoting and launching new products
- Business development of new products
- Geographic expansion for products coverage
- Numeric coverage and weighted coverage of business

Professional and project activities at FaME, TBU in Zlin

1. Team leader - IGA Internal Grant Agency; Project -IGA/FaME/2021/006: "I4.0 – development of big data driven business concepts oriented on lean management transfer (governance role and SMEs implementations model)"- Guarantor: Prof. Ing. Felicita Chromjaková, Ph.D.
   [2021 – 2023]
   • Managing funds
   • Leading and monitoring research performance of the team
   • Various items procurement as per need
   • Research travel plans
   • Disseminating research results to the specialized and wider audience
2. Member of Internal Grant Agency; Project -IGA/FaME/2022/005 "I4.0 and Circular Economy Adoption for Manufacturing and Logistics Processes."
3. Member of Internal Grant Agency; Project -IGA/FaME/2022/008 "Implementation of big data solutions for transformation of traditional firm into digitalized one."

Awards and Recognition

(2019-2022) Awarded extra ordinary scholarships from the rector of Tomas Bata University, on the basis of excellent research performance throughout the PhD.

1. Extraordinary Scholarship
   Tomas Bata University in Zlin [29/04/2022]
   The student has published an article in Review of Managerial Science
2. Extraordinary Scholarship
   Tomas Bata University in Zlin [05/11/2021]
   The student has actively worked to meet the goal of the IGA project
3. Extraordinary Scholarship

Tomas Bata University in Zlin [27/10/2021]
The student elaborated a detailed proposal of the article and granted for cases deserving special consideration

4. Extraordinary Scholarship
Tomas Bata University in Zlin [29/06/2021]
The student has published an article in Technological Forecasting and Social Change

5. Extraordinary Scholarship
Tomas Bata University in Zlin [01/04/2021]
The student has published an article in Computers in Human Behaviour

6. Extraordinary Scholarship
Tomas Bata University in Zlin [01/10/2020]
The student has published an article in the Technological Forecasting and Social Change

7. Extraordinary Scholarship
Tomas Bata University in Zlin [01/10/2020]
The student has published an article in the Journal of Knowledge Management.

Ad-hoc Reviewer:

- European Academy of Management
- Knowledge Management Research & Practice
- Asia-Pacific Journal of Business Administration
- International journal of emerging market

APPEDICIES

Annexure 1 Brief description of selected articles (Source: author's own)

No	Authors	Study theme and purpose	Journal
1	Abdullah et al. (2017)	The study investigates that how corporate social responsibility enhances the performance of employees, and what other relevant variables strengthen this relationship	Sustainability
2	Agostini & Filippini (2019)	The paper examines the role of managerial and organizational practices to adopt I4.0 technologies	European Journal of Innovation

3	Alnoor et al. (2020)	The research focuses to explore the factors that are vital to affect ability of employees to embrace new technology. The term general self-efficacy is investigated	Global Business and Organizational Excellence
4	Andrews (2010)	This article explores the effects of structure and organizational SC on organizational performance	Human Relations
5	Ansari et al. (2012)	This paper discussed the role of SC in developing capabilities. The research offers a framework to understand the social impact of business-driven ventures	Journal of Management Studies
6	Azanza et al. (2013)	The study presents to validate the questionnaire relevant to the Authentic Leadership Questionnaire (ALQ). The questionnaire intends to determine the authentic leadership components like relational transparency, self-awareness, internalized moral perspective, and balanced processing	Journal of Work and Organizational Psychology
7	Bandura (1977)	The study offers theoretical framework to describe and to foresee psychological alterations, and states that psychological procedures alter the intensity and strength the self-efficacy.	Psychological Review
8	Bandura (2012)	In this study, the functional properties of perceived self-efficacy are explored	Journal of Management
9	Barney (1991)	The study examines the relationship between resources of firm and sustained competitive advantage. The study discusses four empirical indicators of firms to generate	Journal of Management

