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What Does Not Kill You Makes You Stronger: Supply Chain Resilience and Corporate Sustainability Through Emerging IT Capability

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Abstract: Global epidemics and international conflicts disrupt supply chain (SC) operations. Many enterprises employ emerging information technology (IT) to reduce SC vulnerability and enhance SC resilience. Technologies like artificial intelligence and blockchain facilitate more robust SC operations such as remanufacturing, just-in-time production, and automated workflow, leading to corporate sustainability along economic, environmental, and social dimensions. From a dynamic capability perspective, this study conceptualizes emerging IT capability and investigates its role in helping enterprises survive SC disruptions and prosper in the long run. A research model depicts the relationships among environmental uncertainty, SC vulnerability vigilance, emerging IT capability, SC resilience, and corporate sustainability. A partial least square (PLS) analysis on survey observations collected from more than two hundred enterprises in China that are highly susceptible to SC disruptions provides supporting evidence to most research hypotheses. The results show that high vigilance to potential SC disruptions will motivate enterprises to develop emerging IT capability, which will enhance SC resilience as well as economic, environmental, and social performances. The mediating role of emerging IT capability suggests a viable path for enterprises to adapt to the increasingly turbulent environment and improve SC resilience and corporate sustainability.

Keywords: Environmental Uncertainty, SC Vulnerability Vigilance, Emerging IT Capability, SC Resilience, Corporate Sustainability.

1. Introduction

Global epidemics and international conflicts disrupt supply chain (SC) operations, leading to business failures around the world [1, 2]. Most enterprises are not ready to deal with looming threats due to SC vulnerability and inadequate preparedness [3]. In the pre-COVID era, organizations used to handle “routine” aspects of SC vulnerability, such as operational interruptions [4]. At present, however, cross-border logistics undergo frequent interruptions, halting corporate production and shipment activities. Black swan events pose unprecedented challenges to many enterprises to identify, monitor, and control all kinds of contingency factors [5]. In addition to short-term survival, they must make strategic adaptation to the increasingly volatile, uncertain, complex, and ambiguous (VUCA) environment for sustainable development.

To avoid operational disruptions, enterprises must strengthen SC resilience by addressing different aspects of vulnerability beyond the traditional cost-efficiency focus [6, 7]. For the survival goal, an organization needs to get vigilant to contingency factors and mitigate them immediately. For the developmental goal, it has to implement organizational innovation for the adaptation to the increasingly turbulent environment. Disastrous events are largely unpredictable, but their rippling effects can still be assessed with various signs, albeit easily overlooked. Organizations vigilant to such clues are able to make necessary adjustments for a timely recovery. Moreover, they must carry out innovations to enhance SC resilience for corporate sustainability.

For organizational innovations, information technology (IT) presents an indispensable resource that enterprises acquire over time [8]. When the external environment is relatively stable and predictable, traditional IT plays an optimizing role in SC operations for cost saving and efficiency improvement [9]. As turbulences become norms, emerging IT exhibits great potential for stabilizing business operations [10, 11], empowering enterprises to meet the challenges posed by SC disruptions. For SC partners to improve disaster responsiveness, for instance, blockchain helps them integrate organizational resources across boundaries and collaborate seamlessly with each other [12, 13]. For another example, big-data analytics enables enterprises to develop and refine forecasting and decision-making models that optimize resource allocation and utilization in a timely and dynamic manner [14].

Concerned about environmental turbulences and SC disruptions, therefore, many organizations seek technological solutions. Extant studies on the use of emerging IT to mitigate SC vulnerability focus on certain technologies for particular purposes, such as additive manufacturing that increases SC flexibility [15]. In dealing with unprecedented challenges, however, enterprises must resort to all measures pertinent, demanding the dynamic capabilities of corporate cognition, resource integration, and organizational innovation [16]. An organization of higher vulnerability vigilance is motivated to develop the capability to employ emerging IT in the pursuit of SC resilience. This emerging IT capability, however, has yet to be understood in terms of its role in helping enterprises deal with SC disruptions. It is necessary to develop construct definitions and measurements, hypothesize nomological relationships, and test them with empirical observations.

The findings may contribute to the literature by bridging the research gap concerning organizational innovation involving emerging IT. Despite the existing studies on how regular IT capability affects firm-level performances in a predictable environment [17, 18], there is an urgent need to explore the development of dynamic capability with regard to emerging IT as a strategic response to a turbulent environment causing SC disruptions. Accordingly, this study examines the roles that SC vulnerability vigilance and emerging IT capability play in short-term survival and long-term development.

The rest of this article is organized as follows. First, it gives a review of the literature on SC vulnerability vigilance, emerging IT, dynamic capability, and corporate sustainability. Then it describes the development of a research model surrounding capability building. The methodology section discusses questionnaire development, as well as data collection and analysis. After the presentation and discussion of results, theoretical and practical implications of the findings are elaborated, along with the conclusion and research limitations.

2. Research Background

2.1 SC Vulnerability and Vigilance

As an emerging measure of corporate sensitivity to external and internal disturbances, SC vulnerability refers to the strategic propensity that risk sources and drivers pose threats to SC continuity and stability beyond quick remedy [19]. In a highly uncertain environment, enterprises experience an overwhelming chance of seeing SC vulnerability turning into acute SC disruptions [20, 21]. Thus, SC vulnerability receives increasing attention from researchers from three aspects: influencing factors, vulnerability assessment, and mitigating measures [19].

Extant research indicates that influencing factors are related to the SC network, organizational partnership, and external environment. First of all, the overall level of SC vulnerability increases exponentially as the practice of outsourcing leads to more procurement links [22]. Complex SC networks are inevitably vulnerable to demand and supply fluctuations as the influence of external factors is amplified [22]. Next, SC vulnerability is also associated with the degree of dependence among participating organizations, especially when they are vertically integrated due to the rippling effects of adverse events from upstream to downstream [19]. Finally, catastrophic events in the external environment, such as the COVID outbreak, can be devastating to operational continuity [23]. As network complexity, partner interdependence, and environment uncertainty interact with each other, enterprises need to closely monitor the situations and intervene before they exacerbate SC vulnerability. However, there is still a lack of research on SC vulnerability vigilance, especially its relationships with SC resilience and corporate sustainability.

Based on the understanding of influencing factors, organizations may assess their relative criticality to SC vulnerability [19]. However, traditional assessment methods are unable to detect SC vulnerability due to poorly coordinated decisions that lead to endogenous disruptions [24]. To more accurately assess SC vulnerability, researchers recently proposed entropy-based vulnerability index [25], system dynamics modeling [24], and graph theory methods [5]. Focusing on SC structural characteristics, however, these methods are unable to capture corporate cognition related to SC vulnerability leading to dynamic capability building.