		sustained competitive advantage- substitutability, value, imitability, and rareness, imitability	
10	Bartol et al. (2001)	This article investigates the effect of rating segmentation based on employee's motivation and fairness perceptions	Journal of Applied Psychology
11	Basl & Doucek (2019)	This article examines the existing readiness indicators and development models utilized for trends defined as "4.0", with an emphasis on I4.0, mainly inside the countries of Europe	Information
12	Basl (2018)	The article examines the existing readiness models and indexes of I4.0. The main purpose is to determine at what extent each model is capable to show the level of any firm towards I4.0 readiness by following its information system	International Conference on Research and Practical Issues of Enterprise Information Systems
13	Bizzi (2015)	The study discussed about the imporatnce of SC within the setup of differenet organizations	International Encyclopedia of the Social & Behavioral Sciences
14	Barton (1995)	The paper investigates the process to build and sustain innovative sources	Harward Business School
15	Bohn (2010)	This research deals with organizational efficacy and develop an instrument to assess it. The paper has two parts of the studies. In first study, divergent and convergent validity is tested of organization efficacy scale, and in the second study instrument validity is statistically tested.	Human Resource Development Quarterly

16	Bozeman et al. (2001)	This study examines the moderating relationship of perceived control on the relationships between organizational commitment, intention to turnover, job satisfaction, job stress and organizational commitment	Journal of Applied Social Psychology
17	Cabrera & Cabrera (2005)	This paper aims to focus and identify the people management practices that facilitate knowledge sharing. Knowledge sharing is one of the key structures that fosters knowledge transfer from one point to other point	International Journal of Human Resource Management
18	Cegarra-Navarro et al. (2021)	The study highlights the knowledge structures adopted by individuals to hide and mis use of available knowledge	Journal of Business Research
19	J. Chen et al. (2020)	The study examines the mediating effect of self-efficacy, social support, and burnout in the relationship between anxiety, depression, and job stress	Journal of Advanced Nursing
20	Chen et al. (2014)	The article focuses on the development status of IoTs that includes application, standardization, policies, and R&D plans. The paper highlights challenges of technologies, applications, and standardizations, and also presents three various platforms of IoT structure. Finally, the prospect and opportunity of IoTs are also discussed	IEEE Internet of Things
21	Chow & Chan (2008)	The aim of the study is to develop an understanding of SC to support the knowledge sharing in any organization	Information & management

22	Cockburn et al. (2000)	This paper begins argues on the origins of competitive considering it as a performance enhancing practice of organizations	Strategic Management Journal
23	C. J. Collins & Clark (2003)	This article argues about the relationship between human resource practices and firm performance. It examines the relationship between human resource practices, internal and external social networks, and firm performance	Academy of Management Journal,
24	C. R. Collins et al. (2014)	The study discusses the factors involved in collective efficacy of neighbourhood residents	American Journal of Community Psychology
25	Davenport & Daellenbach (2011)	This study examines the role of SC to contribute the member identification process in virtual organizations where the distributed membership may prevent face-to-face communications.	British Journal of Management
26	de Assis Dornelles et al. (2022)	This research examines the importance of I4.0 technology to enhance capabilities of worker and manufacturing activities. The study aims to build a conceptual framework on this growing issue by integrating deep learning from existing literature	Computers & Industrial Engineering
27	De Carolis & Saparito (2006)	The article discusses the interaction of personal factors and SC to influence entrepreneur behaviour	Entrepreneurship Theory and Practice
28	Donate & Sánchez de Pablo (2015)	This study aims to define the role of a specific type of leadership- knowledge oriented leadership that promotes knowledge management behaviour to attain innovation	Journal of Business Research

29	Drath & Horch (2014)	This research column intends to provide the core ideas behind the concept of I4.0 and discusses the basic requirements for industries to become successful in implementing this strategy	IEEE Industrial Electronics Magazine
30	Eastin & LaRose (2000)	The study the relationship of internet use to the Internet self-efficacy judgments. The findings explore the negative relationship of Internet stress and self-disparagement to Internet self-efficacy.	Journal of Computer-Mediated Communication
31	Ersoy et al. (2022)	This vein of research investigates the knowledge sharing practice among the stakeholders of real-life industry in the meat sector. The study discusses the type of knowledge sharing and all the differences of knowledge sharing among specific groups of stakeholders of meat industry	Business Strategy and the Environment
32	Erum et al. (2020)	The study investigates the mediation role of self-efficacy by empirically validating the family motivation and civility that is considered as antecedents of affective commitment and organizational citizenship	European Journal of Investigation in Health, Psychology and Educatio
33	Ersoy et al. (2022)	This study investigates the knowledge sharing networks challenges, barriers and benefits in the food supply chain industry that can improve the circular strategies of the firms like recover, recycle, repurpose, remanufacture, refurbish, reuse, rethink, and reduce	Business Strategy and the Environment

34	Feltz & Lirgg (1998)	This study examines the team efficacy, and the relationship among tram performance, team efficacy, and player efficacy	Journal of Applied Psychology
35	Fornell & Larcker (1981)	The study developed and applied a testing system that is based on measures of shared variance within the measurement model, structural model, and overall model	Journal of Marketing Research
36	Ganguly et al. (2019)	This stream of research aims to focus on the role of tacit knowledge sharing to foster innovative capability. Specifically, all the three dimensions of SC (relational, cognitive and structural) are considered as important precursors of tacit knowledge sharing.	Journal of Knowledge Management
37	Ghobakhloo (2020)	This study identifies the sustainability functions of I4.0	Journal of Cleaner Production
38	Gooderham (2007)	The paper introduces the conceptual model regarding knowledge sharing by embracing various aspects of SC. It also discusses the influence of modifiable practices and external environment	Knowledge Management Research & Practice
39	Grabowska (2020)	The study aims to contribute in the literature of i4.0 development	Management Systems in Production Engineering
40	Grillitsch & Nilsson (2022)	This paper investigates the role of gradual and initial trust in the development of regions by introducing a view to shed light on how, why, and when trust affects the dynamics involved in regional development, either in a positive way or negative way	Industry and Innovation

41	Haddara & Elragal (2015)	This research intends to respond to the question about the readiness of today's ERP systems for (FoF) Factory of Future	Procedia Computer Science
42	Han & Li (2015)	This paper uses the knowledge based dynamic perspective and discusses the relationship between intellectual capital and innovative performance	Management Decision
43	Inkpen & Tsang (2005)	The paper examines the role of SC dimensions to affect the knowledge transfer among three network types: strategic alliances, intra-corporate networks, and industrial districts	Academy of management review
44	Johnson et al. (2013)	The article presents the findings by reviewing the literature on human capital, board demographics, and SC composition research.	Journal of Management
45	Judge et al. (2007)	The paper presents the empirical review on the state and trait goal orientation. This paper examines three dimensions of goal orientations: avoid performance, learning, and prove performance along with supposed precursors significances of these dimensions	Journal of Applied Psychology
46	Júnior et al. (2019)	This study identifies the role of knowledge-based dynamic capabilities (KBDCs) to influence the course of evolving sustainable innovations.	Sustainability
47	Khan et al. (2019)	This paper examines the mediating effect of learning to transform the potential absorptive capacity into	International Business Review

		realized absorptive capacity and its influence on exploratory and exploitative innovation	
48	J. Kim et al. (2020)	This study highlights the adoption behaviour of e-books from the viewpoint of user confrontation by developing a theoretical framework	Journal of Enterprise Information Management
49	T. T. Kim et al. (2013)	This study investigates to explore the role of knowledge-sharing enablers (three dimensions of SC, including relational, structural, and cognitive SC) on the processes of knowledge-sharing behaviours: collecting knowledge collecting and donating knowledge, for a better organizational performance	International Journal of Contemporary Hospitality Management
50	Koçak et al. (2013)	This study intends to examine the SC and self-efficacy of women entrepreneurs to affect their opportunity recognition.	International Journal of Entrepreneurship and Small Business
51	H. J. Lee et al. (2020)	This article explores the significant matter of public service innovation (creative behaviour and perceived organizational innovativeness) and analyses a theoretical model regarding the roles of Confucian culture (group-oriented and hierarchical values), SC (trust and reciprocity), and public service motivation (policymaking-oriented and societally driven)	International Public Management Journal
52	I. Lee & Lee (2015)	This paper discusses five IoT technologies that are crucial in successful IoT-based products and services deployment and	Business Horizons