Based on vulnerability assessment, enterprises may develop and implement different strategies to mitigate SC vulnerability [5]. To increase logistics transparency and traceability, for example, many organizations adopt the inventory redundancy strategy [26]. In the increasingly turbulent environment, emerging IT is found particularly helpful for addressing SC vulnerability at each SC node by enhancing information visibility and responsiveness [27, 28]. It also facilitates knowledge acquisition and sharing among participating organizations, and the strengthened partnership is conducive to SC resilience from the perspective of knowledge management [22].

Extant studies on SC vulnerability are mostly based on the risk management paradigm assuming that managers can evaluate the probability and outcome of potential adverse events and formulate solutions based on prior experience and knowledge [29]. However, black swan events like COVID-19 are almost unpredictable, demanding enterprises to cultivate organizational vigilance concerning deeper alertness to environmental uncertainty in addition to conventional risk management. Based on the elimination of blind spots, such proactiveness helps organizations develop dynamic capabilities so that managers can respond quickly to disasters when they strike.

Rooted in the cognitive concept of vigilance in psychology, organizational vigilance describes an enterprise's awareness of potentially hazardous situations that require time and effort to deal with [30]. An organization’s awareness of risk factors contributing to potential SC disruptions, which can be called *SC vulnerability vigilance*, is the prerequisite for an enterprise to implement preventative measures. In the extant literature, such alertness is also referred to as safety-oriented corporate culture [31].

Several recent studies provide additional insights on organizational alertness pertinent to the VUCA environment. Enterprises with higher vigilance can detect potential risks of relatively weak and vague early warning signals [32]. Keeping an eye on SC resilience, organizations should proactively strengthen the line of defense to prevent things from getting out of control, rather than passively waiting for disasters to happen [33]. On the other hand, enterprises that do not cultivate the “vigilance” culture are forced to respond to SC disruptions with limited choices of actions, leading to compromised maneuverability [34]. Therefore, organizations must be sensitive to external risk factors and prepare for potential SC disruptions no matter how improbable they seem [35]. Despite these conceptual discussions, there is a lack of empirical investigation on the relationship between vulnerability vigilance and capability building. For construct operationalization, Appendix A lists the publications concerning the external risk factors to which organizations need to get alert from supply-, demand-, and environment-side aspects.

2.2 Emerging IT

The era of Industry 4.0 ushers in the ecological thinking for manufacturers to adapt business operations to the changing environment [36]. Such an adaptation takes the primary forms of technological innovation and organizational restructuring. As the main technical driver, emerging

IT such as big data analytics (BDA), artificial intelligence (AI), and internet of things (IoT) greatly facilitate production and marketing with better control and forecast [37, 38].

Emerging IT enhances SC operations from three main aspects: information processing, process visibility and agility, and inter-organization partnership. A supply chain can be viewed as an adaptive decision system reacting to environmental dynamics based on real-time data processing [39]. Cloud computing and BDA enable organizations to handle and share huge amounts of data for SC process control based on supply and demand [37, 40]. Enhancing timeliness and accuracy of demand forecast, BDA helps enterprises make decisions to mitigate downstream risks [41], especially the bullwhip effect of demand distortions on supply chain fluctuation [42]. Meanwhile, cloud platforms not only provide enterprises storage and computing services but also facilitate real-time exchange of information among SC partners [43-45].

Enterprises may also leverage emerging IT to detect potential risks and improve SC visibility and agility [46, 47]. On a centralized and integrated digital network enabled by IoT, for instance, SC partners enhance mutual visibility by making operations transparent to each other [48]. Similarly, blockchain as a distributed database technology allows enterprises to track the origin of raw materials and components as well as product conditions at different stages [49, 50]. Based on the information gathered, organizations can quickly identify threats and react to them, leading to a higher level of SC agility [49, 50].

The employment of emerging IT also enables SC partners to knit a more cohesive network through information sharing and resource integration [51, 52]. As COVID-19 swept the world, for instance, businesses using AI to streamline SC operations demonstrated better survivability [53]. Nevertheless, a single technology cannot cope with all kinds of threats, and organizations need to employ various tools available for different needs. Each member may establish sufficient hardware infrastructure for implementing cutting-edge SC software applications when they become available [54]. The promotion of information sharing among SC partners deepens their IT assimilation [55]. Through IT resource integration and information sharing across organizational boundaries, enterprises enhance “bridging capabilities” that strengthen their defense against external disturbances [56].

Essential to organizational competitiveness in the information age, IT capability refers to the corporate ability to mobilize and deploy hardware and software for the achievement of strategic goals [57]. Collectively, it allows organizations to deepen IT assimilation and increase operation agility through technology integration and operation coordination [55, 58]. In this way, IT capability helps enterprises bridge their technological gaps and absorb external knowledge [59].

Extant studies conceptualize and operationalize IT capability pertaining to traditional IT, but emerging IT capability is somewhat distinctive. For instance, an enterprise capable of capitalizing latest technological development may become proactive to SC disruptions by capturing early warning signs. Thus, emerging IT capability pertains to the integration of revolutionary technologies and reconfiguration of other organizational resources for strategic endeavors. Whereas the existing research on emerging IT typically focuses on the application of a single technology at a time, this study addresses the dynamic capability enabling the employment of multiple technologies to enhance SC resilience.

Appendix B compares the dimensions of traditional IT capability and emerging IT capability based on their frequencies in publications. Focusing on application development and technical support, traditional IT capability mainly comprises human-resource, infrastructure, and relationship aspects. The emergence of distributed technologies (e.g., cloud computing, blockchain) shifts the focus of IT capability from in-house architecture to cross-organization integration [60].

Concerning how well an organization can incorporate such technologies in business operations for strategic goals, emerging IT capability is a multidimensional construct of which the taxonomy is still under development [57]. Nevertheless, researchers have reached some consensus regarding its essential elements, among which the new IT management dimension stands out in addition to those shared with traditional IT capability.

2.3 Organizational Adaptation and Dynamic Capability

Organizational adaptation refers to how managers purposefully react to shifts in the environment [61]. In a turbulent environment, SC partners need to adjust or even overhaul their strategies to adapt to changes [62]. To gain operational resilience, therefore, an enterprise needs to prioritize the adaptive strategies, understand contingency factors, and mobilize necessary resources [63]. Such organizational adaptation requires enterprises to develop dynamic capabilities for resource coordination and conflict management to support continuous strategic and operational adjustments [64].

A considerable body of literature employs the concept of dynamic capability to explain organizational adaptation to environmental changes [65]. To cope with external turbulences, enterprises must integrate knowledge from various sources, leading to dynamic capability [66]. Facilitated by information technology, such a capability allows enterprises to adjust business processes for ambidextrous SC [67]. Based on qualitative methods, researchers explored the relationship between corporate innovation and SC resilience from a dynamic capability perspective [68]. Nevertheless, the cultivation of dynamic capability demands corporate cognition in form of vulnerability vigilance, which receives scarce attention.