		debates three categories of IoT for the use of enterprise applications to improve customer value	
53	R. Lee & Jones (2008)	This relative research studies the features of budding entrepreneurs' cognitive SC that is created via electronic and face-to-face communication.	International Small Business Journal
54	Lefebvre et al. (2016)	This paper investigates the relationship between SC of network members and learning network performance that enables to improve knowledge sharing factor among various network members	International Journal of Information Management
55	Liu et al. (2019)	This paper purposes a new integrated network model by combining the network ties concept (eg business ties and political ties), the association of interior critical attributes (like human capital, SC, and innovation capability). It also analyses that how those serious attributes effect competitive advantage and organization performance	Management Decision
56	Lu (2017)	This research discusses two variables namely as mass per unit are characteristics and flow rate per uni	Journal of Industrial Information Integration.
57	Liu et al. (2019)	The purpose of this paper is to propose a new integrated model that combines the concepts of network ties (eg political ties and business ties), the organization of internal critical attributes (such as SC, human capital and innovation capability) and analyses of how those critical attributes	Management Decision

		influence organization performance and competitive advantage	
58	Lunenburg (2011)	This article examines the self-efficacy in the workplace and also explores its implications for performance and motivation	International journal of management, business
59	Maisiri & van Dyk (2019)	This paper explores the I4.0 readiness level of the firms of South African industry	South African Journal of Industrial Engineering
60	Malik & Kotabe (2009)	This study has developed a model a dynamic capability development model in the firms of merging markets. The research also recognises three dynamic capability development mechanisms: reverse engineering, organizational learning, and manufacturing flexibility.	Journal of Management Studies
61	March (1991)	This paper focuses on the relationship between the examination of new possibilities and the manipulation of old certainties in organizational learning. The research examines some difficulties in assigning resources between the two, mainly those presented by the circulation of costs and benefits across time and space, and the effects of ecological interface.	Organizational Science
62	Maurer et al. (2011)	The study suggests the organizational performance upshots of the SC of organization members that hinge on the mediating developments of assimilation, resource mobilization, and use	Organizational Studies
63	McDonnell (2020)	This research article discusses political efficacy and explores	Local Government Studies

		the effect of the size of municipality population on two important features of democratic culture: political participation, and political efficacy	
64	Nahapiet & Ghoshal (1998)	This paper discusses and examines the different dimensions of SC such as structural SC, relational SC, and cognitive SC. It also argues about the relationship of SC dimensions and necessary processes to create intellectual capital	Academy of management review
65	Nizam et al. (2020)	This study uses the time series data from Pakistan between 1975 to 2017 and examines the long-run relationship between ICTs, carbon emissions, and energy demand	Environmental Science and Pollution Research
66	Ozanne et al. (2022)	This study uses middle-range theorizing to propose dynamic capabilities (DC) as the key sources of sensing, seizing and reconfiguration that can transform SC into organizational resilience	Industrial Marketing Management
67	Pacchini et al. (2019)	This vein of research proposes a model to measure and examine the i4.0 readiness level of manufacturing firms	Computers in Industry,
68	Parayitam et al. (2022)	This study empirically examines the connection between knowledge sharing of individuals, emotional exhaustion and organizational outcomes	International Journal of Knowledge Management
69	Parellada et al. (2011)	This study presents an overview about the future of the service industries	The Service Industries Journal
70	Peterson (2020)	This article has discussed the self-efficacy in personal selling	Journal of Personal Selling & Sales Management

		research. It examines the ways to conceptualize, investigate and measure the self-efficacy	
71	Puspita et al. (2020)	This paper aims to examine the effect of capabilities (Innovation Capability and Supply Chain Capability) and resources (Strategic Orientation) to build competitive advantages that meet the characteristics of VRIN (Valuable, Rare, Inimitable, Non-substitution	International Journal of Scientific & Technology Research
72	(Quint et al., 2015)	This paper suggests a system architecture for a learning that is based on mixed-reality by combining physical objects and virtual objects through Augmented Reality.	Procedia Computer Science
73	(Rajnai & Kocsis, 2018)	This study discusses the processes of assessing the readiness of firms regarding i4.0	IEEE 16th World Symposium
74	Razzaq et al. (2019)	This article examines the mediation effect of organizational commitment in the association between knowledge worker performance and knowledge management practices	Business Process Management Journal
75	Ridings et al. (2002)	This study examines the effects of trust in virtual communities. The results show that trust effects the intension of members to give and get information through the virtual communities	The Journal of Strategic Information Systems
76	Rönkkö & Evermann (2013)	This study is a critical examination and review about the use of Partial Least Squares Path Modelling	Organizational Research Methods
77	Rost (2011)	This research examines the effect of week network	Research policy

		planning in innovation creation process	
78	(Saks, 1995)	This study stream investigates the mediating and moderating effect of self-efficacy on the connection between newcomer adjustment and training	Journal of Applied Psychology
79	Salanova et al. (2020)	The article explores the discussion on individual level self-efficacy. The study analyses that how group self-efficacy and transformational leadership are two different group level constructs that projects individual level self-efficacy	Current Psychology
80	(Sánchez et al., 2015)	This article examines the mediating effect of strategic human resource practices on firm performance and knowledge management	Revista Europea de Dirección y Economía de La Empresa
81	Savage & Tokunaga (2017)	This study discussed about Internet self-efficacy. It This study employs general aggression theory to underwrite to a well theoretical understanding of the convergence of inputs that drives into decision-making connecting cyberbullying enactment	Computers in human Behavior
82	Shamim et al. (2017)	This study explores the role of managers to enhance the knowledge management at the individual level. It explains that the role of goal orientation of employees through supervisory orientations enhances knowledge management among employees. The study takes hotel industry as a context	International Journal of Hospitality Management

83	Shamim, Cang, et al. (2019)	This study extends the literature on knowledge oriented leadership (KOL) in hospitality sector and investigates its role in forecasting KM behaviour among individual level employees this sector. The study uses partial least square for SEM and examines the mediating effect of employee work attitudes including creative self-efficacy, effective commitment, and work engagement	The International Journal of Human Resource Management
84	(Shamim, Cang, Yu, et al., 2017)	This study aims to fill the research gap by exploring the management issues of i4.0 in the services sector. The study uses the cases from the hospitality industry	Energies
85	Shamim, Zeng, et al. (2019)	This vein of research investigates the relationship of big data management capabilities with the exploratory and exploitative activities of employees at the individual level. Additionally, the mediating role of big data value creation is also examined to the relationship of big data management capabilities with exploratory and exploitative activities.	International Business Review
86	Shamim et al. (2020)	This study investigates the role of big data contractual and relational governance to enhance big data decision-making performance of firms located in China. It examines the mediation of big data analytics (BDA) capability in the relationship of	Technological Forecasting and Social Change

		contractual and relational governance with decision-making performance. Moreover, this study also examines the moderating role of data-driven culture in the relationship of big data analytics capability and decision-making performance	
87	(Sheen & Yang, 2018)	This study suggests an assessment method to measure the readiness level of a company or country for the innovation that is required to establish a smart factory	IEEE Technology and Engineering Management Conference
88	Sheng & Hartmann (2019)	This article underlines the significance of knowing relationships between companies and multinational companies' headquarters to realize the relationship between companies' resources and MNCs' headquarters innovation capability	Journal of International Management
89	Singh et al. (2021)	This study investigates the ways the companies adopt to utilize strategic resources to enhance innovation performance. The context of the studies is multinational enterprises from the emerging markets	Journal of International Management
90	(Sony & Naik, 2019)	This study aims to highlight the key factors to assess i4.0 readiness for the firms, the interrelations that happen between these factors of readiness. The study also presents the future research avenues based on the research findings	Benchmarking: An International Journal.
91	Stentoft et al. (2020)	This study uses a mixed-method approach to examine	Production Planning & Control

		the drivers and challenges of I4.0 readiness and highlights the preparation among small and medium-sized manufacturers of Denmark	
92	(Stock & Seliger, 2016)	This study discusses the sustainable manufacturing opportunities in i4.0 era	Procedia Cirp
93	(Sulistyani & Suhariadi, 2022)	This article examines the mediating effect of self-Efficacy between the relationship of SC and Entrepreneurial Orientation	Sustaibability
94	Taylor (2007)	The study discussed about the ways used by the international human resource management (IHRM) system to influence the concept and application of SC in multinational companies. The study also explores challenges faced by IHRM due to the broad diversity of explanations and expressions of SC found in the global business environment	Human Resource Management Journal
95	Teece (2007)	This study magnets on the social and behavioural sciences in an effort to stipulate the nature and micro basics of the capabilities essential to endure greater enterprise performance in an open economy with quick innovation and globally detached sources of innovation, invention, and manufacturing capability	Strategic management journal
96	Teece et al. (1997)	This paper discusses the dynamic capabilities framework that analyses the methods and sources of wealth capture and creation by private enterprise firms working in	Strategic management journal