Rather than relying on themselves, SC partners collaborate with each other to better cope with environmental disturbances [69]. The effort requires SC vulnerability vigilance in terms of organizational leadership that converts risk awareness to environment adaptation [34]. The strategic goal of such an adaptation is to enhance SC resilience through the allocation of limited resources to mission-critical areas [70]. In particular, the uptake of emerging IT (e.g., BDA, cloud computing, and blockchain) helps organizations strengthen SC partnerships, increase inventory redundancy, improve demand forecasting, and reach out to potential customers to ensure business continuity [45, 53]. In this sense, emerging IT capability captures an organization's ability to absorb technical knowledge, develop shared platforms, and deploy complex applications in response to changes in the external environment.

2.4 Corporate Sustainability in Turbulent Environment

Organizations embracing the challenge of overcoming SC vulnerability may turn a crisis into an opportunity as their effort to build SC resilience is likely to pay off eventually in terms of sustainable development [71]. The enhanced economic, environmental, and social performances comprise the triple bottom line of corporate sustainability [72]. By addressing environmental uncertainty with waste reduction and resource optimization, organizations may attain both operational continuity and corporate sustainability [13, 73].

The integration of economic, social, and environmental performances requires a technology-driven approach [74]. Organizations may optimize information, material, and capital flows to strike a balance between organizational profitability and social responsibility [75]. Facing an increasingly uncertain future, more and more enterprises employ emerging IT applications to facilitate on-demand production, remanufacturing, and product recycling [76, 77]. This is conducive to corporate sustainability, especially its economic and environmental aspects. As information stability and immutability become increasingly critical in a turbulent environment, organizations need to be more innovative may ensure this aspect of social stability and fairness.

For instance, enterprises deploy blockchain to prevent illegal looting of intellectual property [78, 79]. Therefore, SC partners must cultivate the ability to utilize all kinds of innovative technologies for corporate sustainability in the long run.

The literature suggests that emerging IT is conducive to the economic, social, and environmental aspects of sustainable development. In the turbulent environment, however, the relationship between emerging IT and corporate sustainability is yet to be examined. Facing SC disruptions, enterprises must ensure short-term survival first and then address long-term development. This study will investigate how enterprises take care of both goals through the establishment of dynamic capability that integrates emerging IT with organizational resources.

3. Hypotheses and Research Model

The literature review suggests that for enterprises to deploy technological resources for environment adaptation, they must build the dynamic capabilities needed [61, 80]. This study includes vulnerability vigilance and emerging IT capability as survival- and development-oriented responses to potential SC disruptions for short-term and long-term outcomes. To expedite the adaptation process, enterprises need to increase sensitivity levels, identify risk factors, make critical decisions, and build dynamic capabilities [81]. With the help of emerging IT, for instance, enterprises can organize digital networks to streamline market analyses and resource allocations, and optimized operations are conducive to business agility and performance in the face of catastrophic events [82]. For emerging IT implementation, enterprises need to tailor organizational structures and operational procedures to technical characteristics, and such organization-technology alignment demands dynamic capability building [83].

In the VUCA environment, supplier and consumer markets are both highly fluid, creating disturbances in supplies, logistics, and demands that lead to SC disruptions [84, 85]. Enterprises must be sensitive to disruptive signals and shift attention from operational efficiency to SC resilience [86]. This requires organizations to have a thorough understanding of the weak points inside the SC, especially the critical nodes of which any failures may cause the breakdown of whole SC operations [32]. Such SC vulnerability vigilance captures corporate cognition of environmental uncertainty, which is perceived by more and more researchers as the antecedent motivating organizations to develop dynamic capabilities rather than merely a moderator [87-89].

H1: Environmental uncertainty has a positive relationship with SC vulnerability vigilance.

Global epidemics and international conflicts bring out the threats of environmental uncertainty to SC disruptions due to dramatic fluctuations in supply and demand [84, 86]. Ushering in the fourth industrial revolution (Industry 4.0), emerging IT facilitates information sharing and SC integration among enterprises: for example, the use of BDA, cloud computing and IoT reduces information distortion in demand and supply forecasts [90]. From a dynamic capability perspective, enterprises need to acquire new resources and abilities, especially those related to emerging IT, for organizational innovation in pursuit of SC resilience [91]. Each organization needs to become agile enough to embrace changes with the help of latest technologies, and commit to IT management, employee training, and relationship building for the IT resource integration within and across its boundary [57]. To adapt to the VUCA environment, therefore, enterprises need to develop the emerging IT capability essential to the flexibility and agility of SC operations.

H2: Environmental uncertainty has a positive relationship with emerging IT capability.

Enterprises cannot afford to miss any signals in the external environment concerning SC disruptions that are due to increasingly complex upstream and downstream operations [92], shifting government policies and consumer preferences [93], and beyond-control catastrophic events [94]. In the upstream, such signals can reside in abnormal shifts of capacity, quality and delivery from every node, and enterprises need to read such warning signs and inform each other to avoid risk accumulation and amplification along the path [95, 96]. In the downstream, market volatility tends to be magnified in a turbulent environment due to the bullwhip effect, and manufacturers must monitor consumer demands and preferences in a "real-time" manner [19, 97]. As emerging IT greatly facilitates information processing and exchange, enterprises sensitive to environmental changes are quick to integrate technological and organizational resources to improve organizational agility and adaptivity [56]. To avoid SC disruptions, an organization needs to reengineer procurement, production, and distribution processes with IT assimilation [49, 50]. Thus, an enterprise's awareness of SC risk factors motivates it to acquire such a dynamic capability.

H3: SC vulnerability vigilance has a positive relationship with emerging IT capability.

A supply chain is resilient if it can recover from a major shock and quickly resume normal operations [20, 21]. Such SC resilience requires high sensitivity and effective responsiveness to disruptive events [98, 99]. Enterprises that stay alert make proactive arrangements (e.g., early warning systems, knowledge bases, and backup plans) for potential SC disruptions [86]. Whenever a black swan event occurs, vigilant organizations may take immediate actions, such as building redundant inventory and establishing new partner relationships, to retain operational robustness [100]. In this sense, SC vulnerability vigilance is conducive to SC resilience.

H4: SC vulnerability vigilance has a positive relationship with SC resilience.

Long-term competitive advantage relies on economic, environmental, and social performances, which constitute the triple bottom lines of corporate sustainability [101]. However, the VUCA environment may easily throw off the balance among three performances: when enterprises are not well prepared for imminent SC disruptions, they tend to strive for short-term survival and ignore long-term development [102]. Enterprises with high SC vulnerability vigilance perceive signs of danger in advance, and quickly implement backup plans to avoid SC disruptions, which is directly helpful for economic performance [102, 103]. To address part shortages, many enterprises resort to product recycling and remanufacturing, leading to environment-friendly production [104]. As for social performance, high vigilance forces SC partners to pay attention to the needs of all stakeholders, and fulfill corporate social responsibility [32]. Therefore, SC vulnerability vigilance is likely to enhance corporate sustainability.

H5: SC vulnerability vigilance has a positive relationship with corporate sustainability.

Widespread impacts of catastrophic events accentuate the importance of emerging IT capability to SC resilience. Internally, IT infrastructure, IT management, and IT human resource (HR) are necessary for organizations to employ different technologies (e.g., IoT, BDA, and blockchain), integrate system functions, and develop employee skills, leading to better demand forecast, inventory control, and production planning [40]. Externally, an excellent IT relationship enables an enterprise to acquire external knowledge from SC partners regarding how to apply emerging IT to strengthen inter-organization collaboration for dealing with all kinds of risks [73, 105, 106]. From both aspects, emerging IT capability enables an organization to allocate resources dynamically and become more robust against adverse events leading to SC disruptions [38].

H6: Emerging IT capability has a positive relationship with SC resilience.

The relationships among IT capability and economic performance, environmental performance, and social performance have long been established [107]. Based on the use of emerging IT, enterprises are in a better position to understand consumer needs and improve economic viability and social image through innovative marketing strategies, such as live commerce on streaming media and trading in used for new [38]. In addition, cutting-edge technologies help enterprises reduce energy consumption and minimize material wastage through the optimization of operational processes and the exploration of the green product market, leading to the sustainable development balancing economic, social, and environmental performances [108].

H7: Emerging IT capability has a positive relationship with corporate sustainability.

With properties like flexibility, adaptability, and robustness, SC resilience is intangible and mostly invisible, and its return on investment is hard to quantify when everything is normal [109]. At a time of emergency when many supply chains are traumatized, however, those of high resilience can still function without hurting the economic performance [110]. Meanwhile, SC disruptions distract enterprises from social and environmental commitments when they strive to survive [105]. In the long run, therefore, SC resilience is essential to the balancing of economic, social, and environmental performances [111]. In this sense, SC resilience is a necessary condition for corporate sustainability as only "healthy and strong" enterprises are able to care about people and planet beyond profit.

H8: SC resilience has a positive relationship with corporate sustainability.

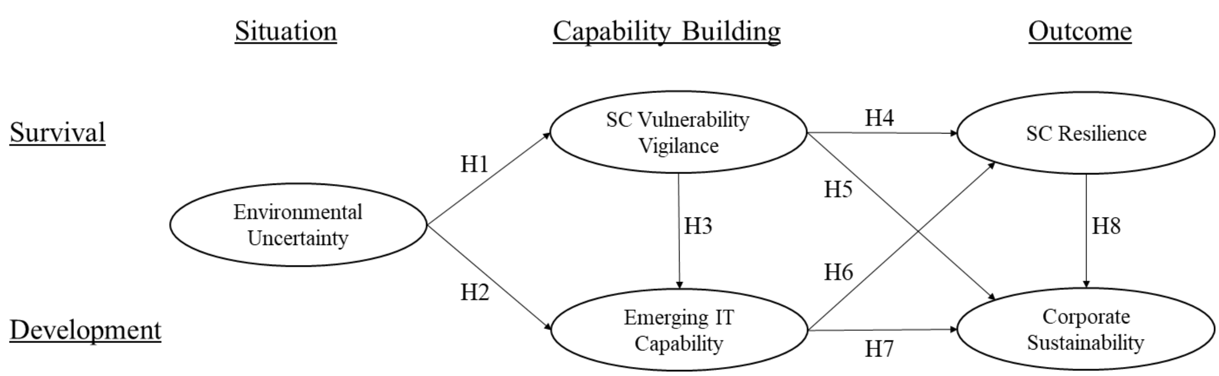


Fig. 1. Research model

Based on hypothesized relationships, Figure 1 gives the research model. It depicts how SC partners make strategic adjustments to handle environmental uncertainty for short-term and long-term viability. Emerging IT capability plays a pivotal role as it serves as the mediator for all the other variables. Altogether, there are 15 mediated relationships across capability building and outcome stages for survival and development goals. When there exist one or more mediators between two variables, the total indirect effect is of interest. Structural model estimates are to be used to assess hypothesized direct effects as well as derived indirect effects.

4. Methodology

As the world's factory, China is greatly affected by global SC disruptions due to trade conflicts and epidemic outbreaks. Enterprises are vulnerable to upstream and downstream fluctuations in the domestic and global markets. Therefore, to test research hypotheses, this study collected survey observations from organizations in China that employ emerging IT for SC operations. Elicited from an executive MBA program, participants comprise the managers in charge of SC operations at 384 enterprises. Based on the contact list, online questionnaires were distributed through email and WeChat.

Data collection lasted for four weeks in 2021 with two reminders (one week and two weeks after the invitation). In the end, 282 observations were obtained, yielding a response rate of 73%. Among all, 33 participants did not indicate the use of any emerging IT by their organizations, resulting in 249 observations for statistical analyses. Early and late responses were compared to assess non-response bias. A t-test on the first and the last 50 responses showed an insignificant difference in each variable at the 0.05 level. A MANOVA test on these 100 observations found that they were not distinct either (Wilks' lambda = 0.890, $p = 0.555$). As they did not exhibit different patterns, non-response bias is not a big concern [112].

In the survey responses, 88% of enterprises (i.e., 249/282) had adopted emerging IT in certain forms. Among more general technologies, BDA, AI, IoT, and cloud computing saw relatively high adoption rates (68.3%, 40.6%, 39.4%, and 35.3%, respectively). Although blockchain is yet to take off (8.0%), its SC applications have been explored. Industry-specific technologies including sensor, robot, radio frequency identification (RFID), virtual/augmented reality (VR/AR), and 3-D printing had lower but still substantial adoption rates (25.3%, 21.7%, 13.7%, 8.8%, and 8.0%, respectively).

Other observation characteristics are shown in Table 1. Organizational profiles were quite diversified, supporting sample representativeness of the target population of enterprises engaging in SC operations. Participants came from various departments and played different roles, and their responses were compared with MANOVA tests. The differences were insignificant across management roles (Wilks' lambda = 0.891, $p = 0.278$) and functional departments (Wilks' lambda = 0.731, $p = 0.092$).