		rapid technological change environments	
97	Tsai & Ghoshal (1998)	This study examines the relationships of SC dimensions with every other dimension and discusses the patters of product innovation and source exchange with the firms	Academy of management Journal
98	(Uphoff & Wijayaratna, 2000)	The paper explains the benefits of SC	World Development
99	Vayre & Vonthron (2017)	The work explores the concept of self-efficacy. The aim of this study is to investigate a model developed for the engagement of online learners that incorporates social support and sense of community as direct and indirect factors. It uses academic self-efficacy as a mediating variable	Journal of Educational Computing Research
100	(Wang & Ho, 2017)	This study offers a unique approach to the concept of corporate social responsibility and to activities of corporate social responsibility by using SC as an enable of consumer citizenship behaviour	Sustainability
101	(Wasko & Faraj, 2005)	This vein of research work examines the SC and knowledge contribution in electronic networks of practice	MIS Quarterly
102	Zhang & Peterson (2011)	This scientific article explores the team-level factors supporting advice exchange networks in teams	Journal of Applied Psychology
103	Zheng et al. (2011)	The aim of the study is to explain the notion of dynamic capabilities from perspective of knowledge-based view and explores the structures of dynamic capabilities on	Journal of knowledge management

		innovation performance in networked environments	
104	Zia et al. (2022)	The main aim of this study is to examine the role of SC elements (ie, structural, relational, and cognitive SC) to enhance i4.0 readiness between developed economy firms and developing economy firms. This study uses innovation capability as a mediator variable and investigates its role to mediate the relationship between SC elements and i4.0 readiness. Moreover, absorptive capacity is also examined as a moderator between SC elements and innovation capability	Review of Managerial Science

Annexure 2 Descriptive Statistics (Source: author's own)

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
ssc1	320	1	7	4.22	2.155	-.098	.136	-1.435	.272
ssc2	320	1	7	4.19	2.129	-.167	.136	-1.388	.272
ssc3	320	1	7	4.17	2.108	-.212	.136	-1.363	.272
rsc1	320	1	7	3.95	1.910	-.185	.136	-1.341	.272
rsc2	320	1	7	4.04	1.824	-.181	.136	-1.271	.272
rsc3	320	1	7	4.21	1.871	-.146	.136	-1.228	.272
rsc4	320	1	7	4.23	1.866	-.108	.136	-1.270	.272
csc1	320	1	7	4.13	2.036	-.123	.136	-1.381	.272
csc2	320	1	7	4.20	2.261	-.142	.136	-1.542	.272
csc3	320	1	7	4.20	2.303	-.105	.136	-1.564	.272
i4r1	320	1	7	4.03	2.195	-.224	.136	-1.520	.272
i4r2	320	1	7	3.84	2.249	-.163	.136	-1.611	.272
i4r3	320	1	7	3.83	2.163	-.133	.136	-1.496	.272
i4r4	320	1	7	3.66	2.068	-.098	.136	-1.476	.272
i4r5	320	1	7	3.68	2.022	-.148	.136	-1.429	.272