Table 1. Sample profile

Characteristic	Frequency	%	Characteristic	Frequency	%
Participant Level			**Industry**		
Lower management	128	51.4	Manufacturing	116	46.6
Middle management	100	40.2	Wholesale and retail	16	6.4
Upper management	21	8.4	Construction	17	6.8
Participant Department			Transport	5	2.0
Functional	86	34.5	IT	24	9.6
Research and development	35	14.1	Service	40	16.1
Production	41	16.5	Outsourcing	3	1.2
Sales	41	16.5	Other	28	11.2
Procurement	19	7.6	**IT Staff**		
Other	27	10.8	1-20	114	45.8
Enterprise Age			21-50	43	17.3
1-5 years	54	21.7	51-100	19	7.6
6-10 years	45	18.1	101-150	11	4.4
10-20 years	55	22.1	>150	62	24.9
20-30 years	33	13.3	**IT Budget**		
>30 years	62	24.9	<200,000	22	8.8
Enterprise Size (Number of Employees)			210,000-500,000	43	17.3
1-49	23	9.2	510,000-1 million	47	18.9
50-99	27	10.8	1.01 million-5 million	55	22.1
100-499	54	21.7	5.01 million-10 million	20	8.0
500-1000	31	12.4	>10 million	62	24.9
>1000	114	45.8			

Listed in Appendix C, the measurement items of the survey questionnaire are adapted from previously validated instruments. In addition, control variables include IT-related IT budget and

IT staff as well as corporate-related Firm Age and Firm Size [113]. Respectively, the two groups of variables are covariates of Emerging IT Capability and Corporate Sustainability pertaining to development-oriented adaptation.

In the research model, three out of five variables are second-order formative constructs. Compared with traditional covariance-based structural equation modeling (SEM), SEM based on partial least squares (PLS) is more capable of handling formative constructs [114]. Thus, SmartPLS 3.0 is used for model estimation.

5. Results

5.1 Measurement Validation

This study validates both reflective and formative constructs as per established guidelines [114]. Table 2 assesses the measurement validity of all reflective constructs. The descriptive statistics indicate that the average responses were moderately positive with reasonable variations. As for internal consistency, all Cronbach alpha (α) values were above 0.7, indicating that the shared variance exceeded error variance. Also supporting the convergent validity within each reflective construct, composite reliability (CR) and average variance extracted (AVE) were above 0.7 and 0.5, respectively. In terms of discriminant validity, the correlation coefficients associated with each construct were less than the square root of its AVE, indicating that the covariance among constructs is not overwhelming. Therefore, the measurement validity of reflective constructs was supported.

Table 2 Reflective construct validation

Construct	1	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4	5.1	5.2	5.3
1 Environmental Uncertainty	**0.779**											
2.1 Supply-side vigilance	0.412	**0.832**										
2.2 Demand-side vigilance	0.385	0.704	**0.851**									
2.3 Environmental vigilance	0.532	0.664	0.556	**0.761**								
3.1 Emerging IT Infrastructure Capability	0.431	0.419	0.391	0.402	**0.831**							
3.2 Emerging IT HR Capability	0.435	0.381	0.333	0.413	0.769	**0.830**						
3.3 Emerging IT Management Capability	0.524	0.461	0.410	0.474	0.755	0.811	**0.863**					
3.4 Emerging IT Relationship Capability	0.448	0.450	0.392	0.448	0.741	0.817	0.855	**0.858**				

4 SC Resilience	0.469	0.428	0.403	0.514	0.491	0.527	0.569	0.606	**0.807**			
5.1 Economic Performance	0.518	0.480	0.434	0.504	0.550	0.573	0.610	0.599	0.704	**0.877**		
5.2 Environmental Performance	0.477	0.484	0.395	0.487	0.509	0.540	0.567	0.573	0.630	0.777	**0.868**	
5.3 Social Performance	0.530	0.464	0.422	0.519	0.512	0.555	0.585	0.551	0.631	0.783	0.802	**0.867**
Mean	4.967	5.104	5.059	5.044	5.124	5.112	5.085	5.187	5.025	5.278	5.26	5.277
SD	0.955	1.036	1.081	0.949	1.03	0.965	0.984	0.976	0.915	0.965	0.991	1.034
Alpha	0.837	0.889	0.81	0.818	0.888	0.887	0.914	0.881	0.893	0.900	0.891	0.836
CR	0.885	0.918	0.887	0.873	0.918	0.917	0.936	0.918	0.918	0.930	0.924	0.901
AVE	0.607	0.692	0.724	0.579	0.691	0.689	0.745	0.737	0.651	0.770	0.753	0.752

Note: The bolded values on the diagonal are the square roots of the average variance extracted (AVE). All correlation coefficients were significant at the 0.001 level (two-tailed test).

Table 3 assesses the distinctiveness of each formative construct's indicators [114]. None of variance inflation factors (VIFs) were above 5, excluding strong collinearity. All but one outer weights were significant, confirming the relative contribution of corresponding indicators. For HR capability, its outer loading was still way above 0.5, supporting its absolute importance.

Table 3. Formative construct validation

Construct	Component	VIF	Loading	Weight
SC Vulnerability Vigilance	Supply-side vigilance	2.527	0.839^{***}	0.239^{*}
	Demand-side vigilance	2.036	0.762^{***}	0.224^{*}
	Environmental vigilance	1.848	0.947^{***}	0.663^{***}
Emerging IT Capability	Infrastructure capability	2.828	0.855^{***}	0.189^{*}
	HR capability	3.962	0.888^{***}	0.112
	Management capability	4.595	0.965^{***}	0.475^{***}
	Relationship capability	4.573	0.937^{***}	0.300^{*}
Corporate Sustainability	Economic Performance	3.088	0.965^{***}	0.588^{***}
	Environmental Performance	3.343	0.890^{***}	0.225^{*}
	Social Performance	3.403	0.899^{***}	0.258^{**}

Note: *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$ (one-tailed test).

5.2 Common Method Bias Assessment

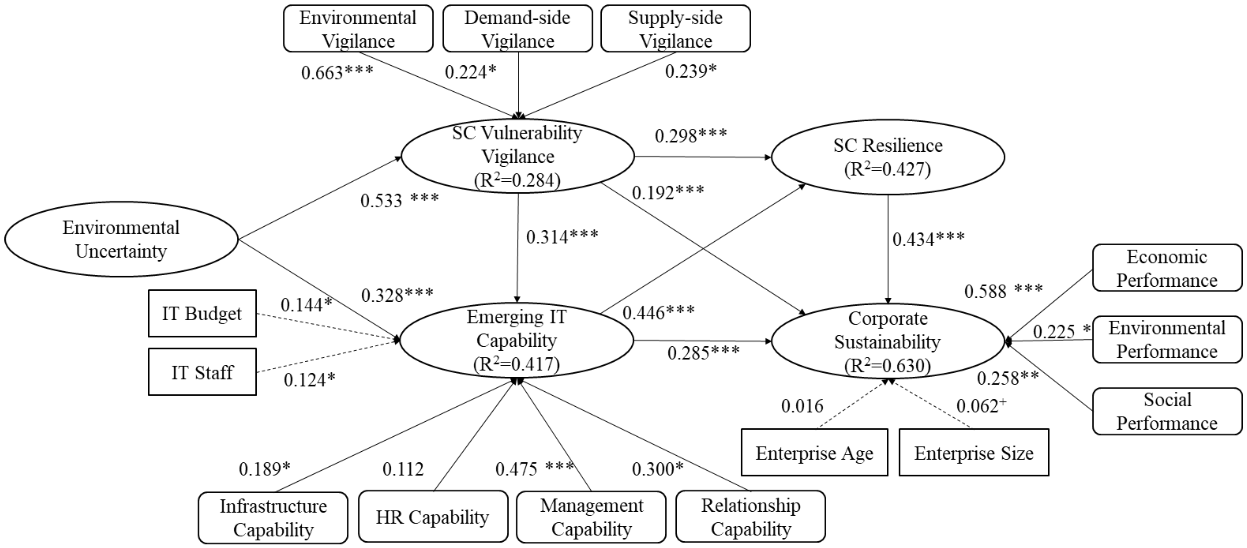
Before hypothesis testing, this study employs multiple approaches to assess common method bias as observations were collected with a survey questionnaire [115]. The first is Harman single-factor test, and the first principal component explained less than half (39.79%) of the total variance. Next, a confirmatory factor analysis compares the default trait-factor model with the one-factor model. The chi-squared (χ^2) changed from 2,640.97 to 5,455.32, and the difference of 2,814.35 was highly significant at 66 increased degrees of freedom (*df*). Meanwhile, the trait-plus-one-factor model only reduced χ^2 by 17.35 to 2,613.62, insignificantly against the *df* change of 83. The common method did not have good explanatory power as a single factor nor made an additional contribution to the trait-factor model.

In addition, more than one third (37.46%) of measures were weakly correlated with others ($r < 0.33$). As such, this study employs the marker variable approach using the second smallest positive correlation coefficient as a conservative estimate of CMB [116]. Among all manifest variables, the smallest correlation coefficient was 0.126, followed by 0.132. The latter was used to adjust the correlations among the indicators of latent constructs in the research model. After the removal of proxy CMB influence, most of the significant correlations still remained significant (90.7%). Based on the rule of thumb commonly used in recent studies [117, 118], therefore, serious common method bias can be ruled out.

5.3 Model Estimation

Figure 2 shows the estimated research model. All hypothesized relationships were found highly significant, controlling for the effects of organizational characteristics on Emerging IT Capability and Corporate Sustainability. To some extent, IT Budget and IT Staff contributed to Emerging IT Capability. Whereas Enterprise Size had a positive effect on Corporate Sustainability, Enterprise Age made little difference.

The model exhibited acceptable predictive powers. It explained 63% of the variance in the outcome variable of corporate sustainability, and over 40% of the variance in both its predecessors, Emerging IT Capability and SC Resilience. Among the components of corporate sustainability, the contribution of economic performance was the most salient. Enterprises must be financially strong enough to offer novel green products/services and fulfill more social responsibility. Among those of Emerging IT Capability, management capability was the most salient. Corporate ability to deploy emerging IT in SC operations is indispensable to strategic planning and resource allocation in the first place.



Note: +: $p < 0.1$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$ (Bootstrapping = 5000; two-tailed test).

Fig. 2. Estimated model

Table 4 shows a highly significant total indirect effect for each pair of distant variables (as all 15 mediated relationships were significant). The exogenous variable of environmental uncertainty affects SC vulnerability vigilance and emerging IT capability at the capability building stage, which leads to SC resilience and corporate sustainability at the outcome stage. Across different stages, therefore, there are two main mediated relationships in parallel: SC vulnerability vigilance mediates the effect of environmental uncertainty on SC resilience for the survival goal (i.e., 0.533 × 0.298 = 0.158), and emerging IT capability mediates the effect of environmental uncertainty on corporate sustainability for the development goal (i.e., 0.328 × 0.285 = 0.093).

Table 4. Testing of mediated relationships

Total Indirect Effect	Estimate	*t*
Environmental Uncertainty -> Emerging IT Capability	0.167	3.672
Environmental Uncertainty -> SC Resilience	0.380	8.919
Environmental Uncertainty -> Corporate Sustainability	0.409	9.321
SC Vulnerability Vigilance -> SC Resilience	0.140	4.033
SC Vulnerability Vigilance -> Corporate Sustainability	0.280	6.675
Emerging IT Capability -> Corporate Sustainability	0.193	4.814

Note: Bootstrapping based on 5,000 subsamples; all significant at 0.001 level with two-tailed tests.

Furthermore, survival-oriented adaptation and development-oriented adaptation are highly intertwined as both are driven by environmental uncertainty. At each stage, the construct of the former enhances that of the latter. Across capability building and outcome stages, emerging IT capability for the development goal influences SC resilience for the survival goal. Together, there are two cross-goal indirect effects: one from SC vulnerability vigilance to SC resilience through emerging IT capability ($0.314 \times 0.446 = 0.140$); the other from emerging IT capability to corporate sustainability through SC resilience ($0.446 \times 0.434 = 0.193$).

6. Discussion

Supporting all research hypotheses, the results reveal how organizations dynamically adapt to the turbulent environment through capability building for short-term survival and long-term development. More frequent epidemics and conflicts underscore environmental uncertainty as a profound factor leading to SC disruptions [26]. Most extant studies on SC risks address those on demand, supply, and technology sides [119]. The few that investigate external turbulence typically treat it as a moderating variable that affects the relationships concerning operational stability and robustness [26, 120]. From a dynamic capability perspective, this study considers environmental uncertainty as the main motivator for enterprises to cultivate SC vulnerability vigilance and develop emerging IT capability in pursuit of SC resilience and corporate sustainability.

Corporate awareness of environmental changes provides strategic guidance to corporate adjustments [34]. This study posits that SC vulnerability vigilance comprises environmental, demand-side, and supply-side aspects. Among them, environmental vigilance was the most salient component ($b = 0.663$, $p < 0.001$), as disastrous events disrupt global supply chains. Such events also amplify demand-side vulnerability and supply-side vulnerability, and enterprises exhibited similar levels of vigilance to both ($b = 0.224$, $p < 0.05$ vs. $b = 0.239$, $p < 0.05$).

Compared with traditional IT capability, emerging IT capability comprises management capability in addition to infrastructure, HR, and relationship aspects. The regression weights of formative components confirm the importance of management capability to emerging IT capability ($b = 0.475$, $p < 0.001$). Among other aspects, relationship capability is found the most salient ($b = 0.300$, $p < 0.05$), followed by infrastructure capability ($b = 0.189$, $p < 0.05$). The diminishing influence of HR capability ($b = 0.112$, $p > 0.1$) suggests that emerging IT capability is less dependent on in-house expertise than traditional IT capability. Of course, HR capability is still un ignorable as indicated by its absolute importance (i.e., loading = 0.888, $p < 0.001$). Yet, its relative importance is eclipsed by the greater contribution made by management capability, as the deployment of emerging IT requires an organization to coordinate with third-party providers for services like cloud computing and blockchain.