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Std. Error	Kurtosis	Std. Error
i4r6	320	1	7	3.74	1.988	-.094	.136	-1.303	.272
i4r7	320	1	7	3.83	1.826	-.061	.136	-1.121	.272
i4r8	320	1	7	3.77	1.761	-.015	.136	-1.216	.272
i4r9	320	1	7	3.81	1.693	-.027	.136	-1.362	.272
i4r10	320	1	7	3.87	1.837	.027	.136	-1.540	.272
i4r11	320	1	7	4.04	1.880	-.004	.136	-1.549	.272
i4r12	320	1	7	4.20	1.807	-.021	.136	-1.490	.272
I4e1	320	1	7	4.36	1.926	.060	.136	-1.526	.272
I4e2	320	1	7	4.14	1.961	.156	.136	-1.405	.272
I4e3	320	1	7	4.10	1.943	.062	.136	-1.365	.272
I4e4	320	1	7	4.07	1.875	.007	.136	-1.331	.272
kbdc1	320	1	7	4.48	2.098	-.432	.136	-1.279	.272
kbdc2	320	1	7	4.34	2.203	-.269	.136	-1.478	.272
kbdc3	320	1	7	4.20	2.341	-.145	.136	-1.646	.272
kbdc4	320	1	7	3.93	2.073	-.035	.136	-1.407	.272
Inovca1	320	1	7	3.98	1.998	-.100	.136	-1.415	.272
Inovca2	320	1	7	4.14	2.024	-.120	.136	-1.426	.272
Inovca3	320	1	7	4.27	2.105	-.141	.136	-1.452	.272
Inovca4	320	1	7	4.09	2.064	.031	.136	-1.432	.272
Valid N (listwise)	320								

Annexure 3 Harman's single factor test (Source: author's own)

Compone nt	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.026	38.312	38.312	12.453	36.627	36.627
2	3.271	9.620	47.932			
3	2.345	6.897	54.829			
4	1.926	5.666	60.494			
5	1.296	3.813	64.308			
6	1.109	3.261	67.569			
7	1.049	3.086	70.655			
8	.840	2.471	73.127			
9	.763	2.244	75.371			
10	.737	2.167	77.538			
11	.620	1.822	79.361			
12	.583	1.716	81.076			
13	.542	1.594	82.670			
14	.489	1.437	84.107			
15	.469	1.379	85.486			
16	.434	1.275	86.762			
17	.425	1.251	88.012			
18	.398	1.171	89.184			
19	.367	1.081	90.264			
20	.344	1.011	91.275			
21	.337	.992	92.267			
22	.311	.915	93.182			
23	.281	.826	94.008			
24	.265	.778	94.786			
25	.261	.768	95.554			
26	.240	.706	96.260			
27	.221	.649	96.909			
28	.194	.570	97.479			
29	.182	.535	98.014			
30	.165	.484	98.498			
31	.154	.454	98.952			
32	.148	.434	99.386			
33	.117	.343	99.730			
34	.092	.270	100.000			

Extraction Method: Principal Component Analysis.

Communalities (Source: author's own)

	Initial	Extraction
ssc1	.638	.360
ssc2	.608	.334
ssc3	.581	.315
rsc1	.640	.371
rsc2	.664	.376
rsc3	.571	.374
rsc4	.585	.371
csc1	.567	.361
csc2	.665	.451
csc3	.587	.401
i4r1	.722	.412
i4r2	.773	.389
i4r3	.789	.313
i4r4	.781	.372
i4r5	.790	.472
i4r6	.772	.574
i4r7	.734	.550
i4r8	.764	.616
i4r9	.779	.641
i4r10	.827	.651
i4r11	.777	.656
i4r12	.658	.487
I4e1	.664	.339
I4e2	.620	.267
I4e3	.653	.331
I4e4	.670	.358

kbdc1	.440	.121
kbdc2	.519	.114
kbdc3	.547	.222
kbdc4	.442	.133
Inovca1	.435	.114
Inovca2	.558	.198
Inovca3	.502	.231
Inovca4	.488	.181

Factor Matrix (Source: author's own)

Items	Factor 1
ssc1	.600
ssc2	.578
ssc3	.561
rsc1	.609
rsc2	.614
rsc3	.611
rsc4	.609
csc1	.601
csc2	.671
csc3	.633
i4r1	.642
i4r2	.623
i4r3	.560
i4r4	.610
i4r5	.687
i4r6	.757

i4r7	.742
i4r8	.785
i4r9	.800
i4r10	.807
i4r11	.810
i4r12	.698
I4e1	.583
I4e2	.517
I4e3	.575
I4e4	.598
kbdc1	.348
kbdc2	.338
kbdc3	.471
kbdc4	.364
Inovca1	.337
Inovca2	.444
Inovca3	.481
Inovca4	.425

Annexure 4 Questionnaire items

Please select the right option (1, 2, 3, 4, 5, 6, or 7) 1=Strongly disagree, 2=Disagree, 3=Slightly disagree, 4=Moderate, 5=Slightly agree, 6=Agree, 7=Strongly agree