The indirect effects pertaining to the survival and development goals (0.158 vs. 0.093) suggest that when a disastrous event hits, enterprises tend to focus on vulnerability vigilance and SC resilience for short-term survival. As observations were collected within one year after the COVID-19 outbreak, it is understandable that most enterprises were still concerned about the former more than the latter in the ongoing crisis.

Meanwhile, survival and development goals cannot be separated from each other as there are mediated relationships connecting the two. By developing emerging IT capability, in particular, enterprises are able to achieve the long-term goal while further enhancing the short-term goal. As such, the indirect effect of emerging IT capability on corporate sustainability through SC resilience was bigger than that of SC vulnerability vigilance on SC resilience through emerging IT capability (0.193 vs. 0.140). Involved in both mediated relationships across two goals, emerging IT capability plays a critical role in bridging corporate efforts to address SC disruptions with short-term as well as long-term solutions.

Organizational characteristics are more or less relevant to emerging IT capability and corporate sustainability. IT staff ($b = 0.124$, $p < 0.05$) was found somewhat less influential than IT budget ($b = 0.144$, $p < 0.05$) to emerging IT capability, which is consistent with the insignificant weight of HR capability. Therefore, it makes more sense for an enterprise to invest in other technological assets (especially management capability) than in-house expertise, as more and more IT functions (e.g., cloud computing) are rendered by third-party service providers. On corporate sustainability, enterprise size made a bigger difference ($b = 0.062$, $p < 0.1$) than enterprise age ($b = 0.016$, $p > 0.1$). Larger enterprises have more resources available for sustainable development, whereas other concerns may bother organizations when they are either too young or too old.

7. Conclusion and Implications

Susceptible to turbulences like epidemics and conflicts, global supply chains face constant disruptions. From a dynamic capability perspective, this study examines the best practices for enterprises to cope with the VUCA environment. It develops a research model that comprises two stages (i.e., capability building and outcome) for two goals (i.e., survival and development). Survey observations collected from Chinese enterprises affected by COVID-19 are used to test the model. The results provide supporting evidence for hypothesized relationships among environmental uncertainty, SC vulnerability vigilance, emerging IT capability, SC resilience, and corporate sustainability. As control variables, organizational characteristics including IT budget, IT staff, and enterprise size are also found to make some differences in development-oriented adaptation. The findings yield theoretical and practical implications.

7.1 Theoretical Implications

This study advances a dynamic capability perspective of organizational adaptation by including SC vulnerability vigilance as the action initiator, emerging IT capability as the transformation enabler, and corporate sustainability as the performance indicator. The empirical research contributes to the literature from four aspects. First, the conceptualization and operationalization of SC vulnerability vigilance and emerging IT capability as formative constructs are helpful for assessing dynamic capability building. SC vulnerability vigilance has three components concerning corporate alertness to risk factors within a supply chain (i.e., upstream and downstream) and beyond (i.e., external environment). Compared with most studies that assume that environment-related factors play moderating roles, this study uses SC vulnerability vigilance to bridge environmental uncertainty and organizational adaptation. The direct effect of SC vulnerability vigilance on corporate sustainability suggests that the former motivates enterprises to resort to every measure conducive to economic, social, and environmental performances. These findings enrich the SC resilience literature by highlighting the roles that corporate cognition plays.

Second, SC partners fully aware of SC risk factors are motivated to employ emerging IT to mitigate their impacts. Managerial measures enhance SC resilience quickly but technological innovations yield more fundamental impacts [90, 121]. Compared with traditional IT capability, emerging IT capability involves management capability as a new component. In this study, emerging IT capability demonstrates more prominent management and relationship components than infrastructure and HR components. In addition to emerging IT capability and SC resilience, the research model includes SC vulnerability vigilance as the antecedent and corporate sustainability as the outcome. The direct and mediated relationships involved capture the dynamic capability building across multiple stages for different goals, which corroborates the Industry 4.0 initiative in the globalization era.

Third, compared with the extant research on the relationship between emerging IT and sustainable development [105], this study suggests that corporate sustainability is not just a "by-product" but the ultimate performance indicator concerning competitive advantage. To solve the immediate part-shortage crisis, for instance, SC partners may employ innovative technologies for remanufacturing, which contributes to sustainable development. The extant literature on SC resilience mainly focuses on managerial measures such as inter-organization collaboration and coordination [97, 122]. Though such measures are found to be somewhat correlated with corporate sustainability [123], they hardly strike the strategic balance between short-term focus and long-term vision. This study extends the organizational adaptation framework with cross-goal linkages through the mediation of emerging IT capability. The rationale is that the survival-oriented adaptation deals with symptoms, whereas the development-oriented adaptation strengthens fundaments. The model demonstrates that with technological innovation, SC partners are able to take care of both through resource integration within and across organizational boundaries. In this way, enterprises may turn crises into opportunities with the help of emerging IT.

Fourth, the study examines the multi-stage and multi-goal adaptation using emerging IT capability as the essential mediator that bridges different processes from environmental uncertainty to corporate sustainability. Previously, researchers focused on the single-stage organizational innovation model involving the direct relationship between vulnerability vigilance and SC resilience [110]. From the dynamic capability perspective, this study interweaves survival-oriented adaptation with development-oriented adaptation, and explores the direct and indirect relationships between adverse situations and desirable outcomes through capability building. Both adaptation processes are driven by environmental uncertainty, and emerging IT plays a pivotal role in dealing with it. For instance, BDA and blockchain help mitigate the bullwhip effect by breaking the information barrier between upstream and downstream with enhanced traceability [124, 125]. Conducive to resource optimization, organizational deployment of innovative applications facilitates both survival- and development-oriented adaptation. Thus, this study demonstrates how the dynamic capability theory can be used in the new socio-technical context.

7.2 Managerial Implications

To enterprises facing potential SC disruptions, the findings yield practical implications in terms of strategic guidelines and best practices. Facing large-scale events like global epidemics and international conflicts, short-term measures are inadequate. Rather, SC vulnerability vigilance motivates organizations to develop well-conceived action plans. First of all, SC partners need to cultivate SC vulnerability vigilance to pinpoint the most pressing threats. Then, they build the dynamic capability to integrate and reconfigure resources to overcome the imminent crisis and promote long-term development. With time and resource constraints, enterprises need to determine their strategic positioning and resort to innovative solutions. Rather than pursuing market expansion, for instance, an enterprise may address the imminent issue of part shortage with remanufacturing. Such movements require organizations to increase investment in emerging IT capability, perform IT integration, and reconfigure IT resources for more fundamental enhancement of SC resilience.

When a disaster hits, most enterprises are concerned about economic viability, distracting their attention from environmental and social responsibilities. Typically, organizations take emergency measures such as redundant inventory and alternative suppliers to ensure operational continuity [28]. The findings of this study suggest that it is possible to bridge survival-oriented adaptation and development-oriented adaptation with the development of emerging IT capabilities. An enterprise must cultivate an organizational culture that encourages employees to use innovative approaches for short-term and long-term goals. Based on Industry 4.0 requirements, SC partners may make a concerted effort to establish technological platforms and integrate organizational resources.