Questions	Your answer						
Structural Social Capital (Chow & Chan, 2008; Nahapiet & Ghoshal, 1998)							
In general, we have a very good relationship with other departments	1	2	3	4	5	6	7
Our relationship departments know what knowledge we have at our disposal	1	2	3	4	5	6	7
We know what knowledge could be relevant to which department	1	2	3	4	5	6	7
Relational Social Capital (Chow & Chan, 2008; Nahapiet & Ghoshal, 1998)							
We feel connected to our business partners	1	2	3	4	5	6	7
We know our business partners will always try and help us out if we get into difficulties	1	2	3	4	5	6	7
We can trust our business partners to lend us a hand if we need it	1	2	3	4	5	6	7
We can rely on our business partners when we need support in our work	1	2	3	4	5	6	7
Cognitive Social Capital (Chow & Chan, 2008)							
Our business partners and we always agree on what is important at work	1	2	3	4	5	6	7
Our business partners and we always share the same ambitions and vision at work	1	2	3	4	5	6	7
Our business partners and we are always enthusiastic about pursing the collective goals and missions of the whole organization	1	2	3	4	5	6	7
Innovative capability (Sheng & Hartmann, 2019)							
We frequently refine existing products and services	1	2	3	4	5	6	7
We regularly implement small adaptations to existing products and service	1	2	3	4	5	6	7

We accept demands that go beyond existing products and services	1	2	3	4	5	6	7
We experiment with new products and services in our local market	1	2	3	4	5	6	7
Knowledge Based Dynamic Capabilities (Zheng et al., 2011)							
Our firm could acquire manufacturing and process knowledge	1	2	3	4	5	6	7
Our firm could create technological knowledge capability	1	2	3	4	5	6	7
Our firm could combine internal and external knowledge	1	2	3	4	5	6	7
Our firm could combine knowledge in different technological or market fields	1	2	3	4	5	6	7
Industry 4.0 efficacy (Bohn, 2010)							
We believe that our employees could have handled a more challenging job than the one they will be doing	1	2	3	4	5	6	7
We have confidence in our abilities to complete difficult projects	1	2	3	4	5	6	7
We feel that we are good to work together to accomplish a specified goal	1	2	3	4	5	6	7
We believe that our employees are more innovative than the employees of other competitors of the same industry	1	2	3	4	5	6	7
Our firm could acquire other knowledge and expertise	1	2	3	4	5	6	7
Industry 4.0 readiness (IBM)							
I use IoT sensors and AI to enable a proactive approach that supports my team and our machines in real-time	1	2	3	4	5	6	7
I'm collecting a lot of machine equipment data, but I'm not sure how to use it for more than routine operation logistics	1	2	3	4	5	6	7
Most of our data comes from routine manual data collections	1	2	3	4	5	6	7
Custom quality assurance models use real-time data feeds to track how critical variables (e.g., temperature, sound, pressure, etc.) impact product quality and process flow	1	2	3	4	5	6	7
We use generalized benchmarks, and workers on the floor are relied upon to identify and report any major issues	1	2	3	4	5	6	7
We don't usually recognize a quality risk until it has been identified down the assembly line	1	2	3	4	5	6	7

Feedback flows easily within our organization for constant communication – data is also shared with our suppliers, customers and partners	1	2	3	4	5	6	7
We are working to connect different communication feeds internally and externally, but it's proving to be a challenge	1	2	3	4	5	6	7
Our communication isn't integrated, so information gets stuck in silos	1	2	3	4	5	6	7
Our organization is developing a 4.0 technical framework, and we're exploring the role our partners will need to play	1	2	3	4	5	6	7
My team is just beginning to build a case for I4.0 to put in front of senior leadership	1	2	3	4	5	6	7
I have a basic understanding of what I4.0 could do for my organization, but I need to learn more	1	2	3	4	5	6	7

Annexure 4 Approval to use IBM questionnaire items

Najam Ul Zia

Social capital and industry 4.0 readiness: Role of innovative capability, industry 4.0 efficacy, and knowledge based dynamic capabilities

Sociální kapitál a připravenost průmyslu 4.0: úloha inovativních schopností, účinnost průmyslu 4.0 a dynamické schopnosti založené na znalostech