7.3 Limitations and Future Research

Though the findings yield meaningful insights, this study has limitations. All the survey data were collected from a single country. The enterprises in China are greatly affected by global SC disruptions, making them a suitable target population. Nevertheless, they may face somewhat unique challenges due to developmental factors, in comparison with enterprises in other countries.

In addition, longitudinal analyses are able to track how organizations make adjustments to a disastrous event at different stages. It is likely that enterprises focus on the survival goal at first, but shift attention to the development goal later on. Nevertheless, such a pattern can only be confirmed with panel data collected from the same pool at different intervals from the impact. The tracking of the adaptation process may also provide insights into digital transformation through which organizations incorporate emerging IT into different aspects of SC operations.

To enhance the generalizability of findings, therefore, future studies may collect observations from multiple countries in different parts of the world, which will provide a more comprehensive understanding of how SC partners at different links deal with global disruptions. In addition, enterprises varying in internal and external resources will adopt different strategies in developing dynamic capabilities to cope with the challenges brought by the turbulent environment. Researchers may explore how organizations tailor their coping strategies in the face of emergencies. Finally, many enterprises have to integrate emerging IT with legacy IT, which opens up the opportunity to examine the interaction between traditional IT capability and emerging IT capability.

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Appendix A. Research on External Risk Factors of SC Vulnerability

Aspect	Factors
Supply-side: [5]; [93]; [96]; [126]; [127]; [128]; [129]; [130]	Supplier disruptions; Supplier dependence; Upstream network complexity; Supplier concentration; Single sourcing; Corporate strategic shifts; Supplier uncertainty; Shortened product life cycle; Time and effort required for supplier development; Information transparency; Supplier Reduction
Demand-side: [93]; [96]; [126]; [127]; [128]; [129]; [130]; [131]	Customer disruptions; Downstream network complexity; Customer dependence; Demand-side risks; Corporate strategic shifts; Demand redundancy; Demand amplification; Order forecast horizon; Just-in-time inventory control; Market and technological turbulence
Environment-side: [5] [6]; [92]; [96]; [127] [128]; [130]	Competitive pressures; Catastrophic events; Environmental complexity; Environment-side risks; Hazard vulnerability; Environmental uncertainty; COVID-19 pandemic

Appendix B. Research on Dimensions of Traditional IT Capability and Emerging IT Capability

Traditional IT Capability	Emerging IT Capability
IT infrastructure: [60]; [132]; [133]; [134]	IT management: [57]; [91]; [135]; [136]; [137]; [138]; [139]
IT human resource: [132]; [134]	IT infrastructure: [57]; [91]; [135]; [136]; [137]; [138]
IT relationship resource: [107]; [134]	IT human resource: [57]; [136]; [138]
IT architecture: [132]; [134]	IT relationship: [91]; [139]
IT integration: [60]; [133]	IT knowledge: [135]; [139]
IT management: [107]	IT architecture: [137]
IT business applications: [60]	IT integration: [91]

Appendix C. Questionnaire Items

Emerging IT Usage

Our organization has implemented the following emerging information technologies (please check all that apply):

Big Data Analysis (BDA); Internet of Things (IoT); Cloud Computing; Artificial Intelligence (AI); Blockchain; Radio-frequency identification (RFID); 3-D printing ; Robot ; Virtual/Augmented Reality (VR/AR); Sensor Technology

Environmental Uncertainty (EU) [84]

Our organization faces uncertainties in the

EU1: … natural environment (e.g., disasters like COVID that impact operational processes).
EU2: … political environment (e.g., new policies in our industry).
EU3: … international environment (e.g., trade disputes and tariff hikes).
EU4: … economic environment (e.g., financial crises and economic recessions).
EU5: … social environment (e.g., ecological concerns that change the market structure).

SC Vulnerability Vigilance

Our organization is proactive to supply chain disruptions by addressing the issues concerning

Environmental Vigilance (EV) [92]

EV1: … natural environment.
EV2: … political environment.
EV3: … international environment.
EV4: … economic environment.
EV5: … social environment.

Supply-side Vigilance (SV) [85]

SV1. … product delivery.
SV2. … business closure.
SC3. … capacity shortage.
SC4. … supplier dependence.
SC5. …concentration risk (e.g., a single procurement source).

Demand-side Vigilance (DV) [96]

DV1: … demand fluctuation.
DV2: … insufficient/distorted information.
DV3: … customer reliance.

Emerging IT Capability

IT Infrastructure (ITI) [135]

For the establishment of emerging IT infrastructure, our organization ensures that it
ITI1. … meets organizational needs.
ITI2. … is flexible enough.
ITI3. … is based on sound data structures.
ITI4. … is accessible to users.
ITI5. … is compatible with existing systems.
IT Human Resource (ITH) [132]
In terms of the human resource concerning emerging IT, our organization ensures that employees
ITH1. … have necessary skills.
ITH2. … are willing to learn.
ITH3. … are capable of project management.
ITH4. … can solve problems.
ITH5. … cooperate with external experts.
IT Management (ITM) [57]
Regarding the management related to emerging IT, our organization ensures that
ITM1. … implementation plan is effective.
ITM2. … the strategy is consistent.
ITM3. … investment is long-term.
ITM4. … leadership is strong.
ITM5. … standards are coherent.
IT Relationship (ITR) [140]
As for organizational relationships involving emerging IT, our organization ensures good communications
ITR1. … among IT and functional departments.
ITR2. … with customers.
ITR3. … with suppliers.
ITR4. … with IT vendors.
Supply Chain Resilience (SCR) [126]
When our organization faces supply chain disruptions, it can
SCR1. … respond to threats quickly.
SCR2. … make appropriate adjustments.
SCR3. … increase opertional flexibility.
SCR4. … maintain business continuity.
SCR5. … develop redundancy (e.g., extra inventory, multiple suppliers).
SCR6. … strengthen internal and external collaborations
Corporate Sustainability
The measures that our organization take help it
Economic performance (ECO) [141]
ECO1. … enhance profitability (e.g., cost reduction, quality improvement).
ECO2. … optimize operations (e.g., information sharing, strategic collaboration).
ECO3. … increase market share.
ECO4. … promote corporate growth.
Environmental performance (ENV) [141]
ENV1. … preserve the environment.
ENV2. … conserve resources (e.g., water, energy).
ENV3. … reduce pollutions.
ENV4. … recycle used products.
Social performance (SOC) [141]
SOC1. … fulfill social responsibilities (e.g., customer needs, employment rate).
SOC2. … enhance employee benefits (e.g., income, health).
SOC3. … improve stakeholder relationships (e.g., communities, governments).